DOE/EA-2146

U.S. Department of Energy
Idaho Operations Office

Final Environmental Assessment for the Microreactor Applications Research, Validation, and Evaluation (MARVEL) Project at Idaho National Laboratory

June 2021

Idaho National Laboratory

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Prepared for the
U.S. Department of Energy
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FIGURES

TABLES

ACRONYMS

AC	Alternating Current
ALARA	As Low As Reasonably Achievable
APAD	Air Permitting and Applicability Determination
APE	Area of Potential Effect
ATR	Advanced Test Reactor
CD	Control Drum
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CRMP	Cultural Resource Management Plan
dBA	Decibels
DBA	Design Basis Accidents
DC	Direct Current
DID	Defense-in-Depth
DOE	U.S. Department of Energy
DOE-NE	Department of Energy Office of Nuclear Energy
DOT	Department of Transportation
EA	Environmental Assessment
EBR	Experimental Breeder Reactor
ECU	Engine Control Unit
EFF	Experimental Fuels Facility
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESRP	Eastern Snake River Plain
FASB	Fuels and Applied Science Building
ft	Foot
GA	General Atomics
Gy	Gray
HAP	Hazardous Air Pollutant
HEPA	High-Efficiency Particulate Air
HFEF	Hot Fuel Examination Facility at the Fuel Manufacturing Facility
HVAC	Heating, Ventilation, and Air Conditioning
I&C	Instrumentation and Controls
IBC	International Building Code

ICRP	International Commission on Radiological Protection
IDAPA	Idaho Administrative Procedures Act
IHX	Intermediate Heat Exchanger
in.	inch
INL	Idaho National Laboratory
km	kilometer
kW	Kilowatt
kWe	Kilowatt Electric
kWth	Kilowatt Thermal
lb	pound
LCF	Latent Cancer Fatality
LLW	Low-level Waste
LMP	Licensing Modernization Project
LOCA	Loss of Cooling Accident
m	Meter
MARVEL	Microreactor Applications Research, Validation and Evaluation Project
MEI	Maximally Exposed Individual
MFC	Materials and Fuels Complex
MLLW	Mixed Low-level Waste
mrem	millirem
MTHM	Metric Tons of Heavy Metal
MWe	Megawatt electric
MWth	Megawatt Thermal
NAAQS	National Ambient Air Quality Standards
NaK	Sodium-Potassium Alloy
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
OSHA	Occupational Safety and Health Administration
PCS	Primary Coolant System
PM	Particulate Matter
PSD	Prevention of Significant Deterioration

R&D	Research and Development
rem	Roentgen- Equivalent- Man
RCRA	Resource Conservation and Recovery Act
RPS	Reactor Protection System
RSAC	Radiological Safety Analysis Computer
SHPO	State Historic Preservation Office
SNF	Spent Nuclear Fuel
SS	Stainless Steel
SSC	Structures, Systems, and Components
TED	Total Effective Dose
TREAT	Transient Reactor Test Facility
TRIGA	Training, Research, Isotopes, General Atomics
TRU	Transuranic
TSS	Transportation Safeguards System
USC	United States Code
WMP	Waste Management Program
yd	Yard
yr	Year
ZPPR	Zero Power Physics Reactor

HELPFUL INFORMATION FOR THE READER

Scientific Notation

Scientific notation expresses numbers that are very small or very large. Negative exponents, such as 1.3×10^{-6}, express very small numbers. To convert the number to decimal notation, move the decimal point to the left by the number of places equal to the exponent, in this case 6. Thus, the number becomes 0.0000013. For large numbers, those with a positive exponent, move the decimal point to the right by the number of places equal to the exponent (e.g., the number 1.3×10^{6} becomes 1,300,000).

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
0.000001	10^{-6}	millionth
0.000000001	10^{-9}	billionth
0.000000000001	10^{-12}	trillionth
0.000000000000001	10^{-15}	quadrillionth

Units

The document uses English units 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).

Unit	Abbreviation
foot	ft
inch	in
kilometer	km
pound	lb
meter	m
Gray	Gy
millirem	mrem
Roentgen-equivalent-man	rem
yard	yd
yr	year

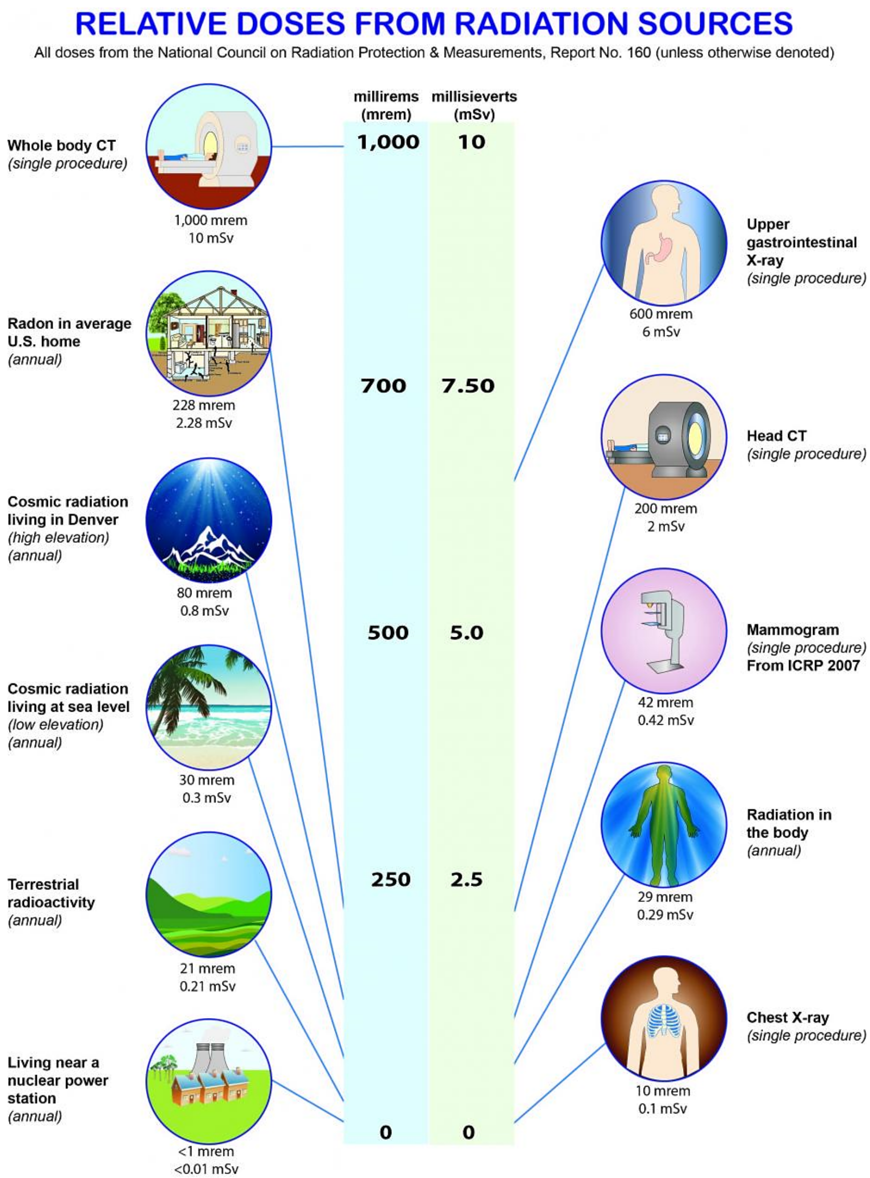
Conversions

To Convert	Multiply By	To Obtain
ft	3.048×10^{-1}	m
lb	4.536×102	grams
gallons	3.785	liters
mi	1.609334	km
square mi	2.590	square km
yd	9.144×10^{-1}	m
m	3.28084	ft
grams	2.204×10^{-3}	lb
liters	2.641×10^{-1}	gallons
km	6.214×10^{-1}	mi
square km	3.861×10^{-1}	square mi
m	1.093613	yd

Understanding Dose (Millirem Doses) and Latent Cancer Fatality

Relative Doses[a]

A dose is the amount of radiation energy absorbed by the body. The United States unit of measurement for radiation dose is the Roentgen Equivalent Man (rem) (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. According to the National Council on Radiation Protection and Measurements (NCRP), the average annual radiation dose per person in the U.S. is 620 millirem. Use this information to help understand and compare dose information described in this document.



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[a] https://www.epa.gov/radiation/radiation-sources-and-doses

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, and assuming the linear no-threshold model, 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.

The Basics of Nuclear Power Reactors

In some elements, the nucleus of an atom can split as a result of absorbing an additional neutron, through a process called nuclear fission. Such elements are called fissile materials. When a nucleus fissions, it causes three important events that result in the release of energy. Specifically, these events are the release of radiation, release of neutrons (usually two or three), and formation of two new nuclei (fission products). Some of the released neutrons collide with other atoms in the fissile materials, causing them to also fission and release more neutrons. Fission also releases a large amount of heat.

Nuclear reactors contain fissile material in the nuclear fuel. A nuclear reactor achieves criticality (and is said to be critical) when each fission event releases a sufficient number of neutrons to sustain a steady-state, ongoing series of reactions. This is called a chain reaction. Generally, the heat produced from fission is removed from the reactor by various methods, sometimes a circulating fluid, and can then be used to produce electricity.

Not every arrangement of fuel can be brought to criticality. A critical concentration of fissile material must be present in order to bring the reactor to a critical state. Otherwise, neutrons can be absorbed by other reactor components, which can inhibit a sustained chain fission reaction. Similarly, even where there is a high-enough concentration of fissile material for criticality, a nuclear reactor must have an appropriate volume and a prescribed geometric form, or interactions between neutrons and fissile material will not be sufficient to sustain a chain reaction. This requirement imposes a limit on the minimum critical volume and critical mass within a reactor.

There are several different types of nuclear reactors, but they have many common characteristics, including a supply of fissionable fuel in the reactor core. Some nuclear reactors also have neutron moderators, which are materials that slow down neutrons to increase their probability of causing fissions or neutron absorbers, which are materials that absorb neutrons and shut down the nuclear reaction and the heat it creates. Reactor control is normally achieved using components made from neutron-absorbing materials such as cadmium, hafnium, or boron. Some nuclear reactor designs also contain a coolant, which absorbs and transports heat from the reactor for electric power production and cools the reactor core to ensure the fuel and core structures maintain their integrity. Finally, a nuclear reactor must have specifically designed shielding around it to absorb and reflect radiation in order to protect plant personnel from exposure.

An "advanced nuclear reactor" is defined in legislation enacted in 2018 as "a nuclear fission reactor with significant improvements over the most recent generation of nuclear fission reactors" or a reactor using nuclear fusion (P.L. 115-248, 2018). Advanced nuclear reactors include light water reactor designs that are far smaller than existing nuclear reactors, and they use different moderators, coolants, and types of fuel. Many of these advanced designs are considered to be small modular reactors, which the Department of Energy (DOE) defines as reactors with electric generating capacity of 300 megawatts and below. Microreactors are small, transportable, and often self-adjusting small modular reactors capable of producing less than 20 megawatts of thermal energy that can be used as heat or to produce electricity. In contrast, existing commercial nuclear reactors generate an average of about 3,000 megawatts of thermal energy.

Many advanced reactor concepts include enhanced passive safety, efficiency, and other improvements over existing commercial reactors. These include gas-cooled reactors, which use graphite as a neutron moderator or have no moderator; liquid metal-cooled reactors, which are cooled by liquid sodium or other metals and have no moderator; molten salt reactors, which use liquid fuel; and fusion reactors, which release energy through the combination of light atomic nuclei rather than fission.

The Department of Energy's Advanced Reactor Demonstration Program is seeking development and demonstration of additional reactors within this decade.

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.

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 that 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).

Decay Heat: For the purposes of this document, decay heat is the heat generated by a nuclear reactor following shut down.

Defense-in-Depth: The practice of using physical systems and administrative systems in a structure of mutual reinforcement to avoid exposure of the public, the workforce, and the environment to nuclear radiation and to radioactive materials.

Dose consequences: The dose consequence 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 coated or clad nuclear fuel.

Graded approach: A process by which the level of analysis, documentation, and actions necessary to comply with a requirement are commensurate with (1) the relative importance to safety, safeguards, and security; (2) the magnitude of any hazard involved; (3) the lifecycle stage of a facility; (4) the programmatic mission of a facility; (5) the particular characteristics of a facility; (6) the relative importance to radiological and nonradiological hazards; and (7) any other relevant factors.

Heat rejection: The unused portion of the thermal energy that must be removed from the system. Waste heat rejection systems include systems and components provided to remove unused or wasted thermal energy from systems (such as the power conversion and residual heat removal system), and channel or direct this energy to the environment.

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

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.

Hot shutdown: Shutdown situation in which a nuclear reactor is maintained at a temperature and pressure at or closely below operating conditions.

Inverter: A power electronic device or circuitry that changes direct current (DC) to alternating current (AC).

Kilowatt-electric (kW_e): One thousand watts of electric capacity. A measurement of electric power output.

Kilowatt-thermal (kW_{th}): A unit of heat-supply capacity used to measure the potential output from a heat source. It represents an instantaneous heat flow and should not be confused with units of produced heat (i.e., KWh (th), or kilowatt-hours-thermal).

Latent cancer fatality (LCF): Based on the *Linear-non-threshold model*, the value reported as an LCF is the risk that a death results from a dose sustained. The Nuclear Regulatory Commission defines LCF as death resulting from cancer that became active after a latent period following exposure to radiation. The Department of Energy defines it as a death from cancer resulting from, and occurring sometime after, exposure to ionizing radiation or other carcinogens.

Linear-non-threshold model: The hypothesized model that assumes that additional cancer risk to persons exposed to ionizing radiation is linear and proportional with respect to the absorbed dose, and becomes zero only at zero dose.

Low-income: The U.S. Census Bureau uses a set of money income thresholds that vary by family size and composition to determine who is in poverty (i.e., classified as "low-income"). If a family's total income is less than the family's threshold, then that family and every individual in it is considered in poverty. The official poverty thresholds do not vary geographically but are updated for inflation using the U.S. Consumer Price Index. The official poverty definition uses monetary income before taxes and does not include capital gains or noncash benefits (such as public housing, Medicaid, and food stamps).

Low Level Waste: Low-level radioactive waste is radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in Section 11e. (2) Of the Atomic Energy Act of 1954, as amended), or naturally occurring radioactive material.

Minority: Individual(s) who are members of one or more of the following population groups as designated in the U.S. Census Bureau data: Black or African-American, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, as well as Hispanic or Latino of any race.

Mixed Waste: Waste that contains both source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954, as amended, and a hazardous component subject to the Resource Conservation and Recovery Act.

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.

Neutron flux: A measure of the intensity of neutron radiation, determined by the rate of flow of neutrons. The neutron flux value is calculated as the neutron density (n) multiplied by neutron velocity (v), where n is the number of neutrons per cubic centimeter (expressed as neutrons/cm^3) and v is the distance the neutrons travel in 1 second (expressed in centimeters per second, or cm/sec). Neutron flux (nv) is measured in neutrons/cm^2/sec.

Neutron moderator: Neutron moderators are a type of material in a nuclear reactor that work to slow down neutrons to make them more effective in the fission chain reaction.

Neutron reflector: A layer of material immediately surrounding a reactor core that scatters back (or reflects) into the core neutrons that would otherwise escape. The returned neutrons can then cause more fissions and improve the neutron economy of the reactor.

Nuclear fuel: Coated or clad nuclear material designed and fabricated to be used to power nuclear systems.

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.

Radiation shielding: Reduction of radiation by interposing a shield of absorbing material between any radioactive source and a person, work area, or radiation-sensitive device.

Reactivity control: Reactivity control systems are used to control the neutron multiplication under normal, abnormal, and emergency conditions.

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.
>
> *Crew member*: The driver and passenger of a transportation vehicle.

Reactor core: The central portion of a nuclear reactor, which contains the fuel assemblies, moderator, neutron poisons, control rods, and support structures. The reactor core is where fission takes place.

Reactivity: A term expressing the departure of a reactor system from criticality. A positive reactivity addition indicates a move toward supercriticality (power increase). A negative reactivity addition indicates a move toward subcriticality (power decrease).

Roentgen-equivalent-man (rem): The United States unit of measurement 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.

Spent Nuclear Fuel: Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing. Test specimens of fissionable material irradiated for research and development only, and not production of power or plutonium, may be classified as waste, and managed in accordance with the requirements of DOE O 435.1 when it is technically infeasible, cost prohibitive, or would increase worker exposure to separate the remaining test specimens from other contaminated material.

Thermal power: Thermal power describes how fast heat is produced. Generally, thermal power refers to the heat input used to generate electricity.

Total Effective Dose: Sum of the ED (for external exposures) and the committed ED (for internal exposures).

Transient: A change in the reactor coolant system temperature, pressure, or both, attributed to a change in the reactor's power output.

Transuranic Waste: Transuranic waste is radioactive waste containing more than 100 nanocuries (3700 becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for: (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; or (3) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61.

Final Environmental Assessment for the Microreactor Applications Research, Validation, and Evaluation (MARVEL) Project at Idaho National Laboratory

1. INTRODUCTION

1.1 Background

The U.S. Department of Energy (DOE) Microreactor Program supports research and development (R&D) of technologies related to the development, demonstration, and deployment of very small, factory fabricated, transportable reactors to provide power and heat for decentralized generation in civilian, industrial and defense energy sectors. Such applications currently face economic and energy security challenges that can be addressed by this new class of innovative nuclear reactors. Led by Idaho National Laboratory (INL), the program conducts both fundamental and applied R&D to reduce the risks associated with new technology performance, manufacturing readiness, and deployment of microreactors. The program aims to verify that microreactor concepts can be licensed and deployed by commercial entities to meet specific use case requirements.

In addition, the National Reactor Innovation Center (NRIC), also led by INL and established by DOE in August 2019, supports the DOE Microreactor Program and aims to accelerate the demonstration and deployment of advanced nuclear energy. NRIC offers capabilities for building and demonstrating reactor concepts.

Microreactors, often referred to as special-purpose reactors or very small modular reactors, are factory manufacturable, easily transportable, and designed to produce up to 20 megawatts thermal (MWth) energy. This power limit allows microreactors to be classified as Hazard Category 2 per the Code of Federal Regulations (CFR) at 10 CFR 830 and DOE-STD-1027 (2019). These reactors are decentralized energy sources that have the ability to provide sustainable and affordable heat and power to remote communities and to industrial users, while having self-contained geometry that requires very low maintenance. Microreactors are inherently safe because they are self-regulating and do not rely on engineered systems to ensure safe shut down and removal of decay heat (Owusu, Holbrook, & Sabharwall, 2018).

1.2 Purpose and Need

The primary mission of the DOE Office of Nuclear Energy (DOE-NE) is to advance nuclear power to meet the Nation’s energy, environmental, and national security needs by enhancing the long-term viability and competitiveness of the existing U.S. reactor fleet, developing an advanced reactor pipeline, and implementing a national strategic fuel cycle and supply chain infrastructure. NE supports a variety of advanced reactor designs, including microreactor concepts. Many microreactor concepts under development in the United States anticipate commercial deployment within the next decade. To advance the deployment of microreactors, DOE needs to resolve technical challenges to improve the economic competitiveness of microreactors, develop experimental infrastructure to enable the testing and demonstration of microreactor technologies, and enable microreactor integration into end-user applications for broad deployment and use.

As the nation's premier nuclear science and technology lab, INL leads DOE-NE efforts for research, development and demonstration projects to help the nation maintain and expand the use of nuclear energy. INL offers a one-of-a-kind research environment with unique capabilities and facilities for advancing nuclear energy. INL has dedicated facilities focused on nuclear R&D, including nuclear fuel fabrication and examination and handling facilities. The DOE-NE Advanced Reactor Technologies program develops new and advanced reactor technologies to improve nuclear energy competitiveness and support meeting the Nation's energy, environmental, and national security needs.

As part of the Advanced Reactor Technologies program, INL performs R&D on reactor concepts and technologies that includes modeling and simulation validation, materials and nuclear fuel development and testing, instrumentation and sensors implementation, and systems testing. Additionally, INL also performs research on integrated energy systems that includes R&D on coupling of nuclear and renewable energy resources to better optimize energy use for the electricity, industrial manufacturing, and transportation sectors.

The purpose of the Microreactor Applications Research Validation and Evaluation (MARVEL) project is to meet the R&D needs identified by DOE and the advanced reactor stakeholder community by designing and building a nuclear microreactor application test platform at INL that will offer experimental capabilities for performing R&D on various operational features of microreactors and improving integration of microreactors to end-user applications, such as off-grid electricity generation and process heat.

2. ALTERNATIVES

In July 2020, the Council on Environmental Quality (CEQ) comprehensively updated its National Environmental Policy Act (NEPA) regulations, which went into effect on September 14, 2020. However, the CEQ clarified that these regulations apply to all NEPA processes begun after the effective date, but gave agencies the discretion to apply them to ongoing NEPA processes (85 Fed. Reg. 137, 2020). This Environmental Assessment (EA) for the MARVEL microreactor nuclear test platform was started prior to the effective date of the revised CEQ regulations, and DOE has elected to complete this EA pursuant to the CEQ regulations at 40 CFR 1508.9(b) (1978, as amended 1986 and 2005). The relevant regulations require that an EA include a brief discussion of alternatives to a MARVEL microreactor nuclear test platform. The DOE Office of Nuclear Energy (DOE-NE) considered alternatives for meeting the need to develop and demonstrate a nuclear microreactor test platform application at INL. For the alternatives to be feasible, the microreactor test platform design and development must meet the following criteria:

- Have a small size, low power output, and low decay heat output
- Use well-established, robust fuel, coolant, and structural materials that are stable and compatible
- Have low fuel burnup, small inventory of fuel, and limited available source term
- Have low-decay heat generation, removed by inherent and passive means
- Incorporate high thermal conductivity materials and enhanced convective and radiative heat transfer to reduce temperature hot spots and large thermal mass to give capacity for heat absorption and dissipation
- Use inherent reactivity feedbacks to ensure reactor power is controlled by physics during overpower or over temperature events
- Incorporate multiple passive barriers to inhibit-fission product release
- Use an ambient pressure system to remove sources of pressure and limit driving forces for postulated release
- Supply electricity for end-user applications
- Supply low-grade and high-grade heat for end-user applications
- Use an available facility not requiring substantial modifications and without interfering with other INL R&D efforts.

2.1 Proposed Action - Microreactor Applications Research, Validation and Evaluation (MARVEL) Project

The MARVEL test platform design incorporates a 100-kilowatt thermal (kW_{th}) and about 20-kW electric (kW_e) microreactor that can be integrated with multiple applications, such as heat and power cogeneration and hydrogen generation, to solve associated R&D challenges. Table 1 summarizes the MARVEL microreactor design parameters discussed in this section. Figure 1 shows a lateral conceptual rendering of the MARVEL microreactor system on the left and cross-sectional rendering of the core on the right.

Table 1. MARVEL microreactor design parameters.

Major Systems	Parameters	Value/Type	Units
Core	Thermal Power	100	kWth
	Core Life	2	years
	Fuel Type	Uranium Zirconium Hydride (UZrH)	-
	Fuel Uranium Enrichment	<19.75	%U235
	Maximum Uranium in Core	<30	kg U
	Number of Fuel Pins	36	-
	Neutron Moderator	Hydrogen in U-ZrH	-
	Peak Cladding Temperature	550	°C
Coolant	Heat-Transfer Method	Liquid-Phase Natural Circulation	-
	Heat-Transfer Fluid (Sodium-Potassium Eutectic [NaK])	120	kg
Reactivity Controls	Reactivity Control	Vertical Control Drums and Inherent Core Reactivity Feedback	-
	Reactivity Control Method 1	Vertical Control Drums	-
	Reactivity Control Motor Type	Radiation-resistance, High-temperature Stepper/Servo Motors	-
	Bearing Type	Lubricant-free Thrust and Guide Bearings	-
	Quantity of Reactivity Method 1	4	-
	Reactivity Control Method 2	Inherent Core Reactivity Feedback	-
Reflector & Shield	Neutron Reflector Material	Beryllium Oxide, Beryllium Metal	-
	Neutron Absorber Material	Boron Carbide (B4C)	-
	Neutron Radiation Shield Material	Boron Carbide (within reactor)	-
	-	Borated Polyethylene (outside the reactor)	-
	Gamma Radiation Shield	Stainless Steel (within reactor)	-
	-	Concrete (outside the reactor)	-
Power Conversion	Power Conversion Technology	Frictionless, Free-Piston Stirling Engines (PCK80, Qnergy)	-
	Power Conversion Efficiency @500° C inlet temperature	20-25	%
	Electrical Power	18-25	kWe
	Number of Power Generators	4	-

Major Systems	Parameters	Value/Type	Units
	Heat Rejection Loop	Water-Propylene Glycol, Closed Loop	-
	Ultimate Heat Rejection Medium	Ambient Air	-
	Raw Power Output (voltage)	295-365	VDC
	Maximum Power Output per Engine	7.1	kWe
High Grade Heat Extraction	High Grade Heat Extraction Fluid	Helium or Nitrogen	-

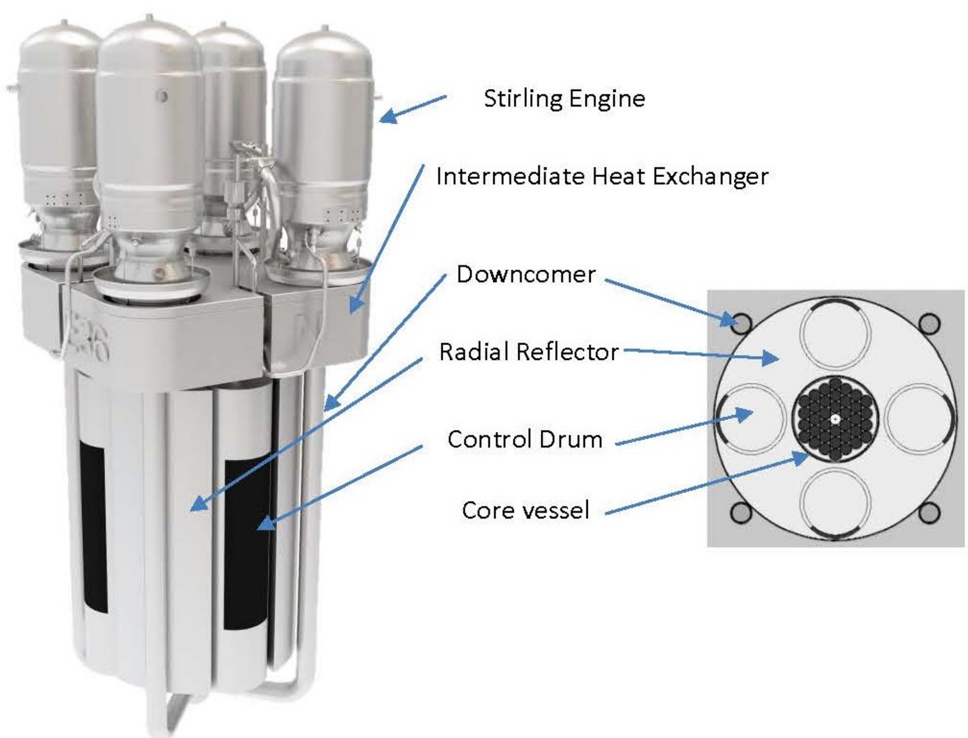

Figure 1. MARVEL microreactor pre-conceptual product design.

Hazard evaluations are performed to support each phase of the MARVEL microreactor's design efforts. The hazard evaluation process for the MARVEL microreactor for compliance with the requirements in 10 CFR 830, *Nuclear Safety Management*, follows a process similar to the Licensing Modernization Project (LMP) as outlined in Nuclear Energy Institute (NEI)-18-04, *Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis Development* (2019). The LMP process is adapted to fit DOE reactor regulatory requirements as applicable and appropriate using a graded approach. This approach provides reasonable assurance of meeting the requirements of 10 CFR 830 (2011) for protection of the public, worker, and environment for the MARVEL microreactor design.

The hazard evaluation of MARVEL microreactor events and associated operations was performed for selection and evaluation of safety classification of structures, systems and components (SSCs), SSC safety functions, and design basis accidents (DBAs) applicable to the MARVEL microreactor design. With these SSCs in place, the MARVEL microreactor can be built and operated safely in the existing Transient Reactor Test (TREAT) facility. The MARVEL microreactor will not operate on days the

TREAT reactor is operating. The MARVEL microreactor safety-in-design approach implements a defense-in-depth (DID) strategy by adopting the traditional five layers of DID to the MARVEL microreactor. The DID layers are an integral part of the SSC classification and performance requirement determination (INL, 2021).

The MARVEL microreactor is proposed to be located in the TREAT Reactor building in the north high-bay equipment pit. Additional space within the TREAT building may be required for heat rejection and instrumentation and control (I&C) equipment, and other equipment may be located outside the building. As such, the documented safety analysis for the MARVEL Project will be in the form of an addendum to the existing TREAT final safety analysis report.

The following discussion summarizes the MARVEL microreactor design.

2.1.1 Reactor Structure System

The Reactor Structure System is the main structural member of the reactor and primary coolant flow path. It includes a machined billet/forging made from 316 stainless steel (SS) and supports the reactor related components located on the reactor, contains primary coolant, and prevents the core from being uncovered during a postulated loss of coolant accident (LOCA). It also supports the reactor vessel and primary coolant piping.

The MARVEL microreactor core barrel, or reactor vessel, is made from a 10-in. 316 SS, schedule 80 pipe. The lower section supports the reactor core fuel assembly, while the upper section supports the cover gas, drain and fill connections, and a safety valve. The upper and lower sections of the reactor core barrel are attached to the top and bottom of the primary support structure, which supports outer permanent reflectors and control drums (CDs) and transfers reactor loads to the pit floor via the secondary containment structure.

The secondary support structure supports the Stirling engines and high-grade heat exchangers and transfers its loads to the pit floor via the secondary containment structure. It also has attachments for instrument and power cable routing.

The primary output structure attaches to the reactor secondary support structure. It can also support a high-grade heat exchange unit, which is interchangeable with the Stirling engines. This unit may be exchanged as necessary to satisfy changing needs of the MARVEL microreactor. A new primary output structure may be designed and interchanged to reside on the secondary support structure.

2.1.2 Secondary Containment Structure

The secondary containment structure, or guard vessel, is a sealed container that secures the reactor onto the pit floor and prevents the core from being uncovered during a postulated LOCA by preventing coolant leakage from the reactor system. If primary coolant leaks into the secondary containment, the fluid level in the secondary containment will rise as liquid level in the primary system falls, until both systems equilibrate. The reactor core and the primary coolant piping reside inside the secondary containment.

The Secondary Containment Structure is the support structure for the reactor and associated primary and secondary components. It supports the reactor system loads, including seismic loads. Radiation shielding fills the interspace voids. The containment has connections for purge gas and a safety valve and attachments for instrument cable routing for reactor instrumentation, including neutron detectors.

2.1.3 Core System

The primary function of the reactor core system is to supply a continuous, stable, and sustainable fission heat source (~100 kW_{th} maximum power level) for the duration of the operation of the system, (i.e., four years). The MARVEL microreactor core is designed to operate continuously for two years, but the microreactor will not operate continuously. Instead, the MARVEL microreactor will be turned on and off numerous times during its lifetime to support research needs. Operations are discussed later in this document. The core contains 36-fuel elements (also referred to herein as fuel pins) arranged in three hexagonal rings around a central hollow channel (Figures 2 and 3) that is available for sensors and detectors.

The side reflector is a stack of beryllium oxide that moderates and reflects neutrons back into the active core. The beryllium oxide side reflector also houses the four rotating CDs

There are also six in-core inserts that displace and re-direct primary coolant away from the core periphery and through the 36-element array to enhance cooling and natural circulation. These inserts are fabricated out of beryllium metal. The core barrel acts as both the up-flow coolant boundary and the inner wall support for the beryllium side reflector annulus.

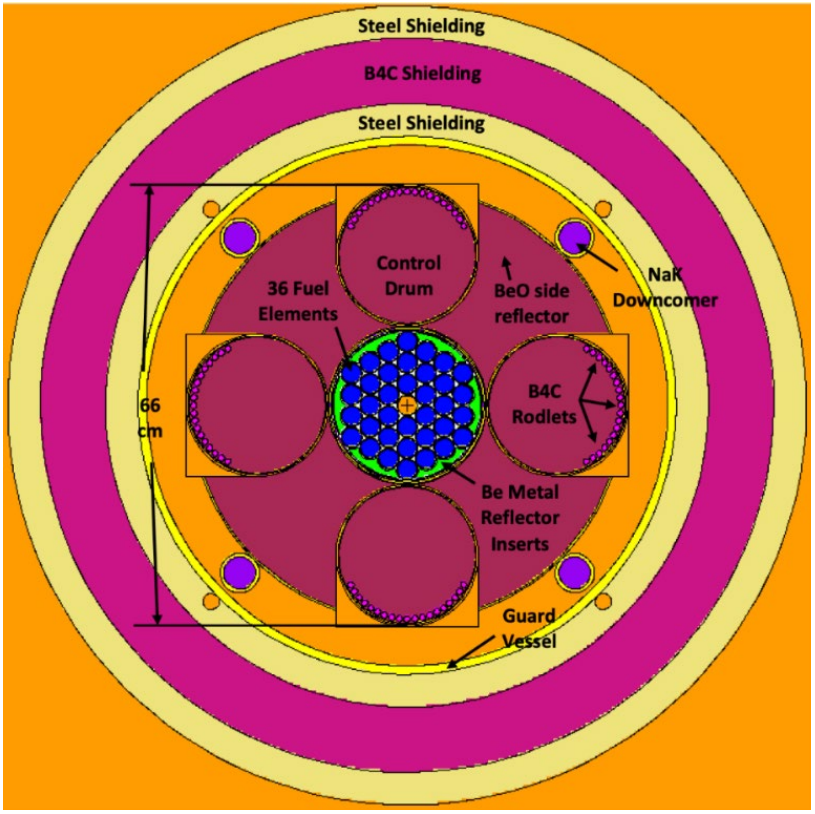

Figure 2. Cross section of the MARVEL microreactor 36-fuel element reactor core.

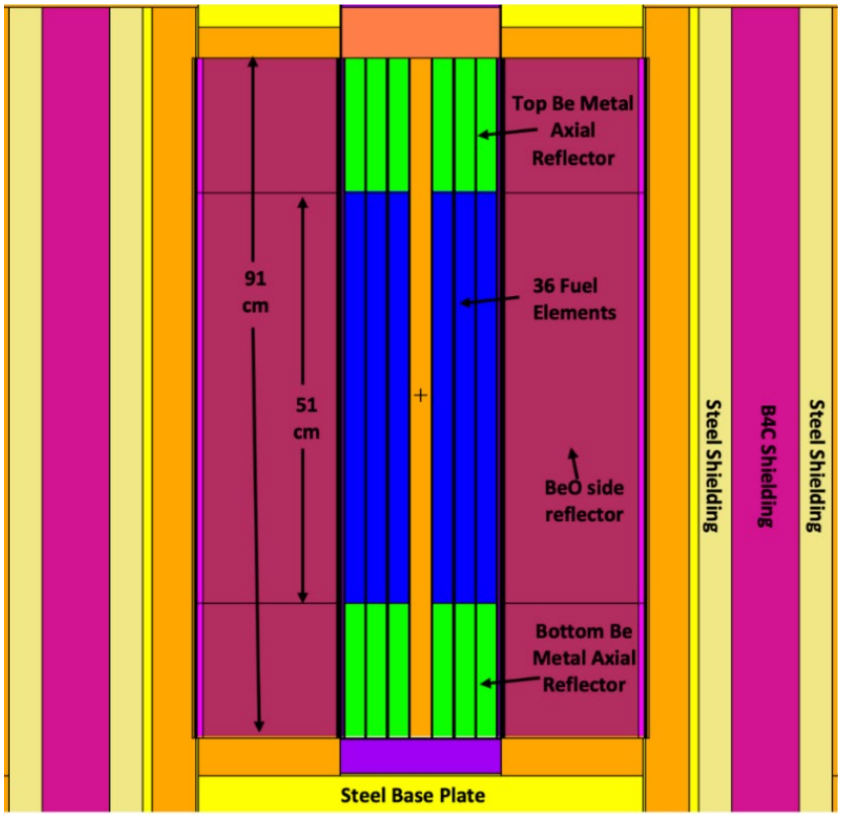

Figure 3. Axial view of the 36-fuel element reactor core system.

2.1.4 Reactor Coolant System

The primary coolant system (PCS) is a four-loop hydraulic circuit assembled to transport nuclear fission heat from the nuclear fuel to the Intermediate Heat Exchanger (IHX) using natural circulation of the primary coolant. The PCS also transfers decay heat to the ultimate heat sink. The following subsystems comprise the PCS: lower plenum, reactor core, reactor vessel, riser, upper head, IHX region, downcomers, the primary coolant, and the inert cover gas. The PCS limits radiation effects and integrates instrumentation for relaying system information to the I&C system. Figure 4 is a preliminary and conceptual rendering that depicts the PCS and IHX components.

The lower plenum is a welded shell located below the bottom of the reactor core and consists of the downcomer, pipes nozzles, and outer thermal insulation. The lower plenum is designed to collect flow from the four downcomer pipes and mix and homogenize the primary coolant before it enters the core.

The primary coolant boundary for the MARVEL microreactor design consists of the reactor vessel, downcomer piping, cover gas line piping, and the reactor vessel head. These SSCs ensure that primary coolant, which may contain any leaked fission or activation products remain within the vessel and oxygen remains outside.

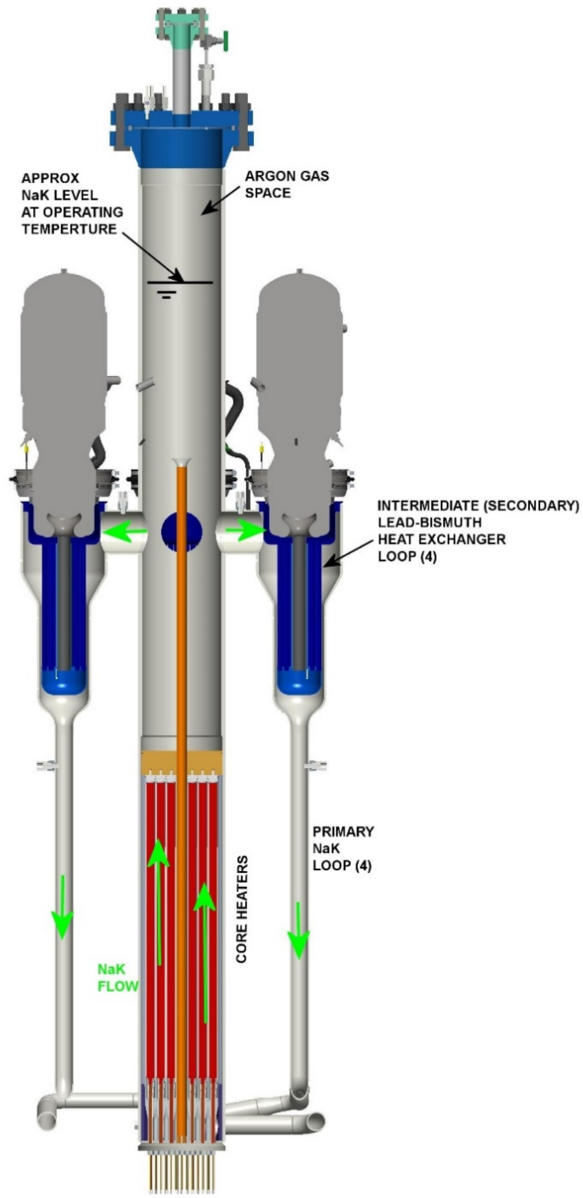

Figure 4. Design of the Primary Coolant System and IHX.

About 120 kg sodium potassium eutectic (NaK), a liquid metal at room temperature, serves as the primary coolant (Baily, 2020). The NaK coolant acts as a radionuclide barrier by retaining fission products by plate-out, chemical solubility, or adsorption mechanisms. Fission heat is generated in the core and removed by natural circulation of NaK. NaK flows upward through the core, rises above the top of the active core, flows through the upper grid plate and radiation shielding to the four Stirling engine heat exchangers.

The Stirling engine heat exchangers connect to the reactor vessel and interface with the NaK coolant via the IHX. The criteria for the IHX coolant are (1) fluid has to be liquid at operating temperature (2) fluid has to be unreactive with air and water at elevated temperature, and (3) the fluid must be able to retain its thermal conductivity properties in radiation environment without significant degradation, and (4) melting point of the coolant should be less than 300 degrees Celsius to avoid manual engine stall, which can simplify controls of these engines. Therefore, lead-bismuth is selected as the coolant choice for the IHX. The IHX contains about 280 kg of lead-bismuth eutectic in total. The cumulative activation of lead bismuth (relative to pure lead) has been evaluated in the *MARVEL Initial Shielding and Dose Calculations* (Trellue, Vedant, Rao, Lange, & Sterbenz, 2021). An argon gas blanket may be maintained on the IHX to reduce formation of lead and bismuth oxide over time during prolonged exposure to ambient air. The lead-bismuth can be allowed to freeze and thaw between operating cycles, without much stressed to the structural components of the IHX and the Stirling tubes. For faster restarts, immersion electrical heater may be utilized to maintain lead in molten states during hot standby.

The Stirling engines are interchangeable with the high-grade heat exchangers. These heat exchangers will also be immersive heat exchangers into the lead-bismuth pool of the IHX, designed solely to extract high temperature heat from the primary coolant for process heating applications. Hence between experiments, either Stirling engines or high-grade heat exchangers are placed in the four IHXs, while the lead-bismuth is molten.

The Stirling engine coils or high-grade heat exchanger, depending on configuration, extract heat from the primary coolant and reduces the NaK temperature. The cooled, denser NaK then flows outward to the periphery of the reactor, downward through four downcomer pipes located outside the beryllium oxide side reflector and through in the lower plenum. The NaK then rises back up through the active core under natural circulation forces driven by the heated section of the active core (51-cm active fuel height).

The riser is a welded shell connected to the top part of the vessel. It homogenizes the NaK exiting the core and supplies the fluid a hot column for establishing natural circulation flow. The top of the riser is connected to the bottom of the upper head.

The upper head allows thermal expansion for the primary coolant, contains the PCS inert atmosphere, and is the path for moving the NaK flow from the riser to the IHX region. The upper head is made of 316-SS machined billet. The machined billet furnishes four horizontal flow paths (one for each loop) for the NaK flow. A welded shell, connected to the top of the billet, provides an expansion volume for the NaK during thermal transients and contains the argon gas for the inert atmosphere and enough NaK to maintain the fluid level above the top of the billet in case of a postulated LOCA. A flange is installed on the top head that allows opening the PCS, and a relief valve is located on the flange.

The four IHX regions are welded to the billet of the upper head subsystem and to the four downcomers. The IHX region is a 316 SS cylindrical shell and a 316 SS reducer welded together. The reducer homogenizes and drives the NaK flow from the IHX bottom head to the inlet of the downcomers. The four downcomers are welded to the IHX region and to the lower plenum subsystems. They drive the NaK flow downward, and serve as the cold legs of the PCS to enable natural circulation. The downcomer subsystem is made of 316 SS pipe and thermal insulation.

Bended sections in the downcomers reduce thermal stresses on the vessel and are rounded to minimize pressure drops. In the last part of the downcomers, a dedicated restricted section allows for installing electromagnetic flow meters (one per loop) to relay information regarding flow rate.

The head space in the reactor above the NaK level contains high purity argon gas (about 50 liters in volume). To accommodate thermal expansion and contraction of the NaK without creating excessive pressures in the primary system, a head tank connects to the reactor vessel gas space. The tank is sized to maintain an acceptable pressure in the vessel throughout the full temperature range. The primary vessel cover gas space, head tank, and piping will be sealed and monitored to identify leaks. The inert gas is supplied from one or more standard high purity Argon gas cylinders through pipes and a regulator. Supply pressure will be less than 15 psig.

Other means of enhancing primary flow may be implemented if needed. This includes an optional gas injection system. This is accomplished by circulating cover gas into the primary coolant near the core outlet using a small gas compressor. The bubbles reduce the local coolant density above the core. The bubbles rise and collect in the cover gas. This gives the downcomer fluid a relatively higher density difference, thus increasing flow rate of the natural circulation. The Gas Injection System will only be implemented if the reactor needs a higher flow rate during development tests.

During startup and restarts, there are no planned maintenance expected on the reactor and power conversion system. The lead-bismuth may utilize external heating to maintain liquid phase for ease of switching Stirling engines and high-grade heat exchangers during initial startup and restarts. Due to the short core life, changing filter elements and installing a purification loop and aerosol filtration and removal system for the argon cover gas system of the primary coolant are not required.

2.1.5 Power Conversion and Heat Rejection System

The power conversion and heat rejection system removes and extracts high-temperature process heat from the IHX, converts that heat into power, and delivers useful electricity to user loads. Alternately, some or all the high-grade heat may be extracted and delivered to a thermal storage medium for integration with heat applications. Figure 5 gives an overview of the power conversion and heat rejection system.

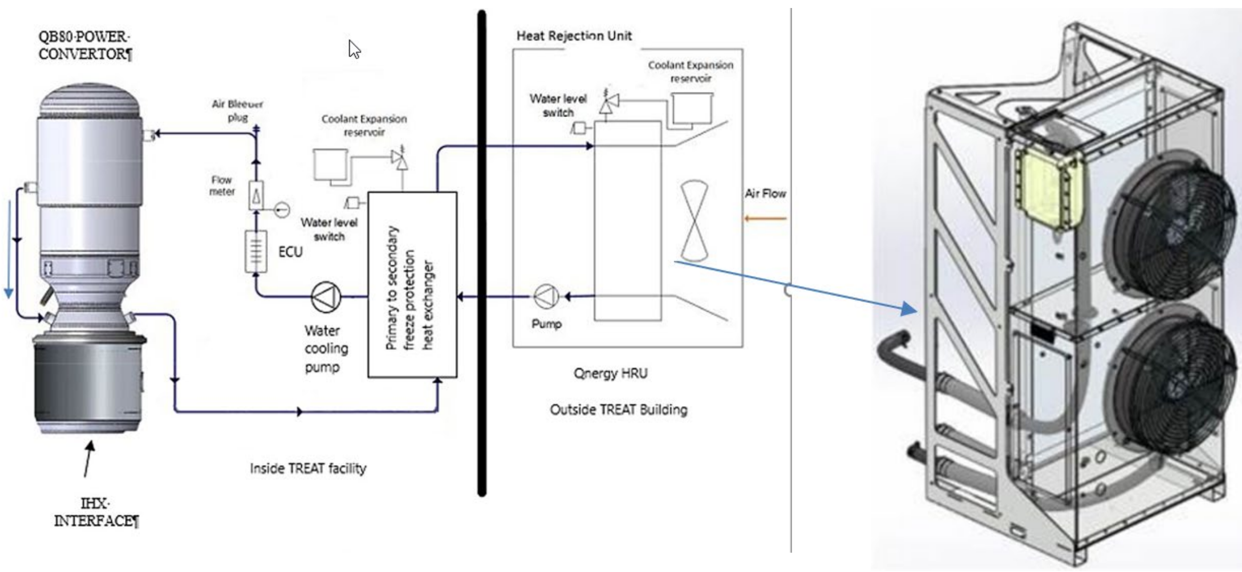

Figure 5. Power conversion and heat rejection equipment.

The power conversion and heat rejection system uses Stirling power conversion equipment and associated controls or a high-grade heat exchanger depending on the configuration, to absorb heat from the reactor and cooling loops. The power convertor absorbs heat from the reactor and uses it to produce electrical energy. The four Stirling engines have custom engine control units (ECU). The piston-free Stirling engines can generate about five kilowatts of power with a 500°C heat source in their hot end heat exchanger. However, net power production starts at about 250°C with a wide range of thermal input, up to a maximum of 7.1 kW per engine. The hot heat exchanger system of the Stirling engine or the high-grade heat exchanger absorbs heat from the reactor and converts it to mechanical motion. Linear alternators convert this mechanical motion to electrical energy and supply direct current (DC) voltage. The system sends the DC voltage to a bus or to an inverter system that converts it to alternating current (AC).

The ECU starts the Stirling engine and receives DC voltage output from the linear alternator. The ECU also monitors system components such as coolant flow, coolant inlet and outlet temperature, and idle mode electrical power dissipation (no electrical load). It also has a shutdown trigger to turn off input heat.

The Stirling engines are closed systems containing helium (110 g per engine) as the power generation coolant. The helium has a maximum allowable working pressure of 73 bar (1060 psig). Heat from the helium gas during the Stirling engine cycle is removed through an external water and propylene glycol, closed loop cooling system. Figure 6 shows the conceptual IHX that connects the Stirling engines to the reactor and the primary coolant.

The low-grade heat rejection system delivers waste heat to the ultimate ambient heat sink (air) through the heat rejection unit located outside the TREAT Reactor building. The low-grade heat rejection system includes a set of pumps and radiators that can be reconfigured for optimized performance.

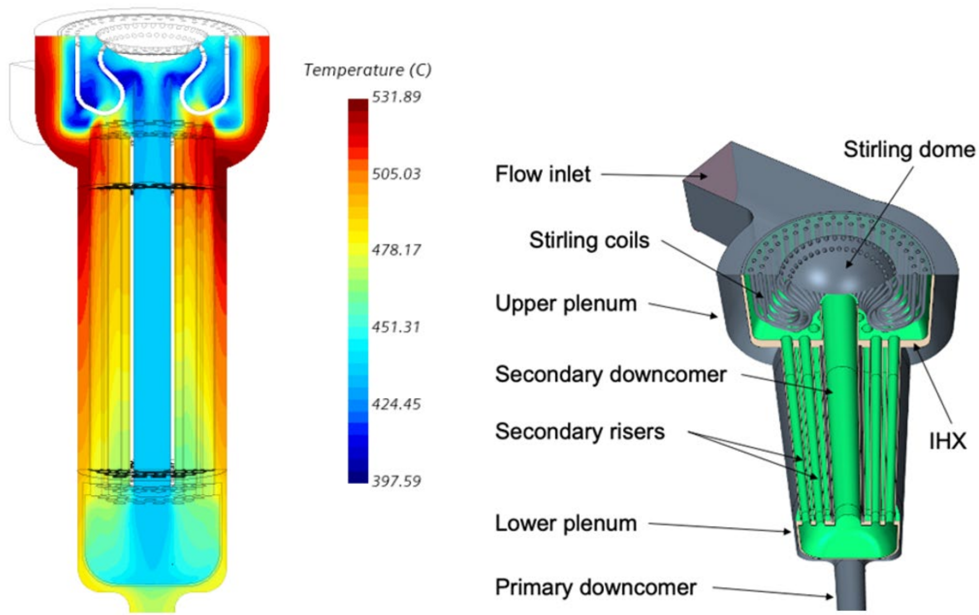

Figure 6. Section schematic of Stirling engine heat exchangers and intermediate lead-bismuth loop.

2.1.6 Fuel System

The fuel system generates heat through fission reactions and transfers it into the primary coolant via the cladding. The fuel system is designed to contain the fuel and fission products. The MARVEL microreactor fuel is based on a well-known Training, Research, Isotopes, General Atomics (TRIGA) fuel material and utilizes sodium bonding between the fuel and cladding to gives sufficient margin to failure to assure the fuel performs safely over the life of the MARVEL microreactor. The fuel cladding functions as the primary fission product boundary.

The MARVEL microreactor requires INL to assemble and weld a maximum of 70 fuel pins, 22-34 of which will be used to verify the quality assurance of the fabrication process. The remaining 36 fuel pins will fuel the MARVEL microreactor. The program proposes to store assembled fuel pins at the Materials and Fuels Complex (MFC) ZPRR facility until transfer to TREAT for core loading. Transporting the fuel pins to TREAT occurs on roads with access controlled by INL security using an approved transport vehicle. Prior to core loading, the fuel will be temporarily stored in the high bay of the TREAT Reactor building.

The MARVEL microreactor fuel is a uranium zirconium hydride (U-ZrHx) containing 30-40wt% uranium that is enriched with 19.75% U235. The MARVEL microreactor fuel material is U-$ZrH_{1.7}$ sodium bonded to type 316 SS cladding. The fuel system consists of cladding, endcaps, fuel pins, neutron reflectors, and gap conductance fluid (sodium) as shown in Figure 7. The entire fuel system is composed of 36 fuel pins. The project will fabricate about 150 kg of fuel, which includes about 50 kg of fuel required for the 22-34 fuel pins that are for quality assurance of the fabrication process. Therefore, less than 100 kg of fuel will be involved in the fission process. Each pin measures about 38-in. (96.5-cm) long. The cylindrical U-ZrH fuel pellets are stacked vertically, cladded in SS, and sodium-bonded to improve fuel pin heat transfer characteristics. Within each fuel pin clad, a top and bottom beryllium oxide (BeO_2) reflector is located above and below the fuel pellet stack, and a fission gas plenum is located above the top beryllium oxide reflector.

Fuel pin assembly

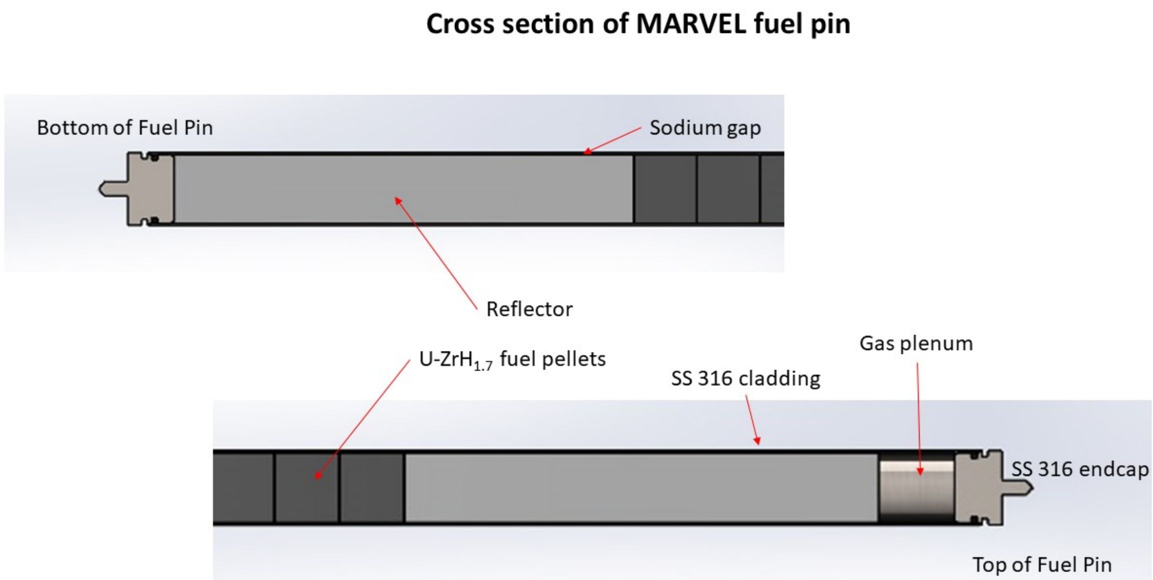

Figure 7. Fuel pin assembly.

Each fuel pellet measures about 1.17 in. (29.72 mm) in diameter by about 1.1 in. long (27.97 mm). Each fuel pin contains 18 fuel pellets. Each fuel pin contains two neutron reflectors made from beryllium oxide; one above the fuel stack and one below the fuel stack and enough sodium, when liquid, to cover the lower reflector, the fuel stack, and one-half to three-fourths the length of the top reflector. Each pin also contains a plenum space to accumulate any released fission gases and gaseous hydrogen.

The cladding and endcaps of the fuel pins are made of 316/316 SS (or Incoloy 800). The 316/316 SS cladding has an interior diameter measuring about 1.25 in. (31.8 mm) and a wall thickness of 0.035 in. (0.89 mm). It is possible to use Incoloy 800 cladding. Incoloy 800 is a high temperature alloy with a higher nickel content than SS 316 and has better high temperature mechanical properties. Overall, the neutronic effect of moving from 316 SS to Incoloy 800 with no other design changes is a reduction in reactivity. This reactivity loss can be compensated for with other design choices. For example, reducing fuel rod cladding thickness has a large neutronic effect that could improve the reactivity of the core to offset reactivity losses (Parry, Lange, Parisi, Wagner, & Arafat, 2020). Regardless of cladding material, the cladding will be manufactured to a consensus standard and will have margin to failure during MARVEL microreactor operation for both off normal and anticipated events.

Two options are available for obtaining MARVEL microreactor fuel: INL production or supply from TRIGA International. TRIGA International, a General Atomics (GA) and Compagnie pour l'Etude et la Realisation de Combustibles Atomiques joint venture, have re-established the TRIGA fuel manufacturing capability in France that was previously performed by GA in San Diego, California. In both procurement scenarios (i.e., INL and TRIGA International) the fuel will fall within the range of U235 enrichment and uranium loading covered by NUREG-1282 (NRC, 1987).

Fuel fabrication at INL would use traditional powder metallurgy processes and laboratory equipment already in use at INL at MFC in the Experimental Fuels Facility (EFF) using the tri-arc melter and the High-Density Fuels argon glovebox. Fuel pin welding and assembly takes place in an inert glovebox in EFF. The ZrH_2 will be procured from commercial vendor.

The proposed fuel fabrication method involves mixing about 30-40 wt% U, either in the form of U powder or UH_3 powder, with 60-70 wt% ZrH_2 powder, which is pressed into compacts and densified in a partial pressure of hydrogen to form $ZrH_{1.7\text{-}1.9}$ (Weeks & Goeddel, 1960). Depleted uranium and highly enriched uranium feedstock are used to achieve the required pellet enrichment of 19.75% U-235. These feedstock materials will be sourced from INL uranium feedstock stores and analyzed for purity prior to use. Surface oxidation is removed via established acid cleaning techniques in EFF.

If INL cannot manufacture the fuel, TRIGA International would manufacture fuel for the MARVEL microreactor from DOE-owned feedstock currently stored at INL and ship the fuel to INL. DOE evaluated the environmental impacts of producing the feedstock material at INL in the *Final Environmental Assessment for the Use of Department of Energy-Owned High-Assay Low-Enriched Uranium Stored at Idaho National Laboratory* (DOE-ID, 2019). Transportation of the feedstock at INL to TRIGA International would be in accordance with applicable Nuclear Regulatory Commission (NRC) and DOT regulatory requirements. TRIGA International would ship a maximum of five fuel pins per cask in about six shipments directly from France to INL using a TN-BGC shipping cask. The unassembled fresh fuel parts would then be assembled at INL in the Fuels and Applied Science Building (FASB), stored in ZPPR, and transported to TREAT for storage prior to core loading, as described above.

The NRC evaluated the impacts on human health and the environment of shipping radioactive materials in NUREG-0170 (1977). In NUREG-0170, the NRC considered the environmental impacts of the transportation of nuclear materials, including imports and exports, pursuant to the NRC regulations, and evaluated marine transport, including overseas shipments through the global commons, and land-based transportation over interstate highways and by rail. The NRC determined that the environmental impacts, radiological and non-radiological, from both normal transportation of nuclear materials and of accidents involving nuclear material shipments were sufficiently small that shipments by all modes of transport could continue without changes to the regulations. Since the analysis performed in NUREG-0170, there have been two affirmations of the findings and the NRC continues to perform investigations using the improved tools and information available (NUREG-2125, 2014). Shipments to and from TRIGA international will use NRC licensed- and DOT-approved casks that comply with all applicable regulations. Impacts of these shipments are bounded by the analysis in NUREG-0170.

2.1.7 Reactivity Control Systems

The reactivity control system includes the four MARVEL microreactor CD systems and supporting electrical components (see Figure 8) that controls criticality and can shut-down the MARVEL microreactor. Criticality occurs when the nuclear fuel sustains a fission chain reaction and each fission releases a sufficient number of neutrons to sustain an ongoing series of nuclear reactions. Neutron absorbing materials disrupt the fission chain reaction by absorbing neutrons to prevent them from causing further fissions. By controlling the number of neutrons available to induce fission, the power of the reactor can be moderated.

The supporting electrical components are installed on the CDs or housed in an adjacent control cabinet. The control cabinet houses the instrumentation necessary to drive the CDs and process data from the system. Electrical cables routed between the CDs and the control cabinet send motor driving signals and other information to and from the system instrumentation.

The CD cylinders are made from beryllium oxide and are ~7.2 in. (18.4 cm) in diameter and ~36 in. (91) cm long. Each drum is supported by 0.75 inch (1.9 cm) diameter rod through the center, and each drum has a neutron absorbing plate made of boron carbide that is ~0.4 in. (1 cm) thick. A non-structural, sheet metal cylindrical wrap may be used to house all the BeO plates. The drums weigh ~110 lbs (50 kg).

Rotation of the CDs controls the number of neutrons available in the core to induce fission, which influences target output electrical power. The rotation of the CDs' neutron absorbing material relative to the core is used to achieve and control criticality or shutdown the reactor and maintain it in a subcritical state. A single CD can shut-down the 36-element core during reactor operations. The CD system has drum forcing components (e.g., motor, spring, and damper) that rotate the CDs, and these components are configured and sized to accommodate operational (a motor rotates the drum) and accident modes (a spring drives the CD system when a safety trip is triggered).

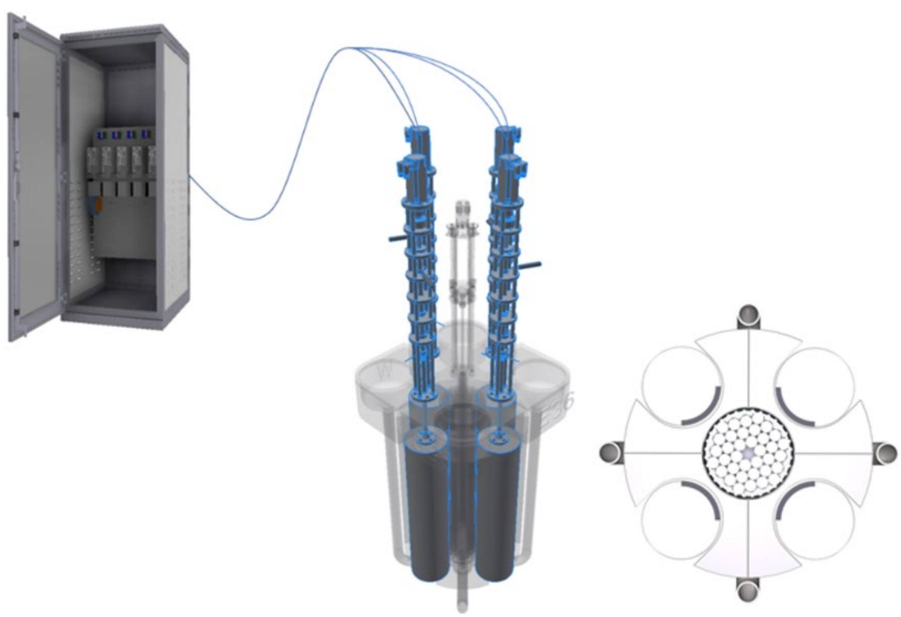

Figure 8. Reactivity control system (showing two of the four CD drive systems).

For the MARVEL microreactor, criticality is achieved when the CD neutron absorbing materials are rotated away from the core. When the CD system positions the neutron absorbing materials directly toward the core, the core is subcritical, or shutdown. As the CDs rotate the poison away from the core, there is a point where initial criticality is achieved. Rotating the CDs beyond the initial criticality position controls the number of neutrons available for sustaining the fission chain reaction in the core and the rate at which fissions occur, thus controlling reactor performance. Instrumentation relays information regarding the position and rotation of the CDs.

The CDs can be controlled manually and automatically using system instrumentation. If a safety related circumstance occurs (e.g., loss of power, seismic event, over temperature, etc.), the Reactivity Control System rotates the CDs past their initial criticality position to shut-down the reactor automatically. The manual rotation mode requires direct activation of the motion control system using manual interfaces linked to the motor driver. The automated mode uses computer activation triggered by information received from system instrumentation (e.g., computer logic executes withdrawal when a reactor parameter measurement sensor achieves a target). These remotely controlled reactor activation modes allow personnel to be remote from the reactor hazards during reactor startup and operation.

2.1.8 Radiation Shielding System

The radiation shielding system absorbs and reflects radiation to protect the facility and reactor materials and components and protect people and the environment during normal operations and accident conditions. Shielding requirements and dose calculations are described in *MARVEL Initial Shielding and Dose Calculations* (Trellue, Vedant, Rao, Lange, & Sterbenz, 2021). Additional shielding may be required pursuant to additional analysis.

The reactor itself will be located in a concrete pit within the TREAT Reactor building at INL that gives a means of isolating the reactor within the TREAT Reactor building. Dimensions of the pit are in Table 2 below.

Figure 9 shows shielding locations and materials. Within the reactor, a large square SS plate above the core serves as the main gamma shielding to protect the Stirling engines or high-grade heat exchanger and other components above the core. This plate is about 30 in. (76 cm) thick and includes an about 4 in. (10 cm) thick section of boron carbide neutron shielding. The core and reflector regions are surrounded by SS and boron carbide cylindrical sections to provide gamma and neutron shielding within the reactor assembly. External to the reactor, 6 in. (15 cm) of borated polyethylene sheets line the concrete pit (sides, top, and bottom below the reactor).

Table 2. Dimensions of TREAT Pit.

Item	Dimension
Pit Floor Thickness	1 ft - 2 in. (35.56 cm)
Pit Wall Thickness	1 ft - 0 in. (30.48 cm)
Depth below cover blocks	10 ft – 0 in. (304.8 cm)
Pit Length	12 ft (365.76 cm)
Pit Width	9 ft (274.32 cm)
Cover thickness	8 in. (20.32 cm)

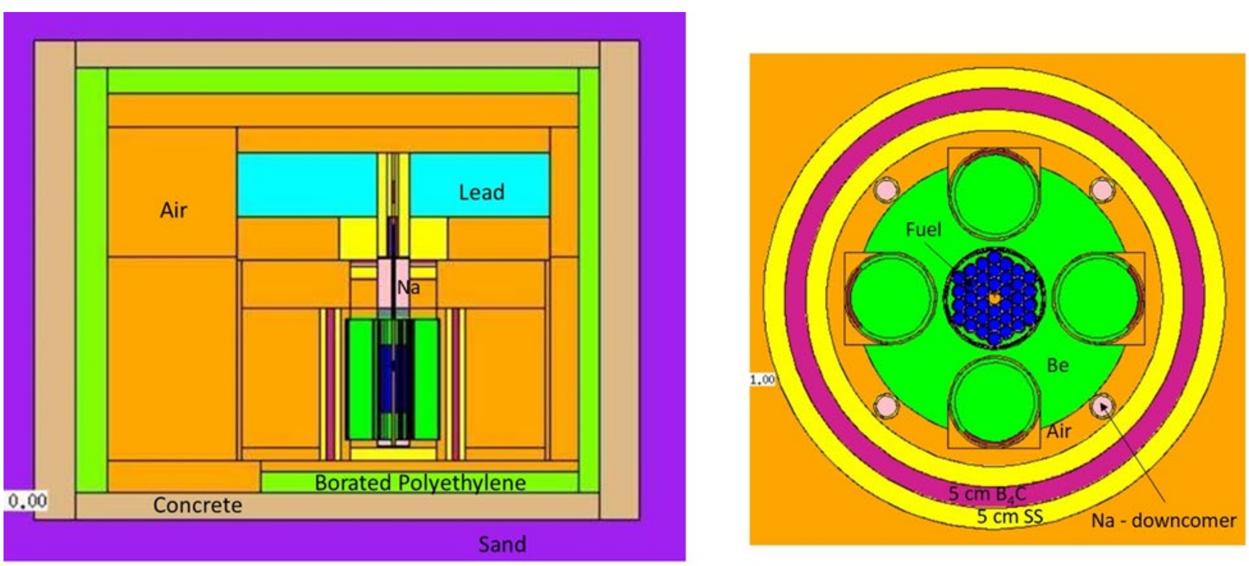

Figure 9. Cross section view of MARVEL microreactor with shielding.

Instrumentation and Control System

The I&C system is responsible to acquire data on key parameters of the systems via the instrumentation and sensors and provide the means to control the MARVEL system. The I&C system has the following main functions: reactor control instrumentation, plant protection, interlocks, drum control, post-accident monitoring, electrical distribution, low-grade heat removal, the control system, and human-machine interface.

The reactor core instrumentation measures the rate of neutron generation (neutron flux), temperature, flow, NaK level and senses for leaks. This system uses neutron sensors (source range and steady state), thermocouples within the primary and secondary loops, flow meters on the primary loop, NaK level probes and leak detection probes to send the operator key information regarding the state of the reactor core. If a NaK leak is detected by the sensors, the sensors send a scram response to the Reactor Protection System (RPS), which shuts the reactor down. The I&C system also monitors other measured parameters and provides for automatic shutdown signals to the Reactor Protection Systems. The reactor power can be calculated from the neutron sensors and from the temperature and flow measurements.

The RPS includes components that shutdown the reactor or shutdown the power conversion system. This system has two safety significant purposes. The first is a manual scram button, and the second is the seismic sensors. Relays supply power to an electromagnetic clutch, which, if de-energized, allows a spring to move the drums to the shutdown position (i.e., scram). The relays are configured so that a power loss causes a scram. The relays are actuated by a manual scram button, accelerometers for detecting seismic events, computer trips, local manual scram and reset buttons. There are two relays that are actuated for each scram type for defense in depth purposes.

Table 3 lists these other components of the system.

Table 3. Non-safety related I&C components.

Component	Function
Interlocks	Limit the excess reactivity insertion and prevent improper event sequencing. Mechanical relays limit the drum rotation to one drum at a time to prevent improper sequencing.
Drum Control	Sends commands to the motor controller and receiving position indicator. Displays CD position.
Post-Accident Monitoring System	Gives information after an accident or unexpected event. Continuously measures dose levels with radiation monitors, detects NaK leaks, indicates reactor shutdown, and stores plant data for analysis
Electrical Production	Communicates with the ECU controller to start and stop power generation, setup electrical parameters, and monitor status and other electrical distribution items from the generators.
Low-Grade Heat Rejection System	Measure flow and temperature, move secondary coolant, and turn fans on and off.
Control System	Performs the logic for control and data conditioning to create indicators for the operator.
Human Machine Interface	Platform where the operator controls plant functions and receives information about the plant conditions. Computer receiving and displaying information via monitors. Interfaces with the control system through a local area network connection.

2.1.9 Siting and Operations

DOE proposes to install the MARVEL microreactor in a concrete storage pit in the north high bay of the TREAT Reactor building near MFC at the INL Site. TREAT provides the MARVEL microreactor with an existing operating Category B reactor facility (pending DOE approval of the TREAT safety basis with the addition of the MARVEL microreactor), operating crews, and recent restart experience. Modifications to the TREAT Reactor building to accommodate the MARVEL microreactor are anticipated to take 5 to 7 months. Constructing, assembling, and performing preoperational testing is expected to last another 2 to 3 months prior to fuel loading.

The preferred location for the I&C system hardware is near the pit inside the TREAT Reactor building. Other options include using a portable shipping container, which will be located outside the TREAT Reactor building. Fluid piping for a closed heat rejection unit connects the power conversion of the reactor to the heat rejection units. Other ancillary equipment may be located outside the building. Figure 10 shows a conceptual layout of equipment. The location of equipment outside of the reactor pit and outside of the TREAT Reactor building could change, but this configuration is limited to the high bay area and the area within the fenced TREAT Facility perimeter.

Modifications of the TREAT Reactor building are necessary to support the MARVEL microreactor. These modifications include installing shield blocks and a Heating, Ventilation, and Air Conditioning (HVAC) system in the north storage pit, installing industry standard I&C components, electrical power and electronic racks, reactor and control room infrastructure, fire suppression system, and heat rejection and electric load dissipation equipment north of the TREAT Reactor building. The proposed modifications to the TREAT Reactor building include the following activities:

- Make penetrations in the fuel storage pit cover(s) for heat rejection fluid loop (i.e., the water-propylene glycol, closed loop)
- Install shielding in the reactor pit
- Route heat rejection ducting from the pit to a condenser unit outside the TREAT Reactor building
- Install a temporary NaK filling station
- Route gas lines and portable gas cylinders to the NaK fill station
- Route conduit and wiring to the condenser unit and the fuel storage pit (power and signal)
- Install fire suppression using an argon gas supply for passivation.

The preparation to bring a new reactor online requires a formal plan to assemble and load the reactor and bring the reactor critical. After achieving criticality, some amount of testing is required to validate the assumptions in the safety basis and demonstrate compliance to the technical specifications for operating the reactor. This process for the MARVEL microreactor is detailed in the *MARVEL Startup Roadmap: Assembly, Fuel Loading, and Initial Startup of MARVEL* (Parry, Chase, & Biggs, 2020) and summarized below:

Reactor assembly involves assembly of the reactor vessel, nuclear instrumentation and chassis, reactivity control systems, primary plant instruments, reactor trip systems (i.e., safety systems, seismic scram system), manual shutdown system, heat rejection system, and shielding. Following assembly, operability testing is performed on these systems. During this time, the system is also used for operator training and procedure testing.

After operability testing, reactor loading begins. The reactor fuel will be loaded manually using methods standard in the nuclear industry. Only one fuel pin will be handled at a time under strict criticality controls to prevent inadvertent criticality. After fuel loading, the top grid plate will be installed; the reactor vessel head will be installed; and the vessel will be filled with NaK and sealed. At this point the final connections to the Stirling engines or high-grade heat exchanger, load banks, and heat exchangers will be made. Once the final connections are complete and have been tested, the reactor trip systems will be re-tested, which is the final check before the initial approach to critical.

The reactor core starts-up from a cold (room temperature) zero-power condition prior to coming up in power. The four CDs are then rotated in small increments to bring the core to a critical state. The regulating CD puts the core on a slow power period and ramps-up in power in a controlled manner. Relays ensure one CD is rotated at a time to avoid any transient overpower conditions during startup.

Similar to commercial reactors, during the initial approach to criticality, the reactor operating parameters will be monitored at predefined hold points to verify the process is proceeding safely and as anticipated. If the reactor operating conditions are not performing as expected, operations will be halted to determine the cause of abnormalities and resumed only when safe operating conditions are again established.

After criticality is achieved, the reactor will be shut down and the process will be repeated to confirm consistency. After initial criticality, reactor physics parameters will be measured to calculate the shutdown margin and excess reactivity for comparison to technical specifications. The reactor will then be increased in power to raise temperature enough to complete a heat balance calibration of the nuclear instruments to determine losses and to test the decay heat removal system.

The final stages of startup include testing the power production of the microreactor. The reactor will be raised to a high enough temperature to start the Stirling engines or high-grade heat exchanger, and the power production will be measured at this level. The power will be increased incrementally to test the range of power production up to 100% reactor power. To improve startup efficiency and remove the complications of the secondary lead heat exchanger solidifying, a hot shutdown mode may be defined and employed for the MARVEL microreactor. Hot shutdown indicates that CDs are rotated in fully in and de-latched to prevent inadvertent criticality.

During normal operations, the reactor core is stepped-up in power before reaching a desired maximum power level. At each power step, predetermined hold points are evaluated to confirm engine efficiency and proper reactor system performance. Operation at maximum power (100 kW) is referred to as the normal hot operation condition. The MARVEL microreactor will normally operate in an automatic control mode including shutdown function involving the CDs. However, the reactor operator can manually control the reactor, in which case the operator has the option to switch from automatic control to manual control. The operator can then manually rotate the control drums to shut the reactor down.

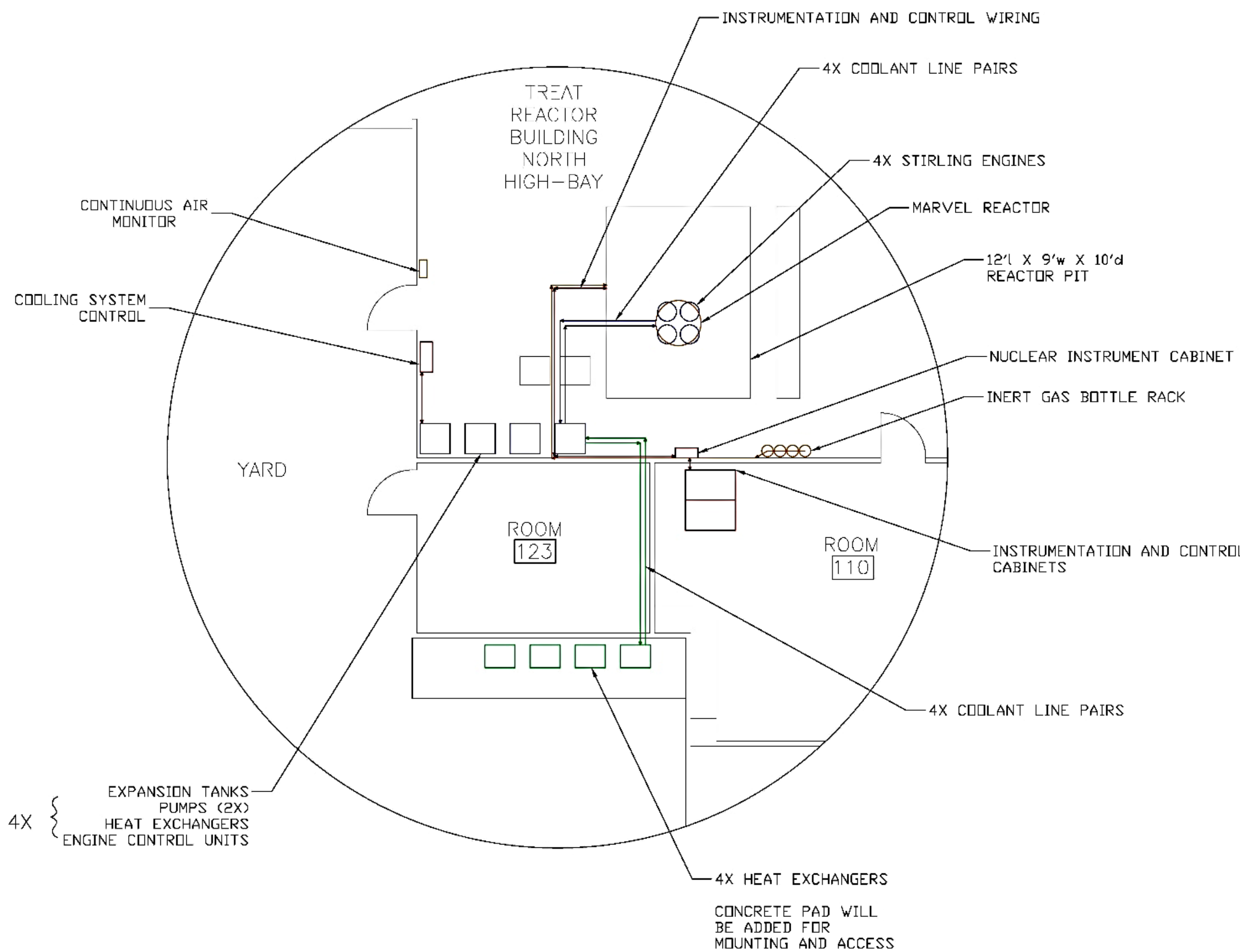

Figure 10. Layout of MARVEL microreactor in the TREAT Reactor building.

The MARVEL microreactor will not operate on days the TREAT reactor is operating. The MARVEL microreactor requires about 10 additional employees (eight employees for construction and two for operations). During normal operation, onsite staff evacuate the TREAT Reactor building and control the MARVEL microreactor from building MFC-724. The control room is located more than half of a mile away and houses the TREAT operator station.

2.1.10 Deactivation and Decommissioning

Deactivation & Decommissioning (D&D) of the MARVEL microreactor is anticipated to occur in phases that vary in length and scope. Because the TREAT Reactor building must be evacuated when the TREAT reactor is operating, D&D activities cannot take place when the TREAT Reactor is operating.

The first phase begins upon final shutdown of the reactor after completion of critical project operations. This phase includes monitoring the reactor and other equipment as systems cool down and radiation levels decay. Systems or components not exposed to a high-radiation field will be disconnected and stored for re-use on other projects or dispositioned. This includes draining, breaking down, and storing equipment from the heat reject system located outside of the reactor pit.

When radiation levels are low enough for safe pit access, the Stirling engines, high-grade heat exchanger used in some operating configurations, pit HVAC, and IHX will be decommissioned, the bulk of the NaK primary coolant (most of the 61 gallons or 120 kg) will be drained from the system, and residual NaK remaining on pipes, vessels, and other components in the reactor vessel systems will be deactivated. Initially, a small amount of moisture is introduced in an inert gas purge to remove the remaining NaK. A water wash is then used to react any lingering coolant. The reaction wash will generate an alkali solution of potassium and sodium hydroxide. The concentration and contact rate is low enough that no detectable reaction with the stainless steel fuel cladding will be observed. This initial phase of the MARVEL microreactor D&D is dependent on the power history and decay times of the radioactive isotopes from the core and activated equipment, which could be from months to years after shutdown.

In order to drain and remove the NaK coolant from the reactor vessel, the argon cover gas will be evacuated and replaced due to potential contamination. The cover gas will be extracted by a simple gas transfer line into a gas storage container, which will be disposed of as discussed in Section 3.7.

NaK removal involves installing a pump or using a vacuum to evacuate the NaK. Vacuum evacuation is preferred. The NaK requires deactivation treatment to convert it to a nonhazardous form for disposal, which could be completed at MFC or through an offsite Treatment Storage Disposal (TSD) facility. Residual waste from NaK treatment must be disposed at an off-site mixed waste Subtitle D or Subtitle C disposal facility, which are readily available Disposition of the NaK is discussed in Section 3.7.

Once the bulk of the NaK has been drained, the residual NaK will need to be removed from the pipes, vessels, and other components. Deactivating and removing the residual NaK is required prior to defueling the reactor to avoid defueling the reactor with NaK contaminated fuel rods. Deactivating residual NaK generally involves converting the sodium and potassium to their respective hydroxide forms using a chemical reaction with high temperature steam and an appropriate cover gas, typically nitrogen, followed by conversion to their respective carbonate forms via chemical reaction with carbon dioxide. The resultant aqueous carbonate solution is then solidified for disposal (Herrmann, Buzzell, & Holzemer, 1998). Following deactivation, the system will be rinsed to remove the constituents formed during deactivation.

The next step removes the IHX. The IHX contains lead-bismuth in a solid form. Separating the IHX from the reactor vessel allows it to be stored for decay or shipped to a treatment facility. Maintaining the IHX intact requires removing the Stirling engines and separating them from the reactor without breaking the IHX boundaries. Removing the IHX intact is necessary to eliminate releasing Polonium-210, which is produced in the IHX from activation of bismuth in the lead-bismuth eutectic coolant.

After deactivating residual NaK in the core, defueling begins with evacuating the argon cover gas and removing the vessel head to access the fuel. Fuel pins will be removed one at a time, and each will be wiped down to verify it is dry and clean. Radiation and contamination surveys will be performed as each assembly is removed. After inspection the assemblies will be placed in designated shipping or storage containers following criticality control protocols. Containers can be dry stored at TREAT or shipped to MFC for storage or reprocessing. Section 3.8 discusses spent fuel in more detail.

After the core is de-fueled, the nuclear instruments will be disconnected and disposed of or stored for re-use. Power to in-pit systems will be disconnected, and reactivity control systems will be removed and disposed of separate from the reactor vessel. The activated beryllium can also be removed from the motor systems and managed as discussed in Section 3.7.

After removing instrumentation, the reactor vessel can be size reduced for packaging and disposal. This can take place in the pit or the vessel can be removed from the pit to the high bay floor. Size reduction requires using contamination controls such as tents and active ventilation. Alternatively, a special waste container could be fabricated, and the entire vessel could be disposed of intact. The reactor pit shielding can be removed for storage if needed, but it is assumed it will remain in place.

2.2 Alternative 2 – No Action

The "No Action" alternative establishes a baseline against which this EA compares the MARVEL microreactor. No action does not necessarily mean doing nothing, but involves maintaining or continuing the existing status or condition. In this document, no action means not manufacturing and operating the MARVEL microreactor concept. INL would continue to pursue other aspects of microreactor R&D such as developing non-nuclear thermal testing of microreactor heat removal systems, evaluating new fuels, materials, instrumentation, and sensors for microreactor designs and investigating power conversion systems.

Not demonstrating the MARVEL microreactor concept would limit DOE's ability to obtain critical information regarding the reliability, efficiency, and safety of microreactors and their integration with end-user applications. This would negatively impact the development and improvement of advanced microreactors.

2.3 Alternatives Considered and Eliminated from Analysis

Table 4 gives a brief description of alternatives to the MARVEL microreactor that were considered for the MARVEL microreactor and the reasons they were eliminated from further evaluation.

Table 4. Alternatives considered for the MARVEL microreactor and criteria for elimination from further analysis.

Alternative	Criteria
INL Facilities other than the TREAT Reactor Building	The MARVEL microreactor project evaluated other INL facilities, including the Experimental Breeder Reactor (EBR)-II containment dome and the Zero Power Physics Reactor (ZPPR). Other facilities evaluated required substantial modifications to support the MARVEL microreactor and/or have ongoing R&D programs with which the MARVEL microreactor would interfere. Therefore, only the TREAT Reactor building was carried forward for additional analysis.
Primary Reactor Coolant	Sodium was evaluated as a candidate for the primary reactor coolant as detailed in Baily (Baily, 2020). Due to the anticipated duty cycle of the reactor and potential safety implications of freezing sodium due to failure of electrical heating systems, sodium was eliminated from consideration.

Alternative	Criteria
Pumped Primary Coolant	Different primary and secondary flow configurations including natural circulation, pump, and gas bubble assisted natural circulation for primary and secondary loops were evaluated in MARVEL Coolant Options (Baily, 2020). It was determined that the challenges and unknown risks of a pumped configuration outweigh the advantages. Specifically: Natural circulation has the fewest components and least amount of piping and piping connections of the evaluated alternatives. Other designs involve incorporating coolant pumps, using double walled piping for an external secondary loop, and developing a heat exchanger. The natural circulation design can be modified to give access to high grade heat through one or more of the Stirling engine connection locations or high-grade heat exchanger that may be used in some operating configurations. This meets the requirement to supply high-grade heat for end-user applications.

3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL IMPACTS

This section provides a brief background description of only those environmental aspects affected by the MARVEL microreactor project.

Under the No Action Alternative (Alternative 2), activities at the INL Site would continue under present day operations, and the MARVEL microreactor project would not be implemented. The No Action Alternative would not result in impacts to resources at the INL Site beyond those captured in the discussion of the affected environment. The environmental impacts of future activities at the INL Site would be evaluated in project or program specific analyses in compliance with NEPA. Therefore, impacts from the No Action Alternative are not discussed further in this EA.

This EA describes the resources that may be affected by the MARVEL microreactor. Discussion of the present day setting in this document is limited to environmental information that relates to the scope of the MARVEL microreactor. The level of detail varies depending on the potential for impacts for each resource area. This section summarizes several site-specific and recent project-specific documents that describe the affected environment and incorporates these documents by reference.

Decisions will be made during ongoing design phases of the MARVEL microreactor that could affect the eventual final design and construction. Application of the safety-in-design principles identified in DOE-STD-1189-2016 (2016), and the evaluations to ensure adequate protection of facility and collocated workers in the safety basis, provide assurance that the design is capable of meeting the requirements outlined in DOE O 420.1C (2019) and 10 CFR 830 (2011) for the TREAT Reactor building location.

The early stages of design development are guided by deterministic decisions that outline the desired safety characteristics for a given design. The safety goals in nuclear facility design and operation are to ensure adequate protection of the public, workers, and environment. This will be achieved for the MARVEL microreactor by proper selection of fuel, cladding, coolant, and structural materials that are stable and compatible, and by following high quality practices in construction and operation. The MARVEL microreactor design will consider the proposed operational ranges for systems and components and ensure that material selection provides for reliable operations during normal operations.

Since the design thermal power of the reactor is not expected to change, the use of an early model for preliminary source term calculations is used for this EA. Any changes in the reactor design will not significantly alter the source term or invalidate the source term's use in the preliminary dose and hazard evaluations (Parry J. , 2020). Therefore, the impacts evaluated in this EA are considered bounding.

An important component in analyzing impacts is identifying or defining the geographic area in which impacts to resources are anticipated to occur. The area of impact is specific to the type of effect evaluated. The area potentially affected was determined by the scope of the MARVEL microreactor, including all potential direct and indirect impacts associated with project. The geographic boundaries for analyses of cumulative impacts in this EA vary for different resources and environmental media. Table 5 briefly describes the areas of impact for each resource area evaluated in this EA.

Table 5. Geographic area in which impacts from the MARVEL microreactor are anticipated to occur.

Resource Area	Region of Influence
Geology and Soils	The area surrounding TREAT and MFC.
Air Quality	INL and nearby offsite areas that could be affected by air quality impacts from the MARVEL microreactor.
Ecological Resources	INL and adjacent offsite areas where ecological communities exist, including non-sensitive and sensitive habitats and species that could be directly or indirectly affected by the MARVEL microreactor.
Cultural and Historical Resources	The TREAT Reactor building.
Infrastructure	INL utilities including power supply, water, and sewer
Waste Management	INL waste treatment, storage, and disposal facilities.
Human Health – Normal Operations	INL onsite project workers and the offsite public within 50 miles of the project location.
Human Health – Facility Accidents	INL noninvolved workers and the offsite public within 50 miles of the project location.

In addition, cumulative impacts can result from individually minor, but collectively significant, onsite or offsite actions occurring over time (40 CFR 1508.7). Those actions within the spatial and temporal boundaries (i.e., project impact zone) of the MARVEL microreactor are considered in this EA. There are several proposed projects at the INL Site that DOE considers reasonably foreseeable that could contribute to cumulative impacts. Those that DOE reviewed include the following:

- Recapitalization of Infrastructure Supporting Naval Spent Nuclear Fuel Handling
- Expanding Capabilities at the Power Grid Test Bed
- Versatile Test Reactor
- Utah Associated Municipal Power Systems Carbon Free Power Project
- Oklo, Inc. microreactor.

DOE reviewed the resources at risk; geographic boundaries; past, present, and reasonably foreseeable future actions; and baseline information in determining the significance of cumulative impacts. Actions that have no impact do not result in cumulative impacts. Conclusions regarding cumulative impacts are included in the following sections.

To guide the assessment of environmental impacts, this EA uses three levels of impact—SMALL, MODERATE, or LARGE—which are defined as follows:

SMALL–Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE–Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE–Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Scoping and preliminary analyses indicate the MARVEL microreactor would not impact the following elements; therefore, this EA does not analyze these elements further for the reasons described:

- Environmental Justice–Analysis identified no adverse human health or environmental effects for the MARVEL microreactor at the INL Site or in surrounding areas. Therefore, the MARVEL microreactor would not affect minority or low-income populations.
- Ground and Surface Water–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 above sea level and 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. The MARVEL microreactor does not include activities that physically or chemically alter surface water resources. The MARVEL microreactor system is a closed system and does not have any liquid or gaseous discharges into the environment during normal operation. Therefore, the MARVEL microreactor does not affect ground or surface water resources.
- Land Use–The facility modifications, construction, and operations proposed as part of the MARVEL microreactor would occur in existing facilities. The MARVEL microreactor does not require construction of new facilities or additional land use or ground disturbance. The MARVEL microreactor would have no impacts on land use or aesthetics.
- Noise–The TREAT Facility is about 3.5 miles from the INL Site boundary. The closest noise-sensitive receptor is an agricultural homestead that is about 5.0 miles from MFC and about 1.9 miles from U.S. Highway 20, which is expected to be the primary noise at this location. Discernable noise from the MARVEL microreactor is generated from the heat rejection units located outside the TREAT Reactor building. Based on manufacturer data, this equipment produces sound in the range of about 65 to 66 decibels (dBA). To give context, a whisper registers about 30 dBA, normal conversation about 50 to 60 dBA, a ringing phone 80 dBA, and a power mower 90 dBA (OSHA, 2011). The MARVEL microreactor will be located at the TREAT Reactor building, which includes a number of noise-generating sources typical of industrial activities such as industrial HVAC equipment, blowers, moving equipment, and vehicles. The noise generated from the MARVEL microreactor and associated facility modifications and other activities would be consistent with other existing industrial equipment at the TREAT Facility and the potential concurrent noise would be similar to existing levels. As a result, the MARVEL microreactor would not cause a change in the noise environment at the INL Site.
- Socioeconomics–Implementing the MARVEL microreactor would result in hiring up to 10 employees at the INL Site. In 2018 the total population of Bannock, Bingham, Bonneville, Butte, Clark, Jefferson, and Madison counties was 322,434. The impacts to population, housing, employment, income, community services, public transportation, and public finance from an additional 10 employees would be negligible. The impacts to socioeconomic factors from the MARVEL microreactor would not likely be distinguishable from current INL Site operations, and the anticipated change would not noticeably alter socioeconomic conditions in the seven county region around the INL Site.

3.1 Idaho National Laboratory Site

The INL Site is an 890-square-mile DOE facility located on the Eastern Snake River Plain. It is primarily located within Butte County, but portions of the INL Site are also in Bingham, Jefferson, Bonneville, and Clark Counties. All land within the INL Site is controlled by DOE, and public access is restricted to highways, DOE-sponsored tours, special-use permits, and the Experimental Breeder Reactor-I National Historic Landmark. The INL Site location and boundary is shown in Figure 11.

Public highways U.S. 20 and 26 and Idaho 22, 28, and 33 pass through the INL Site, but off-highway travel within the INL Site and access to INL Site facilities are controlled. Currently, INL employs about 5,200 people. No permanent residents reside on the INL Site. Population centers in the region include large cities (more than 10,000 residents), such as Idaho Falls, Pocatello, and Blackfoot, located to the east and south, and several smaller cities (less than 10,000), such as Arco, Fort Hall, Howe, and Atomic City, located around the INL Site.

Vegetation is dominated by low shrubs, such as sagebrush and rabbitbrush, a wide variety of grasses, and some juniper trees. The area is populated with animals that inhabit sagebrush grasslands. Animals include pronghorn, deer, elk, coyotes, badgers, rabbits and many birds including raptors, game birds, and waterfowl, a variety of small rodents, and several small reptiles. Many of the plants and animals that live within the boundaries of INL are culturally significant to the Shoshone-Bannock Tribes.

Cultural resources are numerous on the INL Site (DOE-ID, 2016). Resources that have been identified include:

- Pre-contact archaeological sites representing Aboriginal hunter-gatherer use over a span of approximately 12,000 years
- Historic archaeological sites representing settlement and agricultural development during the period from 1805 and the late 1920s
- Historic architectural properties associated with World War II and with the development of nuclear science and technology
- Areas of cultural importance to the Shoshone-Bannock Tribes.

Many of these resources are eligible for nomination to the National Register of Historic Places (NRHP). Archaeological sites and Native American resources are generally located in undeveloped areas, while historic architectural properties are found within facility perimeters at the INL Site. A tailored approach to management of these resources and compliance with relevant federal and state law is included in DOE-ID's INL Cultural Resource Management Plan (DOE-ID, 2016), which is based on a Programmatic Agreement among DOE-ID, the Idaho State Historic Preservation Office (SHPO) and the Advisory Council on Historic Preservation as well as an Agreement in Principle between DOE-ID and the Shoshone-Bannock Tribes.

The area surrounding the INL Site is classified as a Prevention of Significant Deterioration Class II area, designated in United States Code (USC) under the Clean Air Act (42 USC 7401 et seq) as an area with reasonable or moderately good air quality while still allowing moderate industrial growth. Craters of the Moon Wilderness Area, which is about 30 miles from the TREAT Facility, is classified as a Prevention of Significant Deterioration Class I area, and is the nearest area to the INL Site where additional degradation of local air quality is severely restricted. The INL routinely monitors air quality using a network of air monitors. The monitors collect samples to measure particulate matter (PM), radioactivity, and other air pollutants.

Releases of radionuclides to the environment from current INL operations can expose individuals near the INL Site to radiation. Types and quantities of radionuclides released from INL operations are listed in the National Emission Standards for Hazardous Air Pollutants (NESHAP) annual reports (DOE-ID, 2020), along with estimated doses caused by these releases. Historically, the dose to the maximally exposed individual (MEI) has been in the range of hundredths of an mrem/yr, and therefore less than 1% of the 10-mrem/yr federal standard.

INL Site workers receive the same dose as the general public from background radiation, but they also receive an additional dose from working in facilities with nuclear materials. The average dose to the individual worker (involved worker) and the cumulative dose to all INL Site workers (total workers) fall within the radiological regulatory limits of 10 CFR 835 (2011). According to the accepted risk estimator of 6.0×10^{-4} latent cancer fatality (LCF) per person-rem among workers, 0.05 LCF is projected for INL Site workers from normal operations in 2018 (DOE, 2020).

MFC is the most eastern INL facility complex. It is located about 38 miles west of Idaho Falls in Bingham County in the southeastern corner of INL. MFC is about 100 acres (inside the MFC fence) and about 2.7 miles from the southern INL Site boundary. MFC includes a wide variety of facilities and capabilities that support INL's nuclear research missions. Activities performed at MFC include R&D for new reactor fuels and related materials and demonstration of various nuclear energy technologies. In addition, MFC supports DOE programs for space and defense radioisotope power systems.

The TREAT Facility is located about 0.8 miles northwest of MFC. It is considered to be a part of MFC but is not located within the MFC fenced area. The TREAT Reactor building includes the TREAT Reactor, high bays, pre and post-irradiation test equipment, and fuel storage. The TREAT Reactor is an air-cooled reactor capable of pulsed transients up to 20 GW of power that is designed to perform transient testing of nuclear fuels and materials to support advances in nuclear energy. 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. The environmental impacts of TREAT operations were evaluated in the *Final Environmental Assessment for the Resumption of Transient Testing of Nuclear Fuels and Materials and Finding of No Significant Impact* (U.S. Department of Energy, 2014). Figure 12 shows the location of MFC and TREAT in relation to other INL Site facilities.

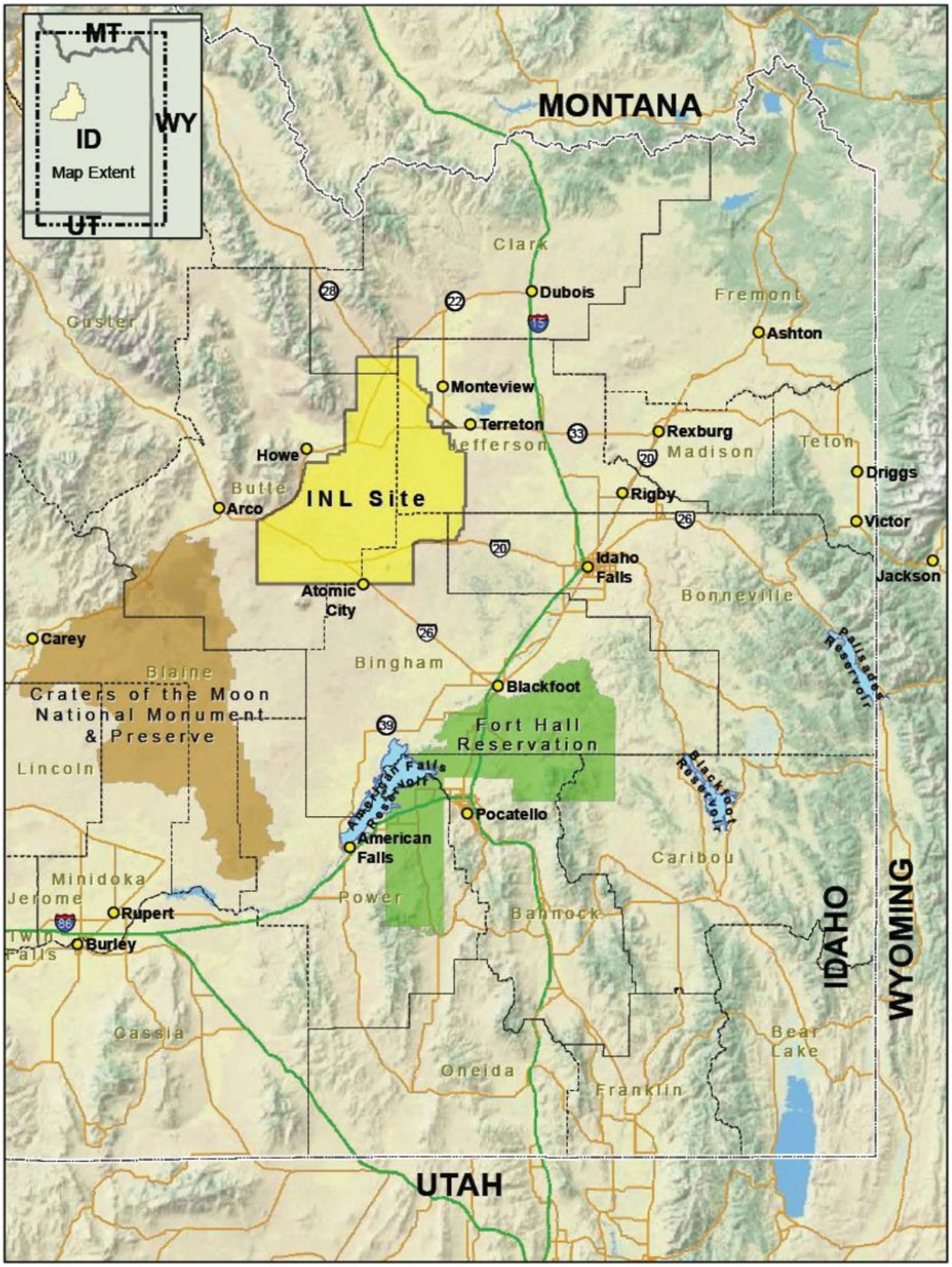

Figure 11. Location of the INL Site.

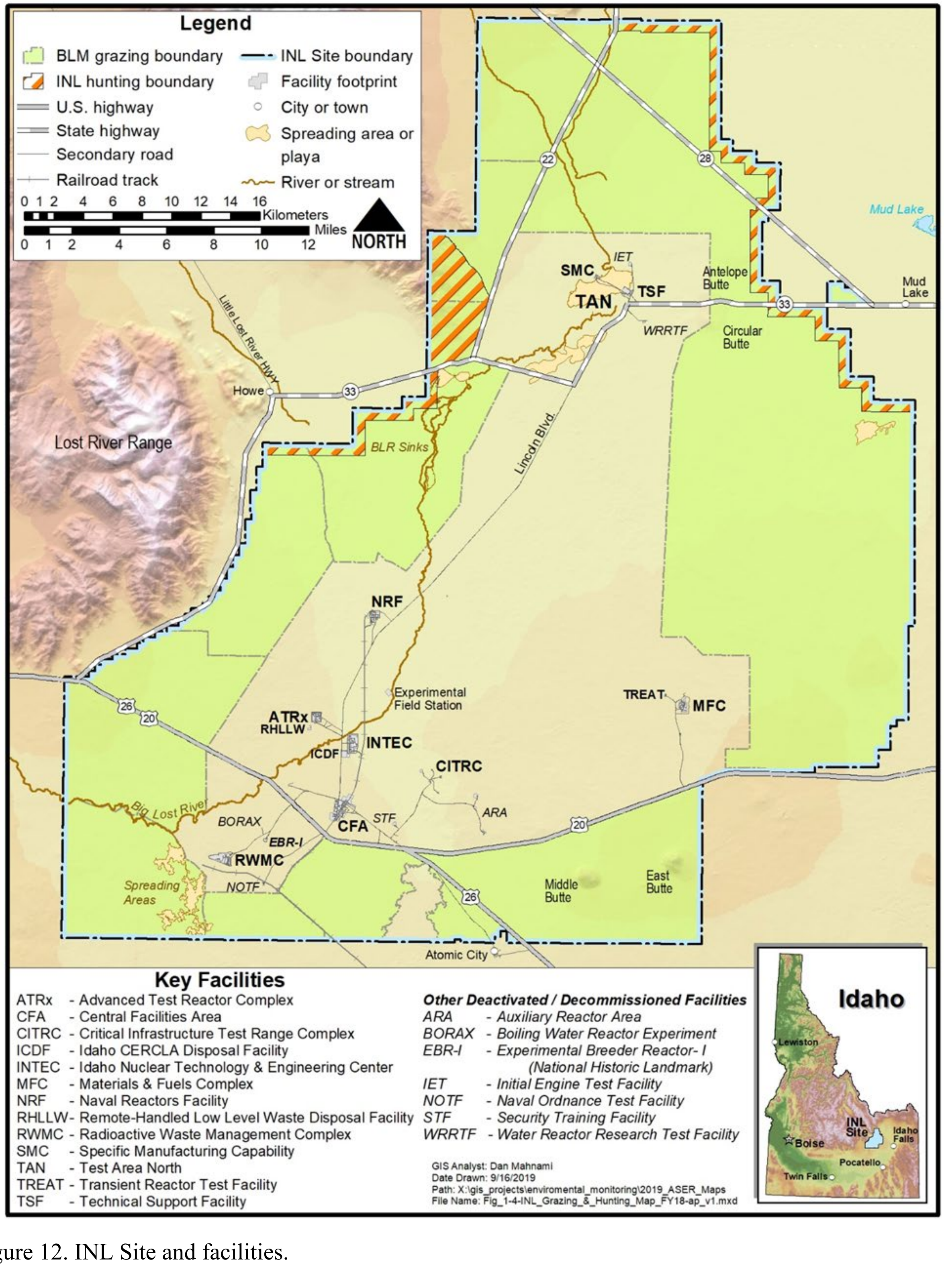

Figure 12. INL Site and facilities.

3.2 Air Quality

Sources of nonradiological air emissions at the INL Site include oil-fired boilers, diesel engines, emergency diesel generators, small gasoline, diesel, and propane combustion sources, and from using chemicals and solvents. Boilers generate steam for heating facilities and are the main source of nonradiological air emissions at the INL Site. Diesel engines are mainly used to generate electricity for facility operations. Miscellaneous non-vehicle sources include small portable generators, air compressors, and welders.

Radionuclide emissions at INL occur from (1) point sources, such as process stacks and vents; and (2) fugitive sources, such as waste ponds, buried waste, contaminated soil areas, and decontamination and decommissioning (D&D) operations. Airborne releases of radionuclides from INL Site operations are reported each calendar year with the calendar year 2019 report released in June 2020 (DOE-ID, 2020). For calendar year 2019 the effective dose equivalent to the MEI member of the public was 5.59E-02 millirem (mrem) per year, which is 0.56 percent of the 10 mrem per year standard for the INL Site.

Radiological air emissions from MFC occur from spent fuel treatment at the Fuel Conditioning Facility, waste characterization, and fuel R&D at the Hot Fuel Examination Facility (HFEF), fuel R&D at the Fuel Manufacturing Facility, and post-irradiation examination at the Irradiated Materials Characterization Laboratory. These facilities are equipped with continuous emission monitoring systems and radionuclide sources are controlled with high-efficiency particulate air (HEPA) filters. The effective dose equivalent to the MEI member of the public from MFC operations in 2019 was about 5.37E-02 millirem (mrem) per year, which is about 96% of the effective dose equivalent to the MEI member of the public for the INL Site (DOE-ID, 2020).

3.2.1 Impacts to Air Quality

The MARVEL microreactor has the potential to generate minor amounts of toxic air pollutants and to generate radionuclide air emissions.

Modifications to the TREAT Reactor building would have no radiological impact on the general public. Required facility modifications are minimal and are typical activities currently performed at INL. Construction activities that occur in nonradiological areas and facility modifications within radiological areas would not generate radiological air emission.

Combustion equipment such as generators, portable heaters, ventilation equipment, and heavy equipment fueled with diesel may be used during project activities. In general, emissions during construction are exempt from Prevention of Significant Deterioration (PSD) review because the PSD requirements are primarily for major stationary sources and specifically exempt temporary increases in these emissions. Emissions from mobile generators are exempt from regulation since the generators will be in place less than 1 year.

In addition, trucks transporting the fuel pins from the fuel fabrication location at MFC to the TREAT Facility produce exhaust emissions. This analysis assumes transportation of fuel pins from MFC to TREAT requires at least 10 batches of shipments between the two facilities. Combustion of fossil fuels in construction equipment, trucks, and worker commuter vehicles would emit nonradiological hazardous air pollutants (HAPs). Temporary emissions include reactive organic gases, nitrogen oxides, and respirable PM with an aerodynamic diameter of 10 micrometers or less (referred to as PM_{10}). PM_{10} consists of PM emitted directly into the air (e.g., fugitive dust, soot, and smoke) from mobile and stationary sources and construction operations.

The mobile and intermittent operation of construction emission sources combined with most construction and facility modifications occurring indoors would result in dispersed concentrations of these HAPs adjacent to construction activities. The substantial transport distance of construction emissions from MFC to the nearest locations of the INL Site boundary (about 3 miles) would produce further dispersion and negligible concentrations of HAPs beyond the INL Site boundary. The intermittent operation of construction and trucks transporting MARVEL microreactor fuel from MFC to the TREAT Reactor building and worker commuter vehicles on public roads would result in low concentrations of HAPs. HAPs concentrations generated by facility modifications and fuel and worker transportation activities would not result in adverse air quality impacts.

Fuel fabrication activities at EFF and FASB, for MARVEL and ongoing activities, have the potential to generate minor amounts of toxic air pollutants and radiological emissions. Fuel fabrication for the MARVEL microreactor at INL will use traditional powder metallurgy processes and bench-scale laboratory equipment already in use at these facilities.

Emissions associated with activities occurring within EFF, including MARVEL and ongoing activities, include small amounts of uranium fumes and particulates and associated chemicals used during the fuel fabrication processes. EFF includes a dual stage bank of HEPA filters and a stack (MFC-794-001). Use of depleted uranium in EFF is limited to 1,000 kg/yr. Use of 5% enriched uranium is limited to 20 kg/yr, and use of 93% enriched uranium is limited to 12 kg/yr. Use of low enriched uranium is limited to 100 kg/yr for the EFF Atomizer (INL, 2019a).

FASB houses a vault, small hot cells, gloveboxes, hoods, and other equipment (sample preparation equipment, multiple microscopes, and other analytical equipment). Research-scale experimental fuel is produced by cleaning, alloying, forming, encapsulation, melting and casting, metal forming and cutting, reactions, welding, and powder processing. Multiple furnaces are used at FASB with a maximum operating temperature of 2200ºC. The FASB west room contains the pyrochemistry glovebox, which is an inert atmosphere glovebox used for developing low-enrichment fuels, treating waste from glovebox operations, working with corrosive materials, and testing equipment used in other facilities.

Emissions associated with activities occurring within FASB include radionuclides and very small amounts of chemicals. The effective dose equivalent (EDE) from FASB operations was calculated using the release factors based on the Environmental Protection Agency (EPA) approved methodology and is less than 0.1 mrem/year. FASB operations do not discharge air pollutants in quantities equal to or exceeding 100 tons per year, nor any pollutants equal to or exceeding the significant emission rates. Evaluations document that each toxic air pollutant emitted is less than all applicable acceptable ambient concentrations and all applicable acceptable ambient carcinogenic concentrations (INL, 2018).

As noted, similar fuel manufacturing activities currently occur in EFF and FASB. Fuel fabrication activities for the MARVEL microreactor uses existing processes in these existing facilities in accordance with the limitations set for in Air Permitting and Applicability Determinations (APAD) for these facilities (INL, 2018) (INL, 2019a). The dose from these facilities is tracked based on inventory on a quarterly basis. Emissions from fuel fabrication for the MARVEL microreactor at EFF, FASB and other facilities at MFC would be consistent with current emissions and operations. The MARVEL fuel fabrication in these INL facilities is not considered a modification in accordance with Idaho Administrative Procedures Act (IDAPA 58.01.01, 2000) and 40 CFR 61 Subpart H (Verdoorn, 2018). As a result, fuel fabrication at INL for the MARVEL microreactor is not anticipated to cause a change in air emissions from these facilities and would not result in adverse air quality impacts. The impacts from fabricating the MARVEL microreactor fuel at INL would be small.

The safety goal of MARVEL microreactor is to control the release of radionuclides to minimize the risk to the public, workers, and environment. This goal is achieved by maintaining fuel integrity, which is the primary contributor to radionuclide release. Fuel integrity is maintained by ensuring the fuel stays below the temperature at which fuel and clad damage occurs. The available data suggest that if fuel temperatures are kept below ~650°C during operation, fission-gas release from fuel into the plenum is negligible. The low fuel centerline temperature reduces fission-product release to negligible amounts and decreases stored energy in the fuel (Olander et. al. 2007). The peak cladding temperature during normal MARVEL microreactor operations is 550°C.

In addition, several barriers inhibit the release to the environment of radioactivity from fission products generated in the MARVEL microreactor. The first barrier is the fuel itself. Many of the fission products will remain trapped in the fuel matrix, though some may diffuse out of the fuel and into the sodium bond liquid or the gas plenum where the fuel cladding, the second barrier, retains the fission products. The third fission-product barrier is the NaK coolant system and the sealed coolant system piping and core barrel. The fourth barrier is the TREAT reactor building with confinement properties that include the building walls, floor, and ceiling. Negative air pressure combined with HEPA filtrations further filters building exhaust air.

The NaK coolant acts as a radionuclide barrier by retaining fission products by plate-out, chemical solubility, or adsorption mechanisms. The radionuclides that are not retained are activation products of potassium, mainly Ar-39 and Ar-41, and will accumulate in the cover gas space. Because the system is sealed, accumulation of Ar-39 can also increase the pressure of the system. It is estimated that about 25 ml of Ar-39 (1.5 curies) and 2.55×10^{-5} ml of Ar-41 (1.96 curies) would be produced over the life of the reactor.

During reactor operation, discharges of liquid or gas from the primary system is not anticipated. The gas volume is sealed, and the total cover gas volume is large enough to accommodate thermal expansion and contraction of the NaK. Discharging NaK or cover gas from the reactor will not be required until decommissioning. At the end of life, prior to coolant draining, the cover gas will be extracted by a simple gas transfer line into a gas storage container, which will be disposed of as LLW as discussed in Section 393.7.

An argon gas blanket may be maintained on the lead-bismuth eutectic heat exchangers to reduce formation of lead and bismuth oxide. During operation of the MARVEL microreactor, activation of the bismuth in the lead-bismuth eutectic (LBE) and the argon cover gas will occur despite available shielding, generating traces of Po-210, Ar-39, Ar-41 and other radionuclides. Argon is gaseous at room temperature, while Polonium volatilizes at elevated temperature. The trace amounts of Po-210 are likely to condense in colder regions if released. However, the MARVEL design isolates the LBE overhead gas region that contains the trace amounts of activation products. Despite trace levels, the activated products will not be released through the stack; rather the design will contain and isolate the cover gas to avoid any potential exposure to the public or onsite personnel. The cover gas will be extracted into a gas storage container, which will be disposed of as discussed in Section 3.7.

Because the MARVEL microreactor is a closed-loop system, there are no direct emissions from the fission process during normal operations. However, neutron activation of the air in the pit (region between the microreactor and the shielding) could conceivably generate minor quantities of particulate and gaseous radionuclides that could be exhausted from the TREAT reactor building stack when the ventilation system is activated. The impact of these potential unabated radioactive air emissions on a collocated worker and offsite member of the public were assessed by Sondrup (2021). Doses were calculated with CAP88-PC, a set of computer programs, databases, and associated utility programs for estimation of dose and risk from radionuclide emissions to the air. CAP88-PC is both a mature and the EPA-recommended model for demonstration of compliance with the applicable performance objective (40 CFR 61, Subpart H). The potential public dose associated with MARVEL operations (3.92E-08 mrem/yr) is below the 10 mrem/yr regulatory standard. The potential dose to a collocated-worker (5.67E-08 mrem/yr) is well below the 5,000 mrem/yr regulatory dose standard.

During decommissioning, hazardous and radioactive materials will be removed to ensure protection of workers, public health and safety, and the environment. Activities associated with D&D of the MARVEL microreactor will be performed in existing INL facilities. The actual emissions would be determined when more definite operational conditions have been defined. D&D operations will comply with all regulatory requirements of the Clean Air Act, and, therefore, are bounded by the regulatory limits. INL will develop an APAD for each applicable source of radiological air emissions associated with the MARVEL microreactor to ensure compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP), Subpart H, including the regulatory limit that facilities must not exceed those amounts that would cause a member of the public to receive an effective dose equivalent (EDE) of 10 mrem/year. The APADs will also demonstrate compliance with the facility emissions cap site wide permit. In the event a Permit to Construct is required, an application for the Permit to Construct will be submitted to Idaho Department of Environmental Quality, pursuant to IDAPA 58.01.01, “Rules for the Control of Air Pollution in Idaho” and an Approval to Construct application will be submitted to EPA, pursuant to 40 CFR 61.96.”

As described above, the MARVEL microreactor (including facility modifications, fuel production, operation, D&D, and waste management) would generate emissions. Review of the impacts shows that the combined activities would produce minor amounts of air emissions. Transport of these emissions to the INL Site boundary would produce negligible ambient air pollutant concentrations at offsite locations. Therefore, the minor increase in offsite air pollutant concentrations produced from the MARVEL microreactor, in combination with emissions from other past, present, and reasonably foreseeable future actions, would result in air pollutant concentrations that would not exceed the state and National Ambient Air Quality Standards and would not substantially contribute to cumulative air quality impacts. Similarly, any radioactive air emissions would result in negligible dose impacts to collocated workers and offsite members of the public. The impacts from the MARVEL microreactor, including cumulative impacts, would be small.

3.3 Ecological Resources

Ecological resources include the plant and animal species, habitats, and ecological relationships of the land and water areas within the area of impact, which is the area directly or indirectly affected by the MARVEL microreactor. Particular consideration is given to sensitive species, which are those species protected under federal or state law, including threatened and endangered species, migratory birds, and bald and golden eagles. For the purposes of this EA, sensitive and protected ecological resources include plant and animal species that are federally (United States Fish and Wildlife Service) or state- (Idaho Department of Fish and Game) listed for protection. Historical reports and further information on ecological resources on the INL Site are available on the DOE-ID Environmental Surveillance, Education, and Research contractor’s website (INL 2019b).

3.3.1 Impacts to Ecological Resources

Impacts to ecological resources are considered significant if they result in a loss of protected or sensitive species or loss of local populations from direct mortality or diminished survivorship.

The facility modifications and operations proposed as part of the MARVEL microreactor would occur in existing facilities. The MARVEL microreactor does not require construction of new facilities or additional land use or ground disturbance. The MARVEL microreactor would have no impacts on ecological resources from these proposed activities.

Trucks transporting fuel pins from the fuel fabrication location at MFC to the TREAT Reactor Facility and worker commuter vehicles have the potential to impact wildlife from inadvertent vehicle strikes. Vehicle noise also disturbs wildlife, causing populations to relocate. While elk and deer adapt to busy highways, roads with continuous, slow-moving traffic cause displacement and changes in range use. Roads displace larger animals, but smaller animals suffer different effects. Because smaller animals are less noticeable and slower-moving, direct kills from motorized vehicles are common.

This analysis assumes transportation of fuel pins from MFC to TREAT requires at least 10 batches of shipments between the two facilities. Increased motor vehicle activity from transportation events between TREAT and MFC would not result in major disruptions to wildlife or increases in wildlife mortality, because the MARVEL microreactor is located where vehicle use regularly occurs. The intermittent operation of trucks transporting MARVEL microreactor fuel from MFC to the TREAT and the low transport speed between facilities further reduce the likelihood of vehicle and wildlife collisions. The loss of protected or sensitive species or loss of local populations from direct mortality or diminished survivorship is not anticipated.

The MARVEL microreactor is anticipated to require an additional 10 employees at the INL Site. The addition of 10 additional worker commuter vehicles on public roads would not be discernible from current INL operations. Therefore, impacts to wildlife would be negligible.

Radiological activities that cause direct radiation of the environment, or that discharge or otherwise release radioactive material into the environment must comply with DOE-STD-1153-2019, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE, 2019b) to show that dose rates to representative biota populations do not exceed the dose rate criteria in DOE Order 458.1. The impact of potential radioactive air emissions on terrestrial biota were assessed using RESRAD-BIOTA and a Level 1 screening analysis are documented in *The Analysis of Radiological Impacts to Terrestrial Biota in Support of the Environmental Assessment for the Microreactor Applications Research, Validation, and Evaluation (MARVEL) Microreactor at Idaho National Laboratory* (Claver & Case, 2020). Radionuclide soil concentrations around the TREAT reactor facility from potential air emissions were conservatively estimated and compared to Biota Concentration Guides (BCGs). Terrestrial BCGs are limiting concentrations of radionuclides in soil that would not cause dose rate criteria for protection of populations of terrestrial biota to be exceeded. The analysis shows that the limits established for protection of terrestrial biota would not be exceeded.

From a cumulative impact perspective, the incremental impacts of the MARVEL Project when added to past, present, and reasonably foreseeable actions at the INL Site are small.

3.4 Cultural and Historic Resources

The MARVEL microreactor was reviewed under section 106 of the National Historic Preservation Act (NHPA) per 36 CFR 800 (2000) through processes identified in the INL Cultural Resource Management Plan (CRMP) (DOE-ID, 2016) and supporting documents by INL Cultural Resource Management Office personnel meeting the appropriate Secretary of the Interior’s Professional Qualifications Standards for cultural resource management under 36 CFR 61 (1999). The Cultural Resource Review is documented in BEA-20-H116 (Scales-English, 2020) and is summarized below:

The direct and indirect Area of Potential Effect (APE) includes the following architectural properties: TREAT Reactor building (MFC-720), TREAT Reactor (MFC-726), TREAT Control Room Building (MFC-724), FASB (MFC-787), and EFF (MFC-794). Of these properties, two were previously evaluated as potentially eligible for listing to the NRHP, one is newly recommended eligible, and two are determined not eligible (MFC-721 and MFC-794). The three historic properties evaluated for potential effects include the following: the TREAT Reactor building (MFC-720) (Category 1), TREAT Reactor (MFC-726) (newly evaluated), and FASB (MFC-787) (Category 3) (DOE-ID, 2016).

The proposed fuel production aspects of the MARVEL microreactor project includes the use of FASB and EFF. FASB is recommended eligible for listing to the NRHP and is considered a historic property per the INL CRMP (DOE-ID, 2016). EFF is recommended not eligible (DOE-ID, 2016). As described, no modifications to the facilities are required, but some internal reconfiguration of bench-scale equipment may occur. Internal reconfigurations of active laboratories are an exempt activity and do not have the potential to affect the historic character of architectural properties.

The TREAT Reactor building and TREAT Reactor are potentially eligible under Criteria A and C for contributions to Science and Engineering dating from 1942 to 1970. FASB is potentially eligible for its contributions to Science and Engineering during the same time period as the TREAT Reactor building (MFC-720) and TREAT Reactor (MFC-726). Within the APE, there are no archaeological resources present, as confirmed by 2013 surveys conducted by Pace and Williams (Pace & Williams, 2013).

Construction of the TREAT Reactor building (MFC-720) began in February 1958 on the high-bay containment building that would house the TREAT Reactor (MFC-726). The TREAT Reactor building was first modified and expanded in 1960. Subsequent modifications and expansions of the building occurred in 1972 and around 1980. It is likely these modifications were made to accommodate expansion in mission and facility needs as the nuclear science and engineering program across the INL Site was in full swing. The reactor was shut down in 1994 and placed in stand-by mode while the building was closed, cool and dim.

Construction began on The TREAT Reactor in February 1958 on the subsurface aspects of the reactor structure and was complete by November in the same year. With the completion of the MFC-720 in 1958, the above-ground components of the reactor were installed and operational by 1959. Criticality occurred on February 23, 1959 (Boland, Geier, MacFarlane, Elias, & Fruend, 1960). Over the years, some modifications have been made to the research equipment used during operation, such as the addition of a hodoscope, but the original structural integrity of the reactor remains intact. During standby from 1994 to 2017, reactor modifications were not made, but components were prepped in a manner which allowed for successful operation after decades of inactivity.

In 2014, actions were initiated to restart the reactor (MFC-726) and upgrade components of the containment building (MFC-720) to meet new needs in research and mission for DOE (DOE-ID, 2014). Restart and use of the facility began in 2017.

Of the three historic properties present within the APE, modifications to meet the needs of the MARVEL microreactor will occur only within the TREAT Reactor building (MFC-720). Due to the operation of MARVEL microreactor inside the MFC-720 and in proximity to the TREAT Reactor (MFC-726), consideration of potential effects to the TREAT Reactor have been evaluated. Modifications to the TREAT Reactor (MFC-726), FASB (MFC-787), or EFF (MFC-794) are not anticipated for the MARVEL microreactor. If reconfiguration of active laboratory spaces are to occur within EFF and FASB, they are considered to be an exempt activity (Internal Reconfiguration of Active Laboratories), as per the INL CRMP (DOE-ID, 2016). MFC-726 will not be impacted in any way throughout the implementation and operation of the MARVEL microreactor project.

The MARVEL microreactor will be placed in a storage pit located in the northern bay of MFC-720. Venting components from the enclosed space during operations require penetrations to accommodate heat and emergency piping and equipment located on the exterior aspect of the building.

As described, the MARVEL microreactor will have no adverse effects to historic properties. The proposed use of the storage pit and indicated modifications to MFC-720 and MFC-721 are consistent with the ongoing R&D activities associated with science and engineering at INL. Furthermore, placing and operating the MARVEL microreactor in proximity to the TREAT Reactor will not affect the historic property. Use of EFF and FASB for fuel production is consistent with science and engineering research activities and does not pose a threat to the historic integrity of FASB.

The MARVEL microreactor would have no adverse effects to eligible or potentially eligible NRHP sites. Therefore, the MARVEL microreactor does not contribute to cumulative impacts to eligible cultural and historical resources.

The proposed use of FASB for fuel fabrication is not anticipated to alter the historic character. Furthermore, internal bench-level reconfigurations of these facilities fall within the definition of an exempt activity (Internal Reconfiguration of Active Laboratories). As such, the proposed use of FASB is determined to have no effect on the historic property.

Per the requirements identified in the INL CRMP (DOE-ID, 2016), the SHPO will not be consulted prior to issuance of the EA for public comment given the undertaking is anticipated to have No Adverse Effects to TREAT building (MFC-720) and TREAT reactor (MFC-726), and No Effects to FASB (MFC-787).

3.5 Geology

The TREAT Facility at INL is located on the Eastern Snake River Plain (ESRP), part of the Snake River Plain, a large physiographic region (~90 km [56 mi] wide and 560 km [348 mi] long) with low-relief and covered by basaltic lava flows and sediments. The Snake River Plain extends in a broad arc across southern Idaho from the Yellowstone Plateau, Wyoming on the east and into eastern Oregon on the west (Figure 13). Surface elevations on the Snake River Plain decrease continually and gradually from approximately 2,000 m (6,562 ft) near Yellowstone, to approximately 650 m (2,132 ft) near the Idaho-Oregon border.

The ESRP represents the track of buried and extinct volcanic centers associated with passage of the North American plate over the relatively stationary “Yellowstone hotspot” (Pierce & Morgan, The Track of the Yellowstone Hot Spot: Volcanism, Faulting, and Uplift, 1992) (Pierce & Morgan, 2009) (Smith, et al., 2009). From about 6.3 to 8.4 million years ago, the crust beneath the ESRP at and near INL’s location was impacted by volcanism associated with the Yellowstone hotspot (McCurry, et al., 2016) (Anders, et al., 2014) (Schusler, Pearson, McCurry, Bartholomay, & Anders, 2020). Volcanism within the last 2.1-million years associated with the Yellowstone hotspot is now beneath the Yellowstone Plateau (Christiansen, et al., 2007), 160 to 230 km (99 to 143 mi) northeast of the INL Site. Since about 4 million to 2,100 years ago in the ESRP at and around INL, basaltic magma has continued to periodically erupt producing volcanic vents and lava flows (Kunz, et al., 1994) (Kunz, Anderson, Champion, Lanphere, & Grunwald, 2002) (Kuntz, Skipp, Champion, Gans, & Van Sistine, 2007). Surface basalt flows at the INL Site range in age from 13,000 years old to 1.2 million years old (Kunz, et al., 1994). During intervening eruptive periods, sediments have been deposited by wind and surface water. Along the southern INL Site border, basaltic magma stagnated in the crust and eventually evolved in composition to erupt from 300,000 years to 1.4 million years ago as rhyolitic domes which formed five buttes with heights between 120 and 750 m (394 to 2,460 ft) (McCurry, Hayden, Morse, & Mertzman, 2008).

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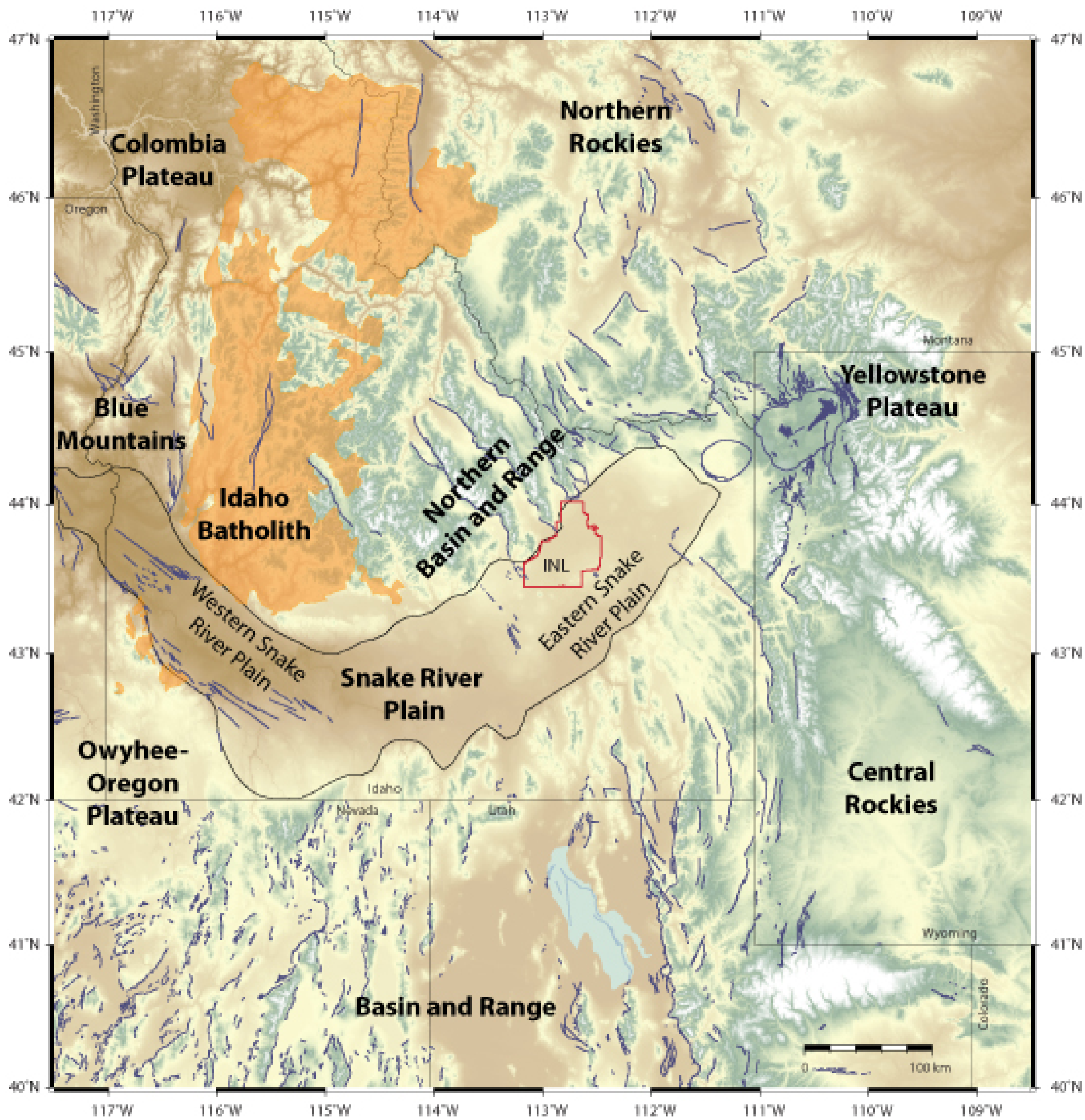

Figure 13. Location of the Snake River Plain and the INL Site.

The Snake River Plain transects and sharply contrasts with the surrounding mountainous country of the Northern Basin and Range Province. Summits of mountains surrounding the Snake River Plain rise to an elevation of 3,660 m (12,000 ft), producing a maximum elevation contrast of about 2,150 m (7,050 ft). North and northwest trending mountain ranges, up to 200 km (124 mi) long and 30 km (19 mi) wide, are separated by intervening basins filled with terrestrial sediments and volcanic rocks. Quaternary (<2.6 million year old) normal faults typically bound the basins along one side adjacent to range fronts. Earthquakes occurring from 1850 to 2014 with magnitudes >2.0 compiled from INL's and other nearby seismic networks show a parabolic distribution of epicenters in the mountainous region outside of the ESRP (Figure 14). The two largest earthquakes, 1959 moment magnitude (M) 7.3 Hebgen Lake, Montana and 1983 M 6.9 Borah Peak, Idaho, produced surface ruptures along 30 to 36 km long normal faults (Doser, 1985) (Crone, et al., 1987). The 1983 earthquake caused ground shaking but no damage at INL since its epicenter was 80 to 115 km (50 to 70 mi) northwest of the INL Site (Figure 14) (Richins, et al., 1987). Infrequent small magnitude earthquakes occur within the ESRP. From 1972 to 2018, INL's seismic network has located 111 microearthquakes with magnitudes <2.4 in the ESRP (Bockholt, Payne, Graw, & Sandru, 2020). Of these, 18 occurred within INL boundaries and none were located near the TREAT Facility.

The TREAT Facility at MFC is located on the eastern part of the INL Site and on thin surficial sediments of primarily eolian origin overlying basaltic lava flows. Surface sediment thicknesses range from ~0.3 m (1 ft) to 3 m (10 ft) and are composed primarily of sandy silt and clayey silt containing basalt rock fragments at some locations. Basaltic lava flows at MFC erupted as Pahoehoe flow types and generally have rubbly zones from the top of the flow to more massive interiors at the center (Northern Testing Laboratories, 1978). MFC is underlain by basalt lava flows that erupted from nearby vents from ~350,000 years ago to over 1.4 million years. The closest basaltic vents are >7 km (4.3 mi) east and south of TREAT. There are no mapped faults at or near TREAT nor volcanically induced features such as ground cracks or fractures (Northern Testing Laboratories, 1978) (Kunz, et al., 1994).

No environmental impacts are assessed from the MARVEL microreactor in TREAT as a result of potential future earthquakes. The TREAT Reactor building is classified as a seismic design category (SDC), SDC-2. Per DOE Order 420.1C, *Facility Safety* (2019), implemented through DOE Standard, DOE-STD-1020, *Natural Phenomena Hazards Design and Evaluation Criteria* (2016), seismic design criteria for TREAT are obtained from the International Building Code (IBC). The MARVEL microreactor and its installation in TREAT will be designed to withstand vibratory ground motions (or ground shaking) as specified by IBC. Ground shaking levels are obtained from the U.S. National Seismic Hazard maps available online from the U.S. Geological Survey (https://www.sciencebase.gov/catalog/item/5d5597d0e4b01d82ce8e3ff1) for the specific rock conditions and geographical location of TREAT. Because no impacts from the MARVEL microreactor would occur as a result of earthquakes, cumulative impacts are not expected.

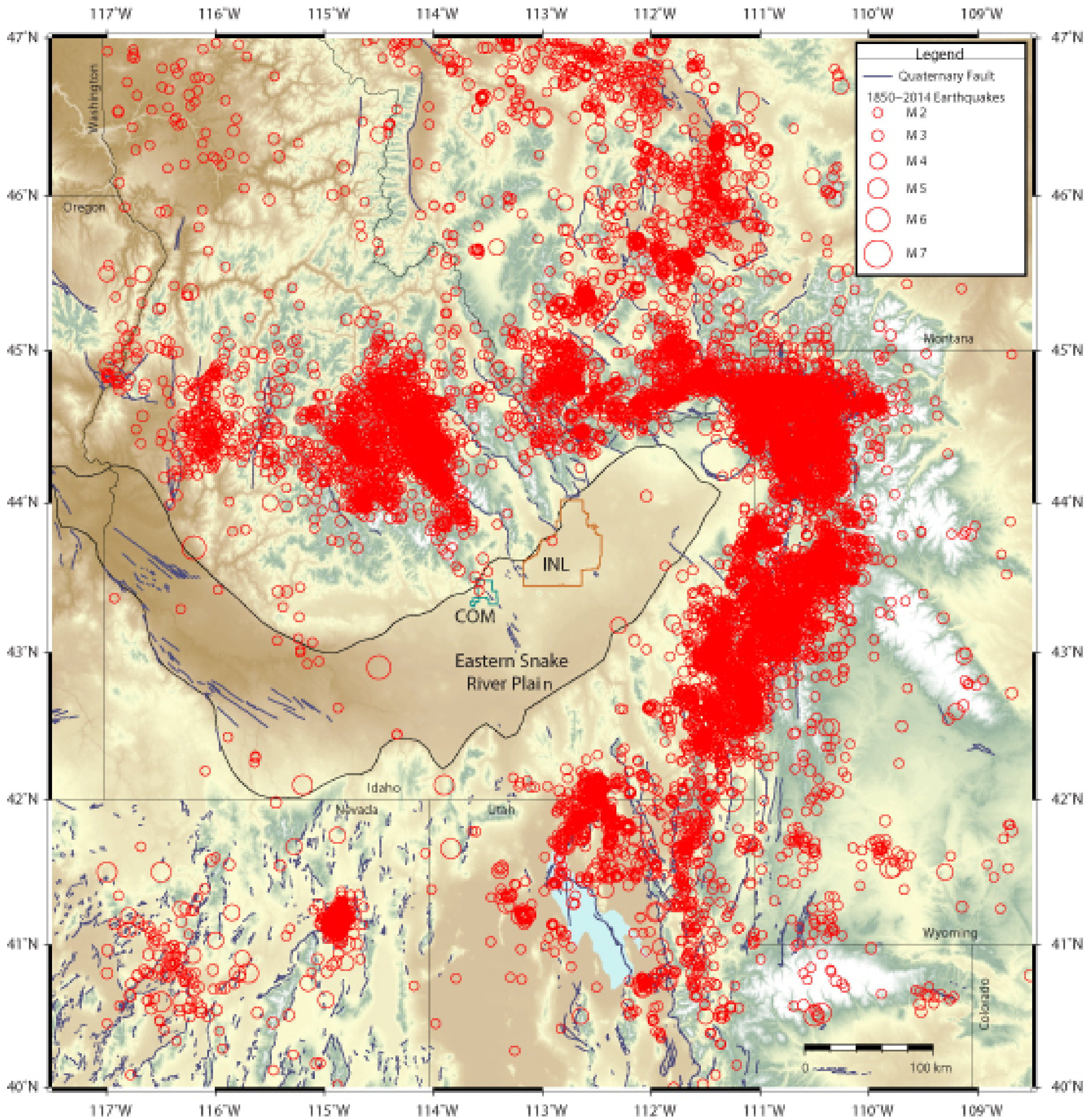

Figure 14. Earthquakes occurring from 1850 to 2014 with magnitudes >2.0 in areas surrounding the INL Site.

3.6 Infrastructure

Site infrastructure includes basic resources and services required to support planned construction and operation activities and the continued operations of existing facilities. For the purposes of this EA, infrastructure is defined as electricity, fuel, water, and sewage.

The facility modifications, construction, operations, and D&D proposed as part of the MARVEL microreactor would occur in existing facilities. The MARVEL microreactor does not require construction of new facilities or additional land use or ground disturbance. In addition, current electrical energy consumption at INL is 156,639 MW-hours annually. The MARVEL microreactor would use about 10 kW-hours of electricity supplied by the INL Site power infrastructure over the life of the project, so the increase in use is anticipated to be less than 0.3%. Impacts to electrical energy consumption at MFC and the INL Site would be small and nearly indiscernible from current consumption rates.

The MARVEL microreactor water loop heat exchanger uses about 116 gallons of water and adding 10 new employees under the MARVEL microreactor would result in a small increase in water consumption. The small increase in water consumption would not affect the ability of the system to provide an adequate supply to meet the requirements for personnel, process, and fire protection purposes.

MFC has a sanitary sewer system to collect and treat domestic wastewater from the facilities. The MFC wastewater lagoons were designed for flows of about 14,950 gallons per day. Adding 10 new employees under the MARVEL microreactor would not result in discernable impacts to the system.

INL employs about 5,200 employees (Jankowski, 2020). During a typical workweek, the majority of employees take buses to various work areas at the INL Site, covering about 70 bus routes. About 1,200 private vehicles also travel to and from the INL Site daily. Adding 10 new commuter trips per day under the MARVEL microreactor would not result in discernable impacts traffic at the INL Site or on public roads.

The MARVEL microreactor would have small impacts on INL Site infrastructure. These small impacts would be nearly indiscernible from current operations when combined with past, present, and reasonably foreseeable future actions. Cumulative impacts would be small.

3.7 Waste Management

The INL Waste Management Program (WMP) provides the processes and procedures for compliant management of radioactive waste, hazardous waste, mixed waste, universal waste, and hazardous recyclables at INL. The INL WMP facilitates management of containerized radioactive waste, hazardous waste, mixed waste, universal waste, and hazardous recyclables from characterization through disposal so that long-term waste storage prior to disposition is minimized and exposures are below allowable levels and as low as reasonably achievable (ALARA) in compliance with DOE Order 435.1 (2007).

All radioactive waste is managed according to subject to DOE O 435.1, *Radioactive Waste Management* (see glossary for definitions of waste types).

The construction and mobilization phase of the MARVEL microreactor would generate non-radioactive electronic waste, scrap metal, and other construction-related debris. Construction debris, electronic waste, and scrap metal could be recycled or disposed of at onsite facilities or sent offsite, but would be recycled to the extent possible, regardless of facility. The various non-radioactive total waste volumes generated as part of the MARVEL microreactor construction and mobilization are expected to be less than 3 m^3 (90 ft^3), some of which can be recycled. To put this volume in perspective, the INL industrial waste landfill accepts and buries about 23,000 m^3 (about 812,000 ft^3) of waste and trash each year. The impact from constructing and mobilizing the MARVEL microreactor on industrial waste generation at the INL Site would be small.

LLW may be generated during construction and would include contaminated used personal protective equipment, wipes and rags, and tools. Solid LLW would be sent to an offsite disposal facility permitted and licensed to accept LLW. It is expected that the contamination levels on the LLW from construction would be very small as a result of the handling of MARVEL microreactor components containing reactor fuel and working in established Radiological Buffer Areas in the TREAT Reactor Facility. The volumes of these various LLWs generated during this phase are expected to be less than 5 m^3 (180 ft^3). The INL WMP has an established source term for contamination and LLW originating in the TREAT Reactor Facility. At the time of disposition, Waste Management personnel will evaluate the source term contribution from the MARVEL microreactor fuel depending on activities that generated the waste, but it is expected that the TREAT source term will be bounding for all LLW.

No mixed low-level waste (MLLW) (waste which is both radioactive and hazardous) is anticipated to be generated during the construction and mobilization phase. However, if MLLW were to be generated, the volumes would likely be minimal and would be accumulated and stored in accordance with federal and state regulations and disposed of at an offsite permitted and licensed facility following existing processes.

Construction and mobilization phase waste will use established INL WMP waste disposition outlets. The expected volumes of all types of construction and mobilization phase waste will not impact existing WMP resources and schedules. This phase may generate up to eight cubic meters (about 280 ft^3) of all waste types. MFC waste management personnel typically handle an average of 680 m^3 (24,000 ft^3) per year.

Waste generate from fuel fabrication in EFF and FASB will generate small amounts of industrial waste, LLW, and MLLW.

It is expected that the waste generated during the microreactor operations phase will be limited to LLW associated with the day-to-day operations and maintenance of the MARVEL microreactor. For comparison purposes, the TREAT and total MFC LLW waste generation for FY2020 was used to evaluate the MARVEL microreactor generation rate, as shown in Table 6.

Table 6. Annual LLW Generations rates for MFC, TREAT and the MARVEL microreactor.

Reactor or Complex	Annual LLW Generation Rate
TREAT	2.72 m^3 (96 $ft^{3)}$
MARVEL	2.72 m^3 (96 ft^3) (assumed the same as TREAT)
MFC	FY2020- 832.45 m^3 (29394 ft^3)

The LLW generated from MARVEL operations would be included in the TREAT facilities' total but was set equivalent for this estimate. This volume expected from MARVEL operations would contribute about 3.3% of the MFC LLW volume. The TREAT facility has a routine LLW collection program and the small contribution from the MARVEL microreactor operation and maintenance would be easily accommodated into standard radioactive waste management programs. The LLW generation at this rate would use existing established INL Waste Management Program waste disposition outlets and would have a negligible impact on Waste Management resources and schedules.

No MLLW is anticipated to be generated during the reactor operations phase. However, if MLLW were to be generated, the volumes would likely be minimal and would be accumulated and stored in accordance with federal and state regulations and disposed of at an offsite permitted and licensed facility following existing processes. The most likely source of MLLW would be sampling and analysis waste, which would be neutralized during the analysis and disposed of as laboratory waste. If the samples are not completely used, the resulting waste will meet requirements for onsite permitted storage, which currently has disposition paths open for treatment and disposal.

For D&D of the MARVEL microreactor, an activation analysis and modeling of the MARVEL microreactor beryllium oxide side reflectors reveals that these components will be DOE LLW or NRC Class A LLW and can be dispositioned through existing disposition paths, either DOE or commercial sites (Black & Grant, 2021) (Trellue, Vedant, Rao, Lange, & Sterbenz, 2021). It is assumed that this analysis would be bounding for other components and wastes that may be generated. Given this, it is concluded that all radioactive waste, other than the reactor fuel, generated in this phase will be NRC Class A LLW or MLLW and has current disposition paths in DOE or commercial facilities.

The disposition of the primary coolant, NaK, will be one of the major waste generating operations. NaK used as the primary coolant can become activated in a neutron flux with predominate activation products being the short-lived, (Trellue, Vedant, Rao, Lange, & Sterbenz, 2021). A minor amount of coolant activation products will be present due to activation of impurities in the coolant. The approximate

61 gallons of NaK primary coolant can be packaged in a manner that can be treated and dispositioned by existing disposition vendors. It may be necessary to package the NaK in small containers to meet Department of Transportation (DOT) and vendor waste acceptance requirements. The treatment methods may include GeoMelt or water/steam deactivation. NaK has been safely managed at MFC facilities through experience with the Experimental Breeder Reactor (EBR)-II sodium systems and the EBR-I NaK systems. The primary coolant treatment from both reactors was conducted at MFC.

Primary system piping and components will need to be drained and free from NaK to be dispositioned as LLW. This LLW debris can be dispositioned using existing disposition paths. These components will also be packaged and treated using an appropriate treatment technology (GeoMelt or water/steam deactivation). Both methods have been successfully demonstrated and completed at MFC and Perma-Fix in Richland, Washington. The proposed technologies to remove and treat the NaK are available and have been conducted in the past. Secondary waste from NaK treatment must be disposed at an off-site mixed waste Subtitle D or Subtitle C disposal facility, which are available at the DOE Nevada Nuclear Security Site, the commercial Waste Control Specialist facility in Texas, or the commercial EnergySolutions Clive facility in Utah.

Propylene glycol can be dispositioned using existing disposition paths. In the event that the ethylene glycol becomes contaminated or potentially contaminated there are disposition paths for radioactive fluids of this type. This waste can be dispositioned in either a liquid or a solid form.

Stirling engine heat exchangers will likely contain hazardous constituents (electronics, heavy metals, etc.) which will require them to be dispositioned as MLLW. Additionally, the portions of the engines that are in the PCS must be demonstrated to be free of unreacted sodium or NaK and reactivity via water submersion with no hydrogen generated. The NaK contaminated Stirling engines will be treated using GeoMelt or water/steam deactivation as discussed above. As noted, both methods have been successfully demonstrated and completed at MFC and Perma-Fix. The metal hazardous constituents can be treated at the same vendor as the NaK. The engines will be disposition as MLLW using existing disposition paths.

Removing the IHX intact is necessary to eliminate releasing Polonium-210, which is produced in the IHX from activation of bismuth in the lead-bismuth eutectic coolant. The IHX containing lead-bismuth eutectic will be removed intact and discarded intact. The IHX would be managed as MLLW due to the lead-bismuth alloy. Disposal facilities are readily available.

Miscellaneous electronics and components may contain hazardous constituents. Due to the existing radiological conditions in the areas surrounding the reactor and radiological conditions that will be created as part of the D&D process, it will likely not be economical to radiologically free release items. Given this, most items that contain hazardous constituents will be classified as MLLW. Disposition of this waste stream will be through existing vendors and disposition paths.

Reactor fuel, reactor vessel and associated activated metal components will be disassembled and analyzed using existing MFC facilities and processes. The resulting waste from this analysis will be dispositioned using existing waste disposition paths (i.e., transuranic (TRU), remote-handled LLW level waste, contact-handled LLW, and MLLW).

Given the small size of the reactor and associated components and systems, the waste volumes generated in this phase will have a small impact on the WMP and disposition vendors. Cumulative radiological and waste generating impacts would be minimal. Radiological releases during normal waste management operations would not result in adverse health impacts. Additional waste volumes would be small compared to current waste volumes at INL. These small volumes would be nearly indiscernible from current operations when combined with past, present, and reasonably foreseeable future actions. Cumulative impacts from waste generation, management, and disposal would be small.

3.8 Spent Nuclear Fuel

Management of spent nuclear fuel (SNF) includes the processes necessary to support the safe and secure storage of the SNF in a configuration that is ready for shipping to an Independent Spent Fuel Storage Installation or permanent repository. This includes: (1) the interim storage for the dissipation of heat and reduction of radiation dose immediately after discharge, (2) treatment of reactive materials and damaged fuel, (3) potential recovery of TRU material (if desirable or as a result of treatment processes), (4) packaging for extended dry storage or transport to a repository, (5) extended dry storage while awaiting packaging or transport to a repository, and (6) transport to a repository. Disposition refers to the permanent disposal of the SNF.

The MARVEL microreactor core will be disassembled and analyzed using existing MFC facilities and processes. Fuel pins are removed from the reactor and surveyed for radiation and contamination. After inspection the assemblies will be placed in designated shipping or storage containers following criticality control protocols. Containers can be dry stored at TREAT or shipped to MFC for storage or reprocessing in accordance with legal, regulatory, operations and scheduling requirements for the transfer and storage of these fuels.

For onsite transport at INL, DOE Order 460.1D (2016) allows for the preparation of a Transportation Safety Document to demonstrate equivalent safety for deviations from hazardous materials transportation requirements. The *INL Transportation Safety Document* (INL, 2017) describes the INL packaging and transportation program and explains the methodology for complying with the rules, laws, and regulations governing onsite and offsite transportation functions at the INL Site.

Non-routine shipments are shipments that do not fully comply with DOT hazardous material regulations and require the preparation of a Transport Plan. Cases that require the preparation of Transport Plans include variations to packaging requirements (such as the use of a packaging not authorized by DOT for shipping the material), packaging limits (such as radiation or contamination limits), and any other DOT requirements that cannot be met. The *INL Transportation Safety Document* (INL, 2017) requires that Transport Plans identify, as applicable, the specific DOT requirement(s) not met, hazard category, safety analysis, technical safety requirements, administrative controls, hazard controls, engineered barriers, and site-mitigating conditions that ensure a level of safety equivalent to that afforded by DOT requirements for routine shipments.

INL allows an alternative to preparing Transport Plans for non-routine shipments. This alternative involves preparing a Documented Safety Analysis that includes transportation activities at nonreactor nuclear facilities. If the Documented Safety Analysis addresses all transportation hazards and controls necessary to provide safety equivalent to DOT regulations, then the requirements of DOE Order 460.1D (DOE O 460.1D, 2016) are met and a Transport Plan is not required for the transportation of the material covered by the Documented Safety Analysis. The INL report *Safety Analysis Report for Intra-INL and MFC Inter-Facility Transfers* (INL, 2019b) is an example of a Documented Safety Analysis prepared in lieu of a Transport Plan. The technical safety requirements derived from INL (INL, 2019b) are contained in the INL report (INL, 2019d).

Preliminary criticality and radiation shielding evaluations for various transfer and storage configurations of the 36 MARVEL microreactor fuel elements were performed (Kitcher, 2020). Configurations include various transfer casks for transferring SNF and irradiated experiments between INL facilities and a SNF storage canister currently in use at INL. The ATR transfer cask, HFEF-5 transfer cask, and the High Load Charger are used for the transfer of irradiated fuel between INL facilities, and these casks could potentially be used for transferring irradiated MARVEL microreactor fuel between INL facilities.

The analysis in Kitcher (2020) also suggests that all three transfer casks give sufficient radiation shielding to workers during transfer of the MARVEL microreactor fuel and storage. These calculations support the planning and strategy for the MARVEL microreactor and demonstrate the technical viability of the different configurations discussed and help identify where engineering and administrative controls may be necessary. A complete criticality safety analysis and radiation shielding analysis, including validation and contingency and accident analysis must be completed by licensed and authorized personnel before any transfer or storage of irradiated MARVEL microreactor fuel.

The MARVEL fuel will be U $ZrH_{1.7}$ sodium bonded to type 316 SS or Incoloy 810 cladding. Sodium-bonded SNF requires special consideration and treatment due to the potential for chemical reaction between elemental sodium and air and water. Thus, the sodium bearing SNF from the MARVEL microreactor requires deactivation or removal of the sodium before disposal. The MARVEL microreactor fuel will be similar to sodium bonded fuel currently managed by DOE at INL. The Fermi-1 and EBR-II SNF serve as examples of uranium metal sodium-bonded fuel. Current technologies can be applied to provide safe and secure management of the MARVEL microreactor SNF. INL currently treats sodium-bonded EBR-II assemblies at MFC using processes evaluated in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (Sodium-Bonded Fuel Environmental Impact Statement [EIS]) (DOE, 2000). Treatment processes may produce various waste streams that must be dispositioned. Waste forms and disposition are discussed in Section 3.7.

The principal function of treating and conditioning the MARVEL microreactor SNF is to remove sodium from SNF containing sodium metal to make it acceptable at a repository. Once the sodium has been separated from the SNF, the material is sorted as a non-sodium-contaminated waste. To treat the elemental sodium extracted by the process, it is anticipated that existing MFC facilities would be used. The analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted.

While the MARVEL microreactor fuel is not specifically addressed in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel*, the 150 kg of MARVEL microreactor fuel represent a minute fraction of the 60 metric tons of heavy metal (MTHM) of sodium-bonded SNF analyzed in the Sodium Bonded Fuel EIS. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS.

The current SNF inventory at INL includes over 250 different types of SNF (Hill & Fillmore, 2005). The INL SNF inventory totals about 315 MTHM (INL, 2019c) stored in both wet and dry storage facilities at the INL site. Disposal options for many of these fuels were identified as part of the Yucca Mountain Repository project, including all necessary treatment packaging and transportation requirements for final disposition. Additional information on these fuel groups may be found in the *Yucca Mountain Repository License Application Safety Analysis Report* (DOE, 2009).

Packaging of SNF serves three necessary purposes: (1) preparation of SNF for extended dry storage, (2) preparation of SNF for transport, and (3) preparation of SNF for eventual disposal in a permanent repository. The DOE Standard Canister provides a high-integrity leak-tight barrier that satisfies the necessary safety functions and facilitates storage, transport, and disposal operations. Per the current DOE SNF disposition strategy, MARVEL microreactor SNF, after appropriate treatment, is expected to be disposed of using the DOE Standard Canister once the appropriate evaluation and analyses are performed.

INL has several facilities with fuel handling and packaging capabilities, though additional modifications for packaging into DOE Standard Canisters may be required. For the MARVEL microreactor fuel concept, existing INL facilities at MFC currently have the capability to handle similar fuels in the INL SNF inventory. Therefore, it is likely that the MARVEL microreactor SNF can be handled using these facilities.

The SNF is required to be stored using a design that (1) assures sub criticality, (2) maintains the fuel as integral units that can be individually handled for repackaging, (3) provides structure that is able to confine the radioactive material to prevent a release to the environment in operational and accident conditions, 4) provides thermal control to dissipate heat that could adversely affect the system's containment function, and 5) provides radiation shielding to minimize personnel dose to levels acceptable in storage and transportation (10 CFR 830, 2011).

The regulations relevant to the storage of SNF are recorded as schedules in the Code of Federal Regulations (CFR). The key schedules dealing with the storage of SNF is 10 CFR 72 which deals with packaging and storing SNF. In addition, INL manages SNF in accordance with the numerous DOE Records of Decision (RODs) and EISs on SNF management, including the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Program* (DOE, 1995). This ROD records a department-wide decision for DOE-owned SNF management and contains decisions dealing with site-wide environmental restoration and waste management programs at the INL Site (DOE, 1995).

MARVEL microreactor SNF may be managed in existing INL facilities so far as the legal, regulatory, operational, and scheduling requirements for the transfer and storage of these fuels in existing facilities are met. Transfer to existing facilities will be predicated on the appropriate analyses and procedures. Existing INL facilities are available to provide extended dry storage for the MARVEL microreactor SNF, including the Radioactive Scrap and Waste Facility, until final disposition is available.

SNF debris would be securely stored with DOE's spent fuel and spent fuel debris inventory awaiting a future disposal facility. The environmental impacts associated with management of spent nuclear fuel debris are addressed in the *Programmatic Spent Nuclear Fuel (SNF) and Idaho National Engineering Laboratory (INEL) Environmental restoration and Waste Management Environmental Impact Statement* (DOE, 1995).

The regulations relevant to the final disposition of SNF are contained in 40 CFR 197 and 10 CFR 63 for the disposal of SNF at the Yucca Mountain site and 40 CFR 191 and 10 CFR 60 for disposal at sites other than Yucca Mountain.

To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 millirem in a year. In addition, worker doses are monitored and controlled below the regulatory limit to ensure that individual doses are less than an INL administrative limit of 700 millirem per year, and maintained at ALARA levels (DOE-STD-1098-2017, 2017). INL would monitor worker doses and take appropriate action to limit individual worker doses below this administrative level. The dose received by workers would be monitored and limited for the MARVEL microreactor SNF management operations at any existing facility.

Individual worker doses from transportation would also be limited to meet DOE administrative worker dose limits. During transfer and storage, the spent fuel would be contained in transportation or storage casks, limiting exposure to workers. DOE limits the dose resulting from the handling of these casks to 10 millirem per hour at a distance of 2 meters from the cask. Spent fuel handling would not impact the total worker exposure.

As with all SNF at present, the question of permanent disposition of SNF is directly dependent on the identification and licensing of a permanent repository for SNF in the United States. However, given the diversity of existing SNF that must be prepared and packaged for direct disposal, MARVEL microreactor fuel will not pose any new challenges. The cumulative impacts from managing the MARVEL microreactor SNF would be small.

3.9 Radiation Exposure and Risk

DOE monitors radiation in the environment and exposure of workers and calculates the radiation doses of members of the offsite general public and onsite workers from operation of the INL Site. Historically, the dose to the MEI has been in the range of hundredths of an mrem/yr and less than 1% of the 10-mrem/yr federal standard (40 CFR 61 Subpart H). For calendar year 2019 the EDE to the MEI member of the public from INL Site operations was 5.59E-02 mrem per year, which is 0.56 percent of the 10 mrem per year standard, for the INL Site (DOE-ID, 2020). The risk of developing a Latent Cancer Fatality (LCF) from this dose is small, much less than 1 in a million. In addition, the annual dose to an individual from INL Site operations is several orders of magnitude less than the average dose of 383 mrem per year from exposure to natural background radiation (e.g., cosmic gamma, internal, and terrestrial radiation) for someone living on the Snake River Plain (VNS Federal Services, 2019). The impacts from radiological air emissions are discussed in Section 3.2.1.

To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 mrem (5 rem) per year. In addition, worker doses must be monitored and controlled below the regulatory limit to ensure that individual doses are less than an administrative limit of 2,000 mrem (2 rem) per year DOE-STD-1098-2017, *Radiological Control* (DOE-STD-1098-2017, 2017), and maintained ALARA.

3.9.1 Impacts from Radiation Exposure and Risk

Because the MARVEL microreactor is a closed-loop system, there are no direct emissions from the fission process during normal operations. However, neutron activation of the air in the pit (region between the microreactor and the shielding) could conceivably generate minor quantities of particulate and gaseous radionuclides that could be exhausted from the TREAT reactor building stack when the ventilation system is activated. The potential dose to an offsite member of the public from these unabated emissions was estimated by Sondrup (2021) and found to be extremely low (3.9E-08 mrem/yr). This is 0.00007% of the 2019 dose to the MEI member of the public for all INL Site operations. Thus, cumulative impacts to the public would be minimal. The dose from MARVEL air emissions to a collocated worker at the TREAT reactor control building (nearest location) was also estimated by Sondrup (2021) and determined to be 5.7E-08 mrem/yr. This is also extremely low and minimal compared to the already low exposures estimated for INL workers (see discussion below). Thus there is effectively no increase in cumulative impacts to the public or collocated workers from radioactive air emissions during normal operations, as discussed in Section 3.2.1.

Fuel fabrication activities for the MARVEL microreactor uses existing processes in these existing facilities in accordance with the limitations set for in 10 CFR Part 835 DOE-STD-1098-2017 (2017), and maintained ALARA. The gloveboxes to be used during fuel fabrication use shielding and radiological designs adequate to limit operator radiological exposure.

INL Site workers receive the same dose as the general public from background radiation, but they also receive an additional dose from working in facilities with nuclear materials. Potential committed doses to workers, the public, and the environment, would be assessed in full compliance with DOE Order 458.1, *Radiation Protection of the Public and the Environment* (2020), and 10 CFR Part 835, *Occupational Radiation Protection*. Dose based consequences of the MARVEL microreactor, as detailed in this EA, are derived from the Annals of the International Commission on Radiological Protection (ICRP) Publication 103, *The 2007 Recommendations of the International Commission on*

Radiological Protection (ICRP, 2007), and in consideration of the latest available scientific information of the biology and physics of radiation exposure.

The MARVEL microreactor would require about 10 workers involved in radiological operations that could receive measurable doses. Based on exposure data for 2019 the average dose to a TREAT worker that receives a dose is about 17 mrem per year, which equates to 0.085 mrem per day (assuming 200 days of work per year). MARVEL microreactor operations would potentially add 2 mrem/yr to an estimated 25 TREAT workers for an additional 50 person-mrem. Consequently, the average MARVEL microreactor worker would be expected to receive a dose of approximately 19 mrem and the total MARVEL microreactor worker dose would be approximately 190 person-mrem. Tables 7 and 8 present the doses and the LCF risks associated with these worker doses. All doses are well within the administrative control level for INL workers (700 mrem per year). During all operations, DOE would implement measures to minimize worker exposures and maintain doses ALARA, including the use of shielding, personal protective equipment, and training mock-ups to improve the efficiency of operations and reduce exposure times (Clark & Christiansen, 2020).

Table 7. MARVEL microreactor personnel anticipated annual worker dose and LCF.

Worker Radiological Risk Normal Operations	Dose for Project	Radiological Risk (LCF)
Average worker	19 mrem	0 (0.00001)
Total workers	190 person-mrem	0 (0.0001)

Table 8. TREAT personnel microreactor anticipated increase in annual worker dose and LCF.

Worker Radiological Risk Normal Operations	Dose for Project	Radiological Risk (LCF)
Average worker	2 mrem	0 (0.000001)
Total workers	50 person-mrem	0 (0.00003)

For comparison, the average total effective dose (TED) for INL employees from 2014 to 2018 was 70.4 mrem as shown in Table 9. Operating the MARVEL microreactor would have a small impact on worker occupational exposure to radiation.

Table 9. Annual radiation doses to INL workers during operations from 2014 to 2018.

Year	Collective TED (person-rem)	Number with Measurable Dose	Avg. Meas. TED (rem)	Radiological Risk (LCF)*
2014	86.202	1174	0.073	0 (0.05)
2015	123.232	1331	0.093	0 (0.07)
2016	92.67	1273	0.073	0 (0.06)
2017	79.008	1175	0.067	0 (0.05)
2018	86.799	1373	0.063	0 (0.05)
AVERAGE	93.582	1265.2	0.074	0 (0.06)
*Calculated using a dose conversion factor of 6 × 10-4 LCF per rem (6 × 10-7 LCF per mrem). Values in parentheses are calculated values. A value of less than 0.5 is considered to result in no LCFs.				

Activities associated with D&D of the MARVEL microreactor will be performed in existing INL facilities. The activation of reactor components has been evaluated in the *MARVEL Initial Shielding and Dose Calculations* (Trellue, Vedant, Rao, Lange, & Sterbenz, 2021). INL would monitor worker doses and take appropriate action to limit individual worker doses below this administrative level. DOE-STD-1098-2017 (2017) identifies an effective ALARA process as including implementation of both engineered and administrative controls to control worker dose. All equipment and operations would be designed and implemented following this principle. Therefore, needed worker protection would be incorporated into the final D&D process potentially reducing worker doses. The dose received by workers would be monitored and limited for the MARVEL microreactor D&D operations at any existing facility in accordance with regulatory limits.

The impacts from radiation exposure from the management of SNF are discussed in Section 3.8.

The average dose to the individual worker (involved worker) and the cumulative dose to all INL Site workers (total workers) fall within the radiological regulatory limits of 10 CFR 835 (2011). Existing low population exposures of humans to radiation from the MARVEL microreactor would remain low because the level of effluent releases and regulatory requirements are not anticipated to change.

3.9.2 Accident Analysis

The hazard evaluation of MARVEL microreactor events and associated operations was performed for selection and evaluation of safety classification of structures, systems and components (SSCs), SSC safety functions, and DBAs applicable to the MARVEL microreactor design. With these SSCs in place, the MARVEL microreactor can be built and operated safely in the existing Transient Reactor Test (TREAT) facility. The MARVEL microreactor will not be operated at the same time as the TREAT Reactor is operating and would not result in an accident event involving the TREAT Reactor.

The MARVEL microreactor will be located in the TREAT Reactor building in the north high-bay equipment pit. As such, the documented safety analysis (DSA) for the MARVEL Project is in the form of an addendum to the existing TREAT final safety analysis.

The MARVEL microreactor is designed to survive a wide variety of off normal, upset or accident conditions. A thorough evaluation of potential accident conditions is ongoing, including an assessment of DBAs for which the reactor is designed and demonstrated to successfully handle with minimal to no release. These events include reactivity insertion events leading to a transient overpower, cooling issues related to loss of flow, and loss of heat sink scenarios. In these DBAs, the MARVEL microreactor is designed to successfully withstand the accident conditions without intervention of active safety systems, instead relying on the passive safety of the design to prevent the release of fission products to the environment.

In all DBA scenarios, the plant control and trip system is designed to activate, and at least 3 of the 4 CDs passively rotate inward to shut down the reactor. In the event that the control and trip system fails, the inherent reactivity feedback mechanisms incorporated into the design provide for the reactor power to be suppressed to a low power stable state without failure of the fuel and fission product boundaries. The passive heat removal system ensures that the reactor heat is rejected without the need for forced flow and external power. Although temperatures in the core may elevate, the passive heat removal design ensures that fuel, clad, and primary coolant boundary temperatures remain within their design performance limits. The fuel, clad, and primary coolant boundary will not be damaged, and all confinement barriers would remain intact. Therefore, there are no radiological releases or radiological consequences postulated in these scenarios.

While the MARVEL microreactor design incorporates significant safety benefits based on passive safety systems, it is plausible that a severe accident could occur that would be beyond the plant design basis. Thus, a maximum reasonably foreseeable accident involving a natural phenomena hazard event, with the energy to structurally impact the core and overwhelm the design of the passive safety features of the reactor is evaluated in ECAR-5363, *MARVEL Environmental Assessment Inhalation Dose Consequence Calculation*s (Reiss, 2021). Of the potential events considered, a structural damage event leading to failure of the CDs to insert and rearrangement of the core leading to a significant reactivity insertion (i.e., power increase) is identified. It is postulated that in the limiting event sequences, the resulting step insertion of reactivity could lead to core damage.

The model and calculations for the reactor accident are documented in ECAR-5363, *MARVEL Environmental Assessment Inhalation Dose Consequence Calculations* (Reiss, 2021). The accident analysis was conducted using Radiological Safety Analysis Computer (RSAC) Program 7.2 to model accident conditions. RSAC 7.2 is a radiological safety analysis tool developed and used extensively at INL for calculating the inhalation dose to collocated workers and offsite public due to accidental radiological releases. It has been independently verified and validated for these types of calculations.

The RSAC 7.2 program used in the analysis allows the user to specify meteorological conditions at the time of the release and calculate diffusion, dispersion, and depletion factors. Other parameters used for inhalation dose consequence evaluation include source term, plume dispersion, receptor breathing rate, ICRP dose conversion factor for each receptor, and deposition factors where appropriate in determining an estimated total effective dose (TED) at each receptor location.

The methodology for dose estimates is further detailed in (Reiss, 2021). The results from the RSAC accident consequence calculations are shown in Table 10.

Table 10. Summary of dose impacts for the highest postulated accident consequences for the MARVEL microreactor.

Receptor	Dose (TED), rem	LCF*
TREAT Control Room at 770 m	2.71E+00	0 (2.0E-03)
Nearest Site Boundary, 6,000 m	1.31E-01	0 (8.0E-05)
Nearest Low Population Zone, 32,000 m	2.28E-02	0 (1.4E-05)
Idaho Falls, 48,000 m	1.66E-02	0 (1.0E-05)
*Calculated using a dose conversion factor of 6×10^{-4} LCF per rem. Values in parentheses are calculated values. A value of less than 0.5 is considered to result in no LCFs.		

Significant adverse consequences from significant releases of radioactive or hazardous materials are limited by the MARVEL core size and fission product inventory. However, DOE requirements for emergency planning in DOE O 151.1D, *Comprehensive Emergency Management System* (DOE, 2019a), the large distances to site boundaries on DOE facilities, and additional safety management programs, mitigate the consequences from these extremely low probability events. In all cases, the release of the fission products is well within guidelines for public exposure. Existing low population exposures of humans to radiation from postulated accidental events associated with the MARVEL microreactor would remain small.

Onsite shipments containing radiological materials undergo an extensive safety analysis and review process to ensure proper safety plans are developed and implemented. 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 even less likely 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 the INL Site 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.

The level of radioactive material releases from effluent releases associated with the bounding accident scenario, when combined with past, present, and reasonably foreseeable actions at INL, are small. Therefore, cumulative effects from the MARVEL microreactor would also be small. Therefore, cumulative impacts from accidental releases would be small.

3.10 Nonradiological Health and Safety

Nonradiological exposures at the INL Site are controlled through programs intended to protect workers from normal industrial hazards. These programs are controlled by the safety and health regulations for DOE contractor workers governed by 10 CFR 851 (2012), which establishes requirements for worker safety and health programs to ensure that DOE contractor workers have a safe work environment. Provisions are included to protect against occupational injuries and illnesses, accidents, and hazardous chemicals.

Potential impacts from noise, exposure to chemicals, and occupational injuries are and would continue to be regulated to be protective of human health. Per 10 CFR 851 (2012), employee exposures to hazardous agents are maintained below the American Conference of Governmental Industrial Hygienists threshold limit values, the Occupational Safety and Health Administration (OSHA) permissible exposure limits, and other applicable standards as defined by DOE. When exposure limits defined by the various agencies conflict, INL policy is to comply with the more stringent limit.

Hazardous materials (radiological and chemical) at the INL Site are minimized to those necessary to accomplish the mission. The MARVEL microreactor will follow site-wide procedures for handling and storing hazardous materials.

Standard Industrial Hazards are hazards that are routinely encountered in general industry and construction; for these hazards, national consensus codes and standards, such as OSHA standards and DOE-prescribed occupational safety and health standards, guide safe design and operation of the MARVEL microreactor. In accordance with the guidelines in DOE-STD-1027-2018, *Hazard Categorization of DOE Nuclear Facilities* (2019), and DOE-STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis* (DOE-STD-3009-2014, 2014), no special analysis is required for these occupational hazards unless they are possible initiators for an uncontrolled release of radioactive or hazardous material.

The level of exposure nonradiological hazards, the regulatory requirements for managing those hazards, and existing exposures are not anticipated to change. Therefore, the direct, indirect, and cumulative impacts from exposure to normal industrial hazards at INL would be small.

3.11 Emergency Preparedness

DOE Order 151.1D, *Comprehensive Emergency Management System,* (DOE, 2019a) describes detailed requirements for emergency management that DOE must implement. Each DOE site, facility, and activity, including the INL Site, establishes and maintains a documented emergency management program that implements the requirements of applicable federal, state, and local laws, regulations, and ordinances for fundamental worker safety programs (e.g., fire, safety, and security). In addition, each DOE site, facility, and activity containing hazardous materials, such as radioactive materials or certain chemicals that do not fall under the purview of fundamental worker safety programs, establishes and maintains an Emergency Management Hazardous Materials Program. Finally, each site that receives or initiates shipments managed by the Office of Secure Transportation must be prepared to manage an emergency involving such a shipment, should that emergency occur on site.

The emergency management system at INL includes emergency response facilities and equipment, trained staff, and effective interface and integration with offsite emergency response authorities and organizations. INL maintains the necessary apparatus, equipment, and a state-of-the-art Emergency Operations Center in Idaho Falls to respond to emergencies, not only at INL, but throughout the local communities.

A readiness assessment will be completed prior to constructing and operating the MARVEL microreactor in the TREAT Reactor building to demonstrate that there is a reasonable assurance that operations are performed safely and provide adequate protection of workers, the public, and the environment. This assessment includes, but is not limited to, an evaluation of safety management programs; operational interfaces, selection, training, and qualification of operations and support personnel; implementation of facility safety documentation; programs to confirm and periodically reconfirm the condition and operability of all safety and support systems; procedures; emergency management; and conduct of operations processes.

3.12 Intentional Destructive Acts

DOE considered Impacts of intentional acts of destruction occurring at an INL facility or during transport between facilities. INL's protective force mitigates the potential for an act of sabotage occurring on site. INL routinely uses 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 protective force monitors and patrols site perimeters to prevent unauthorized entry. Access to INL roads would be restricted during transport of radioactive materials. Security measures would be in place to mitigate the likelihood and consequences of sabotage. Transportation crewmembers would be screened for behavioral and substance abuse issues and would receive safety and security training. Crewmembers would conduct a thorough inspection of vehicles and loads before transport. During transport, crewmembers have a means of communication and immediately report suspicious activity encountered while in route.

The potential for and consequences of intentional destructive acts against the TREAT Reactor were based on conservative assumptions and evaluated in the *Final Environmental Assessment for the Resumption of Transient Testing of Nuclear Fuels and Materials* (DOE-ID, 2014), which states that an act of sabotage at the TREAT Reactor building would result in dose consequences similar to the highest consequence event scenarios evaluated for the TREAT Reactor. The EA for the Resumption of Transient Testing (DOE-ID, 2014) further found that (1) doses and LCFs for members of the public were negligible for all scenarios at the TREAT Reactor building, (2) that administrative controls and protective actions and equipment would be used to mitigate worker doses, and (3) the accident consequences for workers are also considered to be negligible.

Accident analyses for the MARVEL microreactor were also evaluated based on conservative assumptions using parameters resulting in the highest postulated dose to workers and public receptors as described in Section 3.9.2, and any acts of sabotage, should they occur, would be expected to result in consequences that would be bounded by the results of accident scenarios detailed in Section 3.9.2. Significant adverse consequences from significant releases of radioactive or hazardous materials are limited by the MARVEL core size and fission product inventory.

Table 11 shows the dose to workers at the TREAT Control Building and the public at the nearest INL Site boundary from the bounding accident analysis for the TREAT Reactor and MARVEL microreactor. Assuming an act of sabotage resulting from the bounding releases from both reactors, the release of fission products would remain small and within guidelines for public exposure. Resultant health impacts to members of the public would be small. Resultant health impacts to workers would be mitigated by normal response actions and would also be small.

Table 11. Summary of dose impacts for the highest postulated accident consequences for the TREAT Reactor and MARVEL microreactor at the TREAT Control Building and nearest INL Site boundary

Source	Dose (TED), rem	LCF
TREAT Control Building 770 m		
TREAT Reactor	6.5	0 (0.015)
MARVEL Microreactor	27.5	0 (0.02)
Public Exclusion Boundary 6,000 m		
TREAT Reactor	0.24	0 (1.4E-04)
MARVEL	2.65	0 (2.0E-3)

3.13 Conclusion

Table 12 lists a summary of the anticipated environmental impacts from the MARVEL microreactor as described in this EA. Implementing the MARVEL microreactor would result in small adverse impacts to the environment. However, these impacts, in conjunction with other past, present, and reasonably foreseeable future actions, would not result in discernible cumulative impacts.

Table 12. Summary of environmental impacts under the MARVEL microreactor.

Resource	MARVEL microreactor
Air	The MARVEL microreactor would produce minor amounts of pollutants and radioactive air emissions. The small increase in offsite air pollutant concentrations produced from the MARVEL microreactor, in combination with emissions from other past, present, and reasonably foreseeable future actions, would not result in air pollutant concentrations that would exceed the state and National Ambient Air Quality Standards and would not substantially contribute to cumulative air quality impacts. Doses to members of the public from radioactive air emissions are insignificant relative to regulatory limits.
Ecological	The facility modifications and operations proposed as part of the MARVEL microreactor would occur in existing facilities. The MARVEL microreactor does not require construction of new facilities or additional land use or ground disturbance. Impacts from radioactive air emissions would be much less than limits established for protection of terrestrial biota. From a cumulative impact perspective, the incremental impacts of the MARVEL microreactor when added to past, present, and reasonably foreseeable actions at the INL Site are small.

Resource	MARVEL microreactor
Historical and Cultural	There would be no adverse effects to eligible or potentially eligible NRHP sites.
Geology	No environmental impacts would occur from MARVEL in TREAT as a result of potential future earthquakes.
Infrastructure	The MARVEL microreactor would have small impacts on INL Site infrastructure. These small impacts would be nearly indiscernible from current operations when combined with past, present, and reasonably foreseeable future actions.
Waste Management	Additional waste volumes from the MARVEL microreactor would be small compared to current disposal volumes at INL. These small volumes would be nearly indiscernible from current operations when combined with past, present, and reasonably foreseeable future actions.
Spent Nuclear Fuel	Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities.
Radiation Exposure and Risk	The level of effluent releases, regulatory requirements (including those for occupational doses), and existing low exposures are not anticipated to change. The level of the expected normal radioactive gaseous effluent releases would remain the same. Normal radioactive liquid effluent releases would remain unchanged. Therefore, cumulative impacts from radiation exposure are not anticipated.
Health and Safety	Potential impacts from noise, exposure to chemicals, and occupational injuries are and would continue to be regulated to be protective of human health. No adverse impacts to human health and safety are anticipated from the MARVEL microreactor. Nonradiological emissions would be minimal.
Emergency Preparedness	INL maintains the necessary apparatus, equipment, and a state of the art Emergency Operations Center in Idaho Falls to respond to emergencies, not only at from the MARVEL microreactor and other INL Site operations, but also throughout local communities.
Intentional Destructive Acts	Acts of sabotage are unlikely, but should they occur, resultant health impacts to members of the public would be small. Resultant health impacts to workers would be mitigated by normal response actions and would also be small.

4. PERMITS AND REGULATORY REQUIREMENTS

The MARVEL microreactor would be regulated by numerous federal and state legal requirements addressing environmental compliance. For some activities, DOE has sole authority to take action, such as under the Atomic Energy Act of 1954. The MARVEL microreactor would be authorized by DOE, just like previous test reactors (e.g., ATR and TREAT). The MARVEL microreactor will not be licensed by the NRC.

The U.S. Department of Transportation regulates commercial transportation of hazardous and radioactive materials. The U.S. Environmental Protection Agency (EPA) would regulate many aspects of the proposed activities. In many cases, EPA has delegated all or part of its environmental protection authorities to the States but retains oversight authority. In this delegated role, the Idaho Department of Environmental Quality regulates most air emissions; discharges to surface water and groundwater; drinking water quality; and hazardous and nonhazardous waste treatment, storage, and disposal. Under DOE Order 436.1, *Departmental Sustainability* (2011), it is DOE's policy to carry out its mission in a sustainable manner by maximizing energy and water efficiency; minimizing chemical toxicity and harmful environmental releases; promoting renewable and other clean energy development; and conserving natural resources while sustaining assigned mission activities.

The major federal laws, regulations, Executive Orders (Presidential directives that apply only to federal agencies), and DOE Orders; state laws and regulations; and other requirements that could apply to the MARVEL microreactor analyzed in this EA are identified in Table 13.

Table 13. Applicable laws, regulations, orders, and other requirements.

Law, Regulation, Order, or Other Requirement	**Description**
General Environmental	
NEPA of 1969, as amended, 42 U.S. Code (USC) § 4321 et seq.	Establishes a national policy for environmental protection and directs all federal agencies to use a systematic, interdisciplinary approach to incorporating environmental values into decision- making.
Council on Environmental Quality, Regulations for Implementing NEPA, 40 CFR Parts 1500–1508	Defines actions that federal agencies must take to comply with NEPA.
DOE National Environmental Policy Act Implementing Procedures, 10 CFR Part 1021	Establishes DOE's program implementing the procedural provisions of NEPA.
Executive Order 11514, *Protection and Enhancement of Environmental Quality*, as amended by Executive Order 11991	Requires Federal agencies to direct their policies, plans, and programs so as to meet national environmental goals established by NEPA.
Executive Order 12088, Federal Compliance with Pollution Control Standards	Directs federal agencies to comply with applicable administrative and procedural pollution control standards established by, but not limited to, the Clean Air Act (CAA), Noise Control Act, Clean Water Act (CWA), Safe Drinking Water Act, Toxic Substances Control Act, and Resource Conservation and Recovery Act (RCRA).
Executive Order 13834, *Efficient Federal Operations*	Focuses on meeting statutory requirements to improve efficiency, optimize performance, eliminate unnecessary use of resources, and protect the environment.
DOE Order 231.1B, *Environment, Safety, and Health Reporting*	Ensures timely collection, reporting, analysis, and dissemination of information on environment, safety, and health issues as required by law or regulations or as needed by DOE.
DOE Order 436.1, *Departmental Sustainability*	Defines requirements and responsibilities for managing sustainability within DOE.
DOE Policy 450.4A, *Integrated Safety Management Policy*	Sets forth the framework for identifying, implementing, and complying with environmental safety and health requirements so that work is performed in the DOE complex in a manner that ensures adequate protection of workers, the public, and the environment.
DOE Policy 451.1, *National Environmental Policy Act Compliance Program*	Establishes DOE's expectations for implementing NEPA; the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508); and the DOE NEPA Implementing Procedures (10 CFR Part 1021).

Law, Regulation, Order, or Other Requirement	Description
Water Resources	
Federal Water Pollution Control Act (Clean Water Act [CWA]), 33 USC 1251 et seq.	Establishes a national program to restore and maintain the chemical, physical, and biological integrity of navigable waters by prohibiting the discharge of toxic pollutants in significant amounts without a permit; requires federal agencies to comply with federal, state, and local water quality requirements; Section 404 of the CWA regulates development activities in jurisdictional surface waters and wetlands, and delegates EPA and the U.S. Army Corps of Engineers (USACE) to share Section 404 enforcement authority regarding the discharge of dredged or fill material into waters of the United States; allows EPA to delegate primary enforcement authority for National Pollutant Discharge Elimination System (NPDES) permits (Section 402) to Idaho. As of 2016, Idaho DEQ received permitting authority to address water pollution by regulating point sources that discharge pollutants to Idaho's surface water.
Safe Drinking Water Act of 1974, as amended, 42 USC 300f et seq.	Establishes a national program to ensure the quality of drinking water in public water systems; allows EPA to delegate primary enforcement authority to Idaho.
National Primary Drinking Water Regulations, 40 CFR Part 141	Creates standards for maximum contaminant levels for pollutants in drinking water; used as groundwater protection standards.
Procedures for Decision-making (Permitting), 40 CFR Part 124	Contains EPA procedures for issuing, modifying, revoking and reissuing, or terminating all RCRA, PSD, and NPDES permits.
Rules Regulating the Idaho Pollutant Discharge Elimination System Program, IDAPA 58.01.25	EPA authorized permitting authority to the Idaho Pollutant Discharge Elimination System (IPDES) Program, like NPDES, to address water pollution by regulating point sources that discharge pollutants to waters of the United States.
Idaho Ground Water Protection Act of 1989 Idaho Wastewater Rules, IDAPA, 58.01.16 Idaho Recycled Water Rules, IDAPA 58.01.17	Establishes the Idaho Groundwater Quality Plan and declares the policy to provide for the protection of the state's ground water for beneficial uses as a public resource. Establishes Creates procedures and requirements for the planning, design, and operation of wastewater facilities and the discharge of wastewaters and human activities which may adversely affect public health and water quality in the waters of the state. Establishes procedures and requirements for the issuance and maintenance of pollution source permits for reuse facilities, also referred to as "reuse permits."
Idaho Groundwater Quality Rules, IDAPA 58.01.11	Establishes minimum requirements for protection of groundwater quality through standards and an aquifer categorization process; serves as basis for administration of programs which address groundwater quality but do not in and of themselves create a permit program.

Law, Regulation, Order, or Other Requirement	Description
Individual/Subsurface Sewage Disposal Rules and Rules for Cleaning of Septic Tanks, IDAPA 58.01.03	Establishes limitations on the construction and use of individual and subsurface sewage disposal systems and establishes the requirements for obtaining an installation permit and an installer's registration permit.
Idaho Rules for Public Drinking Water Systems, IDAPA 58.01.08	Controls and regulates the design, construction, operation, maintenance, and quality control of public drinking water systems to provide a degree of assurance that such systems are protected from contamination and maintained free from contaminants that may injure the health of the consumer.
Air Quality	
Clean Air Act of 1970, as amended, 42 USC 7401 et seq.	Requires federal agencies to comply with air quality regulations; includes four major programs: 1) the National Ambient Air Quality Standards (NAAQS); state implementation plans; new source performance standards; and NESHAP; allows EPA to delegate authority for most CAA provisions to Idaho, who would issue or modify permits, as needed, for stationary sources associated with the proposed activities.
Ambient Air Quality Standards/State Implementation Plans, 40 CFR Parts 51 and 58	Establishes the NAAQS, which are divided into primary and secondary categories for carbon monoxide, lead, nitrogen dioxide, ozone, sulfur dioxide, and PM.
Prevention of Significant Deterioration, 40 CFR 51.166	Establishes processes for maintaining air quality in areas already in compliance with the NAAQS (attainment areas); requires comprehensive preconstruction review and the application of best-available control technology for major stationary sources.
New Source Performance Standards, 40 CFR Part 60	Creates industry- and process-specific standards that apply to any new, modified, or reconstructed sources of air pollution.
National Emission Standards for Hazardous Air Pollutants and for Source Categories, 40 CFR Parts 61 and 63	Defines HAPs (such as radionuclides, mercury, and asbestos) and maximum achievable control technologies by industry or process. (Proposed activities would add to site HAPs emissions, whose combined ambient concentrations are then compared to the standards).
National Emission Standards for Emissions of Radionuclides other than Radon from DOE Facilities, 40 CFR Part 61, Subpart H	Establishes requirements for monitoring radionuclide emissions from facility operations and analyzing and reporting radionuclide doses; limits, in Subpart H, the radionuclide dose to a member of the public to 10 mrem per year.
State Operating Permit Programs, 40 CFR Part 70	Defines minimum permit requirements, including air pollution control, reporting, monitoring, and compliance certification requirements; includes permitting program known as Title V for major sources of air pollution.
Idaho Environmental Protection and Health Act, IC, Title 39, Health and Safety, Chapter 1, Department of Health and Welfare, Sections 39-105 Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01	Provides for development of regulations for the control and permitting of air emission sources. Provides rules and permitting programs to control air pollutant emissions in Idaho.

Law, Regulation, Order, or Other Requirement	Description
Ecological Resources	
Migratory Bird Treaty Act of 1918, 16 USC 703 et seq. Migratory Bird Permits, 50 CFR Part 21	Implements several international treaties related to the protection of migratory birds and makes it illegal to take, capture, or kill any migratory bird, or to take any part, nest, or egg of any such birds; applies to purposeful actions, not to incidental take.
Endangered Species Act of 1973, 16 USC 1531 et seq. Interagency Cooperation – Endangered Species Act of 1973, as amended, 50 CFR Part 402	Requires federal agencies to assess whether actions could adversely affect threatened or endangered species or their habitat.
Cultural and Historic Resources	
American Antiquities Act of 1906, 16 USC 431 et seq. Preservation of American Antiquities, 43 CFR Part 3	Protects prehistoric American Indian ruins and artifacts on federal lands; authorizes the President to designate historic areas as national monuments.
Historic Sites Act of 1935, 16 USC 461 National Historic Landmarks Program, 36 CFR Part 65	Provides for the preservation of historic American sites, buildings, objects, and antiquities of national significance, and serves other purposes.
National Historic Preservation Act of 1966, 16 USC 470 et seq. National Register of Historic Places, 36 CFR Part 60 et seq. Curation of Federally Owned and Administered Archaeological Collections, 36 CFR Part 79 Protection of Historic Properties, 36 CFR Part 800	Sets forth the procedural requirements for listing properties on the National Register of Historic Places; identifies the process for evaluating the eligibility of properties for inclusion in the National Register of Historic Places: requires consultation with the State Historic Preservation Officer and Native American tribes prior to any action that could affect historic resources (this consultation will be accomplished for the proposed activities, as needed).
Archaeological and Historic Preservation Act of 1974, as amended, 16 USC 469 et seq.	Requires the preservation of historical and archaeological data (including relics and specimens) that might otherwise be irreparably lost or destroyed as the result of federal construction projects.
American Indian Religious Freedom Act of 1978, 42 USC 1996	Protects and preserves, for American Indians, their inherent right of freedom to believe, express, and exercise their traditional religions, including access to sites.
Archaeological Resources Protection Act of 1979, 16 USC 470aa-mm Protection of Archaeological Resources, 43 CFR Part 7	Protects archaeological resources and sites on federal and American Indian lands and establishes the uniform definitions, standards, and procedures to be followed by all federal land managers in providing protection for archaeological resources located on public lands and American Indian lands of the United States, including collections of prehistoric and historic material remains, and associated records, recovered under the authority of the American Antiquities Act (16 USC 431-433), the Reservoir Salvage Act (16 USC 469–469c), Section 110 of the National Historic Preservation Act (16 USC 470h-2), or the Archaeological Resources Protection Act (16 USC 470aa-mm).

Law, Regulation, Order, or Other Requirement	Description
Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments*	Requires consultation and coordination with American Indian Tribes prior to taking actions that affect federally recognized tribal governments.
Executive Order 13287, *Preserve America*	Promotes the protection of federal historic properties and cooperation among governmental and private entities in preserving cultural heritage.
DOE Order 144.1, *Department of Energy American Indian Tribal Government Interactions and Policy*	Establishes a policy committing DOE to consultation with American Indian tribal governments to solicit input on DOE issues.
DOE Policy 141.1, *Department of Energy Management of Cultural Resources*	Ensures that DOE programs and field elements integrate cultural resources management into their mission and activities.
Idaho Historic Preservation Act, IC, Title 67, Chapter 46, Preservation of Historic Sites	Requires consultation with responsible local governing body for historic preservation.
Infrastructure	
Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, Chapter 103, Subchapter 1, Hazardous Substances Releases, Liability, Compensation	Regulates construction of hazardous waste storage, including for radioactive materials.
Waste Management	
Low-Level Radioactive Waste Policy Act of 1980, 42 USC 2021 et seq. Criteria and Procedures for Emergency Access to Non-Federal and Regional Low-Level Waste Disposal Facilities, 10 CFR Part 62	Specifies that the federal government is responsible for the disposal of certain LLW, including LLW owned or generated by the DOE; and specifies States are responsible for the disposal of commercially generated LLW; pertains to waste that could be generated by the proposed activities.
Nuclear Waste Policy Act of 1982, 42 USC 10101 et seq. Disposal of High-Level Radioactive Wastes in Geologic Repositories, 10 CFR Part 60 Licensing Requirements for the Independent Storage of SNF and High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste, 10 CFR Part 72	Establishes national program for the disposal of high-level radioactive waste and used nuclear fuel.
Byproduct Material, 10 CFR Part 962	Defines byproduct material as identified in the Atomic Energy Act, and clarifies that the hazardous portion of mixed radioactive waste is subject to RCRA
DOE National Security and Military Applications of Nuclear Energy Authorization Act of 1980, Public Law 96-164, 93 Stat. 1259	Includes information related to the authorization basis of the Waste Isolation Pilot Plant for the disposal of contact-handled and remote-handled transuranic waste.

Law, Regulation, Order, or Other Requirement	Description
Solid Waste Disposal Act of 1965 as amended by RCRA of 1976 and the Hazardous and Solid Waste Amendments of 1984, 42 USC 6901 et seq. RCRA Regulations for Non-hazardous Waste, 40 CFR Parts 239-259 RCRA Regulations for Hazardous Waste, 40 CFR Parts 260-273	Establishes comprehensive management system for hazardous wastes, addressing generation, transportation, storage, treatment, and disposal; allows, per Section 3006 of RCRA (42 USC 6926), States to establish and administer permit programs with EPA approval; allows EPA to delegate primary enforcement authority to Idaho.
Federal Facility Compliance Act of 1992, 42 USC 6961 et seq.	Waives sovereign immunity for federal facilities under RCRA; requires DOE to conduct an inventory and develop a treatment plan for mixed wastes.
Toxic Substances Control Act of 1976, 15 USC 2601 et seq. Toxic Substances Control Act, 40 CFR Parts 700-799	Gives EPA the authority to screen and regulate new and existing chemicals to protect the public from the risks of exposure to chemicals; establishes specific provisions to address polychlorinated biphenyls, asbestos, radon, and lead-based paint.
Pollution Prevention Act of 1990, 42 USC 13101 et seq. Comprehensive Procurement Guidelines for Products Containing Recovered Materials, 40 CFR Part 247	Establishes requirement to prevent pollution by emphasizing source reduction and recycling. EPA is charged with developing measures for source reduction and evaluating regulations to promote source reduction.
DOE Order 435.1, *Radioactive Waste Management*	Ensures that all DOE radioactive waste is managed in a manner that is protective of worker and public health and safety and the environment.
Idaho Hazardous Waste Management Act, IC Title 39, Chapter 44 Idaho Rules and Standards for Hazardous Waste, IDAPA 58.01.05	Requires proper controls for the management of solid and hazardous waste. Establishes requirements applicable to all hazardous waste management facilities in Idaho.
Idaho Solid Waste Facilities Act, IC Title 39, Chapter 74 Idaho Solid Waste Management Rules, IDAPA 58.01.06	Establishes requirements applicable to all solid waste and solid waste management facilities in Idaho.
Nuclear Materials Management	
Atomic Energy Act of 1954, as amended, 42 USC 2011 et seq.	Provides fundamental jurisdictional authority to DOE and NRC over governmental and commercial use, respectively, of nuclear materials; authorizes DOE to establish standards to protect health or minimize dangers to life or property for activities under DOE jurisdiction; allows DOE to issue a series of orders to establish a system of standards and requirements that ensure safe operation of DOE facilities.
Procedural Rules for DOE Nuclear Facilities, 10 CFR Part 820	Governs the conduct of persons involved in DOE nuclear activities and, in particular, to achieve compliance with DOE nuclear safety requirements.
Nuclear Safety Management, 10 CFR Part 830	Governs the conduct of DOE contractors, DOE personnel, and other persons conducting activities (including providing items and services) that affect, or may affect, the safety of DOE nuclear facilities.

Law, Regulation, Order, or Other Requirement	Description
DOE Order 410.2, *Management of Nuclear Materials*	Establishes requirements and procedures for the lifecycle management of nuclear materials within DOE.
DOE Order 425.1D, *Verification of Readiness to Start Up or Restart Nuclear Facilities*	Establishes requirements for DOE for verifying readiness for startup of new nuclear facilities and for the restart of existing nuclear facilities that have been shut down.
DOE Order 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*	Establishes selection, qualification, and training requirements for management and operating contractor personnel involved in the operation, maintenance, and technical support of DOE reactors and nonreactor nuclear facilities.
DOE Order 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*	Establishes a safety management program required by 10 CFR Part 830 for maintenance and the reliable performance of structures, systems, and components that are part of the safety basis at Hazard Category 1, 2, and 3 DOE nuclear facilities.
DOE Policy 470.1B, *Safeguards and Security Program*	Ensures that DOE efficiently and effectively meets all its obligations to protect special nuclear material, other nuclear materials, classified matter, sensitive information, government property, and the safety and security of employees, contractors, and the general public.
DOE Order 470.4B, *Safeguards and Security Program*	Identifies roles and responsibilities for the DOE Safeguards and Security Program.
Human Health	
Occupational Safety and Health Act of 1970, 29 USC 651 et seq. Occupational Safety and Health Standards, 29 CFR Part 1910, 29 CFR Part 1926	Ensures worker and workplace safety, including a workplace free from recognized hazards, such as exposure to toxic chemicals, excessive noise levels, and mechanical dangers. Establishes standards to protect workers from hazards encountered in the workplace (Part 1910) and construction site (Part 1926).
Worker Safety and Health Program, 10 CFR Part 851	Creates DOE's health and safety program to control and monitor hazardous materials to ensure that workers are not being exposed to health hazards, such as toxic chemicals, excessive noise, and ergonomic stressors.
Occupational Radiation Protection, 10 CFR Part 835	Establishes radiation protection standards, limits, and program requirements for protecting workers from ionizing radiation resulting from DOE activities.
Chemical Accident Prevention Provisions, 40 CFR Part 68	Provides the list of regulated substances and thresholds, and the requirements for owners or operators of stationary sources concerning the prevention of accidental releases, and the state accidental release prevention programs approved under CAA Section 112(r).
Environmental Radiation Protection Standards for Management and Disposal of SNF, High-Level, and Transuranic Radioactive Wastes, 40 CFR Part 191	Applies to radiation doses received by members of the public as a result of the management (except for transportation) and storage of SNF, transuranic, or high-level radioactive wastes.

Law, Regulation, Order, or Other Requirement	Description
DOE Order 420.1C, *Facility Safety*	Establishes facility and programmatic safety requirements for DOE facilities, including nuclear and explosives safety design criteria, fire protection, criticality safety, natural phenomena hazards mitigation, and the System Engineer Program.
DOE Policy 420.1, *Department of Energy Nuclear Safety Policy*	Documents DOE's nuclear safety policy.
DOE Order 430.1C, *Real Property Asset Management*	Establishes a corporate, holistic, and performance-based approach to real property lifecycle asset management that links real property asset planning, programming, budgeting, and evaluation to program mission projections and performance outcomes. To accomplish the objective, this Order identifies requirements and establishes reporting mechanisms and responsibilities for real property asset management.
DOE Order 440.1B, *Worker Protection Program for DOE (including the National Nuclear Security Administration) Federal Employees*	Describes the DOE program to protect workers and reduce accidents and losses; adopts occupational safety and health standards.
DOE Order 458.1, *Radiation Protection of the Public and the Environment*	Establishes requirements to protect the public and the environment against undue risk from radiation associated with radiological activities conducted under the control of DOE, pursuant to the Atomic Energy Act of 1954, as amended.
Transportation	
Hazardous Materials Transportation Act of 1975, 49 USC 5101 et seq. Transportation, Subchapter C, Hazardous Materials Regulations, 49 CFR Parts 171–180	Provides the U.S. DOT with authority to protect against the risks associated with transportation of hazardous materials, including radioactive materials, in commerce. Establishes DOT requirements for classification, packaging, hazard communication, incident reporting, handling, and transportation of hazardous materials.
DOE Order 460.1D, *Hazardous Materials Packaging and Transportation Safety*	Describes DOE safety requirements for the proper packaging and transportation of offsite shipments and onsite transfers of radioactive and other hazardous materials.
DOE Order 460.2A, *Departmental Materials Transportation and Packaging Management*	Describes DOE requirements and responsibilities for materials transportation and packaging management to ensure the safe, secure, and efficient packaging and transportation of materials, both hazardous and nonhazardous.
DOE Order 461.1C, *Packaging and Transportation for Offsite Shipment of Materials of National Security Interest*	Affirms that the packaging and transportation of all offsite shipments of materials of national security interest for DOE must be conducted in accordance with DOT and NRC regulations that would be applicable to comparable commercial shipments, except where an alternative course of action is identified in the Order.
DOE Order 461.2, *Onsite Packaging and Transfer of Materials of National Security Interest*	Establishes safety requirements and responsibilities for onsite packaging and transfers of materials of national security interest to ensure safe use of Transportation Safeguards System (TSS), non-TSS Government- and contractor-owned and/or leased resources.

Law, Regulation, Order, or Other Requirement	Description
Idaho Transportation of Hazardous Waste, IC Title 18, Chapter 39 Hazardous Materials/Hazardous Waste Transportation Enforcement, IC Title 49, Chapter 22	Regulates transportation of hazardous materials/hazardous waste on Idaho highways.
Environmental Justice	
Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, as amended by Executive Order 12948	Requires each federal agency to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations.
Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, as amended by Executive Order 13296	Requires each federal agency to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and to ensure that its policies, programs, activities, and standards address disproportionate environmental health or safety risks to children.
Emergency Management	
Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601 et seq.	Provides broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment.
Emergency Planning and Community Right-to-Know Act of 1986, 42 USC 11001 et seq.	Requires that Federal, State, and local emergency planning authorities be provided information regarding the presence and storage of hazardous substances and their planned and unplanned environmental releases, including provisions and plans for responding to emergency situations involving hazardous materials.
Price-Anderson Act and Amendments, 42 USC 2210 Financial Protection Requirements and Indemnity Agreements, 10 CFR Part 140	Establishes a system of financial protection for persons who may be liable for and persons who may be injured by a nuclear incident.
Oil Pollution Prevention, 40 CFR Part 112	Outlines the requirements for both the prevention of and the response to oil spills; includes requirements for Spill Prevention, Control, and Countermeasure Plans, and for Facility Response Plans.
Designation, Reportable Quantities, and Notification, 40 CFR 302	Requires facilities to notify federal authorities of spills or releases of certain hazardous substances designated under the Comprehensive Environmental Response, Compensation, and Liability Act and Clean Water Act; specifies the quantities of hazardous substance spills/releases that must be reported to authorities and delineate the notification procedures for a release that equals or exceeds the reportable quantities.
Emergency Planning and Notification, 40 CFR Part 355	Describes emergency planning provisions for facilities in possession of an extremely hazardous substance in a quantity exceeding a specified threshold quantity; could apply to substances to be used in the proposed facilities.
Hazardous Chemical Reporting: Community Right-To- Know, 40 CFR Part 370	Establishes reporting requirements for providing the public with important information on the hazardous chemical inventories in their communities.

Law, Regulation, Order, or Other Requirement	Description
Toxic Chemical Release Reporting: Community Right- To-Know, 40 CFR Part 372	Establishes reporting requirements for providing the public with important information on the release of toxic chemicals in their communities.
Radiological Emergency Planning and Preparedness, 44 CFR Part 351	Requires emergency plans for DOE nuclear facilities; defines additional DOE responsibilities for assisting the Federal Emergency Management Agency.
Executive Order 12580, *Superfund Implementation*	This EO gives responsibility to a federal agency for hazardous substance response activities when the release is from, or the sole source of the release is located in, any facility or vessel under the control of that agency.
Executive Order 12656, *Assignment of Emergency Preparedness Responsibilities*	Ensures that DOE has sufficient capabilities to meet defense and civilian needs during national emergency; establishes DOE as the lead agency responsible for energy-related emergency preparedness and for assuring the security of DOE nuclear materials and facilities.
Executive Order 12856, *Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements*	Requires all federal facilities to comply with the provisions of the Emergency Planning and Community Right-to-Know Act (EPCRA); requires reports to be submitted pursuant to EPCRA, Sections 302–303 (Planning Notification), 304 (Extremely Hazardous Substances Release Notification), 311–312 (Material Safety Data Sheet/Chemical Inventory), and 313 (Toxic Chemical Release Inventory Reporting).
DOE Order 151.1D, *Comprehensive Emergency Management System*	Establishes policy; assigns roles and responsibilities; provides the framework for developing, coordinating, controlling, and directing DOE's emergency management system (i.e., emergency planning, preparedness, response, recovery, and readiness assurance).
DOE Order 153.1, *Departmental Radiological Emergency Response Assets*	Establishes requirements and responsibilities for the DOE national radiological emergency response assets and capabilities and Nuclear Emergency Support Team assets.
Standards and Procedures for Application of Risk-Based Corrective Action at Petroleum Release Sites, IDAPA 58.01.24	Establishes standards and procedures to determine whether and what risk-based corrective action measures should be applied to petroleum release sites.

5. COORDINATION AND CONSULTATION

5.1 Shoshone-Bannock Tribes

DOE briefed the Shoshone-Bannock Tribes Tribal staff on September 9, 2020 and the Fort Hall Business Council on September 30, 2020 on the MARVEL microreactor EA and project.

5.2 State of Idaho

DOE briefed the Idaho Governor's Office on the MARVEL EA and project on September 14, 2020.

5.3 Congressional

DOE briefed staff members of Sen Risch, Sen Crapo, and Congressman Simpson on September 15, 2020.

5.4 Idaho Department of Environmental Quality

DOE briefed staff from the Idaho Department of Environmental Quality on the MARVEL microreactor and EA on September 14, 2020.

6. REFERENCES

10 CFR 830. (2011, January 1). Nuclear Safety Management. *Code of Federal Regulations*. Office of the Federal Register.

10 CFR 835. (2011, January 1). Occupational Radiation Protection. *Code of Federal Regulations*. Office of the Federal Register.

10 CFR 851. (2012, January 1). Worker Safety and Health Program. *Code of Federal Regulations*. Office of the Federal Register.

36 CFR 61. (1999). Procedures for State, Tribal, and Local Government Historic Preservation Programs. *Code of Federal Regulations*. Office of the Federal Register.

36 CFR 800. (2000). Protection of Historic Properties. *Code of Federal Regulations*. Office of the Federal Register.

40 CFR 1500-1508. (1978, as amended 1986 and 2005). CEQ Regulations for Implementing NEPA. *Code of Federal Regulations*. Office of the Federal Register.

40 CFR 61 Subpart H. (1989). National Emission Standards for Hazardous Air Pollutants. Office of the Federal Register.

85 Fed. Reg. 137. (2020, July 16). Council on Environmental Quality Update to the Regulations Implementing the Procedural Provisions of the National Environmental Policy Act. *40 CFR Parts 1500, 1501, 1502, 1503, 1504, 1505, 1506, 1507, 1508, 1515, 1516, 1517, and 1518*.

Anders, M. H., Rodgers, D. W., Hemming, S. R., Saltzman, J., Divenere, V. J., Hagstrum, J. T., . . . Walter, R. C. (2014). A Fixed Sublithospheric Source for the Late Neogene Track of the Yellowstone Hot Spot: Implications of the Heise and Picabo Volcanic Fields. *Journal of Geophysical Research: Solid Earth, V. 119*. DOI:10.1002/2013JB0483.

Baily, C. (2020, October). MARVEL Coolant Options. *INL/MIS-20-60277*. Idaho Falls, ID: Idaho National Laboratory.

Black, R., & Grant, R. (2021, January). MARVEL Reactor Waste Management Environmental Assessment Technical Evaluation. *TEV-4157*. Idaho Falls, ID: Idaho National Laboratory.

Bockholt, B. M., Payne, S. J., Graw, J. H., & Sandru, J. M. (2020). INL Seismic Monitoring Report: January 1, 2018 - December 31, 2018. *INL/EXT-19-56524*. Battelle Energy Alliance.

Boland, J. F., Geier, J. D., MacFarlane, D. R., Elias, P., & Fruend, G. A. (1960). Design Summary Report on the Transient Test Reactor Facility (TREAT). Argonne, IL: U.S. Atomic Energy Commission. Argonne National Laboratory. Reactor Engineering Division.

Christiansen, R. L., Lowenstern, J. B., Smith, R. B., Heasler, H., Morgan, L. A., Nathenson, M., . . . Robinson, J. E. (2007). Preliminary Assessment of Volcanic and Hydrothermal Hazards in Yellowstone National Park and Vicinity. *U.S. Geological Survey Open-file Report 2007-1071*. Reston , VA: U.S. Geological Survey.

Clark, K., & Christiansen, N. (2020, December 21). TREAT-RCE-2020-010 Rev. 0. *INL Radiological Control Evaluation for Preliminary Personnel Dose Estimates for Operations of the Microreactor Applications Research Validation and Evaluation Project (MARVEL)*. Idaho Falls, ID: Idaho National Laboratory.

Claver, K. T., & Case, M. J. (2020, December 29). Analysis of Radiological Impacts to Terrestrial Biota in Support of the Environmental Assessment for the Microreactor Applications Research, Validation, and Evaluation (MARVEL) Microreactor at Idaho National Laboratory. *VFS-ID-ESER-SURV-089*. Idaho Falls, ID: Veolia Nuclear Services-Federal Services.

Crone, A. J., Machette, M. N., Bonilla, M. G., Lienkaemper, J. J., Pierce, K. L., Scott, W. E., & Bucknam, R. C. (1987). Surface Faulting Accompanying the Borah Peak Earthquake and Segmentation of the Lost River Fault, Central Idaho. *Bulletin Seismological Society of America, V. 77*.

DOE. (1995, April). Programmatic Spent Nuclear Fuel (SNF) and Idaho National Engineering Laboratory (INEL) Environmental Restoration and Waste Management Environmental Impact Statement. *DOE/EIS-0203-F*. U.S. Department of Energy.

DOE. (2000, July). Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel. *DOE/EIS-0306*. Washington , DC: U.S. Department of Energy Office of Nuclear Energy.

DOE. (2003, January). Estimating Radiation Risk from Total Effective Dose Equivalent (TEDE) ISCORS Technical Report No. 1. *DOE/EH-412-0015/0802 rev. 1*. Washington, DC: U.S. Department of Energy.

DOE. (2009, February). Yucca Mountain Repository License Application Safety Analysis Report. *DOE/RW-0573, Rev. 1*. U.S. Department of Energy.

DOE. (2019a, October 4). DOE Order 151.1D Chg 1 (MinChg). *Comprehensive Emergency Management System*. Washington, DC: U.S. Department of Energy.

DOE. (2019b, February 19). DOE-STD-1153-2019. *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*. Washington, DC: U.S. Department of Energy Office of Environment, Health, Safety and Security.

DOE O 420.1C Chg 3. (2019, November 14). Facility Safety. Washington, DC: U.S. Department of Energy Office of Environment, Health, Safety and Security.

DOE O 435.1 Chg 1. (2007). Radioactive Waste Management. Washington , DC: U.S. Department of Energy Office of Environmental Management.

DOE O 460.1D. (2016, December 20). Hazardous Materials Packaging and Transportation Safety. Washington, DC: U.S. Department of Energy.

DOE Order 436.1. (2011, May 2). Departmental Sustainability. Washington , DC: U.S. Department of Energy Office of Management.

DOE Order 458.1 Admin. Chg. 4. (2020, September 15). Radiation Protection of the Public and the Environment. U.S. Department of Energy.

DOE-ID. (2014, February). Environmental Assessment for the Resumption of Transient Testing of Nuclear Fuels and Materials. *DOE/EA-1954*. Idaho Falls, ID: Department of Energy Idaho Operations Office.

DOE-ID. (2016). Idaho National Laboratory Cultural Resource Management Plan. *DOE.ID-10997 Rev. 6*. Idaho Falls, ID: U.S. Department of Energy Idaho Operations Office.

DOE-ID. (2019, January 10). Final Environmental Assessment for the Use of Department of Energy-Owned High-Assay Low-Enriched Uranium Stored at the Idaho National Laboratory. *DOE/EA-2087*. Idaho Falls, ID: U.S. Department of Energy.

DOE-ID. (2020). *National Emission Standards for Hazardous Air Pollutants - Calendar Year 2019 INL Report for Radiolnuclides.* Idaho Falls: Idaho National Laboratory.
DOE-STD-1020-2016. (2016, December). Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities. Washington, DC: U.S. Department of Energy.
DOE-STD-1027-2018 Chg Notice 1. (2019, January 22). Hazard Categorization of DOE Nuclear Facilities. Washington , DC: U.S. Department of Energy Office of Environment, Health, Safety and Security.
DOE-STD-1098-2017. (2017, January 31). Radiological Control. Washington, DC: U.S. Department of Energy Office of Environment, Health, Safety, and Security.
DOE-STD-1189-2016. (2016, December). Integration of Safety into the Design Process. Washington, DC: U.S. Department of Energy Office of Environment, Health, Safety and Security.
DOE-STD-3009-2014. (2014, November 12). Preparation of Nonreactor Nuclear Facility Documented Safety Analysis. Washington , DC: U.S. Department of Energy Office of Environment, Health, Safety and Security.
Doser, D. I. (1985). Source Parameters and Faulting Processes of the 1959 Hebgen Lake, Montana Earthquake Sequence. *Journal of Geophysical Research Solid Earth, V. 90*.
Herrmann, S. D., Buzzell, J. A., & Holzemer, M. J. (1998, March). Treatment of EBR-I NaK Mixed Waste at Argonne National Laboratory and Subsequent Land Disposal at the Idaho National Engineering and Environmental Laboratory. *ANL/ED/CP-94029*. Idaho Falls, ID: Argonne National Laboratory-West.
Hill, T. J., & Fillmore, D. L. (2005, October). Managing Spent Nuclear Fuel at the Idaho National Laboratory. *INL/CON-05-00706*. Idaho Falls, ID: Idaho National Laboratory.
ICRP. (2007). The 2007 Recommendations of the International Commission on Radiological Protection. *ICRP Publication 103 Ann. ICRP 37 (2-4)*. The International Commission on Radiological Protection.
INL. (2017, October). INL Transportation Safety Document (TSD). *Report No. PDD-2500, Rev. 6*. Idaho Falls, ID: Idaho National Laboratory.
INL. (2018, October). Air Permitting Applicability Determination for FASB Operations Including Uranium Reaction and Zone Refining. Idaho Falls, ID: Idaho National Laboratory.
INL. (2019a, November). Experimental Fuels Facility (EFF) East Air Permit Applicability Determination. Idaho Falls, ID: Idaho National Laboratory.
INL. (2019b, April). Safety Analysis Report for Intra-INL Transportation and MFC Inter-Facility Transfers. *Report No. SAR-413 Rev. 5*. Idaho Falls, ID: Idaho National Laboratory.
INL. (2019c, June 19). Spent Fuel Database. *Version 7.0.5*. Idaho Falls, ID: Idaho National Laboratory.
INL. (2019d, April). Technical Safety Requirements for Intra-INL and MFC Inter-Facility Transfers. *Report No. TSR-413, Rev. 3*. Idaho Falls, ID: Idaho National Laboratory.
INL. (2021). Safety Design Strategy for the Microreactor Applications Research Validation and Evaluation Project (MARVEL) . *SDS-119*. Idaho Falls, Idaho : Idaho National Laboratory.
Jankowski, M. (2020, September 21). Personal Email: INL Head Count Report by Organization and Group for May. Idaho Falls , ID.
Kitcher, E. D. (2020, July). Preliminary Criticality and Radiation Shielding Analysis for the Storage and Transfer of Irradiated MARVEL Reactor Fuel. *INL/EXT-20-59200*. Idaho Falls, ID: Idaho National Laboratory.
Kuntz, M. A., Skipp, B., Champion, D. E., Gans, P. B., & Van Sistine, D. P. (2007). Geologic Map of the Craters of the Moon 30' x 60' Quadrangle, Idaho. *U.S. Geological Survey Scientific Investigations Map*.
Kunz, M. A., Anderson, S. R., Champion, D. E., Lanphere, M. A., & Grunwald, D. J. (2002). Tension Cracks, Eruptive fissures, Dike, and Faults Related to Late Pleistocene-Holocene Basaltic Volcanism and Implications for the Distribution of Hydraulic Conductivity in the Eastern Snake River Plain, Idaho. *Geology, Hydrogeology, and Environmental Remediation: Idaho National*

Engineering and Environmental Laboratory, Eastern Snake River Plain, Idaho. Geological Society of America Special Paper, 353.

Kunz, M. A., Skipp, B., Lanphere, M. A., Scott, W. E., Pierce, K. L., Dalrymple, G. B., . . . Rodgers, D. W. (1994). Geologic Map of the Idaho National Engineering Laboratory and Adjoining Areas, Eastern Idaho. *U.S. Geological Survey Miscellaneous Investigation Map, I-2330, 1:100,000 scale*.

McCurry, M., Hayden, K. P., Morse, L. H., & Mertzman, S. (2008). Genesis of Post-Hot Spot, Atype Rhyolite of the Eastern Snake River Plain Volcanic Filed by Extreme Fractional Crystallization of Olivine Tholeiite. *Bulletin of Volcanology, V. 70*.

McCurry, M., McLing, T., Smith, R. P., Hackett, W. R., Goldby, R., Lochridge, W., . . . Plummer, M. (2016, February 22-24). Geologic Setting of the Idaho National Laboratory Geothermal Resource Research Area. *Proceedings, 41st Workshop on Geothermal Reservoir Engineering*. Stanford, California: Stanford University.

NNSA. (2007, October). Supplement Analysis Disposition of Surplus Highly Enriched Uranium. *DOE/EIS-0240-SA-1*. Washington, D.C.: U.S. Department of Energy National Nuclear Security Administration.

Northern Testing Laboratories. (1978, June). Report of Geotechnical Investigation for TREAT Upgrade Project. Idaho Falls, ID: Prepared for Argonne National Laboratory-West.

NRC. (1977, December). Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes. *NUREG-0170 (40 FR 23768)*. Washington, DC: U.S. Nuclear Regulatory Commission.

NRC. (1987, August). Safety Evaluation Report on High-Uranium Content, Low-Enriched Uranium-Zirconium Hydride Fuels for TRIGA Reactors. *NUREG-1282*. U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation.

NRC. (2012). Spent Fuel Transportation Risk Assessment. *NUREG-2125*. Rockville, MD: U.S. Nuclear Regulatory Commission.

Nuclear Energy Institute. (2019, April). Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis Development. *NEI Technical Report 18-04*. NEI.

Olander, D., Greenspan, E., Garkisch, H. D., & Petrovic, B. (2009, August). Uranium-zirconium hydride fuel properties. *Nuclear Engineering and Design Volume 239, Issue 8*.

OSHA. (2011). *OSHA Factsheet Laboratory Safety Noise.* Retrieved from OSHA.gov: https://www.osha.gov/Publications/laboratory/OSHAfactsheet-laboratory-safety-noise.pdf

Owusu, D., Holbrook, M. R., & Sabharwall, P. (2018, August). Regulatory and Licensing Strategy for Microreactor Technology. *INL/EXT-18-51111*. Idaho Falls, ID: Idaho National Laboratory.

P.L. 115-248. (2018). Nuclear Energy Innovation Capabilities Act of 2017.

Pace, B. R., & Williams, J. B. (2013, November). Cultural Resource Investigations for the Resumption of Transient Testing of Nuclear Fuel Material. *INL/EXT-13-29097*. Idaho Falls, ID: Idaho National Laboratory.

Parry, J. (2020, July 13). ECAR-5139. *MARVEL Reactor End of Life Preliminary Radiological Source Term*. Idaho Falls, ID: Idaho National Laboratory.

Parry, J. R., Chase, B. C., & Biggs, J. R. (2020, October). MARVEL Startup Roadmap: Assembly, Fuel Loading, and Initial Startup of MARVEL. *INL/LTD-20-60303*. Idaho Falls, ID: Idaho National Laboratory.

Parry, J. R., Lange, T. L., Parisi, C., Wagner, A. R., & Arafat, Y. (2020, October). Marvel Fuel Strategy . *INL/LTD-20-60304*. Idaho Falls, ID: Idaho National Laboratory.

Pierce, K. L., & Morgan, L. A. (1992). The Track of the Yellowstone Hot Spot: Volcanism, Faulting, and Uplift. *Regional Geology of Eastern Idaho and Western Wyoming: Geological Society of America Memoir 179*.

Pierce, K. L., & Morgan, L. A. (2009). Is the Track of the Yellowstone Hot Spot Driven by a Deep Mantle Plume? - Review of Volcanism, Faulting, and Uplift in Light of New Data. *Journal of Volcanology and Geothermal Research, V. 188*.

Reiss, T. P. (2021, January). MARVEL Environmental Assessment Inhalation Dose Consequence Calculations. *ECAR-5363*. Idaho Falls, ID: Idaho National Laboratory.

Richins, W. D., Pechmann, J. C., Smith, R. B., Langer, C. J., Goter, S. K., Zollweg, J. E., & King, J. J. (1987). The 1983 Borah Peak, Idaho Earthquake and its Aftershocks. *Bulletin of the Seismological Society of America, V. 77*.

Scales-English, M. C. (2020, December 1). BEA-20-H116. *Microreactor Applications Research, Validation and Evaluation Project (MARVEL)*. Idaho Falls, ID: Idaho National Laboratory.

Schusler, K. L., Pearson, D. M., McCurry, M., Bartholomay, R. C., & Anders, M. H. (2020). Regionally Continuous Miocene Rhyolites Beneath the Eastern Snake River Plain Reveal Localized Flexure at its Western Margin: Idaho National Laboratory and Vicinity. *Rocky Mountain Geologist, V. 57*.

Smith, R. B., Jordan, M., Steinberger, B., Puskas, C. M., Farrell, J., Waite, G. P., . . . O'Connell, R. (2009). Geodynamics of the Yellowstone Hot Spot and Mantle Plume: Seismic and GPS Imaging, Kinematics, Mantle Flow. *Journal of Volcanology and Geothermal Research, V. 88*.

Sondrup, A. (2021, January 6). Evaluation of Impacts from Radiological Air Emissions During MARVEL Microreactor Operations. *ECAR-5358*. Idaho Falls, ID: Idaho National Laboratory.

Trellue, H., Vedant, M., Rao, D. V., Lange, T., & Sterbenz, J. (2021, January 6). MARVEL Initial Shielding and Dose Calculations. *LA-UR-21-20049*. Albuquerque, NM: Los Alamos National Laboratory.

U.S. Department of Energy. (2014, February). Final Environmental Assessment for the Resumption of Transient Testing of Nuclear Fuels and Materials and Finding of No Significant Impact. Idaho Falls, ID: DOE.

Verdoorn, M. A. (2018, January 23). Modification of a Facility Regulated by 40 Code of Federal Regulations (CFR) Part 61, Subpart H. *EMS-TI-063*. Idaho Falls, ID: Idaho National Laboratory.

VNS Federal Services. (2019, September). Idaho National Laboratory Site Environmental Report Calendar Year 2018. *DOE/ID-12082(18)*. Idaho Falls, ID: Environmental Surveillance, Education, and Research Program U.S. Department of Energy Idaho Operations Office.

Weeks, I. F., & Goeddel, W. V. (1960, March 22). 2,929,707. *Method of Fabricating a Uranium-Zirconium Hydride Reactor Core*. U.S. Patent Office.

Appendix A Response to Public Comments

Response to Public Comments

The formal comment period for the Draft Environmental Assessment for the Microreactor Applications Research, Validation and Evaluation (MARVEL) Project at Idaho National Laboratory ended on January 25, 2021. DOE extended the public comment period to February 9, 2021. DOE received numerous comments from interested parties and groups. DOE considered all comments received. The following pages contain DOE's responses to the comments. This document is being prepared as an appendix to the Final EA and DOE will send copies to those individuals and groups who gave DOE comments. This document will also be available online and to other interested parties upon request. Comments are organized by commenter in alphabetical order (see Table A-1).

Table A-1. List of commenters, commenters affiliation (if any), and comment number.

Commenter	Comment ID Number
Almansor, Falih Hasan Ahmed	1
Andreae, Tim	112
Beall, Virginia	117
Benbrooks, Don	92
Bohrer, Deborra	111
Boyer, Devon, Fort Hall Business Council	124
Brandt, Eric W.	97
Broscious, Chuck	3
Canham, Susan	120
Chisholm, Bill	89
Cotton, Chip (Arthur)	4
Cotton, Ian, Snake River Alliance	34
Crnich, Chris	8
Drew, Buck	90
Duarte, Gary J.	6
Fauci, Joanie	11
Ford, Leigh	107
Fowkes, William M.	113
French, Dan	109
Giese, Mark M.	10
Giese, Mark M.	98
Gilbert, Dean	115
Graber, Lori	91
Hawley, Daniel	102
Hoefnagels, Julie	116
Howard, J. W.	100
Hughes, William F.	110
Ismério de Oliveira, Clésio	114
Jody (No Surname Given)	95

Commenter	Comment ID Number
Jones, Ellen	13
Kaufmann, Theresa	99
Knott, Jeanne	103
Krafchuk, Bonnie	118
Kusy, Bryant, LCPC	16
Luna, Kristen	121
Manwaring, Nathan	7
McDonald, Steve	88
McNamara, Jim	94
O'Brien, Kathy	15
Olson, Marilyn	96
Pierson, Scott	35
Porterfield, Donivan	17-32
Provencher, Richard	14
Rady, Steve	123
Razvi, Junaid	33
Riener, Jerry	122
Rushing-Raynes, Laura	93
Sadler, Jonathan	104
Sattison, Marty, IANS	36
Siemer, Darryl	2
Sprinkle, James	5
Stewart, Lon	119
Thatcher, Tami	37-87
True, Doug, Nuclear Energy Institute	106
VanDusen, Scott	9
Williams, Theresa	105
Wilson, Andrea	101
Workman, E.	108

Issues Raised During the Public Comment Period

Fifty-seven individual responses during the public comment period. Most of the comments focused on the following: (1) alternative forms of energy, (2) the aquifer, (3) the cost of nuclear energy, (4) legacy waste, (5) the public comment period, (6) safety, (7) SNF, (8) use of tax dollars, and (9) waste disposal. Many commenters expressed their opposition or support for DOE's action in general. There were many comments received that were not within the scope of this EA. Comments focusing on activities such as past business practices; perceived mismanagement, fraud, waste, and abuse; and ethical responsibility were noted but no further responses were prepared as they are unrelated in the context of the EA. Table A-2 provides DOE's responses to comments on a comment-by-comment basis.

Table A-2. Response to comments.

Date/Name	Comment ID Number	Comment	DOE Response
1/7/2021 Falih Hasan Ahmed Almansor	1	The most important features that should be provided in the steam engines that I must use are that their efficiency is high, and this feature is not available in steam turbines. Strategic innovations for the production, storage and rationalization of energy consumption:- the dilemma of energy production and storage and all environmental pollution resulting from car engines currently is due to the lack of technology that can convert the reciprocating movement of all types of pistons (engine pistons. Steam presses, oil presses, and all fluid presses) into rotational motion, so I own a patent for converting reciprocating motion. To rotational motion of the highest value and I have new innovations to address this dilemma. The innovative mechanical technology will lead to a fundamental change in energy production from solar heaters, nuclear reactors and fuel. The new technology will double the efficiency of internal combustion engines and make them more environmentally friendly, and will enable us to use internal combustion engines as helicopter engines, thus we will end the use of cars due to the low cost of these aircraft compared to the cost of the automobile industry. Because of the ability to convert steam pressure into rotational motion with the highest efficiency, we will be able to convert the sun's heat into a great source of energy. And because of the high efficiency in converting the movement of oil pistons, we will be able to store energy hydraulically, in a very large quantity and in a sustainable way, and we will eliminate the use of batteries. We will be able to increase the capacity of nuclear reactors, and we will also be able to manufacture very small thermal reactors that are used in all fields of life due to their small size. We will be able to produce energy from all waterfalls and water slopes, no matter how small the amount of water is, and without building dams. To sure from my ability to innovations see	DOE acknowledges your comments. Thank you.

Date/Name	Comment ID Number	Comment	DOE Response
		Gear Engine Patent at 3DMAX Program https://youtu.be/ucjFDe2Fv9wu. video link for patent depicting the operation first engine in world working on gears instead of crankshaft. https://youtu.be/MGdxEKb4pJM I have new strategic innovations in addition of my three patents.	
1/12/2021 Darryl Siemer	2	A year ago Wiley/Scriveners published my book ("Nuclear Power") having to do with what a nuclear renaissance should/could be and what I'd seen/learned/done during my 28 year career as an INEL/INEEL/INL "Consulting Scientist". It wasn't very complimentary about how that Site's been managed or optimistic about its future. I'm currently writing an update of that book & was hoping to be able to say some good things. It's tough to do that when it's apparent that its management is still as confused about what nuclear power is and should be as it was 16 years ago when I retired. Anyway, I've just sent off another "letter to the editor" to the IF Post Register that sums up my opinions/comment about INL's MARVEL proposal. Here it is: DOE is currently seeking stakeholder input on one of its "Lead Nuclear Engineering" Lab's proposals - see https://www.id.energy.gov/insideNEID/PDF/Final%20MARVEL%20Draft%20EA%20DOE%20EA-2146.pdf It's a very nicely written document exemplifying what INL seems to be most interested in championing - a terribly inefficient (20% heat to electricity), super safe (it's to be " manufactured to a consensus standard"), super expensive per kilowatt, Na/K eutectic liquid metal cooled (same as EBR I) , micro "burner" (not breeder) reactor suitable for powering only tiny, cost-is-no-object, niche applications.	DOE acknowledges your support for the No Action Alternative. In the context of the EA, "sustainable" means the MARVEL microreactor is able to be maintained at a certain power level for the duration of the operation of the system (EA p. 6). The purpose of this EA is to assess the environmental impacts of the proposed action. Evaluating nuclear energy's place in the energy market is also outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. Legacy waste management is also outside the scope of this EA. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.

Date/Name	Comment ID Number	Comment	DOE Response
		For political purposes, it's also being characterized as "sustainable". However, what "sustainable" means in this context isn't really explained It certainly doesn't have to do with generating nuclear power in a way that would address its fuel supply limitations - the feature that renders today's power reactors/fuel cycle unsustainable. I suspect that it means making enough work to keep lots of INL's people busy/working/paid for the foreseeable future I'm going to be recommending the "The No Action Alternative" because INL/DOE has more important and more relevant work to do. I'd recommend starting that off by hiring an outfit (Duratek?) to come in & vitrify its remaining liquid reprocessing waste (SBW). If INL can't or won't do a simple thing like that after >15 years & a billion dollars worth of "steam reforming" boondoggling, it's got zero credibility. Darryl Siemer	
1/13/2021 & 1/14/2021 Chuck Broscious	3	The Environmental Defense Institute requests that the 14 day comment period be extended to 90 (ninety) days. Regards Chuck Broscious Environmental Defense Institute President	DOE's NEPA implementing procedures are found in 10 CFR 1021. Section 1021.301 (d) states, "At DOE's discretion, this review [i.e., the public comment period] shall be from 14 to 30 days." The public comment period for this EA complied with the regulation and was extended an additional two weeks.
1/14/2021 Chip (Arthur) Cotton GE Research, US	4	Good morning. I was hoping you could tell me who the OEM is for the Marvel micro-reactor. Thanks, Chip	DOE assumes OEM is an acronym for "Original Equipment Manufacturer." INL is designing and building the MARVEL microreactor application test platform.
1/14/2021 James Sprinkle	5	I think the Microreactor project should proceed as soon as possible. James Sprinkle retired	DOE acknowledges your comment. Thank you.
1/16/2021 Gary J. Duarte	6	Dear Sirs, we have reviewed part of your draft assessment for the MARVEL project at INL. We have visited INL on several occasions and with a group of	DOE acknowledges your comments. Thank you.

Date/Name	Comment ID Number	Comment	DOE Response
US Nuclear Energy FND		people from Nevada and USNEF. The work INL does on nuclear technology is the best available and the nuclear industry need its continuation. https://www.id.energy.gov/insideNEID/PDF/Final%20MARVEL%20Draft%20EA%20DOE%20EA-2146.pdf Gary J. Duarte, Director US Nuclear Energy Foundation	
1/18/2021 Nathan Manwaring	7	I welcome the arrival of additional experiment programs and other economic opportunities in Idaho. While a variety of nuclear technologies have been successfully demonstrated in Idaho with adequate safety for the public and the environment, plans for any new reactor like MARVEL ought to include a fee-based cleanup requirement, in which the U.S. DOE will pay a fee to the state of Idaho for each unit of time that a public problem (such as waste streams) exist in the State. In this way, any problem created for Idaho as a state will be mitigated by the payment of a negotiated fee, and just incentive will exist to clean up the problem. Nathan Manwaring	DOE acknowledges your comment. Thank you. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE follows applicable waste management statutes. The wastes from the MARVEL microreactor project would be managed and dispositioned as addressed in the EA. DOE agreements with the State of Idaho are outside the scope of this EA.
1/19/2021 Chris Crnich	8	As a resident of Arco, Idaho and a long time supporter of the nuclear energy proposals, I hardily support and agree with current studies to have a continued effort to develop, test, and deploy the microreactor technology. With the long standing successes and research accomplished at INL, it would be in the best interests of our community, state, and country to continue to have a safe and efficient energy source. You are the leaders in the development of such energy sources. We need to have more options for clean and dependable energy sources and I believe this is one of the projects that will assist us in a sustainable, clean, efficient energy source for many years to come. Thank you. Chris.	DOE acknowledges your comments. Thank you.
1/19/2021 Scott VanDusen	9	Dear DOE Please don't fall into the nuclear trap. I had to flee when reactor 4 exploded. I walked around with a Geiger counter for months. It was terrifying because at the time	DOE takes its responsibility for the safety and health of the workers and the public seriously. Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL

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		my wife was pregnant and foetal exposure to Cesium doesn't make for fully functional humans as you may have heard. I was born and raised in Idaho. I love Idaho. Please don't go nuclear, there isn't any need when solar and wind are cheaper than coal. Nuclear is just another boondoggle subsidised by taxpayers where private companies get all the profit while we the people get all the risk. Thanks for reading me, Scott VanDusen from Blackfoot now in Japan	microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. The annual federal budget process and federal spending is outside the scope of this analysis. Analysis of renewable energy is also outside the scope of this analysis. DOE acknowledges your comments and notes they are outside the scope of this analysis. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
1/19/2021 Mark M Giese	10	Nuclear is too expensive, no one wants to deal with the radioactive waste, and it is way to slow to help mitigate the climate crisis (plus it is NOT carbon free). Please protect the freshwater aquifer; we should not be supporting technologies that create radioactive waste that could be used in weapons proliferation. No to any nuclear reactors. Thank you. --Mark M Giese	Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. DOE takes its responsibility for the safety and health of the workers and the public seriously. As noted in the EA, the MARVEL microreactor system is a closed system, and does not have any liquid or gaseous discharges into the environment during normal operation and would not affect groundwater resources (p. 24). Nuclear Nonproliferation is another issue that is considered beyond the scope of the EA. The fuel for the MARVEL microreactor is unsuitable for diversion to nuclear weapons. SNF would be securely stored with DOE's spent fuel and spent fuel debris inventory awaiting a future disposal facility in accordance with legal, regulatory,

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			operations and scheduling requirements for the transfer and storage of these fuels. DOE acknowledges your comments and notes they are outside the scope of this analysis.
1/20/2021 Joanie Fauci	11	I am writing to express my opposition to this project. I am opposed to any nuclear project until we have a safe method of nuclear waste disposal. I have been to the INL site. I have seen pits where waste was dumped. I have seen storage facilities that have been years in cleanup and are still not cleaned up. We have no place to store the waste. We have no way to transition the waste. What is the purpose of this project and why are we even considering it? We have much safer and cheaper means of energy production anymore. Nuclear power is old school, expensive, dangerous. There is no reason to go there. Stop wasting our time and money! Regards, Joanie Fauci	DOE follows applicable waste management statutes. Please refer to Section 3.8 of the EA for a discussion of the MARVEL SNF. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA. The analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). The purpose of the proposed action is discussed in Section 1.2. The purpose of this EA is to assess the environmental impacts of the proposed action. Analysis of solar and wind power and other forms of energy is outside the scope of this analysis.

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			DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
1/20/2021 Ellen Jones	13	I am writing to object to the proposed MARVEL microreactor at Idaho National Laboratory. I do not want this expensive and dangerous reactor to be built and operated atop the Snake River Aquifer, the primary water source for all of Southern Idaho. Anything that creates more radioactive waste is a step in the wrong direction. Please do not approve this proposed project. Sincerely, Ellen Jones	DOE takes its responsibility for the safety and health of the workers and the public seriously. Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. The MARVEL microreactor system is a closed system and does not have any liquid or gaseous discharges into the environment during normal operation and would not affect groundwater resources (p. 24). DOE follows applicable waste management statutes. Please refer to Section 3.8 of the EA for a discussion of the MARVEL SNF. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA. The analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as

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			the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). DOE acknowledges your comment. Thank you.
1/23/2021 Richard Provencher	14	The Marvel microreactor EA appears to sufficiently address the hazards associated with operation of the reactor at INL and other support activities such as fuel fabrication and initial fuel treatment post operations. With the experience of operating EBR-2 at INL and other supporting functions, the INL is best suited and has existing capabilities that have been safely managed to operate the reactor and deal with the hazards such as the sodium in the fuel and the sodium potassium used in the reactor. NE and INL have thoroughly developed the design approach and evaluated the safety considerations for the Marvel reactor at this stage and it is reflected in the details provided in the EA. This extends to how the reactor will ultimately be decommissioned with sufficient detail to demonstrate a well thought out approach. Co-locating the reactor at the TREAT facility makes sense and its operation will not add any significant impacts to what already exists and is occurring there. The INL site is the best suited location for this reactor testing capability in the U.S. due to its expansive size and remote location, closeness to existing capabilities that are needed to support the reactor's operations and manage its wastes, and presence of an experience base that is	DOE acknowledges your comments supporting the proposed action. Thank you.

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		knowledgeable in EBR-2 operations that were conducted at the INL site. The Marvel microreactor will demonstrate the ability to use a distributed nuclear power source to provide electricity and heat source applications that are critically needed in the U.S. and the world. These applications will help reduce carbon emissions into the atmosphere, manufacture alternative fuels, and provide energy sources for water purification through such technologies as desalination which is much needed in the American west and throughout the world. The EA is sufficiently thorough, establishes that the hazards are manageable and can be controlled, and shows that INL is the best suited location for this work. For these reasons, I support the project and approval of the EA. R.B. Provencher	
1/23/2021 Kathy O'Brien	15	To Whom It May Concern: I am writing in regard to the MARVEL Microreactor. This is a new, untested nuclear microreactor proposed for the Idaho National Laboratory. I do not want any more dangerous and expensive nuclear energy development in Idaho. I am very tired of the all nuclear waste we have to deal with that is not being dealt with all that well. I am very against this project. Sincerely, Kathy O'Brien	DOE takes its responsibility for the safety and health of the workers and the public seriously. Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. DOE follows applicable waste management statutes. Please refer to Section 3.8 of the EA for a discussion of the MARVEL SNF. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA. The analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the

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			various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). DOE acknowledges your comments. Thank you.
1/23/2021 Bryant Kusy, LCPC	16	TO: U.S. Department of Energy Idaho Operations Office 1955 Fremont Avenue, MS 1235 Idaho Falls, Idaho 83415 RE: DOE/EA-2146 Draft Environmental Assessment for the Microreactor Applications Research, Validation and Evaluation (MARVEL) Project at Idaho National Laboratory As a nearly lifelong resident of Idaho (I've lived in both the Magic and the Treasure Valley for decades) I do not want more dangerous and expensive nuclear energy development in Idaho. Honestly I would like the DOE to finally accept that wind, solar and battery storage is more feasible, safer and now far more cost effective than nuclear. How large of a solar array and/or wind farm could we have on INL lands that would NOT pose a threat to our water aquifer? "The INL industrial waste landfill accepts and buries about 23,000 m3 (about 812,000 ft3) of waste and trash each year. MARVEL will not increase this significantly." But anything that ADDS and does not REDUCE this impact is leaving us problems for hundreds, thousands of	Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. Analysis of renewable energy is outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE takes its responsibility for the safety and health of the workers and the public seriously. Section 3.9.2 of the EA discusses the hazard evaluation of the MARVEL microreactor and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. DOE follows applicable waste management statutes. The wastes would be managed and dispositioned as addressed in Section 3.7 of the EA. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the

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		years. And STORAGE of WASTE has NOT been solved. Given we've had since the 1950s to figure nuclear waste storage out and that we STILL have not, I don't think adding more (no matter the quantity) is really intelligent at this point, particularly with alternate energy resources are now more economical. Unresolved: The current SNF inventory at INL includes over 250 different types of SNF (Hill & Fillmore, 2005). The INL SNF inventory totals about 315 MTHM (INL, 2019c) stored in both wet and dry storage facilities at the INL site. Disposal options for many of these fuels were identified as part of the Yucca Mountain Repository project, including all necessary treatment packaging and transportation requirements for final disposition. Additional information on these fuel groups may be found in the Yucca Mountain Repository License Application Safety Analysis Report (DOE, 2009). "Existing INL facilities are available to provide extended dry storage for the MARVEL microreactor SNF, including the Radioactive Scrap and Waste Facility, until final disposition is available." FINAL DISPOSAL is still not solved and likely will NOT be (for disposal at sites other than Yucca Mountain) thus it is unethical and immoral to ADD any more waste to the equation. It is long past the time to realize that if something is unecological, it is both unethical and immoral. "As with all SNF at present, the question of permanent disposition of SNF is directly dependent on the identification and licensing of a permanent repository for SNF in the United States. However, given the diversity of existing SNF that must be prepared and packaged for direct disposal, it is not anticipated that MARVEL microreactor fuel will pose any new challenges. The cumulative impacts from managing the MARVEL microreactor SNF would be small." It is clear that much of the proposed nuclear development is not really about energy production. Outside of space	current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). DOE follows applicable waste management statutes. Please refer to Section 3.8 of the EA for a discussion of the MARVEL SNF. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA. The analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). As noted by the commenter, Section 3.8 of the EA states that as with all SNF at present, the question of permanent disposition of SNF is directly dependent on the identification and licensing of a permanent repository for SNF in the United States. Evaluating options for a final disposal site for DOE-managed SNF is outside the scope of this

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		travel, the main impetus for more nuclear research (here and in Russia and China) has everything to do with weapons, replenishing an aging arsenal and developing new weapons for what could trigger another arms race, this time with not just Putin but with China, Iran and who knows which country next. A better tact is to support disarmament and decontenting research and holding all countries accountable to reduce this force that could destroy ALL life on earth, if ever unleashed. And have we not learned ANYTHING from Chernobyl, Fukushima, Three Mile Island and all the toxic waste health hazards, carcinogenic cancers? Rocky Flats? The U.N. Treaty on the Prohibition of Nuclear Weapons On 7 July 2017 – following a decade of advocacy by ICAN and its partners – an overwhelming majority of the world's nations adopted a landmark global agreement to ban nuclear weapons, known officially as the Treaty on the Prohibition of Nuclear Weapons. On 22 January 2021, the treaty will enter into force. It prohibits nations from developing, testing, producing, manufacturing, transferring, possessing, stockpiling, using or threatening to use nuclear weapons, or allowing nuclear weapons to be stationed on their territory. It also prohibits them from assisting, encouraging or inducing anyone to engage in any of these activities. The United States did not participate in the negotiation of the treaty at the United Nations in New York in 2017 and thus did not vote on its adoption. On the opening day of the negotiating conference, it organised a gathering of several states to protest the treaty-making process. In 2016, the United States voted against the UN General Assembly resolution that established the formal mandate for states to commence negotiations on "a legally binding instrument to prohibit nuclear weapons, leading towards their total elimination". [from https://www.icanw.org/united_states]	analysis and subject to National Environmental Policy Act (NEPA) review by DOE prior to making a decision on any option for a final disposal site. The purpose of the proposed action is discussed in section 1.2 of the EA. Nuclear weapons and disarmament are outside the scope of this analysis. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.

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		So I call on you and all policy and decision-makers involved at INL to reconsider expansion of more nuclear research. Decommission these endeavors and shift the workforce to wind, solar and battery use and even production. Why let Elon Musk reap all the rewards? I think of Detroit. Don't close down factories, RETOOL them for more sustainable growth. It does not make sense or "cents" to produce nuclear energy largely siphoned off to Utah or other states when Idaho is left "holding the bag" of radioactive waste. How does this in any way fit with Conservative principles? Idaho can do so much better. Idaho Power sees this to be true (hydroelectric at its heart). Idaho citizens see it. Europe sees it. Even economists and world scientists see it. Why can't INL? Bryant Kusy	
1/24/2021 Donivan Porterfield	17-32	Mr. Kropp, Attached is a PDF document with my public comments on the on the draft environmental assessment for construction of the MARVEL microreactor at Idaho National Laboratory. Mr. Donivan Porterfield DOE_IOO_EA-2146_ public_comment_po	Mr. Porterfield's comments are printed on pages A-68 through A-72, and Table A-3 lists DOE's responses to Mr. Porterfield's comments.
1/25/2021 Junaid Razvi	33	Thank you for the opportunity to review and comment on the Draft EA for MARVEL. The MARVEL design appears to be a FOAK in nearly all key aspects, so I am assuming its system design and operability (e.g. limiting conditions of operation) will be evaluated from the ground up, relying on available data for the proposed UZrHx fuel matrix itself. That notwithstanding, I would like to offer the following comment(s) on MARVEL's proposed Fuel System using UZrH1.7-1.9 (pages 11 - 13 of Draft EA) which seems to rely on using experience with the well established UZrHx	The commenter is correct. The MARVEL fuel is relying on existing data for system design and operability following data from SNAP reactor concepts and TRIGA reactor concepts. The basis for other limiting conditions is based off data from EBR-II experiments, namely limiting conditions for the cladding. The MARVEL fuel design is not "significantly different" from well-established U-ZrHx fuels. The proposed differences from well establish fuel designs (TRIGA) are—H/Zr ratio, in cladding coolant, and cladding. The H/Zr ratio proposed is

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		fuel design, even though the proposed design is significantly different to require further evaluation and a qualification program for use in MARVEL. In other words, the conclusions of NUREG-1282 are not necessarily applicable to the MARVEL design. More specifically: The described Fuel System appears to rely heavily on USNRC's Safety Evaluation Report NUREG-1282, without any further fuel design and qualification efforts. It should be noted however, that the acceptance by NRC of the UZrHx fuel based assembly for TRIGA type research reactors was limited in scope, in particular: NRC's acceptance is limited to 30 wt% U. While irradiation data exists for higher U densities - up to 45% - fuels greater than 30 wt% U were only approved by NRC for further testing, not routine use. Current UZrHx fuel assemblies used in TRIGA type reactors are manufactured - and licensed - to a lower, average Zr/H ratio of 1.6 per assembly. The proposed Zr/H ratio of 1.7 - 1.9 has not been subject to a fuel qualification process. In particular, hydrogen migration during irradiation, leading to fuel cracking and resulting cladding stresses, need to be evaluated for the higher ratios and approved by the regulatory body. NUREG-1282 approved fuel uses He in the fuel-clad gap, not Na. The difference in heat transfer properties, as well as fuel matrix-Na interactions, needs to be evaluated, studied and documented. I recall that UC-Berkeley researchers were proposing a similar design for use in LWRs, but to the best of my knowledge no fabrication or irradiation testing was ever performed. The second comment concerns the proposed fuel fabrication methodology, without citing any precedent utilizing this method for fabricating UZrHx fuel pellets. MARVEL is proposing a new process completely different than the one currently used and forms the basis of NUREG-1282 approvals. It continues to be the currently deployed process for fabricating UZrHx fuel.	slightly higher than that used by TRIGA reactors, TRIGA aims for H/Zr of 1.6-1.65; MARVEL will also aim for a H/Zr ratio of 1.65 (range 1.6-1.7). In-cladding coolant is helium in TRIGA, while MARVEL is relying on sodium. The use of sodium decreases the fuel centerline temperature due to its heat transfer properties. The cladding used by TRIGA is Incoloy 800 (~0.020" wall thickness), and MARVEL will use type 316 stainless steel (~0.035" wall thickness). The *MARVEL Cladding Integrity* study (INL, 2020) evaluated the performance and reliability of the MARVEL cladding. Although not all of the components have been used in the same system, each component has been well characterized for use as components in reactors. Sodium was widely used as in-cladding coolant in EBR-II experiments, and thousands of EBR-II driver fuel pins were Type 316 stainless steel that contained sodium and alloys of UZr. UZrH fuel is well characterized through its use in research reactors, and it, along with sodium coolant, was used in some of the SNAP reactor experiments. Since a formal fuel qualification program has the goal of qualifying fuel for a production environment in which performance and reliability characteristics must be ensured with minimal risk reducing constraints, MARVEL is not employing a formal fuel qualification program, but will have a Fuel Acceptance Plan, as the reactor is not intended to be used in a production environment, but for research purposes. This does not mean the MARVEL fuel will not be required to demonstrate the ability perform its safety and design functions. However, because of the short duration of MARVEL operations and the resulting low burnup (approximately 3% 235U burnup) on the MARVEL fuel, it is possible to put risk-reducing

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		INL also does not cite any experience with fabricating the fuel using the proposed mixing and compacting method, and it is not stated if TRIGA International – as backup supplier - has qualified this method either, so it will be necessary to conduct a full fuel qualification and PIE program with fuel manufactured with this process. I look forward to hearing how the above comments are resolved, and we look forward to seeing MARVEL achieve a successful outcome. If there are questions about my comments above, please do not hesitate to reach out. Sincerely, Junaid Razvi Junaid Razvi PhD	constraints on the well-understood fuel type in a new operating environment and application such as MARVEL, providing the assurance that the MARVEL fuel will perform adequately and remain safe. This strategy will demonstrate the acceptability of the MARVEL fuel for this one-time application through a combination of testing, modeling, and reliance on the well understood properties of uranium-zirconium hydride fuel known as TRIGA fuel and provide the assurances that the fuel will perform adequately in the MARVEL reactor with minimal risk. Although the H/Zr ratio proposed has not been subjected to a fuel qualification process, the proposed ratio is of the same crystal structure as TRIGA (H/Zr 1.6). H/ZR 1.6-1.9 is relatively stable under irradiation and at operational temperature ranges. It is understood that fuel will crack under irradiation. However, stress on the cladding due to its behavior under irradiation is expected to be minimal as the fuel will not see more than 5% burnup. Evaluation of additional stress on the cladding can be found in *Marvel Fuel System: Fuel Cladding Integrity* (Wagner, A.R., January 2021. INL-EXT-21-61273 Rev. 1). The MARVEL project has performed fuel performance analyses, using data from Olander et al. (2009), which is a key literature reference for physical properties of U-ZrHx fuel with sodium bonding. This reference investigated UZrH fuel for use in high burnup reactors like LWRs. MARVEL burnup is a fraction of that of LWR and thus is within the data range presented in that reference. In addition to the literature of irradiation data referenced in Olander et al., the MARVEL fuel concept is similar to the SNAP10A experiment, which was also irradiated and subsequently characterized. Hence there is extensive physical

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			property data for this fuel type to predict fuel performance with a high degree of confidence. In addition, the analyses also shows the MARVEL design has sufficient margins to safety limits. The Olander et al. paper has been added for reference. If TRIGA international is utilized as a supplier, the U-ZrHx fuel will be made using direct hydriding method, which is a well-established fuel fabrication method, and not the powder metallurgy method. INL and LANL have demonstrated the feasibility of the powder metallurgy method, based on initial experimental data seen from both labs. LANL has conducted much of the initial R&D, and the viability of the fabrication method will tested as R&D efforts begin at INL.
1/25/2021 Ian Cotten	34	I am writing to share my comments in opposition of the proposed MARVEL project microreactor. For the reasons outlined below, I urge the DOE to halt this project. Cost: Included in the stated purpose of the Environmental Assessment DOE cites a need to "to improve the economic competitiveness of microreactors". Taxpayer money should not be wasted on propping up a dying industry. Investments in the energy industry should be directed toward the advancement of renewable energy technologies. Contamination: Included in the Environmental Assessment are several mentions of the potential for radionuclides to be released into the atmosphere. No amount of such material is safe and should not be accepted. Waste: As with any nuclear energy endeavor, there is no long term, safe, viable plan for the disposal of radioactive waste that this project would produce. Continuing to create waste that will remain harmful to the environment and humans for tens of thousands of years and expecting future generations to bear the weight of that responsibility is short-sighted and dangerous.	Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. The annual federal budget process and federal spending is also outside the scope of this analysis. Analysis of renewable energy is also outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE acknowledges your comments and notes that they are outside the scope of this EA. DOE takes its responsibility for the safety and health of the workers and the public seriously. The safety goal of the MARVEL microreactor is to control the release of radionuclides to minimize the risk to the public, workers, and environment. The analysis in the EA found that 1) the average dose to the individual worker (involved worker) and the cumulative dose to all INL Site workers (total workers) fall within the radiological regulatory limits of 10 CFR 835 (2011) and 2) that existing low population exposures of humans to

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		Application/Alternatives: The Environmental Assessment states that if deployed, microreactors could "provide sustainable and affordable heat and power to remote communities and to industrial users…"; Renewable energy sources such as wind, solar, and geothermal possess that capability without the dangers of nuclear energy. Public Involvement: The public comment period of just 14 days is an inadequate amount of time for the public to read, analyze, and formulate any sort of meaningful comment in response to the Environmental Assessment. The comment period should be extended in order to allow for the public to fully participate in this process. I support Alternative 2 (No Action). In order to better ensure the current and future human and environmental health of the State of Idaho, as well as keeping taxpayer money away from a failing nuclear energy industry. Thank you for your consideration of these comments. Cheers, Ian Cotten (He/Him) Energy Program Manager SNAKE RIVER ALLIANCE	radiation from the MARVEL microreactor would remain well below regulatory limits (p. 47). DOE also follows applicable waste management statutes. SNF is addressed in Section 3.8, and other wastes would be managed and dispositioned as addressed in Section 3.7 of the EA. DOE's NEPA implementing procedures are found in 10 CFR 1021. Section 1021.301 (d) states, "At DOE's discretion, this review [i.e., the public comment period] shall be from 14 to 30 days." The public comment period for this EA complied with the regulation and was extended an additional two weeks. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons. DOE acknowledges your support of the No Action Alternative.
1/25/2021 Scott Pierson	35	Greetings. I have reviewed the Draft Environmental Assessment for the MARVEL Project at INL. and think that it will be a good start. This type of energy supply if done safely with current technology can serve to fill an important part of the energy need of our country and world. Please move forward with this effort. Best regards, Scott Pierson	DOE acknowledges your comments. Thank you.

Date/Name	Comment ID Number	Comment	DOE Response
1/26/2021 Marty Sattison/IANS	36	The Idaho Section of the American Nuclear Society appreciates the opportunity to weigh in on the Draft Environmental Assessment for the MARVEL Project (DOE/EA-2146). On behalf of the hundreds of IANS members, Martin Sattison Chair, Idaho Section, American Nuclear Society IANS Comments on the Draft Environmental Assessment for Microreactor Applications Research, Validation and Evaluation (MARVEL) Project at Idaho National Laboratory The Idaho Section of the American Nuclear Society concurs with the conclusions of the report and agrees that the MARVEL Project does not pose any noticeable threats to the public, the environment, nor workers at the proposed facility. The design has many noteworthy safety and design features that make such a statement possible. These include: A very small inventory of nuclear materials Avoidance of the use of new technologies in the areas of fuel design and fabrication, structural and reactor materials, coolants and heat exchanger media, etc. Safety-by-design features, such as natural circulation coolant flow, passive heat removal, safe shutdown without human intervention, five layers of defense-in-depth, etc. Use of an existing nuclear facility with an accepted Final Safety Analysis Report that envelopes the expected operations and accident scenarios postulated for the MARVEL design Use of existing and proven waste streams and infrastructure	DOE acknowledges your comments. Thank you.

Date/Name	Comment ID Number	Comment	DOE Response
		An entire life-cycle plan for the safe and environmentally sound design, construction, testing, operations, and decontamination, decommissioning and dismantling of the microreactor and associated facilities. The Idaho Section of the American Nuclear Society fully supports DOE acceptance and approval of the MARVEL Project Environmental Assessment.	
1/26/2021 Tami Thatcher	37-87	Please find attached pdf file of comments by Tami Thatcher on the Department of Energy MARVEL DOE/EA-2146. A notification that you received my public comment submittal would be appreciated. Thank you. Sincerely, Tami Thatcher	Ms. Thatcher's comments are printed on pages A-78 through A-96, and Table A-4 lists DOE's responses to Ms. Thatcher's comments.
1/26/2021 Steve McDonald	88	I have read the Draft EA for the subject project and I find it thorough and complete in addressing any issues that could be foreseen through the life of the project. I can see many benefits in undertaking this type of research and little downside to doing so. Steve McDonald	DOE acknowledges your comments. Thank you.
2/8/2021 Bill Chisholm	89	To Whom It May Concern, For most of my adult life I have been actively engaged in environmental, energy and peace issues. I have a long history of involvement in clean-up issues at INEL with many names, numerous tax payer funded projects that served no real purpose but to subsidize the nuclear industry. I have been arrested a number of times, participated in endless hearings, I have put energy proposals on the table and even a new way of thinking as suggested by Albert Einstein. This project is not needed, we have not exhausted clean alternatives which include wind, solar and design, but also lifestyle choices including transportation.	The purpose of this EA is to assess the environmental impacts of the proposed action. The annual federal budget process and federal spending is outside the scope of this analysis. Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. Analysis of solar and wind power and other forms of energy is outside the scope of this analysis. The purpose and need for the proposed action is discussed in Section 1.2 of the EA. DOE acknowledges your support of the No Action Alternative. Thank you.

Date/Name	Comment ID Number	Comment	DOE Response
		I strongly support the No Action Alternative. I am opposed to energy policy by project proposal, it stifles coherent and creative thinking. Bill Chisholm	
2/8/2021 Buck Drew	90	Mr. Lovejoy, Hello. I am a retired dentist. I spent my career trying to reduce the impacts of radiation on my staff and patients. I do believe with technological advances we kept the office safe for everyone. The DOE has proposed that the Microreactor could operate for 60 years. This information tells me that one VTR at INL could produce 30 metric tons of spent nuclear fuel over its lifetime. My objection to a new reactor facility would be the radioactive waste. There is no safe long term solution. Idaho is too pristine to pollute at this level. Thanks for you consideration, Buck Drew, DDS	Analysis of construction and operation of the Versatile Test Reactor is outside the scope of this analysis. The MARVEL microreactor will not operate for 60 years. The MARVEL microreactor core is designed to operate continuously for two years, but the microreactor will not operate continuously. Instead, the MARVEL microreactor will be turned on and off numerous times during its lifetime to support research needs. Please refer to Section 3.8 of the EA for a discussion of the MARVEL SNF. DOE follows applicable waste management statutes. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA, and waste from MARVEL microreactor project has a path for disposition. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/8/2021 Lori Graber	91	I am against bringing this to idaho. We do not need nuclear waste here! Let it go somewhere else and preserve our beautiful state Thank you Lori Graber	DOE follows applicable waste management statutes. The wastes would be managed and dispositioned as addressed in Section 3.7 of the EA. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of

Date/Name	Comment ID Number	Comment	DOE Response
			radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). In addition, the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/8/2021 Don Benbrooks	92	I am against bringing this to Idaho. We don't need more nuclear waste! Focus on things that preserve our beautiful state This is dangerous and harmful Don Benbrooks	DOE follows applicable waste management statutes. The wastes would be managed and dispositioned as addressed in Section 3.7 of the EA. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the

Date/Name	Comment ID Number	Comment	DOE Response
			current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). In addition, the Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/8/2021 Laura Rushing-Raynes	93	Hello. It is my understanding the MARVEL Microreactor is new and untested. The untested part worries me, but what worries me more is nuclear waste. I do not want future generations saddled with the problem of disposal. Or current generations saddled with even the slightest chance of accidents of any kind. Investing in renewable energy technologies is the only way to preserve our fragile biosphere and keep our air, water and precious soil safe and clean. Ourselves, too.	DOE follows applicable waste management statutes. Please refer to Section 3.8 of the EA for a discussion of the MARVEL SNF. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA. The analysis in the Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel (DOE, 2000)

Date/Name	Comment ID Number	Comment	DOE Response
		I support the " No Action Alternative". Let's take action to bring more renewable technology to our beautiful Idaho so that it can stay that way for future generations. It's only fair. Thank you. Laura R-R Dr. Laura Rushing-Raynes Associate Professor of Voice Head, Voice Studies Boise State University Department of Music	showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). The purpose of this EA is to assess the environmental impacts of the proposed action. Analysis of solar and wind power and other forms of energy is outside the scope of this analysis. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.

Date/Name	Comment ID Number	Comment	DOE Response
2/8/2021 Jim McNamara	94	We have had a dismal history in the NW of residual radioactive waste and failed reactor projects. Renewable energy as an additive to our future needs is the path we should be taking. Hydrogen power can be made cost effective with research and time. Wind and future hydro power sources through tidal management is at our doorstep. The health concerns with nuclear waste from decades ago still is an issue that is yet unresolved. Look ahead for solutions! Jim McNamara	The purpose of this EA is to assess the environmental impacts of the proposed action. Analysis of solar and wind power and other forms of energy is outside the scope of this analysis. DOE follows applicable waste management statutes. The wastes would be managed and dispositioned as addressed in Section 3.7 of the EA. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). In addition, the analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted.

Date/Name	Comment ID Number	Comment	DOE Response
			DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/8/2021 Jody	95	We had a contract, a signed deal with the government-no more nuclear waste in Idaho! Is the government breaking their promise?This reactor poses a nuclear proliferation threat! ●The proposed reactors would be cooled with liquid sodium. Liquid sodium is a highly volatile liquid which burns when exposed to air, and explodes when exposed to water. ●The budget for this project is estimated to be $3-6 billion. If history is any indication,the actual costs will end up well beyond that projection. Taxpayer money should beinvested in the development of safer and cleaner renewable energy resources insteadof keeping a dying nuclear energy industry on life support ●This type of reactor requires plutonium for fuel, which is a key component in nuclear bombs and thus poses a nuclear proliferation threat. This reactor would also use uranium enriched at higher levels than are currently used in nuclear reactors. ●The DOE has proposed that this type of reactor could operate for 60 years, meaning that one VTR at INL could produce 30 metric tons of spent nuclear fuel over its lifetime.Creating more dangerous radioactive waste with no viable and safe long term wastesolution places an enormous threat on the future of Idaho's environmental and Taxpayer money should not be wasted on propping up a dying industry when we could be investing in	Analysis of construction and operation of the Versatile Test Reactor is outside the scope of this analysis. DOE follows applicable waste management statutes. Please refer to Section 3.8 of the EA for a discussion of the MARVEL SNF. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA. The analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the

Date/Name	Comment ID Number	Comment	DOE Response
		renewable energy technologies. While the EA states that micro reactors could "provide sustainable and affordable heat and power to remote communities and to industrial users…", renewable energy can already do these things without the nuclear waste and without endangering other beings, present and future. Continuing to create waste that will remain harmful to the environment and humans for tens of thousands of years and expecting future generations to bear the weight of that responsibility is not only dangerous, it's unjust.	current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). Nuclear nonproliferation is another issue that is considered beyond the scope of the EA. The fuel for the MARVEL microreactor is unsuitable for diversion to nuclear weapons. SNF would be securely stored with DOE's spent fuel and spent fuel debris inventory awaiting a future disposal facility in accordance with legal, regulatory, operations and scheduling requirements for the transfer and storage of these fuels. The MARVEL microreactor is not cooled with liquid sodium. About 120 kg potassium sodium eutectic (NaK), a liquid metal at room temperature, serves as the primary coolant for the MARVEL microreactor. The hazards associated with NaK were considered in the EA. The budget for the MARVEL microreactor is not $3-6 billion. Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. Analysis of renewable energy is also outside the scope of this analysis. The annual federal budget process and federal spending is also outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE acknowledges your comments and notes that they are outside the scope of this EA. The MARVEL microreactor does not use plutonium for fuel. The MARVEL microreactor fuel is a uranium zirconium hydride (U-ZrHx) containing 30-40wt% uranium that is enriched with 19.75% U235.

Date/Name	Comment ID Number	Comment	DOE Response
			The MARVEL microreactor will not operate for 60 years. The MARVEL microreactor core is designed to operate continuously for two years, but the microreactor will not operate continuously. Instead, the MARVEL microreactor will be turned on and off numerous times during its lifetime to support research needs. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/8/2021 Marilyn Olson	96	To Whom It May Concern: Taxpayer money should not be wasted on propping up a dying industry when we could be investing in renewable technologies. Please support the " No Action Alternative "-Alternative 2. Thank you for your time and consideration. Marilyn Olson	The annual federal budget process and federal spending is outside the scope of this analysis. Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. Analysis of renewable energy is also outside the scope of this analysis. DOE acknowledges your support of the No Action Alternative. Thank you.

Date/Name	Comment ID Number	Comment	DOE Response
2/8/2021 Eric W Brandt	97	I'm supporting the " No Action Alternative" - Alternative #2. Continuing to create waste that will remain harmful to the environment and humans for tens of thousands of years and expecting future generations to bear the weight of that responsibility is not only dangerous, it's unjust! Taxpayer money should not be wasted on propping up a dying industry when we could be investing in renewable energy technologies. While the EA states that microreactors could "provide sustainable and affordable heat and power to remote communities and to industrial users…" Renewable energy can already do these things without the nuclear waste and without endangering other beings, present and future. Kindly take the right, safe actions and don't bring in this new system. Thanks for considering my POV, All the best, Eric "Discover the Source" with Metabolic Typing & Functional Diagnostic Nutrition Eric Brandt	DOE acknowledges your support of the No Action Alternative. Thank you DOE follows applicable waste management statutes. Please refer to Section 3.8 of the EA for a discussion of the MARVEL SNF. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA. The analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43).

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			The annual federal budget process and federal spending is outside the scope of this analysis. Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. Analysis of renewable energy is also outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE takes its responsibility for the safety and health of the workers and the public seriously. Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.

Date/Name	Comment ID Number	Comment	DOE Response
2/8/2021 Mark M Giese	98	I support the " No Action Alternative" -- Alternative 2. Taxpayer money should not be wasted on propping up a dying industry when we could be investing in renewable energy technologies. While the EA states that microreactors could "provide sustainable and affordable heat and power to remote communities and to industrial users…", renewable energy can already do these things without the nuclear waste and without endangering other beings, present and future. Thank you. --Mark M Giese	DOE acknowledges your support of the No Action Alternative. Thank you. The annual federal budget process and federal spending is outside the scope of this analysis. Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. Analysis of renewable energy is also outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE follows applicable waste management statutes. Please refer to Section 3.8 of the EA for a discussion of the MARVEL SNF. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA. The analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste

Date/Name	Comment ID Number	Comment	DOE Response
			storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). DOE takes its responsibility for the safety and health of the workers and the public seriously. Section 3.9.2 of the EA discusses the hazard evaluation that was performed the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/8/202 Theresa Kaufmann	99	To Whom It May concern: I am writing to oppose the construction of the MARVEL untested nuclear reactor in Idaho for a few reasons. Our taxpayer moneys should be used to invest in current renewable clean energy technologies that are available and sustainable and affordable. We know the final costs of nuclear projects always go way above projected costs. The nuclear industry is a dying industry and it should not be propped up with taxpayer dollars. Nuclear energy is not clean energy. The reactor will produce more nuclear waste which is a significant problem with no solution in sight. INL already bears a significant burden of nuclear waste and to add more waste that will last for tens of thousands of years with no storage solution in sight is a terrible legacy to leave to future generations.	The annual federal budget process and federal spending is outside the scope of this analysis. Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE follows applicable waste management statutes. Please refer to Section 3.8 of the EA for a discussion of the MARVEL SNF. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA.

Date/Name	Comment ID Number	Comment	DOE Response
		I support the "No Action Alternative" - Alternative 2. Thank you for considering my statement. Theresa Kaufmann	The analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons. DOE acknowledges your support of the No Action Alternative. Thank you.

Date/Name	Comment ID Number	Comment	DOE Response
2/8/2021 J. W. Howard	100	My support is for NO ACTION ALTERNATIVE ~ Alternative 2. Common Horse Sense should be in play here. Common sense for: A) an untested reactor (s); ~ No B) taxpayers to pay for it; ~ No C) site location over ground water; ~ No D) hurry up speed up process; ~ No E) asking AL Idaho tribal governments; ~ they should be FIRST folks you ask permission, go sit with Fort Hall, Duck Valley… F) an expanded INL buffer area ~ No you are messing with Big Southern Buite, Craters OTM, & King Mtn for recreation G) poor strategy "… provide sustainable & affordable heart & power to remote communities & to industrial users" ~ No a Thousand times No This proposal lacks a modicum of Common Sense. Haste makes waste said Ben Franklin in his Poor Richards Almanac. Idaho National Lab can do better than this horse hydrocarbon gig. Hence, I am urging NO ACTION ALTERMNATIVE ~ Alternative 2 Joel W. Howard	Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. DOE takes its responsibility for the safety and health of the workers and the public seriously. The MARVEL microreactor system is a closed system, and does not have any liquid or gaseous discharges into the environment during normal operation and would not affect groundwater resources (p. 24). DOE briefed the Shoshone-Bannock Tribes Tribal staff on September 9, 2020 and the Fort Hall Business Council on September 30, 2020 on the MARVEL microreactor EA and project. The proposed action does not expand the INL Site boundary or facility boundaries for any facility within the INL Site. The facility modifications, construction, and operations proposed as part of the MARVEL microreactor would occur in existing facilities. The MARVEL microreactor does not require construction of new facilities or additional land use or ground disturbance. The MARVEL microreactor would have no impacts on land use (EA p. 24). The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.

Date/Name	Comment ID Number	Comment	DOE Response
			DOE acknowledges your support of the No Action Alternative. Thank you.
2/8/2021 Andrea Wilson	101	To whom it may concern: We do not need a new, untested nuclear reactor in Idaho. We should be investing in renewable energy technologies. While the EA states that microreactors could “provide sustainable and affordable heat and power to remote communities and to industrial users…”, renewable energy can already do these things without the nuclear waste and without endangering other beings, present and future. Continuing to create waste that will remain harmful to the environment and humans for tens of thousands of years and expecting future generations to bear the weight of that responsibility is not only dangerous, it's unjust. As a mother, I am opposed to anything which makes the world worse for my children and their future children. I support the "No Action Alternative" - Alternative 2. Please choose this option. Please let me know how you will proceed. Sincerely, Andrea Wilson	DOE takes its responsibility for the safety and health of the workers and the public seriously. Section 3.9.2 of the EA discuss the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. Analysis of renewable energy is outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE follows applicable waste management statutes. The wastes would be managed and dispositioned as addressed in Section 3.7 of the EA. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). In addition, the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted.

Date/Name	Comment ID Number	Comment	DOE Response
			The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons. DOE acknowledges your support of the No Action Alternative. Thank you.
2/9/2021 Daniel Hawley	102	Taxpayer money should not be wasted on propping up a dying industry when we could be investing in renewable energy technologies. While the EA states that microreactors could “provide sustainable and affordable heat and power to remote communities and to industrial users…”, renewable energy can already do these things without the nuclear waste and without endangering other beings, present and future. Continuing to create waste that will remain harmful to the environment and humans for tens of thousands of years and expecting future generations to bear the weight of that responsibility is not only dangerous, it's unjust. I support the " No Action Alternative" - Alternative 2. Daniel Hawley	Evaluating nuclear energy’s place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. Analysis of renewable energy is also outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE takes its responsibility for the safety and health of the workers and the public seriously. Section 3.9.2 of the EA discusses the hazard evaluation that was performed the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. DOE follows applicable waste management statutes. Please refer to Section 3.8 of the EA for a discussion of the MARVEL SNF. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA.

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			The analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons. OE acknowledges your support of the No Action Alternative. Thank you.

Date/Name	Comment ID Number	Comment	DOE Response
2/9/2021 Jeanne Knott	103	Dear to whom it may concern, I am writing regarding the proposed MARVEL Microreactor. Taxpayer money should not be wasted on propping up a dying industry when we could be investing in renewable energy technologies. While the EA states that microreactors could "provide sustainable and affordable heat and power to remote communities and to industrial users…", renewable energy can already do these things without the nuclear waste and without endangering other beings, present and future. Continuing to create waste that will remain harmful to the environment and humans for tens of thousands of years and expecting future generations to bear the weight of that responsibility is not only dangerous, it's unjust. We need to move on to a less environmentally harmful energy source. I am supporting the " No Action Alternative" - Alternative 2. Jeanne Knott	Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. Analysis of renewable energy is also outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE takes its responsibility for the safety and health of the workers and the public seriously. Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. DOE follows applicable waste management statutes. The wastes would be managed and dispositioned as addressed in Section 3.7 of the EA. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). In addition, the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and

Date/Name	Comment ID Number	Comment	DOE Response
			guidelines and no mitigation measures would be warranted. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons. DOE acknowledges your support of the No Action Alternative. Thank you.
2/9/2021 Jonathan Sadler	104	The proposed reactors would be cooled with liquid sodium. Liquid sodium is a highly volatile liquid which burns when exposed to air, and explodes when exposed to water. ● The budget for this project is estimated to be $3-6 billion. If history is any indication, the actual costs will end up well beyond that projection. Taxpayer money should be invested in the development of safer and cleaner renewable energy resources instead of keeping a dying nuclear energy industry on life support. ● This type of reactor requires plutonium for fuel, which is a key component in nuclear bombs and thus poses a nuclear proliferation threat. This reactor would also use uranium enriched at higher levels than are currently used in nuclear reactors.	Analysis of construction and operation of the Versatile Test Reactor is outside the scope of this analysis. The MARVEL microreactor is not cooled with liquid sodium. About 120 kg sodium potassium eutectic (NaK), a liquid metal at room temperature, serves as the primary coolant for the MARVEL microreactor. The hazards associated with NaK were considered in the EA. The budget for the MARVEL microreactor is not $3-6 billion. Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. Analysis of renewable energy is also outside the scope of this analysis. The annual federal budget process and federal spending is also outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. Nuclear Nonproliferation is another issue that is considered beyond the scope of the EA. The MARVEL microreactor does not use plutonium

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		● The DOE has proposed that this type of reactor could operate for 60 years, meaning that one VTR at INL could produce 30 metric tons of spent nuclear fuel over its lifetime. Creating more dangerous radioactive waste with no viable and safe long term waste solution places an enormous threat on the future of Idaho's environmental and human health. It is irresponsible and shortsighted to propose a project that creates waste that we still do not know how to deal with. Thanks you for your time and consideration, Jonathan Sadler	for fuel. The MARVEL microreactor fuel is a uranium zirconium hydride (U-ZrHx) containing 30-40wt% uranium that is enriched with 19.75% U235. The fuel for the MARVEL microreactor is unsuitable for diversion to nuclear weapons. SNF would be securely stored with DOE's spent fuel and spent fuel debris inventory awaiting a future disposal facility in accordance with legal, regulatory, operations and scheduling requirements for the transfer and storage of these fuels. The MARVEL microreactor will not operate for 60 years. The MARVEL microreactor core is designed to operate continuously for two years, but the microreactor will not operate continuously. Instead, the MARVEL microreactor will be turned on and off numerous times during its lifetime to support research needs. DOE follows applicable waste management statutes. Please refer to Section 3.8 of the EA for a discussion of the MARVEL SNF. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA. The analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted.

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			Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/9/2021 Theresa Williams	105	Taxpayer money should not be wasted on propping up a dying industry when we could be investing in renewable energy technologies. While the EA states that microreactors could "provide sustainable and affordable heat and power to remote communities and to industrial users…", renewable energy can already do these things without the nuclear waste and without endangering other beings, present and future. Continuing to create waste that will remain harmful to the environment and humans for tens of thousands of years and expecting future generations to bear the weight of that responsibility is not only dangerous, it's unjust. I support the " No Action Alternative" - Alternative 2. Thank you for receiving my comment on this proposal to bring a new, untested nuclear reactor to Idaho. Sincerely, Theresa Williams	The annual federal budget process and federal spending is outside the scope of this analysis. Evaluating nuclear energy's place in the energy market is also outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. Analysis of renewable energy is also outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE takes its responsibility for the safety and health of the workers and the public seriously. Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. DOE follows applicable waste management statutes. Please refer to Section 3.8 of the EA for a

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			discussion of the MARVEL SNF. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA. The analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons. DOE acknowledges your support of the No Action Alternative. Thank you.

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2/9/2021 Doug True Nuclear Energy Institute (NEI)	106	Dear Mr. Kropp: The Nuclear Energy Institute (NEI) expresses its support for the development of the Environmental Assessment for the Microreactor Applications Research, Validation and Evaluation Project (MARVEL) at Idaho National Laboratory (INL). The MARVEL project will construct a 100 kw-thermal microreactor, at INL, that will offer experimental capabilities for performing R&D on various microreactor operational features and improving integration of microreactors with end-user applications, such as off-grid electricity generation and process heat. Many companies are developing microreactors and at least two companies are planning to deploy microreactors by 2025 in North America. Microreactors have the unique capability to operate for many years without refueling and can provide both electricity and heat when needed and are ideally suited for small communities, microgrids and remote locations. We encourage DOE to continue its engagement with end-users and stakeholders to utilize MARVEL, when operational, for research and development on various aspects of microreactors including remote operations and anticipated applications beyond electricity (e.g., process heat, hydrogen production, and water purification). Sincerely, Doug True Doug True | Senior Vice President and Chief Nuclear Officer	DOE acknowledges your comment supporting the proposed action. Thank you.
2/9/2021 Leigh Ford	107	Thank you for the opportunity to comment. Although the time period given to comment was too short, especially during these unprecedented days of pandemic, and political and economic stress, I am grateful the deadline was extended even just a little. Taxpayer money should not be wasted on propping up the dying nuclear industry when we could be investing in renewable energy technologies. The climate crisis is happening now and nuclear is too expensive, slow,	DOE's NEPA implementing procedures are found in 10 CFR 1021. Section 1021.301 (d) states, "At DOE's discretion, this review [i.e., the public comment period] shall be from 14 to 30 days." The public comment period for this EA complied with the regulation, and DOE extended the public comment period an additional two weeks. The annual federal budget process and federal spending is outside the scope of this analysis.

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		environmentally damaging and dangerous to be a consideration. While the EA states that microreactors could "provide sustainable and affordable heat and power to remote communities and to industrial users…", renewable energy can already do these things without the nuclear waste and without endangering other beings, present and future. Renewable energy is cheaper, faster, less environmentally damaging and far less dangerous. The EA does not sufficiently address the nuclear waste issue. Continuing to create radioactive waste will be dangerous to the environment, humans and all living beings for tens of thousands of years and expecting future generations to bear the weight of that responsibility is not only dangerous, it's unjust. I'd rather leave my children with clean water and an unadulterated land. I support the " No Action Alternative" - Alternative 2. Leigh Ford	Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. DOE takes its responsibility for the safety and health of the workers and the public seriously. Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. Analysis of renewable energy is also outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE follows applicable waste management statutes. Please refer to Section 3.8 of the EA for a discussion of the MARVEL SNF. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA. The analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL

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			activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons. DOE acknowledges your support of the No Action Alternative. Thank you.
2/9/2021 E Workman	108	This kind of project makes no sense. Without the ability to safely store the long term radioactive waste, this proposed reactor is not conducive to a safe future for Idaho's health. A huge amount of money will be spent on a project for a dying industry. Our taxpayers money should be spent on solving our problems with safe and clean renewable energy resources.	DOE follows applicable waste management statutes. The wastes would be managed and dispositioned as addressed in Section 3.7 of the EA. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). In addition, the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as

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			the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. The annual federal budget process and federal spending is outside the scope of this analysis. Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. Analysis of renewable energy is also outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/9/2021 Dan French	109	I want to express my disapproval of continuing or adding nuclear power sources. We should be focusing on solar primarily as well as wind and other clean energy sources. The radioactive waste created by nuclear power makes nuclear a bad choice. It is also FAR more expensive than solar or wind. It would seem that advancing nuclear would be for the sole benefit of protecting people in an outdated and economically un feasible industry at the expense of tax payers.	The purpose of this EA is to assess the environmental impacts of the proposed action. Analysis of renewable energy is outside the scope of this analysis. The annual federal budget process and federal spending is outside the scope of this analysis. Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. DOE acknowledges your comments but notes they are outside the scope of this analysis.
2/9/2021 William F. Hughes	110	DOE/INL Overhead Team, It is time to transition from the INL's complete focus on nuclear power to expanding the capacities of alternative energy production and improving the efficiencies in associated storage.	The purpose of this EA is to assess the environmental impacts of the proposed action. Analysis of solar and wind power and other forms of energy is outside the scope of this analysis.

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		The expansive area of the INL Site in Idaho offers an abundant opportunity for solar and wind energy development. Cutting-edge science and study to promote the compatibility of solar and wind production with the high desert ecosystems found in the Western U.S. would help sustain the economic benefits and employment provided by the INL to the Upper Snake River Valley. Transforming the INL into a global hub investigating the science of alternative energy and its storage would preserve this economic asset in Idaho, and lead the way for a sustainable, clean energy future for this nation and the world, removing the threat of radioactive contamination of the Snake River Aquifer. Thank you, William F. Hughes	DOE takes its responsibility for the safety and health of the workers and the public seriously. The MARVEL microreactor system is a closed system, and does not have any liquid or gaseous discharges into the environment during normal operation and would not affect groundwater resources (p. 24). The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/9/2021 Deborra Bohrer	111	It is abhorrent to entertain the use of these reactors. The DOE is in not trying to justify the use of this dangerous and toxic energy source because it has spent so much capital and human resource on an illegitimate and falsified need. We have legitimate renewable resources that we should be pursuing to the best of our ability and we need to put an end to this devastating energy. Deborra Bohrer	Analysis of solar and wind power and other forms of energy is outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE acknowledges your comments but notes they are outside the scope of this analysis.

Date/Name	Comment ID Number	Comment	DOE Response
2/9/2021 Tim Andreae	112	I am an Idaho tax-payer for the past 23 years and I am in opposition to the proposal for the Marvel reactor. By nature, nuclear reactors work with and create incredibly long-lived toxic substances. The cost to the environment of creating Plutonium for instance is never figured in at the start, even though the costs of containment will continue indefinitely, let alone the risk of exposure and the cost to human and ecological life in the event that in the next 250,000 years there's a breach in the containment. Even at face value, the cost of the Marvel micro-reactor far exceeds the cost of other renewable energy options, such as wind and solar. To me, it's a no-brainer where to put the money: do we sink it into a black hole that produces radioactive waste and endless expense along with the energy output, or do we put our money into tried and true means of producing energy with no toxic waste byproduct? Thank you for your consideration Tim Andreae	The scope of this EA does not include plutonium production. This EA does not address the economics or affordability of nuclear power. Analysis of solar and wind power and other forms of energy is also outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE acknowledges your comments but notes they are outside the scope of this analysis
2/9/2021 William M. Fowkes	113	I support the 'no action' alternative #2 for Marvel reactors. Clean renewable energy will be the sustainable option now and in the future. I do not believe a bridge technology that generates radioactive waste is the direction that is needed or wise. We don't need to go down that path and generate that inertia or risk increase. This is not a risk free technology, and having such contamination potential sitting over the vast Snake River aquifer is not justifiable. Sincerely, William M. Fowkes	DOE acknowledges your support of the No Action Alternative. Thank you. Analysis of solar and wind power and other forms of energy is outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE takes its responsibility for the safety and health of the workers and the public seriously. The MARVEL microreactor system is a closed system, and does not have any liquid or gaseous discharges into the environment during normal operation and would not affect groundwater resources (p. 24). The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE acknowledges that many different perceptions are represented in the

Date/Name	Comment ID Number	Comment	DOE Response
			comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/9/2021 Clésio Ismério de Oliveira	114	Dear Garrett I read the main parts of the document draft-ea-2146-marvel-idaho-2021-01.pdf. There was no question about safety or the environment. Success to MARVEL Project! All The Best Clésio	DOE acknowledges your comment. Thank you.
2/9/2021 Dean Gilbert	115	I support the No Action Alternative. The potential health and environmental cost is too great. Lets continue to move toward Wind and Solar resources. Deanie Gilbert	DOE acknowledges your support of the No Action Alternative. Thank you. The purpose of this EA is to assess the environmental impacts of the proposed action. Analysis of solar and wind power and other forms of energy is outside the scope of this analysis. DOE acknowledges your comments but notes they are outside the scope of this analysis
2/9/2021 Julie Hoefnagels	116	To whom it may concern: This email is respectfully submitted in opposition the building of any micro reactors at the INL site in southeastern Idaho. This institution has already taken in nuclear waste from the nuclear submarine fleet and from the Three Mile Island accident, and the waste brought in was originally stored in unsafe conditions. As a result, the INL site is now a Super Fund site. All of this nuclear activity and material is right above the Snake River Plain Aquifer, and I do not feel that any future reactors, either for the purpose of research or electric power production, should be built, including the new micro reactors.	DOE takes its responsibility for the safety and health of the workers and the public seriously. The MARVEL microreactor system is a closed system, and does not have any liquid or gaseous discharges into the environment during normal operation and would not affect groundwater resources (p. 24). Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. The annual federal budget process and federal spending is outside the scope of this analysis.

Date/Name	Comment ID Number	Comment	DOE Response
		I am a longtime Idaho resident, and am very concerned about future nuclear developments, their cost to the taxpayer and danger to our environment and to our posterity. Thank you for your consideration. Julie Hoefnagels	The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/9/2021 Virginia Beall	117	Clean renewable energy will be the sustainable option now and in the future. I do not believe a bridge technology that generates radioactive waste is the direction that is needed or wise. We don't need to go down that path and generate that inertia or risk increase. This is not a risk free technology, and having such contamination potential sitting over the vast Snake River aquifer is not justifiable in my mind. Sincerely, Virginia Beall	Analysis of solar and wind power and other forms of energy is outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE takes its responsibility for the safety and health of the workers and the public seriously. Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. The MARVEL microreactor system is a closed system, and does not have any liquid or gaseous discharges into the environment during normal operation and would not affect groundwater resources (p. 24). The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.

Date/Name	Comment ID Number	Comment	DOE Response
2/9/2021 Bonnie Krafchuk	118	Dear Mr. Garrett Kropp, The Marvel Microreactor is not in the best interests of Idaho. This reactor is not a marvel but instead endangers humans and other beings both now and in the future. There is no lasting and safe manner in which to store nuclear waste. Additionally, the production of nuclear energy is prohibitively expensive. Luckily we have renewable forms of energy that can be used instead without threatening the health of humans or the environment. I choose Alternative 2 - No Action. Thank you for your consideration, Bonnie Krafchuk	DOE acknowledges your comment. Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. DOE follows applicable waste management statutes. The wastes would be managed and dispositioned as addressed in Section 3.7 of the EA. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). In addition, the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted.

Date/Name	Comment ID Number	Comment	DOE Response
			Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power, leaving that decision to those proposing to use nuclear power. Analysis of solar and wind power and other forms of energy is outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE acknowledges your support of the No Action Alternative. Thank you.
2/9/2021 Lon Stewart	119	I urge you to support Alternative 2, "No Action" in the Environmental Assessment for the MARVEL Microreactor. Nuclear reactors of any size do not have a viable means of deactivating the spent nuclear fuel. We should not be adding to the existing quantity of spent fuel that is dangerous to human health and the environment for thousands of years, even if it is just small amounts. Just because we have the technology and resources to create electricity from nuclear energy does not mean we have to continue developing the resource. The world has lots of coal left but we are weening ourselves away from that resource, The world has lots of petroleum remaining and we are weening ourselves away from that resource as well. We should ween ourselves away from nuclear too. All of these have human and environmental affects. INL should consider research in advancing renewable forms of energy such as solar and wind or energy storage, not on forms of energy that have seen their day. INL has been storing different levels of nuclear waste for years, much still waiting to be processed and sent off for final storage, not deactivation. Some of this research and production waste has created explosive incidents while being prepared for shipment. There is no guarantee that if the MARVEL Microreactor project was to commence that its waste would not be stored on site for ears nor	DOE acknowledges your support of the No Action Alternative. Thank you. DOE follows applicable waste management statutes. Please refer to Section 3.8 of the EA for a discussion of the MARVEL SNF. The wastes other than SNF would be managed and dispositioned as addressed in Section 3.7 of the EA. The analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of

Date/Name	Comment ID Number	Comment	DOE Response
		create similar incidents causing exposure to humans or the environment. Even if procedures are in place for handling these wastes, the human factor still exists and unfavorable incidents will occur. A final repository for spent nuclear fuel does not exist within the United States. Even though a work was put into such a place, Yucca Mountain, it has been canceled and a new site has not been developed. Even if it did exist, storing the waste for "eternity" does not solve the problem of the waste, it only hides it. How would we know if our modeling of the storage disposal site would be accurate for the thousands of years for the waste to become non-harmful. There are better ways to satisfy the demand for electricity without causing harm to human health and the environment for generations to come by experimenting with nuclear power. Alternative 2, No Action is the best option in the MARVEL Microreactor Environmental Assessment. Respectfully submitted, Lon Stewart	radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). Analysis of solar and wind power and other forms of energy is outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action. Section 3.8 of the EA notes that as with all SNF at present, the question of permanent disposition of SNF is directly dependent on the identification and licensing of a permanent repository for SNF in the United States. Evaluating options for a final disposal site for DOE-managed SNF is outside the scope of this analysis and subject to National Environmental Policy Act (NEPA) review by DOE prior to making a decision on any option for a final disposal site. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/9/2021 Susan Canham	120	I am not in favor of nuclear energy given the waste and potential danger when problems arise. Money is better spent on renewable energy technologies that are not potentially toxic to people and the environment. Susan Canham	DOE acknowledges your comment. Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. DOE follows applicable waste management statutes. The wastes would be managed and dispositioned as addressed in Section 3.7 of the EA.

Date/Name	Comment ID Number	Comment	DOE Response
			Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). In addition, the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted. Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. Analysis of solar and wind power and other forms of energy is outside the scope of this analysis. The purpose of this EA is to assess the environmental impacts of the proposed action.

Date/Name	Comment ID Number	Comment	DOE Response
			DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/9/2021 Kristen Luna	121	Dear Garrett Kropp and all else who have a hand in this, I Kristen Luna a Caldwell citizen do not condone this abuse of our ecosystem and the general public. We do not need more toxic dirty energy. You have no rights to the land you are using and abusing. This is outright disgusting, negligent and should be illegal. There are better power sources available besides nuclear. Far more sustainable and not harmful. I don't even understand why you would invest in this nuclear power source after knowing it has a literal time limit on it before failure and extreme damage to the environment or it fails and you have to abandon it. Which means you are wasting money and simultaneously taking a severely risky gamble with unforgiving damages to your fellow man and land you call home. I beg you to reconsider and jump on board with some of the amazing clean tech that is available to save earth water and land while helping save money. It's really that simple. You do not have permission to continue the way you are. Sincerely Kristen Luna	Congress has authorized the Department of Interior to "withdraw," or set aside, public land to meet the needs of federal agencies such as DOE. Withdrawals occur through a mechanism known as a public land order. The INL Site lands were withdrawn from the public domain through Public Land Orders No. 318, 545, 637, and 1770. The public land orders do not have specific time limitations; therefore, authority to administer these lands is expected to remain with DOE for the foreseeable future. DOE takes its responsibility for the safety and health of the workers and the public seriously. Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. The purpose of this EA is to assess the environmental impacts of the proposed action. Analysis of solar and wind power and other forms of renewable energy is outside the scope of this analysis.

Date/Name	Comment ID Number	Comment	DOE Response
			DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/9/2021 Jerry Riener	122	Hello, I am taking the time to write a few comments on the proposed MARVEL MicroReactor. I fully support Alternative Plan #2 for the following reasons: 1. Nuclear should not be pursued since there are no long term plans in terms of waste. 2. MicroReactor is not addressing or taking into account the cost of infrastructure of downstream implications. 3. Nuclear energy has alway costed more than it is estimated, and no tangible results specially for the state of Idaho. Jerry Riener	DOE acknowledges your support of the No Action Alternative. Thank you. DOE follows applicable waste management statutes. The wastes would be managed and dispositioned as addressed in Section 3.7 of the EA. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). In addition, the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted.

Date/Name	Comment ID Number	Comment	DOE Response
			The EA was prepared in accordance with NEPA, the Council on Environmental Quality's regulations on implementing NEPA (40 CFR 1500 through 1508) and DOE's NEPA regulations (10 CFR 1021). None of these regulations require the inclusion of a cost analysis. The basic objective of the EA is to provide the public and DOE decision-makers with a description of the reasonable alternatives for the MARVEL microreactor and information about potential impacts on public health and safety and the environment. Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
2/10/2021 Steve Rady	123	I am voicing my opposition to this nuclear reactor proposal. This technology still represents a grave threat to Idaho's environment. We are the Nation's wilderness leader in the lower 48, as well as the lower 48's most vast white water capability. These facts alone should cause future nuclear materials storage or development in Idaho to be cancelled. We have a sustainable unlimited power source in the sun and with new solar capacity and technology, this type of energy generation is no longer viable or cost effective.	This comment was received after the deadline for public comments. DOE takes its responsibility for the safety and health of the workers and the public seriously. Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. Analysis of solar and wind power and other forms of energy is outside the scope of this analysis. The

Date/Name	Comment ID Number	Comment	DOE Response
		I hope that you will look at all the negative aspects of nuclear power and cancel this program at the earliest opportunity. Steve Rady	purpose of this EA is to assess the environmental impacts of the proposed action. Evaluating nuclear energy's place in the energy market is outside the scope of this effort. This EA does not address the economics or affordability of nuclear power. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE acknowledges your comments but notes they are outside the scope of this analysis.
3/2/2021	124-128	Devon Boyer, Chairman, Fort Hall Business Council	Chairman Boyer's comments are printed on pages A-123 through A-125, and Table A-5 lists DOE's responses to The Shoshone-Bannock Tribes' comments.

January 24, 2021

Mr. Garrett Kroppl
U.S. Department of Energy
1955 N. Fremont Avenue
Idaho Falls, ID 83415
marvel@id.doe.gov

Re: Draft Environmental Assessment for construction of MARVEL microreactor at INL.

Dear Mr. Kropp,

Thank you for the invitation to submit public comments on the draft environmental assessment for construction of MARVEL microreactor at Idaho National Laboratory. Below are my public comments regarding the draft environmental assessment.

Glossary

"Graded approach: A process by which the level of analysis, documentation, and actions necessary to comply with a requirement are commensurate with (1) the relative importance to safety, safeguards, and security; (2) the magnitude of any hazard involved; (3) the lifecycle stage of a facility; (4) the programmatic mission of a facility; (5) the particular characteristics of a facility; and (6) any other relevant factor."

> *The above "graded approach" definition appears to come from DOE M 435.1-1 Chg 2 (Admin Chg), "Radioactive Waste Management Manual". An alternative definition could be that from 10 CFR 830, "Nuclear Safety Management": (1) the relative importance to safety, safeguards, and security; (2) the magnitude of any hazard involved;*[17]
>
> *(3) the life-cycle stage of a facility or item; (4) the programmatic mission of a facility; (5) the particular characteristics of a facility or item; (6) the relative importance to radiological and nonradiological hazards; and, (7) any other relevant factors.*

Section 1.1 (Background)

"This power limit allows microreactors to be classified as Hazard Category 2 per the Code of Federal Regulations (CFR) at 10 CFR 830 and DOE-STD-1027 (2019). These reactors are decentralized energy sources that have the ability to provide sustainable and affordable heat and power to remote communities and to industrial users, while having self-contained geometry that requires very low maintenance. Microreactors are inherently safe because they are self-regulating and do not rely on engineered systems to ensure safe shut down and removal of decay heat (Owusu, Holbrook, & Sabharwall, 2018)."[18]

Section 1.2 (Purpose and Need)

"The purpose of the Microreactor Applications Research Validation and Evaluation (MARVEL) project is to meet the R&D needs of DOE and NRIC by designing and building a nuclear microreactor application test platform at INL that will offer experimental capabilities for performing R&D on various operational features of microreactors and improving integration of microreactors to end-user applications, such as off-grid electricity generation and process heat."[19]

Section 2 (Alternatives)

"Incorporate multiple passive barriers to inhibit-fission product release"[20]

Section 2.1 (Proposed Action - Microreactor Applications Research, Validation and Evaluation (MARVEL) Project) and section 6 (References)

"The MARVEL microreactor safety-in-design approach implements a defense-in-depth (DID) strategy by adopting the traditional five layers of DID to the MARVEL microreactor. The DID layers are an integral part of the SSC classification and performance requirement determination."

> *It may be useful to provide reference to the noted defense-in-depth strategy.*[21]

Section 2.1 (Proposed Action - Microreactor Applications Research, Validation and Evaluation (MARVEL) Project) and section 6 (References)

"The hazard evaluation process for the MARVEL microreactor for compliance with the requirements in 10 CFR 830, Nuclear Safety Management, follows a process similar to the Licensing Modernization Project (LMP) as outlined in Nuclear Energy Institute (NEI)-18-04, Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis Development (2018)."

"Nuclear Energy Institute. (2018, September). Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis Development. NEI Technical Report 18-04. NEI."

> *I believe that the noted September 2018 version of 18-04 is a working draft and the final version is dated April 1, 2019.*[22]

Section 2.1 (Proposed Action - Microreactor Applications Research, Validation and Evaluation (MARVEL) Project)

"The MARVEL microreactor will not be operated at the same time as the TREAT Reactor is operating."

> *It should be clarified whether this is to indicate that the TREAT Reactor will not be operated while the MARVEL microreactor is installed and operational in the TREAT facility, i.e., for a period of years. Or is the meaning to suggest that only when the MARVEL microreactor is actually operating. Suggest using the same phrasing as is used later in this document: "The MARVEL microreactor will not operate on days the TREAT reactor is operating."*[23]

Section 2.1 (Proposed Action - Microreactor Applications Research, Validation and Evaluation (MARVEL) Project)

"As such, the documented safety analysis for the MARVEL Project will be in the form of an addendum to the existing TREAT final safety analysis report."

> *It is unclear if MARVEL operation will also require any modifications be made to the main portion of the TREAT facility safety analysis report to for example include a limiting condition of operation regarding MARVEL.*[24]

Section 2.1 (Proposed Action - Microreactor Applications Research, Validation and Evaluation (MARVEL) Project) – Reactor Coolant System

"The Stirling engines are interchangeable with the high grade heat exchangers. These heat exchangers will also be immersive heat exchangers into the lead-bismuth pool of the IHX, designed solely to extract high temperature heat from the primary coolant for process heating applications. Hence between experiments, either Stirling engines or high grade heat exchangers are placed in the four IHXs, while the lead-bismuth is molten."

Later in this document there is discussion of steps that would be taken in the Deactivation and Decommissioning phase to eliminate releasing polonium-210 from the lead-bismuth eutectic but such a concern is not expressed during the operational phase. There also seems to be presumption that all produced polonium-210 would remain within the lead- bismuth eutectic.[25]

Section 2.1 (Proposed Action - Microreactor Applications Research, Validation and Evaluation (MARVEL) Project) – Fuel System

"The MARVEL microreactor fuel is a uranium zirconium hydride (U-ZrHx) containing 30- 40wt% uranium that is enriched with 19.75% U235. The MARVEL microreactor fuel material is U-$ZrH_{1.7}$ sodium bonded to type 316 SS cladding. The fuel system consists of cladding, endcaps, fuel pins, neutron reflectors, and gap conductance fluid (sodium) as shown in Figure 7. Theentire fuel system is composed of 36 fuel pins, or about 150 kg of fuel, which includes about 50 kg of fuel required for the 22-34 fuel pins that are for quality assurance of the fabrication process. Therefore, less than 100 kg of fuel will be involved in the fission process. Each pin measures about 38-in. (96.5-cm) long."

If 100 kg of fuel is utilized containing 30-40wt% uranium, then the total uranium mass could range from 30 to 40 kg. This may be more than the Table 1 value of "<30 kg U".

The NUREG-1282 fuel specification that is later referenced, only allows for up to 30% uranium with enrichment up to 20%, designated as 30-20 fuel.[26]

Section 2.1 (Proposed Action - Microreactor Applications Research, Validation and Evaluation (MARVEL) Project) – Reactivity Control Systems

Section 2 (Alternatives) indicates a microreactor design criteria of "Use inherent reactivity feedbacks to ensure reactor power is controlled by physics during overpower or over temperature events". Table 1 further indicates that Reactivity Control Method 2 is "Inherent Core Reactivity Feedback", yet no mention of this important method is presented in this section. There is a brief mention of the reliance on this method in section 3.9.3 (Accident Analysis).[27]

Section 2.1.2 (Alternatives Considered and Eliminated from Analysis)

Was there consideration of alternatives to the use of beryllium metal / beryllium oxide for neutron reflection in the design gives the health hazards inherent with this material?[28]

Section 3.2.1 (Impacts to Air Quality)

"During reactor operation, discharges of liquid or gas from the primary system is not anticipated. The gas volume is sealed, and the total cover gas volume is large enough to accommodate thermal expansion and contraction of the NaK. Discharging NaK or cover gas from the reactor will not be required until decommissioning. At the end of life, prior to coolant draining, the cover gas will be extracted by a simple gas transfer line into a gas storage container, which will be disposed of as LLW as discussed in Section 3.7."[29]

Section 3.2.1 (Impacts to Air Quality)

"The NaK coolant acts as a radionuclide barrier by retaining fission products by plate-out, chemical solubility, or adsorption mechanisms. The radionuclides that are not retained are activation products of potassium, mainly Ar-39 and Ar-41, and will accumulate in the cover gas space. Because the system is sealed, accumulation of Ar-39 can also increase the pressure of the system. It is estimated that about

25 ml of Ar-39 (1.5 Curies) and 2.55×10^{-5} ml of Ar-41 (1.96 Curies) would be produced over the life of the reactor.[30]

"An argon gas blanket may be maintained on the lead-bismuth eutectic heat exchangers to reduce formation of lead and bismuth oxide, and the process of maintaining this blanket would involve venting small volumes of argon gas (about one cubic foot per day or less). This gas will not contain radionuclides, and the gas temperature will be low enough that there should only be trace amounts of lead fumes. Formation of oxide may require periodic oxide removal and replenishment of the heat exchangers."

> *Is there a good basis that the NaK argon cover gas and the lead-bismuth argon cover gas are sufficiently isolated to eliminate consideration for release of Ar-39 and Ar-41? Also that there won't be any volatilization of polonium-210 from the lead-bismuth into the argon cover gas.*[31]

Section 6 (References)[32]

10 CFR 830. (2011, January 1). Nuclear Safety Management. *Code of Federal Regulations*. Office of the Federal Register.

10 CFR 835. (2011, January 1). Occupational Radiation Protection. *Code of Federal Regulations*. Office of the Federal Register.

10 CFR 851. (2012, January 1). Worker Safety and Health Program. *Code of Federal Regulations*. Office of the Federal Register.

36 CFR 61. (1999). Procedures for State, Tribal, and Local Government Historic Preservation Programs. *Code of Federal Regulations*. Office of the Federal Register.

36 CFR 800. (2000). Protection of Historic Properties. *Code of Federal Regulations*. Office of the Federal Register.

40 CFR 1500-1508. (1978, as amended 1986 and 2005). CEQ Regulations for Implementing NEPA. *Code of Federal Regulations*. Office of the Federal Register.

40 CFR 61 Subpart H. (1989). National Emission Standards for Hazardous Air Pollutants. ~~Code of Federal Regulations.~~ *Code of Federal Regulations*. Office of the Federal Register."

Section 6 (References)

"Anders, M. H., Rodgers, D. W., Hemming, S. R., Saltzman, J., Divenere, V. J., Hagstrum, J. T.,

. . . Walter, R. C. (2014). A Fixed Sublithospheric Source for the Late Neogene Track of the Yellowstone Hot Spot: Implications of the Heise and Picabo Volcanic Fields. Journal of Geophysical Research: Solid Earth, V. 119. DOI:10.1002/2013JB0483."

Sincerely yours,

Mr. Donivan R. Porterfield

Table A-3. DOE response to comments from Mr. Donivan R. Porterfield.

Comment ID Number	Comment	DOE Response
17	"Graded approach: A process by which the level of analysis, documentation, and actions necessary to comply with a requirement are commensurate with (1) the relative importance to safety, safeguards, and security; (2) the magnitude of any hazard involved; (3) the lifecycle stage of a facility; (4) the programmatic mission of a facility; (5) the particular characteristics of a facility; and (6) any other relevant factor." *he above "graded approach" definition appears to come from DOE M 435.1-1 Chg 2 (Admin Chg), "Radioactive Waste Management Manual". An alternative definition could be that from 10 CFR 830, "Nuclear Safety Management": (1) the relative importance to safety, safeguards, and security; (2) the magnitude of any hazard involved; (3) the life-cycle stage of a facility or item; (4) the programmatic mission of a facility; (5) the particular characteristics of a facility or item; (6) the relative importance to radiological and nonradiological hazards; and, (7) any other relevant factors.*	The recommended change has been made to the EA.
18	Section 1.1 (Background) fix capitalization, add punctuation and remove redundant word.	The recommended change has been made to the EA.
19	Section 1.2 remove 'I' from NRIC	NRIC stands for "National Reactor Innovation Center." The EA has not been changed.
20	Section 2 add hyphen to "Incorporate multiple passive barriers to inhibit fission product release" between "inhibit" and "fission."	The hyphen is misplaced. The EA has not been changed.
21	"The MARVEL microreactor safety-in-design approach implements a defense-in-depth (DID) strategy by adopting the traditional five layers of DID to the MARVEL microreactor. The DID layers are an integral part of the SSC classification and performance requirement determination." *It may be useful to provide reference to the noted defense-in-depth strategy.*	The reference to the *Safety Design Strategy for the Microreactor Applications Research Validation and Evaluation Project (MARVEL*) (INL, 2021) has been added to Section 2.1 and the references.
22	I believe that the noted September 2018 version of 18-04 is a working draft and the final version is dated April 1, 2019.	The document has been updated with the final version from April 2019.

Comment ID Number	Comment	DOE Response
23	It should be clarified whether this is to indicate that the TREAT Reactor will not be operated while the MARVEL microreactor is installed and operational in the TREAT facility, i.e., for a period of years. Or is the meaning to suggest that only when the MARVEL microreactor is actually operating. Suggest using the same phrasing as is used later in this document: "The MARVEL microreactor will not operate on days the TREAT reactor is operating."	The recommended change has been made to the EA.
24	"As such, the documented safety analysis for the MARVEL Project will be in the form of an addendum to the existing TREAT final safety analysis report." *It is unclear if MARVEL operation will also require any modifications be made to the main portion of the TREAT facility safety analysis report to for example include a limiting condition of operation regarding MARVEL.*	MARVEL safety basis documentation will meet the requirements of 10 Code of Federal Regulations (CFR) 830, *Nuclear Safety Management*, Subpart B, *Safety Basis Requirements*. In accordance with DOE-STD-1189-2016, this SDS documents the expectations and the format for integrating the major modifications to the TREAT facility, and describes the actions necessary to update or revise the existing TREAT facility safety basis. The MARVEL DSA format and content strategy will be to develop an addendum to the existing TREAT SAR-420. SAR-420 experiment Chapter 10 will need to be replaced with a new power generation chapter in the addendum. TS-420 will be revised to add controls derived from SAR-420 addendum. Additional controls as derived from the addendum accident analysis will also be added.
25	"The Stirling engines are interchangeable with the high grade heat exchangers. These heat exchangers will also be immersive heat exchangers into the lead-bismuth pool of the IHX, designed solely to extract high temperature heat from the primary coolant for process heating applications. Hence between experiments, either Stirling engines or high grade heat exchangers are placed in the four IHXs, while the lead-bismuth is molten." *Later in this document there is discussion of steps that would be taken in the Deactivation and Decommissioning phase to eliminate releasing polonium-210 from the lead-bismuth eutectic but such a concern is not expressed during the operational phase. There also seems to be presumption that all produced polonium-210 would remain within the lead-bismuth eutectic.*	During operation of the MARVEL microreactor, activation of the bismuth in the lead-bismuth eutectic (LBE) and the argon cover gas will occur despite available shielding, generating traces of Po-210, Ar-39, Ar-41 and other radionuclides. Argon is gaseous at room temperature, while Polonium volatilizes at elevated temperature. The trace amounts of Po-210 are likely to condense in colder regions if released. However, the MARVEL design isolates the LBE overhead gas region that contains the trace amounts of activation products. Despite trace levels, the activated products will not be released through the TREAT stack; rather the design will contain and isolate the cover gas to avoid any potential exposure to the public or onsite personnel. This information has been added to Section 3.2.1 for clarification.

Comment ID Number	Comment	DOE Response
26	"The MARVEL microreactor fuel is a uranium zirconium hydride (U-ZrHx) containing 30-40wt% uranium that is enriched with 19.75% U235. The MARVEL microreactor fuel material is U-ZrH1.7 sodium bonded to type 316 SS cladding. The fuel system consists of cladding, endcaps, fuel pins, neutron reflectors, and gap conductance fluid (sodium) as shown in Figure 7. The entire fuel system is composed of 36 fuel pins, or about 150 kg of fuel, which includes about 50 kg of fuel required for the 22-34 fuel pins that are for quality assurance of the fabrication process. Therefore, less than 100 kg of fuel will be involved in the fission process. Each pin measures about 38-in. (96.5-cm) long." *If 100 kg of fuel is utilized containing 30-40wt% uranium, then the total uranium mass could range from 30 to 40 kg. This may be more than the Table 1 value of "<30 kg U".* *The NUREG-1282 fuel specification that is later referenced, only allows for up to 30% uranium with enrichment up to 20%, designated as 30-20 fuel.*	As discussed in *The MARVEL Fuel Strategy,* (Parry, et. al. 2020) the MARVEL fuel is a uranium-zirconium hydride fuel (U-ZrH1.7) which is the same as the fuel qualified for use in TRIGA reactors. The fuel used for MARVEL will be manufactured by TRIGA International or INL. In either case, the fuel will fall within the range of 235U enrichment and uranium loading covered by NUREG-1282. Both potential suppliers will implement a quality assurance program to ensure the fuel performs as required by NUREG-1282. Using a known fuel type eliminates many of the risks of a new fuel with the only changes being associated with the reactor type and neutron spectrum difference.
27	*Section 2 (Alternatives) indicates a microreactor design criteria of "Use inherent reactivity feedbacks to ensure reactor power is controlled by physics during overpower or over temperature events". Table 1 further indicates that Reactivity Control Method 2 is "Inherent Core Reactivity Feedback", yet no mention of this important method is presented in this section. There is a brief mention of the reliance on this method in section 3.9.3 (Accident Analysis).*	The MARVEL reactor inherent reactivity feedback mechanism to safely control the reactor depends on two things: a limit on the excess reactivity of a single control drum set by an adjustable hard mechanical limit, and the strong negative Doppler reactivity coefficient of the reactor. Current design of the Reactivity Control System (as discussed in R.G. 1.232) for the reactor will be controlled by selecting a control drum and moving it to increase or decrease reactivity of the core. Only one control drum is powered and may be moved at a single time. This limits the amount of excess reactivity that could possibly be inserted into the core in an accident scenario. At this early stage of the design, conformance to the GDC are still being discussed with the DOE. Additionally, there are physical mechanisms in the control drum drive trains that mechanically limit the degree that a control drum may rotate called the "drum out limit." The drum out limit places a hard limit on the total amount of excess reactivity in a single control drum at a time. The amount of excess reactivity limited by the drum out limit is calculated by analysts before the reactor is started. The drum out limit that corresponds to the excess reactivity limit is then set by human operators physically accessing the reactor and control drums.

Comment ID Number	Comment	DOE Response
		The human operators may set the drum out limit to any position required to ensure safe operations of the reactor, even during uncontrolled transients. Once the drum out limit is set, it cannot be adjusted during operation. Any additional adjustment of the drum out limit would require reactor shutdown followed by a decay time before the drum out limit mechanisms could be physically accessed and adjusted to their new positions. Further, the MARVEL microreactor self-limits the reactivity insertion due to a very strong Doppler reactivity coefficient. The coolant temperature coefficient is positive, but it is ~50 times smaller than the Doppler. The other temperature reactivity coefficients (Be and BeO moderators, core axial expansion) are negative or are significantly smaller than the Doppler. Therefore, the strong Doppler coefficient leads to a power reduction as the fuel temperature is being increased by a positive reactivity insertion or by a loss-of-flow or loss-of-heat sink. The transient analysis that shows the inherent reactivity effect the best is the unprotected transient overpower. The transient case assumes that one control drum is instantaneously rotated from the critical position to the maximum out position (which is a limit set through the drum out limit). In this case, the drum out limit is set so that a single control drum has $0.45 of excess reactivity. For this accident scenario, all of the design criteria are passed. If necessary, the ability to set the drum out limits could allow for modifying the limiting transient overpower scenario even more by setting the excess reactivity in a single drum to less than $0.45. The transient analyses for the MARVEL microreactor are documented in INL-EXT-21-6124 *Primary Coolant and Decay Heat Removal System* (INL, 2021).
28	*Was there consideration of alternatives to the use of beryllium metal / beryllium oxide for neutron reflection in the design gives the health hazards inherent with this material?*	Due to the challenges of irradiated beryllium neutron reflectors, other materials were investigated. All of the materials can be used at the nominal operating temperature of 550–600ºC. Other materials evaluated included aluminum oxide, beryllium oxide, depleted uranium, graphite, magnesium oxide, sodium hydroxide, sodium deuteroxide, natural uranium, zirconium hydride, and zirconium deuteride. The results showed that beryllium and its compounds provide the highest reactivity in the core.

Comment ID Number	Comment	DOE Response
29	Section 3.2.1 correct reference to waste section from 3.9 to 3.7	The recommended change has been made to the EA.
30	Section 3.2.1 capitalize "curies"	This non-SI unit of radioactivity is not capitalized.
31	*Is there a good basis that the NaK argon cover gas and the lead-bismuth argon cover gas are sufficiently isolated to eliminate consideration for release of Ar-39 and Ar-41? Also that there won't be any volatilization of polonium-210 from the lead-bismuth into the argon cover gas.*	During operation of the MARVEL microreactor, activation of the bismuth in the lead-bismuth eutectic (LBE) and the argon cover gas will occur despite available shielding, generating traces of Po-210, Ar-39, Ar-41 and other radionuclides. Argon is gaseous at room temperature, while Polonium volatilizes at elevated temperature. The trace amounts of Po-210 are likely to condense in colder regions if released. However, the MARVEL design isolates the LBE overhead gas region that contains the trace amounts of activation products. Despite trace levels, the activated products will not be released through the stack; rather the design will contain and isolate the cover gas to avoid any potential exposure to the public or onsite personnel.
32	Section 6 edits to spelling, consistency	The recommended changes have been made to the EA.

Public Comment Submittal on the U.S. Department of Energy Draft Environmental Assessment for Microreactor Applications Research, Validation and Evaluation (MARVEL) Project at Idaho National Laboratory (DOE/EA-2146)

Comment submittal by Tami Thatcher, due January 26, 2021.

Send comments to marvel@id.doe.gov

The Department of Energy's Environmental Assessment for the design and demonstration of the Microreactor Applications Research Validation and Evaluation Project (MARVEL), which allowed a scant 14 days for review, is inadequate, especially given the glaring omissions and disinformation in the EA. [2] [37]

According to the Department of Energy, MARVEL is a sodium-potassium cooled, thermal microreactor with a power level of less than 100 kilowatts of electricity. The EA states the thermal power level is expected to provide only 20 kilowatts of electricity, which would light something like 300 light bulbs. This is tiny, yet the Department of Energy considers anything up to 20 megawatts-thermal (or 20,000 kilowatts-thermal) to be included in the category of "microreactor." In contrast, a large commercial nuclear reactor generates an average of about 3,000 megawatts of thermal energy and about 1000 MW of electricity.

The fuel will be 150 kilograms of about 20 percent uranium-235 enrichment in 36 fuel pins and the fuel material will be uranium-zirconium-hydride in a stainless steel cladding. Each fuel pin is about 38-in. long and will be sodium-bonded. In contrast, existing large commercial nuclear reactors use roughly 100,000 kilograms of fuel, but at less than 5 percent uranium-235 enrichment. MARVEL will be using High-Assay Low-Enriched Uranium (HALEU) and Stirling engines.

MARVEL is actually a micro-sized reactor, unlike the significantly larger reactors DOE likely may want to deploy. Far larger problems will occur if mobile or micro reactors are actually deployed in our country or beyond our borders. The real problem will be having one of these on the free-way next to you in a snowstorm pile up car accident or having one operating where you work or where you live and the continued storage of the spent nuclear fuel because there is no spent nuclear fuel repository. The trillions of dollars it will cost to attempt to confine the spent nuclear fuel will be placed on future generations as well as the radiological harm from radiological releases.[38]

DOE's public outreach has been inadequate and deliberately misleading, the draft Environmental Assessment is not bounding, representative, or clear about waste management of the proposed expansion or its consequences, and a full Environmental Impact Statement is needed.[39]

The EA is actually stating that the EA will allow the continued burial of beryllium waste over the Snake River Plain aquifer, without clearly stating so. The EA omits the serious health and environmental problems of beryllium handling and its waste disposal.[40] The INL has a long history of not fully disclosed beryllium releases. The disposal limits on beryllium at WIPP as so strict that the INL cleanup contractor lied about the presence of beryllium carbide in waste. The lie was only revealed because of the explosion of the waste drums of uranium and beryllium carbide.[41]

The EA has failed to disclose how the Department of Energy's reclassification of high level waste will impact the Idaho National Laboratory.[42]

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[2] *Draft Environmental Assessment for the Microreactor Applications Research, Validation and Evaluation Project at Idaho National Laboratory (DOE/EA-2146),* January 2021 at https://www.id.energy.gov/ or https://www.id.energy.gov/insideNEID/PDF/Final%20MARVEL%20Draft%20EA%20DOE%20EA-2146.pdf

The EA will apparently allow spent nuclear fuel, as well as radiologically contaminated beryllium, from MARVEL to be buried over the Snake River Plain Aquifer or in low-level waste commercial facilities and must fully discuss the beryllium waste issues as well as health hazards.[43]

The EA is unclear and deliberately vague as to where the spent nuclear fuel from the INL's Radioactive Scrap and Waste Facility is actually being disposed of.[44]

The EA fails to mention that the Department of Energy is simultaneously pretending it has a spent fuel repository while refusing to construct a facility at the INL (limited to fuel at INL) for spent nuclear fuel repackaging for a repository.[45]

The EA fails to mention that DOE is on track to miss all of the main milestones in the 1995 Idaho Settlement Agreement because it is not repackaging spent nuclear fuel or high-level waste for permanent disposal or even for shipment to pawn off the waste for "temporary" storage in another state, such as New Mexico.[46]

The EA unscientifically and indefensibly pretends that the Department of Energy has a spent fuel disposal program when U.S. court proceedings have found that the DOE has no spent fuel disposal program.[47]

Despite no completed design or construction or licensing of the non-existent DOE standardized canister, the MARVEL EA states that the DOE's standardized canister will be used to package the MARVEL spent nuclear fuel for disposal at the non-existent Yucca Mountain.

The fiction used by the EA is intentionally deceptive because for years now the design of the standardized canister design and its neutron absorbers was never completed, never built and never licensed. But that is consistent for the spent nuclear fuel disposal facility, which it names as Yucca Mountain, does not exist and has not been funded since 2010.[48]

Because the Department of Energy does not have a program for spent nuclear fuel disposal, the EA the costs and risks of continued storage of Department of Energy owned spent nuclear fuel have not been addressed. The EA is therefore built on a foundation of sand. This pushes the cost and the potential for devastating radiological releases on to future generations. The DOE lavishly is spending money on new ways to make more spent nuclear fuel, all while not funding the work of aging management of spent nuclear fuel, not funding the needed repackaging facilities and not having conducted a credible repository program.[49]

The DOE is only pretending that a repository will soon be operational. The courts have forced the DOE to stop collecting money into the Nuclear Waste Fund because the DOE has no spent nuclear fuel repository program and does not even have an appropriate estimate of the cost of getting a repository, packaging and/or repackaging the waste, and waste emplacement. Simply hand-waving that there was a past EIS that assumed wrongly that a repository would be in place is not truthful and undermines the entire purpose of the NEPA process. The truth is that the DOE has not found a feasible way of isolating spent nuclear fuel from air, water and soil for the millennia that the waste is radio-toxic.[50]

The EA fails to acknowledge the significantly increased problems as well as higher costs for safe disposal of higher enriched fuels and higher burnup fuels.[51]

The EA fails to acknowledge the billions of dollars already needed to repackage spent nuclear fuel and the trillions of dollars to continue attempting to find a way to isolate these wastes from the biosphere.[52]

The EA allows the careless disposal of spent nuclear fuel over the Snake River Plain aquifer if DOE deems the spent nuclear fuel to be related to research. This artificial definition defies science and is simply to shortcut proper disposal to isolate the material from soil, air and groundwater.[53]

The EA asserts that environmental monitoring programs are adequate even though elevated levels of gross alpha in our public water supplies go without gamma spectrometry evaluations to determine the level of americium, plutonium and other INL released radionuclides.[54]

The EA incorrectly states that "INL maintains the necessary apparatus, equipment, and a state of the art Emergency Operations Center in Idaho Falls to respond to emergencies, not only at from the MARVEL microreactor and other INL Site operations, but also throughout local communities." **The EA fails to acknowledge decades of repeated inadequate emergency preparation for site emergencies in terms of training, decontamination, radiological medical treatment, inadequate emergency radiological monitoring during and after the emergency.**[55]

The EA claims that the accident release consequences are only a few rem, yet fails to acknowledge only short-term dose and ignores the long term ingestion consequences, the crop interdiction, the uncompensated and uninsurable car, home, business, livelihood and health costs of an accident radiological release.[56]

The EA fails to acknowledge that the monitoring will ignore the uranium-235 released by the accident as well as inadequate actinide (plutonium, americium, curium, etc.) monitoring because of intentional environmental monitoring inadequacies to avoid implicating the INL as the source of the contamination. The decay products from plutonium-240 and uranium-236 are thorium decay progeny which the environmental monitoring falsely asserts are from naturally occurring thorium-232. The elevated levels of uranium-234, uranium-235, uranium-236 are intentionally not delineated by the specific isotope so the DOE can falsely claim that the uranium is naturally occurring.[57]

From the 1961 SL-1 accident where radiological monitoring was especially inadequate for emergency responders, to the 2011 plutonium inhalation accident caused by management failure to heed repeated warnings of high worker risks and the multiple failures that caused the event and the multiple failures in responding to the event, to the 2018 four drums of waste that exploded and fire fighters, once again, responded without support of adequate training or radiological support personnel.[58]

The EA fails to acknowledge that the lack of proper decontamination facilities means that an injured worker is going to radiologically contaminate medical facilities in Idaho Falls.[59]

The EA omits mention of the airborne releases by production of high assay low-enriched uranium fuel and omits deliberate and unnecessary as well as inadequately monitored INL Test Range radiological releases and others.[60]

The EA generally fails to address the Department of Energy's refusal to acknowledge strong epidemiology that shows far more cancer risk and other health risks than the biased and inadequate models it relies on.[61]

The EA specifically implies that its radiation monitoring and radiation health models are adequate.[62]

The EA fails to address the inadequacy of the radiation health modeling despite years of double the thyroid cancer incidence in the counties surrounding the INL. As the DOE has been forbidden to conduct epidemiology because of its many past efforts to improperly bias human epidemiology, the assessment of growingly obvious health impacts of INL radiological releases must be conducted by properly independent evaluation. This has not been done, as is evident in the DOE's environmental assessment for the Versatile Test Reactor which displays some of the increased cancer rates yet fails to utter any recognition of the obvious doubling of thyroid cancers in counties surrounding the INL. The incidence of thyroid cancer has been doubling for years and is wide-spread, yet the rates ramp up at double the rest of Idaho and the US, in the counties surrounding the INL. Refusing to recognize the impact, which would not be predicted by DOE's accepted radiological release estimates and radiation health models, is immoral as well as not based on scientific integrity.[63]

In 1975, the rate of thyroid cancer incidence for men and women combined was 4.8 per 100,000 in the US. In 2015, thyroid cancer incidence reached 15.7 per 100,000 according to the Surveillance, Epidemiology, and End Results Program (SEER) website. Thyroid cancer incidence and mortality in the US may have finally leveled off after years of increases, according to the National Cancer Institute, Surveillance, Epidemiology, and End Results Program (SEER).[3] However, several counties surrounding the Idaho National Laboratory have roughly double (or more) the thyroid cancer incidence than the Idaho state average and US average.

The SEER 9 region is roughly 10 percent of the US population and includes parts of California [San Francisco and Oakland], Connecticut, Georgia [Atlanta only], Hawaii, Iowa, Michigan [Detroit only], New Mexico, Utah, and Washington [Seattle and Puget Sound region].[4]

Thyroid cancer incidence in the US increased, on average, 3.6 percent per year during 1974- 2013, from 4.56 cases per 100,000 person-years in 1974-1977 to 14.42 cases per 100,000 person- years in 2010-2013. These thyroid cases were not trivial: the mortality also increased. Mortality increased 1.1 percent per year from 0.40 per 100,000 person-years in 1994-1997 to 0.46 per 100,000 person-years in 2010-1013 overall and increased 2.9 percent per year for SEER distant stage papillary thyroid cancer.[5] From 1974 to 2013, the SEER 9 region cancer data included 77,276 thyroid cancer patients and 2371 thyroid cancer deaths.

Bonneville County, where Idaho Falls is located, has double the thyroid cancer rate of the US and double the rate compared to the rest of Idaho, based on the Cancer Data Registry of Idaho (CDRI) for the year 2017.[6] See Table 1.

Table 1**.** Bonneville County thyroid cancer incidence rate compared to the rest of Idaho, 2017.

Cancer type	Sex	Rate in Bonneville County	Adjusted Rate in Bonneville County	Rate for remainder of Idaho
Thyroid	Total	28.2	30.7	14.2
	Male	16.0	17.8	7.4
	Female	40.3	43.5	21.0

Table notes: Rates are expressed as the number of cases per 100,000 persons per year (person-years). Rates are expressed as the number of cases per 100,000 persons per year (person-years). Adjusted rates are age and sex- adjusted incidence rates for the county using the remainder of the state as standard. Data from Factsheet for the Cancer Data Registry of Idaho, Idaho Hospital Association. Bonneville County Cancer Profile. Cancer Incidence 2013-2017. https://www.idcancer.org/ContentFiles/special/CountyProfiles/BONNEVILLE.pdf

[3] National Cancer Institute, Surveillance, Epidemiology, and End Results Program, Cancer Stat Facts: Thyroid Cancer. https://seer.cancer.gov/statfacts/html/thyro.html.

[4] National Cancer Institute, Surveillance, Epidemiology, and End Results Program, Cancer Query System. https://seer.cancer.gov/canques/incidence.html.

[5] Hyeyeun Lim et al., JAMA, "Trends in Thyroid Cancer Incidence and Mortality in the United States, 1974-2013," April 4, 2017. https://pubmed.ncbi.nlm.nih.gov/28362912/ or https://jamanetwork.com/journals/jama/fullarticle/2613728

[6] C. J. Johnson, B. M. Morawski, R. K., Rycroft, Cancer Data Registry of Idaho (CDRI), Boise Idaho, Annual Report of the Cancer Data Registry of Idaho, *Cancer in Idaho – 2017*, December 2019. https://www.idcancer.org/ContentFiles/AnnualReports/Cancer%20in%20Idaho%202017.pdf

Some people have wondered if the thyroid incidence rate is due to overdiagnosis of elderly patients—no, it is not. A study of pediatric thyroid cancer rates in the US found that in pediatric patients with thyroid cancer diagnosed from 1973 to 2013, the annual percent change in pediatric cancer incidence increased from 1.1 percent per year from 1973 to 2006 and markedly increased to 9.5 percent per year from 2006 to 2013.[7]

Some people have wondered if the increased rate of incidence is due to overdiagnosis of trivial nodules—no, it is not. The figures for the incidence rates for large tumors and advanced- stage disease suggest a true increase in the incident rates of thyroid cancer in the United States.

I've seen this just from a handful of acquaintances in Idaho Falls.

For pediatric patients, the thyroid incidence rate was 0.48 cases per 100,000 person-years in 1973 to 1.14 cases per 100,000 person-years in 2013. The incidence rate for large tumors were not significantly different from incidence rates of small (1-20 mm) tumors.

Both thyroid cancer US trend studies (by Lim and by Qian) used the SEER cancer incidence file maintained by the National Cancer Institute and includes 9 high-quality, population-based registries.

As the SEER 9 region thyroid incidence peaked at 15.7 per 100,000, and the State of Idaho thyroid incidence average was 14.2 per 100,000, Bonneville County reached thyroid cancer rates of 30.9 per 100,000.[8] But other counties near the Idaho National Laboratory also have elevated thyroid cancer incidence rates: Madison (29.3 per 100,000), Fremont (27.9 per 100,000), Jefferson (28.9 per 100,000), and Bingham (28.6 per 100,000). But let's not forget Butte county. Butte county's thyroid cancer rate of 45.9 per 100,000 puts it in a class by itself. Much of Butte county is within 20 miles of the INL and nothing says radiation exposure like Butte's leukemia rate at 3 times the state rate and myeloma at 5 times the state average rate.

The news headline for the Idaho cancer register report issued in 2018 read that "cancer trends for Idaho are stable."[9] That is what citizens were supposed to take away from the 2017 cancer rate study in Idaho. Why were citizens not told about any of the cancers in the counties in Idaho that significantly exceeded state average cancer rates and exceeded the rest of the US?[10]

The wide-spread thyroid cancer incidence increases in the US do not appear to be due to radiation exposure. I suspect other governmentally permitted and highly profitable environmental toxins related to our food and perhaps also cell phone use. **But the rates that are double the rest of Idaho and the US in only counties near the Idaho National Laboratory are, I believe, due to the radiological releases from INL and are perhaps aggravated by airborne chemical releases from the INL.**

The Department of Energy and the State of Idaho are actively ignoring the likely environmental causes of elevated rates of cancer in the communities surrounding the INL and especially the elevated rates of childhood cancer.[64]

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7 Z. Jason Qian et al., *JAMA*, "Pediatric Thyroid Cancer Incidence and Mortality Trends in the United States, 1973-2013," May 23, 2019. https://pubmed.ncbi.nlm.nih.gov/31120475/ or https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6547136/

8 Environmental Defense Institute February/March 2020 newsletter article "Rate of cancer in Idaho continues to increase, according to Cancer Data Registry of Idaho."

9 Brennen Kauffman, *The Idaho Falls Post Register*, "New cancer report on 2017 shows stable cancer trends for Idaho," December 13, 2018.

10 https://statecancerprofiles.cancer.gov/

The forty-first annual report of the Cancer Data Registry of Idaho (CDRI) was issued in December 2019 for the year 2017.[11] While the rate of some cancers decreased, the bad news for the State of Idaho is that the overall rate of cancer incidence continues to increase.

And, very importantly, childhood cancers in Idaho continue to increase. Pediatric (age 1 to 19) cancer increased at a rate of about 0.6 percent per year in Idaho from 1975 to 2017, see https://www.idcancer.org/pediatriccancer.

The rate of childhood cancer incidence in Bonneville County exceeded the remainder of the state for boys, based on the adjusted rate of cancer incidence. For girls the rate was high, but not above the remainder of the state, see Table 2.

Table 2. Bonneville County childhood cancer incidence rate compared to the rest of Idaho, 2017.

Cancer type	Sex	Rate in Bonneville County	Adjusted Rate in Bonneville County	Rate for remainder of Idaho
Pediatric Age 0 to 19	Total	17.8	17.9	18.2
	Male	19.0	**19.3**	19.1
	Female	16.5	16.5	17.2

Table notes: Rates are expressed as the number of cases per 100,000 persons per year (person- years).

The INL has continued to release radionuclides to the air within 50 miles of the lab with radionuclides including iodine-131, iodine-129, americium-241, strontium-90, cobalt-60, plutonium-238, plutonium-239, ruthenium-103, cesium-134 and cesium-137 and many others. And while doing so, has continued to insinuate that all the radionuclides are from former nuclear weapons testing or some other mysterious source. A study published in 1988 found the mallard ducks near the ATR Complex percolation ponds at the Idaho National Laboratory to be full of transuranic radionuclides including plutonium-238, plutonium-239, plutonium-240, americium- 241, curium-242 and curium-244.[12] An employee who I knew had the habit of jogging around the radioactive waste ponds at lunchtime. He died of liver cancer in his 50s. This health- conscious non-smoker was told, like the rest of us, that the radioactivity in the ponds was mainly tritium and was of no health concern what-so-ever.[65]

The stated radionuclide releases from the Idaho National Laboratory to air have often been incomplete or underestimated the releases. The stated "effective dose equivalent" whole body dose has been a *fictional* fraction of a millirem.[66]

[11] C. J. Johnson, B. M. Morawski, R. K., Rycroft, Cancer Data Registry of Idaho (CDRI), Boise Idaho, Annual Report of the Cancer Data Registry of Idaho, *Cancer in Idaho – 2017*, December 2019. https://www.idcancer.org/ContentFiles/AnnualReports/Cancer%20in%20Idaho%202017.pdf

[12] O. D. Markham et al., Health Physics, "Plutonium, Am, Cm and Sr in Ducks Maintained on Radioactive Leaching Ponds in Southeaster Idaho," September 1988. https://pubmed.ncbi.nlm.nih.gov/3170205/ (This study evaluated the concentrations of strontium-90, plutonium-238, plutonium-239, plutonium-240, americium-241, curium-242 and curium-244 in the tissues of mallard ducks near the ATR Complex reactive leaching ponds at the Idaho National Laboratory. It found the highest concentrations of transuranics occurred in the gastrointestinal tract, followed closely by feathers. Approximately 75%, 18%, 6% and 1% of the total transuranic activity in tissues analyzed were associated with the bone, feathers, GI tract and liver, respectively. Concentrations in the GI tracts were similar to concentrations in vegetation and insects near the ponds. The estimated total dose rate to the ducks from the Sr-90 and the transuranic nuclides was 69 millrad per day, of which 99 percent was to the bone. The estimated dose to a person eating one duck was 0.045 mrem. The ducks were estimated to contain 305 nanoCuries of transuranic activity and 68.7 microCuries of strontium-90.)

The INL releases tons of volatile organic compounds with chlorine compounds to the air, such as the vapor extraction of carbon tetrachloride from buried Rocky Flats waste at the INL's Radioactive Waste Management Complex. A few years ago, EPA monitoring found high levels of carbon tetrachloride in Idaho Falls air. This emission is said to be within federal guidelines, but because chlorine compounds are so unhealthy for the thyroid, the prevalent chemical toxins that are released by the INL that are not even discussed in its environmental monitoring reports may need to be considered in light of elevated thyroid cancer incidence rates near the INL.[67]

The radiation dose reconstruction analysts for the Center for Disease Control, who determine eligibility for the Energy Employee Occupational Illness Compensation Program (EEOICP) continue to ignore what went on and what is still going on at INL facilities, particularly the ATR Complex formerly known as the Test Reactor Area. The radiation dose reconstruction has continued to pretend that the fuel composition of the operating reactors and lack of fuel melt in these reactors means that workers were not exposed to airborne contamination. The CDC need only look at the radionuclides in the ducks. The levels of transuranics including americium-241 and curium in the air at the ATR Complex and other facilities at the INL are sometimes extensive.[13, 14] [68]

The extensive airborne concentrations of americium-241 at the INL may be important to the underestimation of thyroid doses and risks of thyroid cancer incidence. A 1993 study estimated that the dose to the thyroid from americium-241 to be about 1.42 times that delivered to bone. They concluded that the thyroid dose is much higher from americium-241 than has been reported in people.[15] [69]

On the potential health harm of americium-241, the Agency for Toxic Substances and Disease Registry has stated that: "The radiation from americium is the primary cause of adverse health effects from absorbed americium. Upon entering the body by any route of exposure, americium moves relatively rapidly through the body and is deposited on the surfaces of the bones where it remains for a long time. As americium undergoes radioactive decay in the bone, alpha particles collide with nearby cell matter and give all of their energy to this cell matter. The gamma rays released by decaying americium can travel much farther before hitting cellular material, and many of these gamma rays leave the body without hitting or damaging any cell matter. The dose from this alpha and gamma radiation can cause changes in the genetic material of these cells that could result in health effects such as bone cancers. Exposure to extremely high levels of americium, as has been reported in some animal studies, has resulted in damage to organs.

The EA fails to address the inadequate and actually fraudulent environmental monitoring by its contractors, including the annual environmental surveillance report contractor, which incorrectly attributes americium-241 from the INL to past nuclear weapons testing.[70]

Take a look at the plutonium and americium-241 releases from the Idaho National Laboratory between 2001 and 2017 based on Department of Energy environmental monitoring reports.[16] The State of Idaho DEQ does not display, report or trend any data before 2013….and I can see why. The huge releases

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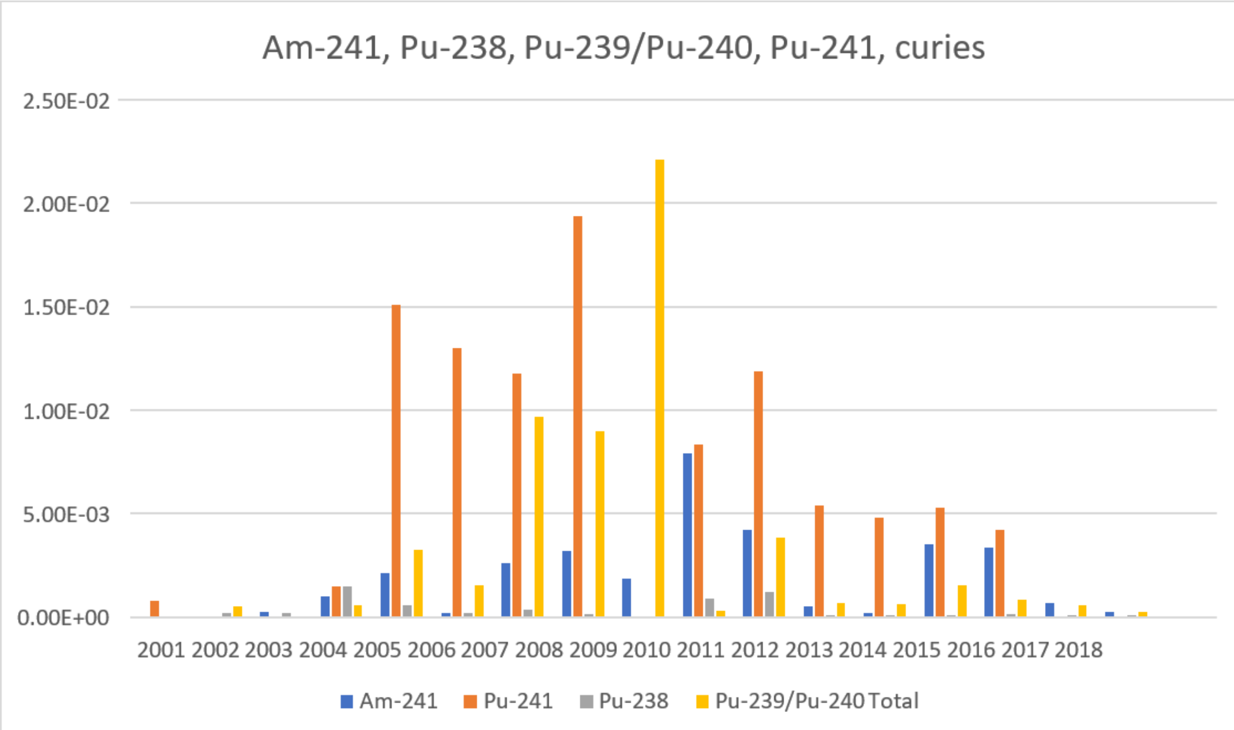
[13] F. Menetrier at al., *Applied Radiation Isot*., "The Biokinetics and Radiotoxicology of Curium: A Comparison With Americium," December 2007. https://pubmed.ncbi.nlm.nih.gov/18222696/ (This study found that the biokinetics of curium are very similar to those of americium-241. Lung and bone tumor induction appear to be the major hazards. Retention in the liver appears to be species dependent.)

[14] R. L. Kathren, Occupational Medicine, "Tissue Studies of Persons With Intakes of the Actinide Elements: The U.S. Transuranium and Uranium Registries," April-June 2001. https://pubmed.ncbi.nlm.nih.gov/11319054/ (This study finds that the dose coefficients for alpha radiation induction of bone sarcoma may be too high while those for leukemia are a factor six too low.

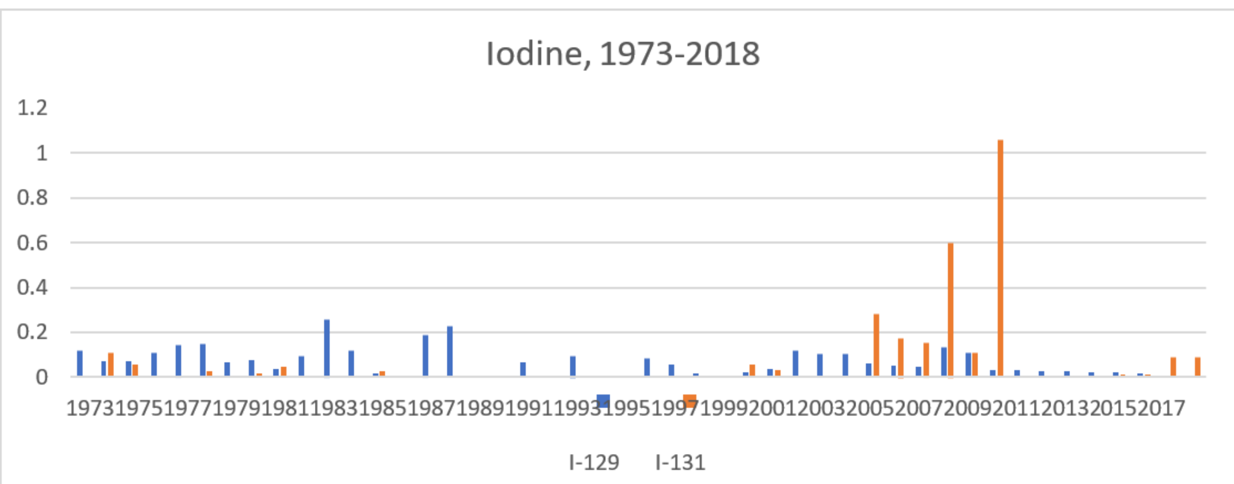
[15] G. N. Taylor et al., Health Physics, "241Am-induced Thyroid Lesions in the Beagle," June 1993. https://pubmed.ncbi.nlm.nih.gov/8491622/

[16] Department of Energy's environmental monitoring reports, see idahoeser.com and inldigitallibrary.inl.gov.

from the INL between 2004 and 2013 are shocking and certainly would not fit well with a tourist brochure for visiting Idaho.



Then let's take a look at the iodine-129 and iodine-131 releases between 1973 and 2017, in curies. The State of Idaho DEQ went from displaying all of their environmental monitoring reports to displaying ten years of the reports, to know displaying only six years of annual reports and only 4 years of quarterly data reports from 2013 to 2018. **Again, here you can see why the Idaho DEQ didn't want to display INL monitoring data before 2013.**



The plutonium and americium-241 and the iodine-129 and iodine-131 are not the only radionuclides with elevated releases from the INL. But these radionuclides might have influenced the elevated thyroid cancers in Bonneville County reported for 2013 to 2017.

Iodine-129 with its 16-million-year half-life has higher inhalation and ingestion dose conversion factors than iodine-131 with its 8-day half-life. While iodine-131 does give a higher air emersion and ground shine dose, the iodine-129 dose often is a dominant dose contributor for INL airborne releases.

The EA fails to address the rather short-lived radionuclides produced in nuclear reactors that were found in marmot tissue as far away as Pocatello Idaho which cannot have come from past weapons testing or radioactive disposal activities such as importation of radioactive waste via train car past Pocatello to US Ecology Grandview Idaho.[71]

The EA ignores the past radiological releases, their resuspension and buildup in the environment.[72]

The INL's EBR-II fuel is the feedstock for its high-assay low-enriched uranium (HALEU), DOE/EA-2087, being pyroprocessed at INL's Materials and Fuels Complex and increasing the radiological airborne emissions from the INL 170-fold, see Table 3.[73]

The EA cumulative impacts evaluation is arbitrary and misleading and fails to address the buildup of radionuclides in our air, water and soil and fails to acknowledge the inadequacy of the environmental surveillance programs.[74]

Table 3. Estimated annual air pathway dose (mrem) to Idaho communities from normal operations to the maximally exposed offsite individual from proposed projects, including the estimated dose from expanding capabilities at the Ranges based on DOE/EA-2063.

Current and Reasonably Foreseeable Future Action	Estimated Annual Air Pathway Dose (mrem)
National Security Test Range	0.04e
Radiological Response Training Range (North Test Range)	0.048d
Radiological Response Training Range (South Test Range)	0.00034a
HALEU Fuel Production (DOE-ID, 2019)	1.6a
Integrated Waste Treatment Unit (ICP/EXT-05-01116)	0.0746h
New DOE Remote-Handled LLW Disposal Facility (DOE/ID 2018)	0.0074a
Recapitalization of Infrastructure Supporting Naval Spent Nuclear Fuel Handling (DOE/EIS 2016)	0.0006c
TREAT (DOE/EA 2014)	0.0011a
DOE Idaho Spent Fuel Facility (NRC, 2004)	0.000063a
Plutonium-238 Production for Radioisotope Power Systems (DOE/EIS 2013)	0.00000026b
Total of Reasonably Foreseeable Future Actions on the INL Site	1.77g
Current (2018) Annual Estimated INL Emissions (DOE2019a)	0.0102f
Total of Current and Reasonably Foreseeable Future Actions on the INL Site [DOE WOULD INCREASE INL'S AIRBORNE RELEASES BY OVER 170 TIMES]	1.78g

Table notes:

Dose calculated at Frenchman's Cabin, typically INL's MEI for annual NESHAP evaluation.

Receptor location is not clear. Conservatively assumed at Frenchman's Cabin.

Dose calculated at INL boundary northwest of Naval Reactor Facility. Dose at Frenchman' Cabin likely much lower.

Dose calculated at INL boundary northeast of Specific Manufacturing Capability. Dose at Frenchman's Cabin likely much lower.

Sum of doses from New Explosive Test Area and Radiological Training Pad calculated at separate locations northeast of MFC near Mud Lake. Dose at Frenchman's Cabin likely much lower. PLEASE NOTE THAT THE PUBLIC AT MUD LAKE IS CLOSER TO THE RELEASE THAN TO FRENCHMAN'S CABIN.

Dose at MEI location (Frenchman's Cabin) from 2018 INL emissions (DOE 2019a). The 10-year (2008 through 2017) average dose is 0.05 mrem/year.

PLEASE NOTE THAT MANY RADIOLOGICAL RELEASES ARE IGNORED AND NOT INCLUDED IN THE RELEASE ESTIMATES IN NESHAPS REPORTING.

This total represents air impact from current and reasonably foreseeable future actions at INL. It conservatively assumes the dose from each facility was calculated at the same location (Frenchman's Cabin), which they were not.

Receptor location unknown, according to the Department of Energy, the agency that is supposed to know the receptor location.

The EA ignores many the ongoing radiological releases including the decision by the U.S. Department of Energy to allow the DOE to release long-lived radionuclides to air and soil at the Idaho National Laboratory, from the Expanding Capabilities at the National Security Test Range and the Radiological Response Training Range at Idaho National Laboratory (DOE/EA-2063) at https://www.energy.gov/sites/prod/files/2019/09/f66/draft-ea-2063-expanding-capabilities- nstr-rrtr-inl-2019-09.pdf. [75]

The EA fails to address the existing contamination levels in communities and drinking water. The draft EA fails to acknowledge that current INL radiological airborne monitoring is woefully inadequate because (1) emissions from the INL are usually based on estimates and not the reality, (2) the current environmental monitoring programs are designed to be inadequate, (3) the reports are tardy by nearly a year and are increasingly tardy, and (4) the quarterly and annual environmental monitoring reports are not reliable and are prone to "lost samples" or "air monitor not functioning" excuses.[76]

Historical and current radiological monitoring programs omit INL releases, and are designed to hide, not reveal, the level and the source of radiological contamination.

The EA fails to truthfully discuss the multitude of INL CERCLA cleanup sites that cannot be released in 2095, as it goes about creating more CERCLA sites at the INL.[77]

DOE expects to continue increasing the "normal background" radiation levels both on and off the Idaho National Laboratory site until our communities all receive unhealthy levels of radionuclide ingestion and inhalation.[78]

"Normal background levels" are already elevated above what was naturally occurring and continue to rise. By selecting a contaminated area to determine "normal background," it appears to me that this is how some radiological facilities can claim to operate within "normal expected background" no matter what radiological release incident just occurred.[79]

The DOE continues to not disclose what it considers "normal background levels" on and off the INL or to trend how the "normal background levels" have changed over time.[80]

The INL's past practices of inflating "normal background levels" meant that employees worked in contaminated areas that when assessed independently during CERCLA cleanup investigations in 1995, these facilities had to be disposed of as radiological waste. Various INL areas had been highly contaminated for decades, and yet not monitored or controlled as such. See the Administrative Record for CERCLA cleanup at the Idaho National Laboratory at https://ar.icp.doe.gov .

The EA fails to acknowledge that the DOE's allowable radiation level of 100 mrem/yr would devastate public health.[81]

The EA relies on the DOE's allowable radiation level of 100 mrem/yr and implies that reaching such high levels would not be a devastation to the health of people in our communities.

By no means is the DOE's 100 mrem/yr dose limit to the public protective of human health. DOE ignores the epidemiology that shows that a few years of an average 400 mrem/yr to adult radiation workers increases cancer risk. Exposure of pregnant women to DOE's allowed 100 mrem/yr dose would greatly harm fetal health. The DOE ignores all modern epidemiology studies for human health effects that show harm greater than DOE chose to believe decades ago, especially to the unborn, and to females and children.[82]

The EA fails to address the fact the radiation workers are still wrongly told that there is no evidence of damage to DNA or genetic effects from radiation exposure to humans. DOE's radiation workers are not told of the infertility and increased risk of birth defects from radiation.[83]

The EA fails to address the fact that the investigations into worker contamination at the INL historically are not complete and do find evidence of inadequate worker protection. The investigations continue at a snail's pace by the Center for Disease Control's National Institute of Occupational Safety and Health (NIOSH) for the Energy Employee Occupational Illness Compensation Program. Meanwhile, injured workers and their survivors die, having had their illness claim wrongly denied.[84]

The EA states that "In addition, worker doses are monitored and controlled below the regulatory limit to ensure that individual doses are less than an INL administrative limit of 700 millirem per year." The EA needs to point out that whenever staying below 700 mrem/yr is inconvenient, they will go over this dose. The fact is if that the Department of Energy wants to claim its limit is 700 mrem/yr and not the current 5000 mrem/yr, then the DOE needs to change the federal limit to 700 mrem/yr. The EA also needs to acknowledge the extent that radiological records of contamination in urine and fecal samples is withheld from workers, enabling errors and deliberate falsifications. Many workers go to medical providers and the worker lacks any exposure and radiological intake history, let alone accurate radiological (and chemical) intake information.[85]

The public as well as radiation workers need to keep in mind that, despite what they may have been taught:

- The cancer risk is not reduced when radiation doses are received in small increments, as the nuclear industry has long assumed.[17]
- Despite the repeated refrain that the harm from doses below 10 rem cannot be discerned, multiple and diverse studies from human epidemiology continue to find elevated cancer risks below 10 rem and from low-dose-rate exposure.[18]
- The adverse health effects of ionizing radiation are not limited to the increased risk of cancer and leukemia. Ionizing radiation is also a contributor to a wide range of chronic illnesses including heart disease and brain or neurological diseases.

The public and radiation workers take cues from their management that they should not be concerned about the tiny and easily shielded beta and alpha particles. DOE-funded fact sheets often spend more verbiage discussing natural sources of radiation than admitting the vast amounts of radioactive waste created by the DOE. The tone and the meta-message from the DOE, the nuclear industry, is that if you are educated about the risks, then you'll understand that the risks are low. Yet, these agencies continue to deny the continuing accumulation of compelling and diverse human epidemiological evidence that the harm of ingesting radionuclides is greater than they've been claiming.

The biological harm that ionizing radiation may cause to DNA is mentioned sometimes but it is emphasized that usually the DNA simply are repaired by the body. And the training to radiation workers will mention that fruit flies exposed to radiation passed genetic mutations to their offspring but workers are told that this phenomenon has never been seen in humans even though, sadly, the human evidence of genetic effects has continued to accumulate. Birth defects and children more susceptible to cancer are the result.

Gulf War veterans who inhaled depleted uranium have children with birth defects at much higher than normal rate. The same kinds of birth defects also became prevalent in the countries were citizens were exposed to DU. There are accounts to suggest that the actual number of birth defects resulting from the World War II atomic bombs dropped on Japan and by weapons testing over the Marshall Islands have been underreported. The Department of Energy early on made the decision not to track birth defects resulting from its workers or exposed populations. But people living near Hanford and near Oak Ridge know of increased birth defects in those communities.

In radworker training, there may be discussion of the fact that international radiation worker protection recommends only 2 rem per year, not 5 rem per year. There is no mention of recent human epidemiology showing the harm of radiation is higher than previously thought and at low doses, below 400 mrem annually to adult workers, increased cancer risk occurs.

There is no mention of the oxidative stress caused as ionizing radiation strips electrons off atoms or molecules in the body at energies far exceeding normal biological energy levels. And there is no

[17] Richardson, David B., et al., "Risk of cancer from occupational exposure to ionizing radiation: retrospective cohort study of workers in France, the United Kingdom, and the United States (INWORKS), BMJ, v. 351 (October 15, 2015), at http://www.bmj.com/content/351/bmj.h5359 Richardson et al 2015 This cohort study included 308,297 workers in the nuclear industry.

[18] US EPA 2015 http://www.regulations.gov/#!documentDetail;D=NRC-2015-0057-0436 . For important low-dose radiation epidemiology see also John W. Gofman M.D., Ph.D. book and online summary of low dose human epidemiology in "Radiation-Induced Cancer from Low-Dose Exposure: An Independent Analysis," Committee for Nuclear Responsibility, Inc., 1990, http://www.ratical.org/radiation/CNR/RIC/chp21.txt And see EDI's April 2016 newsletter for Ian Goddard's summary and listing of important human epidemiology concerning low dose radiation exposure.

discussion explaining the harm of inhaling or ingesting radioactive particles of fission products such as cesium-137, strontium-90, or iodine-131; of activation products such as cobalt- 60; or transuranics such as plutonium and americium; or of the uranium itself.

The volatile or gaseous radionuclides, some of which can't be contained even with air filters—include technetium-99, tritium, carbon-14, iodine-129, argon-39, krypton-85, and radon-222 as the volatile radionuclides dominating the proposed Greater-Than-Class C radioactive waste disposal for the Andrews County, Texas facility. In Idaho, it appears that the DOE fails to adequately address these gaseous emissions from waste and other sources.

Often radionuclides with low curie levels dominate the harm to human health from radioactive waste disposal. So, when DOE states an overall curie level without stating which radionuclides and their specific curie levels, neither the radiotoxicity nor the longevity of the radioactive waste has been indicated.

Uranium and thorium and their decay products may be natural but in concentrated form in drinking water, soil or air, they are harmful. Radioactive waste disposal classification has often left out concentration limits for these radionuclides. Massive amounts of depleted uranium are considered Class A radioactive waste but won't be safe at the end of 100 years but will actually be more radioactive through decay progeny. The DOE has typically ignored its extensive releases of uranium and transuranic radionuclides to Idaho communities.

Plutonium-238, plutonium-239, and other transuranic radionuclides in radioactive waste in what appear to be low curie amounts also pose health harm. Is DOE planning to say that they stayed below some curie amount, while not disclosing the actual radionuclides released?

Cancer rates for uranium are typically based on natural forms for uranium and not chemically altered forms that may be more soluble in the human body. The internal radiation cancer harm is not based on solid epidemiological evidence and there are experts from Karl Z. Morgan to Chris Busby to Jack Valentine that understand that the accepted models may understate the cancer harm by a factor of 10, 100 or more. The nuclear industry continues to ignore the epidemiological evidence that implies tighter restrictions are needed.

Importantly, the chemical forms released by the INL may be more harmful than predicted because of particle size, temperatures during processing or releases, or other factors which may affect retention in the human body.

The DOE has long given presentations to the public that deliberately withheld information about long-lived radionuclide contamination. Even now, when filters are evaluated and found to have americium-241, plutonium-238 and plutonium-239, for example, the DOE and State of Idaho usually pretend to not know the source of the radionuclides.

Monitoring of waste burial sites for CERCLA at INL has often been inadequate and biased to hide contamination findings by reduced monitoring and reduced reporting. Spotty monitoring of land and the aquifer means "no discernable trend could be found."

At the Idaho National Laboratory, formerly the Idaho National Engineering and Environmental Laboratory, the Idaho National Engineering Laboratory, and the National Reactor Testing Station, historical releases were monitored yet not actually characterized as to what and how many curies were released. When asked by the governor in 1989 to provide an estimate of the radionuclides released from routine operations and accidents, the Department of Energy issued the "INEL Historical Dose

Evaluation."[19, 20] It has been found to have underestimated serious releases by sometimes 10-fold. Furthermore, the past environmental monitoring used all along to claim no significant releases had occurred were not used in the INEL Historical Dose Evaluation. The environmental records that could have been used against the Department of Energy or its contractors were destroyed.

The Center for Disease Control commenced reviewing the DOE's radiological release estimate that were the basis for denying that any epidemiological study was needed in Idaho communities near the site. The CDC in 2007 issued its review of the 1989 study and found many releases, some of the largest ones, underestimated by a factor of 7.[21] Errors causing underestimation of the INL releases continue to be found as energy worker compensation studies have continued. The INL was originally called the National Reactor Testing Station, later called the Idaho Engineering Laboratory, and then the Idaho National Engineering and Environmental Laboratory before being named the Idaho National Laboratory.

The estimates of the 1991 INEL Historical Dose Evaluation[22] continue to be found in error and to significantly underestimate what was released.[23, 24, 25] Theoretical and idealized modeling of the releases were used for estimating the releases for the 1991 INEL HDE without using environmental monitoring to confirm the estimates—except for the 1961 SL-1 accident in which the environmental monitoring showed that the **theoretical modeling had underestimated the release**. In fact, many of the environmental monitoring records were deliberately destroyed before the 1991 report was released.[26] INL airborne releases included a long list of every fission product that exists including iodine-131, long-lived I-129, tritium, strontium-90, cesium-37, plutonium, and uranium.

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[19] US Department of Energy Idaho Operations Office, "Idaho National Engineering Laboratory Historical Dose Evaluation," DOE-ID-12119, August 1991. Volumes 1 and 2 can be found at https://www.iaea.org/inis/inis-collection/index.html

[20] Environmental Defense Institute's comment submittal on the Consent-based Approach for Siting Storage for the nation's Nuclear Waste, July 31, 2016. http://www.environmental-defense-institute.org/publications/EDIXConsentFinal.pdf

[21] Center for Disease Control, CDC Task Order 5-2000-Final, Final Report RAC Report No. 3, by Risk Assessment Corporation, October 2002. https://www.cdc.gov/nceh/radiation/ineel/to5finalreport.pdf

[22] US Department of Energy Idaho Operations Office, "Idaho National Engineering Laboratory Historical Dose Evaluation," DOE-ID-12119, August 1991. Volumes 1 and 2 can be found at https://www.iaea.org/inis/inis-collection/index.html p. 40.

[23] Risk Assessment Corporation, "Identification and Prioritization of Radionuclide Releases from the Idaho National Engineering and Environmental Laboratory," October 8, 2002, https://www.cdc.gov/nceh/radiation/ineel/to5finalreport.pdf See p. 117, 118 for SL-1.

[24] SENES Oak Ridge, "A Critical Review of Source Terms for Select Initial Engine Tests Associated with the Aircraft Nuclear Program at INEL," Contract No. 200-2002-00367, Final Report, July 2005. http://www.cdc.gov/nceh/radiation/ineel/anpsourceterms.pdf See p. 4-67 for Table 4-13 for I-131 estimate for IET's 10A and 10B and note the wrong values for I-131 are listed in the summary ES-7 table.

[25] CDC NIOSH, "NIOSH Investigation into the Issues Raised in Comment 2 for SCA-TR-TASK1-005," September 3, 2013. https://www.cdc.gov/niosh/ocas/pdfs/dps/dc-inlspcom2-r0.pdf See p. 3 stating various episodic releases underestimated by the INEL HDE: IET 3, IET 4 and IET 10.

[26] Chuck Broscious, Environmental Defense Institute Report, "Destruction and Inadequate Retrieval of INL Documents Worse than Previously Reported," Revised September 1, 2018. http://environmental-defense-institute.org/publications/DocDestruction.pdf

The source documents for the INEL HDE are in fact part of the Human Radiation Experiments collection of DOE documents. Why? Because there was enough information available for the DOE to know that showering nearby communities and their farms and milk cows with radiation really was likely to be harmful to their health. The INL (formerly the NRTS, INEL and INEEL) takes up dozens of volumes of binders in the DOE's Human Radiation Experiments collection and that isn't including the boxes of documents no one can get access to or the records that were deliberately disposed of.[27]

DOE and the CDC still not disclosing the full extent of historical releases, including the magnitude of the 1961 SL-1 release which affected communities including Atomic City and Mud Lake.[86]

Communities near the INL, include Atomic City to the south and Mud Lake to the north and Osgood west of the MARVEL project have been adversely affected already and isn't the harm done to those poor people enough?

The Atomic Energy Commission, predecessor of the Department of Energy, claimed that no other fission products were detected other than 0.1 Curies of strontium-90 and 0.5 curies of cesium-137 within the perimeter fence of the SL-1.[28] The derived release fractions based on trying to fit the AEC claims to a computer derived release fraction show that the AEC claimed low curie amount releases are fiction. Never before or since has a reactor fuel had such low release fractions! The AEC not only left out many radionuclides, they underestimated the amount of the fission product releases from the accident by a factor of over 22 for iodine-131, 588 for Cs-137 and 277 for Sr-90. And even with the low-balled curie releases, the SL-1 accident was a serious accident.

Despite what Risk Assessment Corporation (RAC) writes about prevailing meteorological conditions at the time of the SL-1 accident being characteristic of the typical conditions at the time of year, the conditions were not typical. During the accident, the prevailing winds were from the north to northeast for 100 hours with an extremely strong inversion. Typical conditions are a prevailing wind in the opposite direction during the daytime, with wind reversals at night typical. The SL-1 radionuclide plume blew south toward American Falls and Rupert, Idaho.

The SL-1 reactor fission product inventory consisted of radionuclides produced during the excursion and also radionuclides the had built up in the fuel during previous reactor operations. The operating history of the reactor consisted of 11,000 hours for a total of 932 MW-days. The reactor accident resulted

[27] February 1995, the Department of Energy's (DOE) Office of Human Radiation Experiments published Human Radiation Experiments: The Department of Energy Roadmap to the Story and Records ("The DOE Roadmap"). See also the INL site profile on Occupational Environmental Dose: http://www.cdc.gov/niosh/ocas/pdfs/tbd/inl-anlw4-r2.pdf) Most of the documents in the DOE's Human Radiation Experiments collection remain perversely out of public reach. Documents are said to be stored at the INL site, out of state in boxes, [Good luck with getting these documents via the Freedom of Information Act] and in the National Archives. I found that retrieving documents from the National Archive would require extensive fees for searches and copying. Where is the transparency in creating a document collection that cannot be viewed by the public?

[28] Report by Risk Assessment Corporation for Centers for Disease Control and Prevention, Department of Health and Human Services, *Final Report Identification and Prioritization of Radionuclide Releases from the Idaho National Engineering and Environmental Laboratory*, RAC Report No. 3, CDC Task Order S-2000-Final, October 2002, pages 117, 118. https://www.cdc.gov/nceh/radiation/ineel/TO5FinalReport.pdf

in a total energy release of 133 MW-seconds. Roughly 30 percent of the core's fuel inventory was missing from the vessel, when examined after the accident.,[29, 30, 31]

Risk Assessment Corporation used the computer code RSAC to calculated a fission product inventory based on operation of the reactor at a power level of 2.03 MW (mega-watts) for 458 days, followed by a shutdown period of 11 days and the excursion power level of 88,700 MW for a period of 0.015 seconds. The Center for Disease Control did not call out what were obvious discrepancies and which meant that the SL-1 radiological consequences have been grossly understated.

Sage brush samples were collected and according to the AEC, the "gamma spectra of representative samples indicated that the activity was due to iodine-131. (IDO-12021, p. 131)

It was customary for the AEC to monitor jack rabbit thyroids and the iodine-131 levels before the SL-1 accident, for jack rabbit thyroids were typically 100 picocuries per gram. After the SL-1 accident, the levels were as high as 750,000 picocuries per gram at the SL-1, 180,000 picocuries/gram at nearby Atomic City, located south of the SL-1, and 50,000 picocuries per gram at Tabor, a farming community southeast of SL-1 and west of Blackfoot, and 11,200 picocuries at Springfield. These rabbit thyroid results reveal much higher rabbit thyroid iodine- 131 levels than produced by the other large episodic and routine releases from the Idaho National Laboratory during the 1950s and 1960s.[32, 33, 34, 35]

The DOE has lied to the public about the SL-1 accident and still publishes false information about the SL-1 accident, you can read my report about the consequences of the SL-1 accident on the Environmental Defense Institute website, *The SL-1 Accident Consequences*, at http://environmental-defense-institute.org/publications/SL-1Consequences.pdf and the cause of the SL-1 accident on the Environmental Defense Institute website, *The Truth about the SL-1 Accident – Understanding the Reactor Excursion and Safety Problems at SL-1* at http://environmental-defense-institute.org/publications/SL-1Accident.pdf

The EA lists various Department of Energy regulations but fails to acknowledge that the Department of Energy is not trustworthy.

From the DOE's nuclear weapons testing at the Nevada Testing Station, in the Pacific islands, and elsewhere, the DOE told people they were safe and then covered up epidemiology that showed people had increased rates of leukemia and cancer from the fallout. The DOE claimed its releases from the INL were too low to cause harm, but when asked to state what it had released to the Idaho skies, the DOE didn't know. Then when the DOE issued a report of estimated releases through its history to 1989, reviews by the Center for Disease Control found the releases had been significantly underestimated. It is also documented that many environmental monitoring records were subsequently destroyed, which would have indicated more contamination that the DOE wanted others to know about. The DOE has lost or

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[29] Department of Energy, Idaho National Engineering Laboratory Historical Dose Evaluation, DOE/ID-12119, August 1991. See https://inldigitallibrary.inl.gov

[30] Atomic Energy Commission, "Final Report of the SL-1 Recovery Operation," IDO-19311, June 27, 1962. See p. III-77 regarding fuel damage. https://inldigitallibrary.inl.gov/PRR/163644.pdf

[31] Atomic Energy Commission, "Additional Analysis of the SL-1 Excursion Final Report of Progress July through October 1962," IDO-19313, November 21, 1962. See p. 27 Table I-VIII. https://inldigitallibrary.inl.gov/PRR/163644.pdf

[32] Atomic Energy Commission, "1958 Health and Safety Division Annual Report, IDO-12012, See p. 72, 73 for iodine-131 in sage brush and rabbit thyroids. https://inldigitallibrary.inl.gov/PRR/112697.pdf

[33] Atomic Energy Commission, "Annual Report of Health and Safety Division, 1959," IDO-12014, See p. 88 for iodine-131 in rabbit thyroids. https://inldigitallibrary.inl.gov/PRR/112700.pdf

[34] Atomic Energy Commission, "Health and Safety Division Annual Report, 1960," IDO-12019, See p. 91 for iodine-131 in rabbit thyroids. https://inldigitallibrary.inl.gov/PRR/90927.pdf

[35] Atomic Energy Commission, "Health and Safety Division Annual Report, 1961," IDO-12021, See p. 128, 133 for iodine-131 in jack rabbit thyroids. https://inldigitallibrary.inl.gov/PRR/163656.pdf

destroyed worker radiation dose records throughout its history when the records would show elevated doses. The DOE uses secrecy, document destruction, omission of key information during public presentations, and adherence to providing false information about its plans, and breaks its commitments. The DOE would not have conducted any cleanup at all if other federal agencies had not been able to say that hazardous chemical laws needed to apply to DOE sites, allowing CERCLA cleanup investigations. The DOE has systematically lied about the pervasive long- lived radionuclides at sites likes the INL, omitting what it well knew, that uranium, plutonium and americium were included in soil and perched water. It omitted this information so well that the DOE and the U.S. Geological Survey have often, without justification, omitted the reporting of extensive radiological contamination at the INL, later found by CERCLA investigations.

DOE lied about its radiological releases decades ago from nuclear weapons testing, reactor testing, and reactor accidents and other operations and it continues to misinform the public about its past and about current contamination.

The Department of Energy has a long history of telling workers they are protected from radiological hazards—but workers got illnesses. Nationwide, billions of dollars of illness compensation have been paid out under the Energy Employee Illness Compensation Program Act (EEICOPA) even with two-thirds of INL claims denied.

DOE lied about its radiological releases decades ago from nuclear weapons testing, reactor testing, and reactor accidents and other operations and it continues to misinform the public about its past and about current contamination.

The Department of Energy has a long history of telling workers they are protected from radiological hazards—but workers got illnesses. Nationwide, billions of dollars of illness compensation have been paid out under the Energy Employee Illness Compensation Program Act (EEICOPA) even with two-thirds of INL claims denied.

The Department of Energy has a long history of saying its radiological releases were too small to affect the public—but studies found that the public had higher infant mortality and certain cancers and leukemia.

The Department of Energy has rightfully earned and continues to earn the public's distrust.

The Department of Energy must not be allowed to unilaterally reclassify HLW waste because the DOE cannot be trusted to comply with its own regulations should its regulations or DOE Orders be deemed inconvenient or costly.

The Idaho National Laboratory along with other Department of Energy operations at Hanford and Rocky Flats have a long tradition of falsification of lung count results. The last situation requiring lung counts, reported that lung counts were not required, despite lung counts being required. Workers are not informed that their lung count results can be manipulated in order to obtain lowered intake results.

The EA fails to acknowledge that the DOE has a record of not being transparent and usually fails to publish the public comment submittals it receives.[87]

The DOE has also conducted numerous public comment opportunities, only to refuse to publish those public comments such as the consent-based interim spent nuclear fuel storage meetings conducted a few years ago.[36, 37]

People might eventually catch on that Idaho is getting more and more radiologically polluted—but with all the deliberate omissions and dis-information, probably not before it's too late.

Table A-4. DOE response to comments from Ms. Tammy Thatcher.

Comment ID Number	Comment	DOE Response
37	The Department of Energy's Environmental Assessment for the design and demonstration of the Microreactor Applications Research Validation and Evaluation Project (MARVEL), which allowed a scant 14 days for review, is inadequate, especially given the glaring omissions and disinformation in the EA.	DOE's NEPA implementing procedures are found in 10 CFR 1021. Section 1021.301 (d), which states, "At DOE's discretion, this review [i.e., the public comment period] shall be from 14 to 30 days." The public comment period for this EA complied with the regulation, DOE extended the public comment period an additional two weeks. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
38	The real problem will be having one of these on the free-way next to you in a snowstorm pile up car accident or having one operating where you work or where you live and the continued storage of the spent nuclear fuel because there is no spent nuclear fuel repository. The trillions of dollars it will cost to attempt to confine the spent nuclear fuel will be placed on future generations as well as the radiological harm from radiological releases.	The proposed action does not involve transporting the MARVEL microreactor on public roads. DOE follows applicable statutes for managing SNF. Section 3.8 of the EA notes that as with all SNF at present, the question of permanent disposition of SNF is directly dependent on the identification and licensing of a permanent repository for SNF in the United States. Evaluating options for a final disposal site for DOE-managed SNF is outside the scope of this analysis and subject to National Environmental Policy Act (NEPA) review by DOE prior to making a decision on any option for a final disposal site. NEPA and CEQ's implementing regulations provide that agencies need not weigh the merits and drawbacks of particular alternatives in a monetary cost-benefit analysis (40 CFR 1502.23).

[36] Before ending the consent-based siting effort, information found about the Department of Energy's consent-based siting at www.energy.gov/consentbasedsiting and its Integrated Waste Management and Consent-based Siting booklet at http://energy.gov/ne/downloads/integrated-waste-management-and-consent-based-siting-booklet

[37] Environmental Defense Institute's comment submittal on the Consent-based Approach for Siting Storage for the nation's Nuclear Waste, July 31, 2016. http://www.environmental-defense-institute.org/publications/EDIXConsentFinal.pdf

Comment ID Number	Comment	DOE Response
		SNF would be managed and dispositioned as addressed in Section 3.8 of the EA. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). The EA addresses the environmental impacts due to the treatment, storage, and disposal of the waste generated by the proposed action. The waste generated from the proposed action will be managed (i.e., treated, stored and disposed) in a safe and environmentally protective manner and in compliance with all applicable Federal and state laws and regulations and applicable DOE orders.
39	DOE's public outreach has been inadequate and deliberately misleading, the draft Environmental Assessment is not bounding, representative, or clear about waste management of the proposed expansion or its consequences, and a full Environmental Impact Statement is needed.	The facility modifications, construction, and operations proposed as part of the MARVEL microreactor would occur in existing facilities. The MARVEL microreactor does not require construction of new facilities or expansion of existing facilities or additional land use or ground disturbance (EA p. 24). In accordance with the NEPA implementing regulations, a federal agency can prepare an EA at any time for a proposed action. If potential significant environmental impacts are identified, an environmental impact statement (EIS) can always be pursued. Conversely, if no significant environmental impacts are identified, the EA is the appropriate level of documentation and no further evaluation is necessary. DOE verifies the level and quality of analysis and data compiled for the EA is suitable for use in an EIS if it is decided that an EIS should be prepared. This course of action is appropriate for use when an agency has a basis for the belief that the proposal will not manifest significant environmental impacts. DOE also considered the context (setting) and intensity (severity) of any potential environmental impacts before deciding on the appropriate level of NEPA review. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impact analyses. The analyses indicate that the proposed action will not have a significant impact and, therefore, an EIS is not necessary.

Comment ID Number	Comment	DOE Response
40	The EA is actually stating that the EA will allow the continued burial of beryllium waste over the Snake River Plain aquifer, without clearly stating so. The EA omits the serious health and environmental problems of beryllium handling and its waste disposal.	An activation analysis and modeling of the MARVEL microreactor beryllium oxide side reflectors reveals that these components will be DOE LLW or NRC Class A LLW and can be dispositioned through existing disposition paths, either DOE or commercial sites (Black & Grant, 2021) (Trellue, Vedant, Rao, Lange, & Sterbenz, 2021). DOE follows applicable waste management statutes. The wastes would be managed and dispositioned as addressed in Section 3.7 of the EA. In addition, nonradiological exposures at the INL Site are controlled through programs intended to protect workers from hazards (EA Section 3.10). These programs are controlled by the safety and health regulations for DOE contractor workers governed by 10 CFR 851 (2012), which establishes requirements for worker safety and health programs to ensure that DOE contractor workers have a safe work environment. Section 851.23(a) requires that contractors comply with Title 10 CFR 850, *Chronic Beryllium Disease Prevention Program.* Per 10 CFR 851 (2012), employee exposures to hazardous agents at INL are maintained below the American Conference of Governmental Industrial Hygienists threshold limit values, the Occupational Safety and Health Administration (OSHA) permissible exposure limits, and other applicable standards as defined by DOE. When exposure limits defined by the various agencies conflict, INL policy is to comply with the more stringent limit.
41	The disposal limits on beryllium at WIPP as so strict that the INL cleanup contractor lied about the presence of beryllium carbide in waste. The lie was only revealed because of the explosion of the waste drums of uranium and beryllium carbide.	Please see response to comment #40.
42	The EA has failed to disclose how the Department of Energy's reclassification of high level waste will impact the Idaho National Laboratory.	High Level Waste (HLW), as defined in the Nuclear Waste Policy Act of 1982 (NWPA), Section 2(12), is the highly radioactive material resulting from the reprocessing of SNF, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations, and other highly radioactive material that the U.S. Nuclear Regulatory Commission, consistent with existing law, determines by rule to require permanent isolation. The proposed action does not involve reprocessing. Management of high-level waste is not part of the scope and analysis of this EA.

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43	The EA will apparently allow spent nuclear fuel, as well as radiologically contaminated beryllium, from MARVEL to be buried over the Snake River Plain Aquifer or in low-level waste commercial facilities and must fully discuss the beryllium waste issues as well as health hazards.	Please see response to comment #40. The wastes from the MARVEL microreactor project would be managed and dispositioned as addressed in Section 3.7 of the EA. Activities supporting the treatment and management of the MARVEL microreactor sodium-bonded SNF and other planned INL activities would not generate larger volumes of radioactive, hazardous, or solid waste beyond the current and projected capacities of INL waste storage or management facilities as evaluated in the Sodium-Bonded Fuel EIS (p. 43). In addition, the analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted.
44	The EA is unclear and deliberately vague as to where the spent nuclear fuel from the INL's Radioactive Scrap and Waste Facility is actually being disposed of.	Materials stored at the Radioactive Scrap and Waste Facility (RSWF) are managed in accordance with DOE's *Programmatic SNF Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (FEIS) and Record of Decision (ROD) (DOE/EIS-0203, 1995) and supplemental analyses (DOE/EIS-0203-SA-01 and DOE/EIS-0203-SA-02) and the Amended Record of Decision (February 1996).
45	The EA fails to mention that the Department of Energy is simultaneously pretending it has a spent fuel repository while refusing to construct a facility at the INL (limited to fuel at INL) for spent nuclear fuel repackaging for a repository.	The regulations relevant to the storage of SNF are recorded as schedules in the Code of Federal Regulations (CFR). The key schedules dealing with the storage of SNF is 10 CFR 72 which deals with packaging and storing SNF. INL manages SNF in accordance with the numerous DOE Records of Decision (RODs) and EISs on SNF management, including the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Program* (DOE, 1995). This ROD records a department-wide decision for DOE-owned SNF management and contains decisions dealing with site-wide environmental restoration and waste management programs at the INL Site (DOE, 1995). MARVEL microreactor SNF may be managed in existing INL facilities so far as the legal, regulatory, operational, and scheduling requirements for the transfer and storage of these fuels in existing facilities are met. Transfer to existing facilities will be predicated on the appropriate analyses and procedures. Existing INL facilities are available to provide extended dry storage for the MARVEL microreactor SNF, including the Radioactive Scrap and Waste Facility, until

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		final disposition is available (EA p. 44). As with all SNF at present, the question of permanent disposition of SNF is directly dependent on the identification and licensing of a permanent repository for SNF in the United States. DOE has planned since the mid-1980s to dispose of SNF in a common mined geologic repository or repositories. This is not the only technical option available, however. An extensive body of knowledge has been developed in the U.S. and other countries relative to SNF disposal options, indicating that there are multiple viable options for safe disposal. Evaluating options for a final disposal site for DOE-managed SNF is outside the scope of this analysis and subject to National Environmental Policy Act (NEPA) review by DOE prior to making a decision on any option for a final disposal site.
46	The EA fails to mention that DOE is on track to miss all of the main milestones in the 1995 Idaho Settlement Agreement because it is not repackaging spent nuclear fuel or high-level waste for permanent disposal or even for shipment to pawn off the waste for "temporary" storage in another state, such as New Mexico.	Idaho Settlement Agreement milestones and management of high-level waste is not part of the scope and analysis of this EA. Nonetheless, DOE is committed to meeting the terms of the Idaho Settlement Agreement. DOE has met more than 90% of the milestones outlined in the 1995 Idaho Settlement Agreement on or ahead of schedule. In other instances, DOE and the state have renegotiated milestones. In November 2019, DOE and the state of Idaho signed a Supplemental Agreement to the 1995 Idaho Settlement Agreement that reaffirms DOE's and the state's commitment to remove Cold War legacy waste and special nuclear materials from Idaho. This agreement ensures continued protection of the Snake River Plain Aquifer while supporting INL's ability to fulfill its mission. Section 3.8 of the EA discusses management of SNF from the MARVEL microreactor. The purpose of this EA is to assess the environmental impacts of the proposed action. The draft EA evaluated the impacts of managing SNF from the proposed MARVEL microreactor project. Management of other fuel is outside the scope of the EA.
47	The EA unscientifically and indefensibly pretends that the Department of Energy has a spent fuel disposal program when U.S. court proceedings have found that the DOE has no spent fuel disposal program.	Please see response to comment #45.
48	Despite no completed design or construction or licensing of the non-existent DOE standardized canister, the MARVEL EA states that the DOE's standardized canister will be used to package the MARVEL spent nuclear fuel for disposal at the non-existent Yucca Mountain. The fiction used by the EA is intentionally deceptive	The DOE standardized canister was developed to avoid reliance on existing data for licensing and to integrate HLW in the co-disposal waste package for the Yucca Mountain Repository. In 1995, a working group that included technical staff from the three major DOE interim storage sites (Hanford, INL, and Savannah River Site), DOE-EM headquarters staff, and the Yucca Mountain Site Characterization Office proposed a package for disposal of HLW in the repository. The canister development program adopted the design and

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	because for years now the design of the standardized canister design and its neutron absorbers was never completed, never built and never licensed. But that is consistent for the spent nuclear fuel disposal facility, which it names as Yucca Mountain, does not exist and has not been funded since 2010.	quality assurance (QA) principles of the American Society of Mechanical Engineers (ASME) Code to support the bases for a low-failure-probability argument (i.e., ASME B&PC Code, Section III, Division 3). A finite element model was developed to predict structural performance of the canister and a testing program was developed to confirm canister performance and also to validate the model. Following the prescribed drops, test canisters were checked for leaks in accordance with the American National Standards Institute (ANSI) N14.51987, *American National Standard for Radioactive Materials-Leakage Tests on Packages for Shipment*. DOE contracted with Foster Wheeler Environmental Corporation (FWENC) to design a facility for packaging and storage of INL SNF based on the standardized canister. In the 2001, as part of the Idaho Spent Fuel Facility (ISFF) design, FWENC completed the design work for the ISFF canister and submitted a 10 CFR 72 license application. The FWENC canister design differed slightly from the preliminary canister design. This canister was licensed by the NRC per 10 CFR 72 for storage of spent fuels at the ISFF in 2004. The ISFF was never completed, no canisters were fabricated, and the license was transferred to DOE in 2009. The design of the licensed canister allows compatibility with a broad range of repository locations and geologic environments (Gordon M. Petersen, Ken Bulmahn, Dayna L. Daubaras, Brett W. Carlsen, Rebecca E Smith *History and Status of DOE's Standardized Canister 19657*, March 2019. INL/CON-18-51893-Revision-0). Section 3.8 of the EA discusses management of SNF, which includes the processes necessary to support the safe and secure storage of the SNF in a configuration that is ready for shipping to an Independent Spent Fuel Storage Installation or permanent repository. Per the current DOE SNF disposition strategy, MARVEL microreactor SNF, after appropriate treatment, is expected to be disposed of using the DOE Standard Canister *once the appropriate evaluation and analyses are performed* (EA p. 44). If these evaluations show the standard canister can support the safe and secure storage of the SNF in a configuration that is ready for shipping to an Independent Spent Fuel Storage Installation or permanent repository, then INL will procure a standard canister. If a different type of SNF container is necessary, INL would design and develop the container package in compliance with all applicable Federal and state laws and regulations and applicable DOE orders to ensure the SNF from the proposed action will be stored and disposed of in a safe and environmentally protective manner. Section 3.8 of the EA notes that as with all SNF at present, the question of permanent disposition of SNF is directly dependent on the identification and licensing of a permanent repository for SNF in the United States. Evaluating options

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		for a final disposal site for DOE-managed SNF is outside the scope of this analysis and subject to National Environmental Policy Act (NEPA) review by DOE prior to making a decision on any option for a final disposal site.
49	Because the Department of Energy does not have a program for spent nuclear fuel disposal, the EA the costs and risks of continued storage of Department of Energy owned spent nuclear fuel have not been addressed. The EA is therefore built on a foundation of sand. This pushes the cost and the potential for devastating radiological releases on to future generations. The DOE lavishly is spending money on new ways to make more spent nuclear fuel, all while not funding the work of aging management of spent nuclear fuel, not funding the needed repackaging facilities and not having conducted a credible repository program.	Please see response to comment #45. NEPA and CEQ's implementing regulations provide that agencies need not weigh the merits and drawbacks of particular alternatives in a monetary cost-benefit analysis (40 CFR 1502.23). The annual federal budget process and federal spending is outside the scope of this analysis. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
50	DOE has no spent nuclear fuel repository program and does not even have an appropriate estimate of the cost of getting a repository, packaging and/or repackaging the waste, and waste emplacement. Simply hand-waving that there was a past EIS that assumed wrongly that a repository would be in place is not truthful and undermines the entire purpose of the NEPA process. The truth is that the DOE has not found a feasible way of isolating spent nuclear fuel from air, water and soil for the millennia that the waste is radio-toxic.	The *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Program* (DOE, 1995) and ROD records a department-wide decision for DOE-owned SNF management and contains decisions dealing with site-wide environmental restoration and waste management programs at the INL Site (DOE, 1995) (EA p. 44). These decisions include the continuation of environmental restoration activities, development of cost-effective treatment technologies for SNF and waste management, and implementation of projects and facilities to prepare waste and treat SNF for interim storage and final disposition. In addition, the analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted.

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		Section 3.8 of the EA notes that as with all SNF at present, the question of permanent disposition of SNF is directly dependent on the identification and licensing of a permanent repository for SNF in the United States. Evaluating options for a final disposal site for DOE-managed SNF is outside the scope of this analysis and subject to National Environmental Policy Act (NEPA) review by DOE prior to making a decision on any option for a final disposal site.
51	The EA fails to acknowledge the significantly increased problems as well as higher costs for safe disposal of higher enriched fuels and higher burnup fuels.	The purpose of this EA is to assess the environmental impacts of the proposed action. The draft EA evaluated the impacts of managing SNF from the proposed MARVEL microreactor project. Management of other fuel is outside the scope of the EA.
52	The EA fails to acknowledge the billions of dollars already needed to repackage spent nuclear fuel and the trillions of dollars to continue attempting to find a way to isolate these wastes from the biosphere.	Please see response to comment #50.
53	The EA allows the careless disposal of spent nuclear fuel over the Snake River Plain aquifer if DOE deems the spent nuclear fuel to be related to research. This artificial definition defies science and is simply to shortcut proper disposal to isolate the material from soil, air and groundwater	The *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management EIS* (DOE, 1995) and ROD records a department-wide decision for DOE-owned SNF management and contains decisions dealing with site-wide environmental restoration and waste management programs at the INL Site (DOE, 1995) (EA p. 45). These decisions include the continuation of environmental restoration activities, development of cost-effective treatment technologies for SNF and waste management, and implementation of projects and facilities to prepare waste and treat SNF for interim storage and final disposition. In addition, the analysis in the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE, 2000) showed that there would be no significant impacts on air quality, water resources, socioeconomics, public and occupational health and safety, environmental justice, and transportation from the various treatment options for sodium-bonded SNF. It further showed that the radiological and nonradiological gas and liquid releases, as well as the associated exposures to workers and the public, would be well below regulatory standards and guidelines and no mitigation measures would be warranted.
54	The EA asserts that environmental monitoring programs are adequate even though elevated levels of gross alpha in our public water supplies go without gamma spectrometry evaluations to determine the level of americium, plutonium and other INL released	The INL Site environmental surveillance programs collect and analyze samples or direct measurements of air, water, soil, biota, and agricultural products from the INL Site and off-Site locations in accordance with DOE Order 458.1, *Radiation Protection of the Public and the Environment*. The purpose of DOE Order 458.1 is to establish requirements to protect the public and the environment against undue risk from radiation associated with radiological activities

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	radionuclides.	conducted under the control of DOE pursuant to the Atomic Energy Act of 1954, as amended. Monitoring activities are performed to generate measurement based estimates of the amounts or concentrations of contaminants in the environment. Measurements are performed by sampling and laboratory analysis or by "in place" measurement of contaminants in environmental media. The INL Site environmental surveillance programs collect and analyze samples or direct measurements of air, water, soil, biota, and agricultural products from the INL Site and off-Site locations in accordance with DOE Order 458.1, *Radiation Protection of the Public and the Environment*, DOEHDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*, and DOE-STD-1196-2011, *Derived Concentration Technical Standard*. The programs meet or exceed requirements within these governing documents and have been determined through technical review to effectively characterize levels and extent of radiological constituents in the environment and distinguish INL Site-related contributions from those typically found in the environment at background levels. Monitoring performed by DOE's INL Management and Operations (M&O) contractor; DOE's INL Environmental Surveillance, Education, and Research Program (ESER) contractor (independent from the M&O contractor); and the Idaho Department of Environmental Quality (DEQ) INL Oversight Program demonstrate that impacts from the INL are low and consistent with the emissions reported in annual INL radionuclide NESHAP reports. DOE contractors' ambient air monitoring data are reported annually in the Annual Site Environmental Reports which are available at the ESER program's website. DEQ's INL Oversight Program Annual Reports are available at DEQ's INL Oversight Monitoring Program website.
55	The EA incorrectly states that "INL maintains the necessary apparatus, equipment, and a state of the art Emergency Operations Center in Idaho Falls to respond to emergencies, not only at from the MARVEL microreactor and other INL Site operations, but also throughout local communities." The EA fails to acknowledge decades of repeated inadequate emergency preparation for site emergencies in terms of training, decontamination, radiological medical treatment, inadequate emergency radiological monitoring during and after the emergency.	DOE takes its responsibility for the safety and health of the workers and the public seriously. The INL Emergency Management Program implements DOE policy and requirements for an emergency management system and a RCRA contingency plan and complies with DOE O 151.1D, *Comprehensive Emergency Management System*, and other DOE and regulatory requirements. DOE ensures that problems (issues) that have a reasonable potential to cause adverse operational, environmental, safety and health, or quality assurance consequences are documented and resolved in an effective and timely manner. Regularly scheduled exercises are conducted to test INL's and coordinating agencies' ability to respond to accidents. These exercises include realistic tests of people, equipment, and communications involved in all aspects of the plans; the plans are regularly reviewed and modified to incorporate experience gained from the exercises. These exercises also periodically include steps to verify the adequacy of

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		interactions with local hospitals, emergency personnel, and state officials. Off-site medical personnel, off-site emergency personnel, state officials, and local officials are periodically included in or observe emergency planning exercises. In addition, a comprehensive annual assessment is conducted to examine the elements of the INL Emergency Management Program using criteria taken from DOE O 151.1D and supporting guides. Other assessments of the INL Emergency Management Program are planned and scheduled to examine special topics as identified by management. Independent assessments are also performed to examine the various aspects of the program that are not directly managed by the INL Emergency Management Department. External assessments of the program are also conducted by DOE and corporate personnel. These assessments ensure that emergency plans, procedures, emergency response activities, and resources are adequate and sufficiently maintained. The INL Site environmental surveillance programs also have the capabilities to monitor routine and non-routine radiological releases and to assess the radiation doses to workers and to members of the public. The programs have been determined through technical review to effectively characterize levels and extent of radiological constituents in the environment and distinguish INL Site-related contributions from those typically found in the environment at background levels. Monitoring performed by DOE's environmental surveillance programs demonstrate that impacts from the INL are low.
56	The EA claims that the accident release consequences are only a few rem, yet fails to acknowledge only short-term dose and ignores the long term ingestion consequences, the crop interdiction, the uncompensated and uninsurable car, home, business, livelihood and health costs of an accident radiological release.	The accident analysis was conducted using Radiological Safety Analysis Computer (RSAC) Program 7.2 to model accident conditions and is documented in ECAR-5127, *Evaluation of the MARVEL Reactor Inhalation Dose Consequence* (Reiss 2021). RSAC 7.2 is a radiological safety analysis tool developed and used extensively at INL for calculating the doses to facility workers, collocated workers, and off-site public due to radiological releases. The evaluation revealed that doses from the ingestion, ground contamination, and air immersion exposure pathways are negligible and are not calculated for on-site workers or off-site public. DOE takes its responsibility for the safety and health of the workers and the public seriously. A beyond design basis accident is recognized as a potential hazard; however, such an event is extremely unlikely because a large number of independent failures would have to happen before an accident could occur. DOE has multiple engineered and administrative controls in place to prevent these failures. In the unlikely event an accidental were to occur, the potential dose to the public is bounded by the accident analysis in the EA.

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57	The EA fails to acknowledge that the monitoring will ignore the uranium-235 released by the accident as well as inadequate actinide (plutonium, americium, curium, etc.) monitoring because of intentional environmental monitoring inadequacies to avoid implicating the INL as the source of the contamination. The decay products from plutonium-240 and uranium-236 are thorium decay progeny which the environmental monitoring falsely asserts are from naturally occurring thorium-232. The elevated levels of uranium-234, uranium-235, uranium-236 are intentionally not delineated by the specific isotope so the DOE can falsely claim that the uranium is naturally occurring.	Please see response to comment #54. The INL Site environmental surveillance programs have the capabilities to monitor routine and non-routine radiological releases and to assess the radiation doses to members of the public. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
58	From the 1961 SL-1 accident where radiological monitoring was especially inadequate for emergency responders, to the 2011 plutonium inhalation accident caused by management failure to heed repeated warnings of high worker risks and the multiple failures that caused the event and the multiple failures in responding to the event, to the 2018 four drums of waste that exploded and fire fighters, once again, responded without support of adequate training or radiological support personnel.	Please see response to comments #54, #55, and #57. The INL Site environmental surveillance programs have the capabilities to monitor routine and non-routine radiological releases and to assess the radiation doses to workers and to members of the public. The programs have been determined through technical review to effectively characterize levels and extent of radiological constituents in the environment and distinguish INL Site-related contributions from those typically found in the environment at background levels. Monitoring performed by DOE's environmental surveillance programs demonstrate that impacts from the INL are low. Worker and public safety are DOE's highest priority, and INL workers are highly trained in performing their jobs. Education and training requirements are commensurate with job functions. Impacts to the offsite public and onsite workers from the MARVEL microreactor are discussed in Section 3.9 and 3.10 of the EA. Occupational exposures at the INL Site are controlled through programs intended to protect workers. These programs are controlled by the safety and health regulations for DOE contractor workers governed by 10 CFR 851 (2012), which establishes requirements for worker safety and health programs to ensure that DOE contractor workers have a safe work environment. To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 mrem (5 rem) per year. In addition, worker doses must be monitored and controlled below the regulatory limit to ensure that individual doses are less than an administrative limit of 2,000 mrem (2 rem) per year DOE-STD-1098-2017, *Radiological Control* (DOE-STD-1098-2017, 2017), and

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		maintained as low as reasonably achievable (ALARA). The purpose of this EA is to assess the environmental impacts of the proposed action. DOE evaluated the potential impacts to human health and the environment from the MARVEL microreactor project and the cumulative impact from past, present, and reasonably foreseeable future actions and found effectively no increase in cumulative impacts to the public or collocated workers during normal operations (EA Sections 3.2.1 and 3.9.1). Section 3.9.2 of the EA discusses the hazard evaluation that was performed for the MARVEL microreactor design and found that the MARVEL microreactor can be built and operated safely in the Transient Reactor Test (TREAT) facility. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
59	The EA fails to acknowledge that the lack of proper decontamination facilities means that an injured worker is going to radiologically contaminate medical facilities in Idaho Falls.	Worker and public safety are DOE's highest priority. As noted in Section 3.11, INL maintains the necessary apparatus, equipment, and a state-of-the-art Emergency Operations Center in Idaho Falls to respond to emergencies, not only at INL, but throughout the local communities. DOE controls personnel exposure to ionizing radiation for emergency response operations at INL consistent with 10 CFR 835, *Occupational Radiation Protection*, and EPA-400/R-17/001, *PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents*, (January 2017) and ensures that the risk of injury to individuals involved in rescue and recovery operations is minimized. INL nuclear facilities have dedicated personnel decontamination areas stocked with decontamination supplies. Decontamination of injured employees is performed under the direction of INL medical professionals and Radiological Control Technician(s) at the decontamination showers and decontamination and treatment rooms at the Central Facilities Area (CFA) Medical Facility, building CFA- 1612. Radiological Control Technicians set up radiological postings and controls and perform monitoring for surface contamination in the decontamination area as required. Injured patients with known contamination may need to be transported off site to a definitive care facility. Area medical facilities such as Eastern Idaho Regional Medical Center (EIRMC) and Portneuf Medical Center are prepared to handle these cases when forewarned, and INL's Occupational Medical personnel make the notifications to

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		the offsite receiving medical facility. Any patient so transported is appropriately covered with sheet wraps and other coverings to contain contamination. Radiological Control Personnel travel with or follow the contaminated employee to the definitive care facility as deemed appropriate. Maintaining a contamination free area at all the entrances and exits of the decontamination or treatment room is essential to protecting staff from contamination. Radiological Control Technicians survey staff members periodically for contamination during decontamination procedures and following patient decontamination. They also remove and dispose of all contaminated material and complete radiological surveys and decontamination of facilities as required.
60	The EA omits mention of the airborne releases by production of high assay low-enriched uranium fuel and omits deliberate and unnecessary as well as inadequately monitored INL Test Range radiological releases and others.	DOE evaluated the environmental impacts of airborne releases from production of high assay low-enriched uranium fuel in the *Final Environmental Assessment for the Use of Department of Energy-Owned High-Assay Low-Enriched Uranium Stored at Idaho National Laboratory* (DOE/EA-2087, January 2019) and from INL Test Range radiological releases in the *Final Environmental Assessment Determination for Expanding Capabilities at the National Security Test Range and the Radiological Response Training Range at Idaho National Laboratory* (DOE/EA-2063, December 2019). DOE evaluated the potential impacts to human health and the environment from the MARVEL microreactor project and the cumulative impact from past, present, and reasonably foreseeable future actions and found effectively no increase in cumulative impacts to the public or collocated workers from radioactive air emissions during normal operations, as discussed in Sections 3.2.1 and 3.9.1 of the EA.
61	The EA generally fails to address the Department of Energy's refusal to acknowledge strong epidemiology that shows far more cancer risk and other health risks than the biased and inadequate models it relies on.	DOE disagrees. Dose based consequences of the proposed action, as detailed in the EA, are derived from the Annals of the ICRP; Publication 103, The *2007 Recommendations of the International Commission or Radiological Protection*, and in consideration of the latest available scientific information of the biology and physics of radiation exposure.

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62	The EA specifically implies that its radiation monitoring and radiation health models are adequate.	Please refer to the response to comment #54 regarding environmental monitoring at the INL Site. Radiological emissions from all INL facilities are measured or calculated in accordance with 40 CFR 61 Subpart H *National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities* (Subpart H - NESHAP) requirements. Emissions from radionuclide emissions sources are required by Subpart H to be calculated in accordance 40 CFR 61 Appendix D Methods for Estimating Radionuclide Emissions or other procedure for which EPA has granted prior approval. Because individual radiological impacts to the public surrounding the INL Site remain too small to be measured by available monitoring techniques, the dose to the public from INL Site operations is calculated using the reported amounts of radionuclides released from INL Site facilities and EPA approved air dispersion codes. Compliance to Subpart H of 40 CFR 615 is demonstrated primarily using the CAP 88 computer code. EPA requires using the CAP 88 computer code. CAP 88 uses dose and risk tables developed by the EPA. Yearly wind statistics are generated for many of the towers in the INL Site meteorological network; these are used to run the CAP 88 plume dispersion code required for NESHAP compliance.
63	The EA fails to address the inadequacy of the radiation health modeling despite years of double the thyroid cancer incidence in the counties surrounding the INL. As the DOE has been forbidden to conduct epidemiology because of its many past efforts to improperly bias human epidemiology, the assessment of growingly obvious health impacts of INL radiological releases must be conducted by properly independent evaluation. This has not been done, as is evident in the DOE's environmental assessment for the Versatile Test Reactor which displays some of the increased cancer rates yet fails to utter any recognition of the obvious doubling of thyroid cancers in counties surrounding the INL. The incidence of thyroid cancer has been doubling for years and is wide-spread, yet the rates ramp up at double the rest of Idaho and the US, in the counties surrounding the	Please refer to the response to comment #62. Dose based consequences of the proposed action, as detailed in the EA, are derived from the Annals of the ICRP; Publication 103, The *2007 Recommendations of the International Commission or Radiological Protection*, and in consideration of the latest available scientific information of the biology and physics of radiation exposure. DOE encourages information exchange and public involvement in discussions and decision making regarding INL Site activities. Active participants include the public; Native American tribes; local, state, and federal government agencies; advisory boards; and other entities in the public and private sectors. The Environmental Oversight and Monitoring Agreement between DOE-ID, Naval Reactors Laboratory Field Office/Idaho Branch Office, and the Idaho DEQ governs the activities of the DEQ-INL Oversight Program and DOE-ID's cooperation in providing access to facilities and information for non-regulatory, independent oversight of INL Site impacts to public health and the environment. More information can be found on the DEQ-INL Oversight Program website at www.deq.idaho.gov The purpose of this EA is to assess the environmental impacts of the proposed action. Evaluating regulatory limits, internationally accepted guidance, and standard modeling is outside the scope of this analysis.

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	INL. Refusing to recognize the impact, which would not be predicted by DOE's accepted radiological release estimates and radiation health models, is immoral as well as not based on scientific integrity.	
64	The Department of Energy and the State of Idaho are actively ignoring the likely environmental causes of elevated rates of cancer in the communities surrounding the INL and especially the elevated rates of childhood cancer.	The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. The INL Site environmental surveillance programs collect and analyze samples or direct measurements of air, water, soil, biota, and agricultural products from the INL Site and off-Site locations in accordance with DOE Order 458.1, *Radiation Protection of the Public and the Environment*; DOEHDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*, and DOE-STD-1196-2011, *Derived Concentration Technical Standard*. The programs meet or exceed requirements within these governing documents and have been determined through technical review to effectively characterize levels and extent of radiological constituents in the environment and distinguish INL Site-related contributions from those typically found in the environment at background levels. The air sampling network covers a 9,000 square mile area in southeast Idaho and Jackson, Wyoming, with over 2,000 samples collected each year and analyzed for key radiological constituents associated with INL Site operations. Each regulated INL Site facility determines airborne effluent concentrations from its regulated emission sources as required under state and federal regulations. Ambient air monitoring performed by DOE's INL Management and Operations (M&O) contractor; DOE's INL Environmental Surveillance, Education, and Research Program (ESER) contractor (independent from the M&O contractor); and the Idaho Department of Environmental Quality (DEQ) INL Oversight Program demonstrate that impacts from the INL are low and consistent with the emissions reported in annual INL radionuclide NESHAP reports. DOE contractors' ambient air monitoring data are reported annually in the Annual Site Environmental Reports which are available at the ESER program's website. DEQ's INL Oversight Program Annual Reports are available at DEQ's INL Oversight Monitoring Program website. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that

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		indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
65	The INL has continued to release radionuclides to the air within 50 miles of the lab with radionuclides including iodine-131, iodine-129, americium-241, strontium-90, cobalt-60, plutonium-238, plutonium-239, ruthenium-103, cesium-134 and cesium-137 and many others. And while doing so, has continued to insinuate that all the radionuclides are from former nuclear weapons testing or some other mysterious source. A study published in 1988 found the mallard ducks near the ATR Complex percolation ponds at the Idaho National Laboratory to be full of transuranic radionuclides including plutonium-238, plutonium-239, plutonium-240, americium- 241, curium-242 and curium-244. 11 An employee who I knew had the habit of jogging around the radioactive waste ponds at lunchtime. He died of liver cancer in his 50s. This health-conscious non-smoker was told, like the rest of us, that the radioactivity in the ponds was mainly tritium and was of no health concern what-so-ever.	The annual INL radionuclide NESHAP reports are available to the public as are INL Annual Site Environmental Reports where emissions are presented by radionuclide and facility. Each regulated INL Site facility determines airborne effluent concentrations from its regulated emission sources as required under state and federal regulations. Ambient air monitoring performed by DOE's INL Management and Operations (M&O) contractor; DOE's INL Environmental Surveillance, Education, and Research Program (ESER) contractor (independent from the M&O contractor); and the Idaho Department of Environmental Quality (DEQ) INL Oversight Program demonstrate that impacts from the INL are low and consistent with the emissions reported in annual INL radionuclide NESHAP reports. DOE contractors' ambient air monitoring data are reported annually in the Annual Site Environmental Reports which are available at the ESER program's website. DEQ's INL Oversight Program Annual Reports are available at DEQ's INL Oversight Monitoring Program website. All discharges to the ATR Complex Evaporation Pond are sampled. This includes any incidental discharges to the pond. The sample results are used to develop a radioactive source term that is used in air dispersion modeling to calculate an offsite dose resulting from discharges. The air dispersion and dose modeling are performed and reported in accordance with EPA requirements contained in 40 CFR 61, Subpart H and Appendix D. Radioactively contaminated soil was found outside the contamination area boundary on the berm of the Evaporation Pond as reported in the 2016 ASER report. The contaminated soil was evaluated under CERCLA 302.4 against isotopic-specific reportable quantities. In accordance with accepted practices for contaminants at the detected levels, a soil cap of at least 30 centimeters of soil was added over the area where the contaminants were found. Upon the end of the useful life of the ATR Evaporation Pond, the facility will be cleaned up and closed in accordance with applicable regulations.

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66	The stated radionuclide releases from the Idaho National Laboratory to air have often been incomplete or underestimated the releases. The stated "effective dose equivalent" whole body dose has been a fictional fraction of a millirem.	DOE disagrees that radionuclide releases from the Idaho National Laboratory to air have often been incomplete or underestimated the releases. The calculated or estimated emissions in the annual INL radionuclide NESHAP reports are greater than measured emissions. The emissions in the annual NESHAP reports are based on the methodology in 40 CFR 61, Appendix D with EPA approved allowances to account for heating. In the absence of emission measurements, this methodology (or similar) must be used because it results in more conservative emission estimates. In addition, annual INL radiological NESHAP dose calculations and the dose calculations presented in the EA for the MARVEL microreactor are compliant with 40 CFR 61, Subpart H (NESHAP) requirements. This regulation requires the model used to predict dose use a 100-year period for emission, deposition and build-up of radionuclides in soil. It is unlikely that current radiological emission sources at the INL will operate for 100 years, especially the MARVEL microreactor which is expected to operate only a few years.
67	The INL releases tons of volatile organic compounds with chlorine compounds to the air, such as the vapor extraction of carbon tetrachloride from buried Rocky Flats waste at the INL's Radioactive Waste Management Complex. A few years ago, EPA monitoring found high levels of carbon tetrachloride in Idaho Falls air. This emission is said to be within federal guidelines, but because chlorine compounds are so unhealthy for the thyroid, the prevalent chemical toxins that are released by the INL that are not even discussed in its environmental monitoring reports may need to be considered in light of elevated thyroid cancer incidence rates near the INL.	Each regulated INL Site facility determines airborne effluent concentrations from its regulated emission sources as required under state and federal regulations. Ambient air monitoring performed by DOE's INL Management and Operations (M&O) contractor; DOE's INL Environmental Surveillance, Education, and Research Program (ESER) contractor (independent from the M&O contractor); and the Idaho Department of Environmental Quality (DEQ) INL Oversight Program demonstrate that impacts from the INL are low and consistent with the emissions reported in annual INL radionuclide NESHAP reports. DOE contractors' ambient air monitoring data are reported annually in the Annual Site Environmental Reports which are available at the ESER program's website. DEQ's INL Oversight Program Annual Reports are available at DEQ's INL Oversight Monitoring Program website. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.

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68	The radiation dose reconstruction analysts for the Center for Disease Control, who determine eligibility for the Energy Employee Occupational Illness Compensation Program (EEOICP) continue to ignore what went on and what is still going on at INL facilities, particularly the ATR Complex formerly known as the Test Reactor Area. The radiation dose reconstruction has continued to pretend that the fuel composition of the operating reactors and lack of fuel melt in these reactors means that workers were not exposed to airborne contamination. The CDC need only look at the radionuclides in the ducks. The levels of transuranics including americium-241 and curium in the air at the ATR Complex and other facilities at the INL are sometimes extensive	The purpose of this EA is to assess the environmental impacts of the proposed action. DOE acknowledges your comment but notes they are outside the scope of this analysis.
69	The extensive airborne concentrations of americium-241 at the INL may be important to the underestimation of thyroid doses and risks of thyroid cancer incidence.	Please refer to the response to comment #64.
70	The EA fails to address the inadequate and actually fraudulent environmental monitoring by its contractors, including the annual environmental surveillance report contractor, which incorrectly attributes americium-241 from the INL to past nuclear weapons testing.	Please refer to response to comment #54. The INL Site environmental surveillance programs collect and analyze samples or direct measurements of air, water, soil, biota, and agricultural products from the INL Site and off-Site locations in accordance with DOE Order 458.1, *Radiation Protection of the Public and the Environment*; DOEHDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*, and DOE-STD-1196-2011, *Derived Concentration Technical Standard*. The programs meet or exceed requirements within these governing documents and have been determined through technical review to effectively characterize levels and extent of radiological constituents in the environment and distinguish INL Site-related contributions from those typically found in the environment at background levels. The air sampling network covers a 9,000 square mile area in southeast Idaho and Jackson, Wyoming, with over 2,000 samples collected each year and analyzed for key radiological constituents associated with INL Site operations. Results are published annually in the INL Site Environmental Report (http://idahoeser.com/Publications_surveillance.htm).

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71	The EA fails to address the rather short-lived radionuclides produced in nuclear reactors that were found in marmot tissue as far away as Pocatello Idaho which cannot have come from past weapons testing or radioactive disposal activities such as importation of radioactive waste via train car past Pocatello to US Ecology Grandview Idaho.	DOE evaluated the potential impacts to human health and the environment from the MARVEL microreactor project and the cumulative impact from past, present, and reasonably foreseeable future actions and found effectively no increase in cumulative impacts to the public or collocated workers from radioactive air emissions during normal operations, as discussed in Sections 3.2.1 and 3.9.1 of the EA. The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
72	The EA ignores the past radiological releases, their resuspension and buildup in the environment.	DOE evaluated the potential impacts to human health and the environment from the MARVEL microreactor project and the cumulative impact from past, present, and reasonably foreseeable future actions and found effectively no increase in cumulative impacts to the public or collocated workers from radioactive air emissions during normal operations, as discussed in Sections 3.2.1 and 3.9.1 of the EA.
73	The INL's EBR-II fuel is the feedstock for its high-assay low-enriched uranium (HALEU), DOE/EA-2087, being pyroprocessed at INL's Materials and Fuels Complex and increasing the radiological airborne emissions from the INL 170-fold, see Table 3.	Please refer to the response to comment # 60 regarding releases from HALEU production and the Radiological Response Training Range and National Security Test Range. The table to which the commenter refers is from DOE/EA-2063 for the Radiological Response Training Range and National Security Test Range. Radiation levels are not increasing by a factor of 170. Please refer to Table 35 of DOE/EA-2063 which shows the estimated annual air dose from all current and reasonably foreseeable future actions at the INL Site at the time DOE/EA-2063 was completed was estimated to be 1.78 mrem, which is roughly a third of the dose an individual receives during a trans-oceanic flight. Also, the DOE/EA-2063 notes in Section 4.1.1, at NSTR the maximum 95th percentile dose for a public receptor is 0.0417 mrem/year, which is about 1/239th the regulatory limit of 10 mrem/year and the maximum 95th percentile dose for a worker is 0.0644 mrem/year (less than 1/77,000th the federal limit of 5,000 mrem/year). At RRTR, the NTR maximum 95th percentile dose for a public receptor is 0.0482 mrem/year, which is less than 1/207th the regulatory limit, and the STR is 3.43E-04 mrem/year, which is also much less than the regulatory limit. The maximum 95th percentile doses for workers are about the same for the NTR (i.e., 0.605 mrem/year) and STR (i.e., 0.594 mrem/year). These doses are less than 1/8200th of the federal worker dose limit of 5,000 mrem/year.

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		DOE evaluated the potential impacts to human health and the environment from the MARVEL microreactor project and the cumulative impact from past, present, and reasonably foreseeable future actions and found effectively no increase in cumulative impacts to the public or collocated workers from radioactive air emissions during normal operations, as discussed in Sections 3.2.1 and 3.9.1 of the EA.
74	The EA cumulative impacts evaluation is arbitrary and misleading and fails to address the buildup of radionuclides in our air, water and soil and fails to acknowledge the inadequacy of the environmental surveillance programs.	Please refer to the response to comment #72.
75	The EA ignores many the ongoing radiological releases including the decision by the U.S. Department of Energy to allow the DOE to release long-lived radionuclides to air and soil at the Idaho National Laboratory, from the Expanding Capabilities at the National Security Test Range and the Radiological Response Training Range at Idaho National Laboratory (DOE/EA-2063).	Please refer to the response to comments #60 and #72.
76	The EA fails to address the existing contamination levels in communities and drinking water. The draft EA fails to acknowledge that current INL radiological airborne monitoring is woefully inadequate because (1) emissions from the INL are usually based on estimates and not the reality, (2) the current environmental monitoring programs are designed to be inadequate, (3) the reports are tardy by nearly a year and are increasingly tardy, and (4) the quarterly and annual environmental monitoring reports are not reliable and are prone to "lost samples" or "air monitor not functioning" excuses.	The INL Site environmental surveillance programs collect and analyze samples or direct measurements of air, water, soil, biota, and agricultural products from the INL Site and off-Site locations in accordance with DOE Order 458.1, *Radiation Protection of the Public and the Environment*; DOEHDBK-1216-2015, E*nvironmental Radiological Effluent Monitoring and Environmental Surveillance*, and DOE-STD-1196-2011, *Derived Concentration Technical Standard*. The programs meet or exceed requirements within these governing documents and have been determined through technical review to effectively characterize levels and extent of radiological constituents in the environment and distinguish INL Site-related contributions from those typically found in the environment at background levels. The air sampling network covers a 9,000 square mile area in southeast Idaho and Jackson, Wyoming, with over 2,000 samples collected each year and analyzed for key radiological constituents associated with INL Site operations. In addition, radiological emissions from all INL facilities are measured or calculated in accordance with 40 CFR 61 Subpart H *National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities* (Subpart H - NESHAP) requirements. Emissions from radionuclide emissions sources are required

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		by Subpart H to be calculated in accordance 40 CFR 61 Appendix D Methods for Estimating Radionuclide Emissions or other procedure for which EPA has granted prior approval. Because individual radiological impacts to the public surrounding the INL Site remain too small to be measured by available monitoring techniques, the dose to the public from INL Site operations is calculated using the reported amounts of radionuclides released from INL Site facilities and EPA approved air dispersion codes. Compliance to Subpart H of 40 CFR 615 is demonstrated primarily using the CAP 88 computer code. EPA requires using the CAP 88 computer code. CAP 88 uses dose and risk tables developed by the EPA. Yearly wind statistics are generated for many of the towers in the INL Site meteorological network; these are used to run the CAP 88 plume dispersion code required for NESHAP compliance. DOE integrates applicable QA requirements into the INL Site monitoring program plans and procedures. The program plans address the QA elements as stated in ANSI/ASQC E4-1994, *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Technology Programs* (e-standard, U.S. Environmental Protection Agency, current version) to verify that the required standards of data quality are met. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impact analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
77	The EA fails to truthfully discuss the multitude of INL CERCLA cleanup sites that cannot be released in 2095, as it goes about creating more CERCLA sites at the INL.	The proposed action will not create additional CERCLA sites at the INL Site. DOE remains committed to its cleanup obligations, permit requirements for active facilities, and safe and effective management of nuclear materials.
78	DOE expects to continue increasing the “normal background” radiation levels both on and off the Idaho National Laboratory site until our communities all receive unhealthy levels of radionuclide ingestion and inhalation.	The EA acknowledges the annual dose to an individual from INL Site operations is several orders of magnitude less than the average dose of 383 mrem per year from exposure to natural background radiation (e.g., cosmic gamma, internal, and terrestrial radiation) for someone living on the Snake River Plain (VNS Federal Services, 2019). DOE evaluated the potential impacts to human health and the environment from the MARVEL microreactor project and the cumulative impact from past, present, and reasonably foreseeable future actions and found effectively no increase in cumulative impacts to the public or collocated workers from radioactive

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		air emissions during normal operations, as discussed in Sections 3.2.1 and 3.9.1 of the EA.
79	"Normal background levels" are already elevated above what was naturally occurring and continue to rise. By selecting a contaminated area to determine "normal background," it appears to me that this is how some radiological facilities can claim to operate within "normal expected background" no matter what radiological release incident just occurred.	Please see response to comment #78.
80	The DOE continues to not disclose what it considers "normal background levels" on and off the INL or to trend how the "normal background levels" have changed over time.	Please see response to comment #78. Section 3.9 of the EA discusses how DOE monitors radiation in the environment and exposure of workers and calculates the radiation doses of members of the offsite general public and onsite workers from operation of the INL Site. DOE evaluated the potential impacts to human health and the environment from the MARVEL microreactor project and the cumulative impact from past, present, and reasonably foreseeable future actions and found effectively no increase in cumulative impacts to the public or collocated workers from radioactive air emissions during normal operations, as discussed in Sections 3.2.1 and 3.9.1 of the EA.
81	The EA fails to acknowledge that the DOE's allowable radiation level of 100 mrem/yr would devastate public health	Worker and public safety are DOE's highest priority. The operations proposed in the EA would be performed in full compliance with DOE Order 458.1, *Radiation Protection of the Public and the Environment*, and 10 CFR Part 835, *Occupational Radiation Protection*. The DOE dose limits for off-site members of the public are based on well-established principles of radiation protection and were developed based on guidance from national and international scientific groups and government agencies, such as the International Commission on Radiological Protection (ICRP), the National Council on Radiation Protection and Measurements (NCRP), the U.S. Environmental Protection Agency (EPA), and in consideration of the latest available scientific information regarding the biology and physics of radiation exposure. For individual members of the public, the ICRP (2007) has recommended a limit on dose equivalent from all man-made sources of 100 mrem per year, and this dose limit is specified in radiation protection standards for the public established and codified by DOE. Reductions in dose limits would be subject to federal rulemaking procedures. The purpose of this EA is to assess the environmental impacts of the proposed action. Evaluating regulatory limits, internationally accepted guidance, and standard modeling is outside the scope of this analysis.

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82	By no means is the DOE's 100 mrem/yr dose limit to the public protective of human health.	Please see response to comment #81. DOE considered the latest available scientific information on the biology and physics of radiation exposure. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impact analyses. The purpose of this EA is to assess the environmental impacts of the proposed action. Evaluating regulatory limits, internationally accepted guidance, and standard modeling is outside the scope of this analysis.
83	The EA fails to address the fact the radiation workers are still wrongly told that there is no evidence of damage to DNA or genetic effects from radiation exposure to humans.	DOE considered the latest available scientific information on the biology and physics of radiation exposure. The purpose of this EA is to assess the environmental impacts of the proposed action. Evaluating regulatory limits, internationally accepted guidance, and standard modeling is outside the scope of this analysis.
84	The EA fails to address the fact that the investigations into worker contamination at the INL historically are not complete and do find evidence of inadequate worker protection.	DOE evaluated the potential impacts to human health and the environment from the MARVEL microreactor project and the cumulative impact from past, present, and reasonably foreseeable future actions and found effectively no increase in cumulative impacts to the public or collocated workers from radioactive air emissions during normal operations, as discussed in Sections 3.2.1 and 3.9.1 of the EA. To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 mrem (5 rem) per year. In addition, worker doses must be monitored and controlled below the regulatory limit to ensure that individual doses are less than an administrative limit of 2,000 mrem (2 rem) per year DOE-STD-1098-2017, *Radiological Control* (DOE-STD-1098-2017, 2017), and maintained as low as reasonably achievable (ALARA). The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
85	The EA states that "In addition, worker doses are monitored and controlled below the regulatory limit to ensure that individual doses are less than an INL administrative limit of 700 millirem per year." The EA needs to point out that whenever staying below 700 mrem/yr is inconvenient, they will go over this	DOE takes its responsibility for the safety and health of the workers seriously. Radiation worker doses at INL are maintained well below limits required by regulations. The regulatory limit is based on recommendations provided by the International Commission on Radiation Protection publications and other independent and peer reviewed documents and in consideration of the latest available scientific information of the biology and physics of radiation exposure. INL monitors worker doses and takes appropriate action to

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	dose. The fact is if that the Department of Energy wants to claim its limit is 700 mrem/yr and not the current 5000 mrem/yr, then the DOE needs to change the federal limit to 700 mrem/yr.	limit individual worker doses below the administrative limit of 700 millirem per year.
86	DOE and the CDC still not disclosing the full extent of historical releases, including the magnitude of the 1961 SL-1 release which affected communities including Atomic City and Mud Lake.	DOE evaluated the potential impacts to human health and the environment from the MARVEL microreactor project and the cumulative impact from past, present, and reasonably foreseeable future actions and found effectively no increase in cumulative impacts to the public or collocated workers from radioactive air emissions during normal operations, as discussed in Sections 3.2.1 and 3.9.1 of the EA. The INL Site environmental surveillance programs collect and analyze samples or direct measurements of air, water, soil, biota, and agricultural products from the INL Site and off-Site locations in accordance with DOE Order 458.1, *Radiation Protection of the Public and the Environment*. The purpose of DOE Order 458.1 is to establish requirements to protect the public and the environment against undue risk from radiation associated with radiological activities conducted under the control of DOE pursuant to the Atomic Energy Act of 1954, as amended. Monitoring activities are performed to generate measurement based estimates of the amounts or concentrations of contaminants in the environment. Measurements are performed by sampling and laboratory analysis or by "in place" measurement of contaminants in environmental media. The INL Site environmental surveillance programs collect and analyze samples or direct measurements of air, water, soil, biota, and agricultural products from the INL Site and off-Site locations in accordance with DOE Order 458.1, *Radiation Protection of the Public and the Environment*, DOEHDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*, and DOE-STD-1196-2011, *Derived Concentration Technical Standard*. The programs meet or exceed requirements within these governing documents and have been determined through technical review to effectively characterize levels and extent of radiological constituents in the environment and distinguish INL Site-related contributions from those typically found in the environment at background levels. Monitoring performed by DOE's INL Management and Operations (M&O) contractor; DOE's INL Environmental Surveillance, Education, and Research Program (ESER) contractor (independent from the M&O contractor); and the Idaho Department of Environmental Quality (DEQ) INL Oversight Program demonstrate that impacts from the INL are low and consistent with the emissions reported in annual INL radionuclide NESHAP reports.

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		The purpose of this EA is to assess the environmental impacts of the proposed action. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
87	The EA fails to acknowledge that the DOE has a record of not being transparent and usually fails to publish the public comment submittals it receives.	The public process for previous DOE proposals is outside the scope of this analysis. The commenter's comments to DOE NEPA evaluations have been published, in full, in DOE/EA-2087 (2019) and DOE/EA-2063 (2019).

The SHOSHONE-BANNOCK TRIBES

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February 1, 2021

Mr. Robert Boston
c/o Mr. Garrett Kropp
U.S. DOE-Idaho Operations Office
1955 Fremont Ave.
Idaho Falls, ID 83415-1222

Submitted via email: marvel@id.doe.gov

RE: Comments on the Draft Environmental Assessment for the Microreactor Applications Research, Validation, and Evaluation (MARVEL) Project at Idaho National Laboratory (DOE/EA-2146)

Dear Mr. Boston:

The Shoshone-Bannock Tribes (SBT) provide this letter in response to DOE's notice of public comment on the MARVEL Project (Project) Draft Environmental Assessment (DOE/EA-2146) (Draft EA). The SBT's aboriginal and treaty territory includes the Idaho National Laboratory (INL) where the Project is planned for development, and we thus have significant rights, resources, and interests impacted by the planned Project. The Draft EA states that this Project is for research and development purposes, would be a relatively small-scale advanced nuclear reactor project, and by design incorporates advanced safety features. While that may be, we have a number of concerns about this Draft EA and its potential environmental impacts that must be considered and addressed.

1. The DOE provided no assessment of potential impacts from the shipment and transport of potential TRIGA-fabricated fuel, which undermines fundamental objectives of NEPA. [124]

The Draft EA states that the preferred location for fuel fabrication is at the MFC Experimental Fuels Facility at INL, while the second option is TRIGA International. Fuel fabrication at TRIGA would require shipment of nuclear fuel to INL from France, likely requiring both marine and land transport. Such shipments would cross the Fort Hall Reservation by interstate highway or rail. As the EA states, TRIGA would do "about six shipments." But this option is not even evaluated in the Draft EA. Instead, DOE referenced a 43-year-old Final

Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes (NUREG-1070), which is sweepingly general and inadequate in its assessments. It does not, for example, examine any potential impacts on specific transportation routes or routes across the Fort Hall Reservation. The result is that the potential environmental impacts from shipments and transportation along specific routes has not been evaluated. This undermines our ability to be fully informed of potential impacts and to have a full and fair opportunity to comment on those impacts (or to participate in the decision-making process). These are fundamental objectives of NEPA, and they should not be cast aside for the sake of expediency.

2. The use of TRIGA fuel should have been analyzed as a separate alternative. [125]

In this MARVEL Project Draft EA, DOE analyzed the Proposed Action and the No Action Alternative. Even though DOE identified that TRIGA fuel may be used for the Project, which would undoubtedly result in a collection of nondisclosed impacts, no analysis or comparison of impacts was assessed for this TRIGA fuel issue. The proper place for that analysis is as a separate alternative, such that there would be a total of three alternatives: Alternative 1 as the Proposed Action with fuel fabrication at INL; Alternative 2 as the Proposed Action but with TRIGA fuel; and Alternative 3 as the No Action Alternative. Surprisingly, DOE does not appear to have even considered analyzing the use of TRIGA fuel as a separate alternative, as evidenced in Table 4 of the Draft EA. The analysis of alternatives is the very heart of NEPA, and we recommend that the DOE modify this Draft EA to meet the NEPA requirement to properly evaluate reasonable alternatives.

3. The Draft EA failed to disclose details on estimated air emissions. [126]

Under Section 3.2.1 of the Draft EA, DOE states: "The MARVEL microreactor has the potential to generate minor amounts of toxic air pollutants and to generate radionuclide air emissions." Throughout this section, DOE largely holds back from providing any specific, detailed information on the actual estimates of air emissions. One exception is emission of radionuclides: "25 ml of Ar-39 (1.5 curies) and 2.55×10^{-5} ml of Ar-41 (1.96 curies) would be produced over the life of the reactor." Beyond this, DOE offers no other detailed information on air emissions. In fact, specific air emissions are also largely not disclosed. For example, DOE states that there are there will be radionuclide air emissions other than Ar-39 and Ar-41, but DOE does not state what those other radionuclides are. In addition, DOE states that they expect air emissions in the form of fugitive dust, soot, smoke, PM10, reactive organic gases, and nitrogen oxides, but DOE does not provide specific details as to estimated amounts of emissions. The same is true for DOE's statement that "impacts from the MARVEL microreactor, including cumulative impacts, would be small." Rather, DOE asserts that air emissions will be in compliance with federal and state laws and air quality standards. This approach is fundamentally counter to the disclosure requirement of NEPA. Without detailed disclosure, DOE has truncated our ability to fairly review and comment on the EA, and we are thereby denied a fair opportunity to properly participate in the decision-making process. This must be remedied.

4. Concerns about waste management and spent nuclear fuel. [127]

The Draft EA disclosed specific annual generation rates of certain types of nuclear waste. For example, Low-Level Waste (LLW) from TREAT is 2.72 m^3, from MARVEL is 2.72 m^3, and from MFC is 832 m^3. The NaK primary coolant would be a major waste-generating operation, but specific amounts that will be generated and processed as waste is not clear, other than the likelihood that 61 gallons of coolant would be subject to packaging for disposition. *See* EA at 41. While MARVEL is a small project for research purposes and is not likely to produce massive amounts of waste, DOE is still required to provide detailed information on the amounts of waste. For example, DOE specified an expected 150 kg of MARVEL spent nuclear fuel to be generated. One significant component that is missing from the Draft EA's waste management and spent fuel analysis is the time frame for processing and removing the various waste streams from Idaho.

5. The DOE provided no details on cumulative impacts. [128]

The DOE also failed to provide any detail or meaningful analysis of cumulative impacts, again making sweepingly vague and generalized statements which run counter the requirements of NEPA. For example, DOE stated at page 33: "From a cumulative impact perspective, the incremental impacts of the MARVEL Project when added to past, present, and reasonably foreseeable actions at the INL Site are small." Yet, no information or details are provided to support that statement. The same is true for DOE's statement under Air Quality that cumulative impacts would be small, which is not supported by any specific or detailed information. Again, this kind of general statement fails the hard look requirement of NEPA, and it eliminates the SBT's ability to understand and evaluate actual specific impacts, review important information, and provide meaningful comments. The proper disclosure of cumulative impacts is especially important to the SBT because the continued advance of projects at INL contribute to the environmental impacts on and around INL. When we lack specific detailed information on impacts, we have no way to be informed of the compromised environmental health in the area. That also means that we are absent significant knowledge about the risks we face as people who still rely on native plants and animals for food and medicine. We ask that DOE begin to correct this major flaw in their NEPA documents now and going forward.

Lastly, we thank the DOE for giving our comments serious consideration and taking time to fully and effectively correct the issues mentioned above.

Sincerely,

Devon Boyer, Chairman
Fort Hall Business Council

cc: FHBC (7)
Chrony
Talia Martin, T/DOE Director
Larae Bill, Cultural Resources Specialist

Table A-5. DOE response to comments from The Shoshone-Bannock Tribes.

Comment ID Number	Comment	DOE Response
124	The DOE provided no assessment of potential impacts from the shipment and transport of potential TRIG A-fabricated fuel, which undermines fundamental objectives of NEPA.	Options for obtaining fresh fuel (i.e., unirradiated fuel) for the MARVEL microreactor are discussed in Section 2.1.6 of the EA. Under the INL option, INL would fabricate the fresh fuel using traditional powder metallurgy processes and laboratory equipment already in use at INL at MFC in the Experimental Fuels Facility (EFF) using the tri-arc melter and the High-Density Fuels argon glovebox. Fuel pin welding and assembly takes place in an inert glovebox in EFF. This option involves no shipping or transportation activities off the INL Site.

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		If INL cannot manufacture the fuel, TRIGA International would manufacture fresh (i.e., unirradiated) fuel for the MARVEL microreactor and ship the fuel to INL. Fresh fuel shipments will use NRC licensed and DOT approved shipping containers that comply with all applicable regulations and established operational and emergency plans and procedures governing the shipment of nuclear materials. The NRC works with DOT to set safety rules for shipping radioactive material. The DOT and the NRC shipping rules are outlined in Title 49 of the Code of Federal Regulations, parts 100 to 177. The NRC prepared the *Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes* (NUREG-0170) to analyze the effectiveness of the Commission's rules for transporting nuclear materials, including unirradiated nuclear fuel. In this EIS (NUREG-0170), the NRC considered the environmental impacts of transporting nuclear materials, including fresh fuel, pursuant to the NRC regulations, and evaluated marine transport and land based transportation over interstate highways and by rail. The Commission examined the potential impacts from these shipments and determined that they do not amount to a significant adverse impact. Radiological impacts from export and import shipments were evaluated separately and were also determined to be negligible compared to impacts from domestic shipments (Chapter 5, Section 5.7). Since the analysis performed in NUREG-0170, there have been two affirmations of the findings and the NRC continues to perform investigations using the improved tools and information available (NUREG-2125, 2014). Shipments from TRIGA international will use NRC licensed- and DOT-approved casks that comply with all applicable regulations. Impacts of these shipments are bounded by the analysis in NUREG-0170.
125	The use of TRIGA fuel should have been analyzed as a separate alternative.	DOE evaluated two alternatives for obtaining fuel for the MARVEL microreactor in Section 2.1.6 of the EA. Fuel fabrication at INL is the preferred path for obtaining the MARVEL microreactor fuel, but if INL cannot manufacture the fuel, TRIGA International would manufacture fresh fuel for the MARVEL microreactor and ship the fresh fuel to INL. The EA notes that in both procurement scenarios (i.e., INL and TRIGA International) the fuel will fall within the range

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		of U235 enrichment and uranium loading covered by NUREG-1282 (NRC, 1987). The EA addresses the differences between INL manufacturing and TRIGA manufacturing. Other than shipping fresh fuel from TRIGA International to INL as discussed in Section 2.1.6 of the EA, the environmental impacts from both options are essentially the same. DOE evaluated the impacts from both alternatives. NEPA does not require repeating this information for two alternatives when it is the same.
126	The Draft EA failed to disclose details on estimated air emissions	Impacts to air emissions are discussed in section 3.2.1 of the EA, which notes that emissions during construction are exempt from Prevention of Significant Deterioration (PSD) review because the PSD requirements are primarily for major stationary sources and specifically exempt temporary increases in these emissions. In addition, the mobile and intermittent operation of construction emission sources combined with most construction and facility modifications occurring indoors would result in dispersed concentrations of HAPs adjacent to construction activities. HAPs concentrations generated by facility modifications and fuel and worker transportation activities would not result in adverse air quality impacts. Section 3.2.1 also notes that the potential unabated radioactive air emissions on a collocated worker and offsite member of the public were assessed by Sondrup (2021) and determined to be extremely low compared to regulatory limits. Doses were calculated with CAP88-PC, a set of computer programs, databases, and associated utility programs for estimation of dose and risk from radionuclide emissions to the air. CAP88-PC is both a mature and the EPA-recommended model for demonstration of compliance with the applicable performance objective (40 CFR 61, Subpart H).

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		According to NEPA's implementing regulations, environmental impacts should be discussed in proportion to their significance, and if the impacts are not deemed significant there should be only enough discussion to show why more study is not warranted (40 CFR. § 1502.2(b)). Incorporation by reference (40 CFR. § 1500.4(j)) and integration of other environmental analyses (40 CFR. § 1500.4(k)) are additional methods that may be used to avoid redundant or repetitive discussion of issues (40 CFR § 1502.1). The EA references the *Evaluation of Impacts from Radiological Air Emissions During MARVEL Microreactor Operations* (Sondrup, 2021), and this reference is available upon request. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
127	Concerns about waste management and spent nuclear fuel	Section 3.7 of the EA includes anticipated amounts of waste to be generated as listed below: • The construction and mobilization phase of the MARVEL microreactor would generate non-radioactive electronic waste, scrap metal, and other construction-related debris. The various non-radioactive total waste volumes generated as part of the MARVEL microreactor construction and mobilization are expected to be less than 3 m^3 (90 ft^3), some of which can be recycled. • LLW may be generated during construction and would include contaminated used personal protective equipment, wipes and rags, and tools. The volumes of these various LLWs generated during this phase are expected to be less than 5 m^3 (180 ft^3). • Construction and mobilization phase waste may generate up to 8 m^3 (about 280 ft^3) of all waste types.

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		• It is expected that the waste generated during the microreactor operations phase will be limited to LLW associated with the day-to-day operations and maintenance of the MARVEL microreactor and would amount to about 2.72 m^3 (96 ft^3) per year. • For D&D of the MARVEL microreactor it is concluded that all radioactive waste generated in this phase, including the NaK primary coolant discussed in Section 2.1 of the EA. The final waste volumes will be determined through a more detailed waste management study determining radionuclides and curie contents to obtain projected dose rates for containers (Black and Grant 2021). Given the small size of the reactor and associated components and systems, additional waste volumes would be small compared to current waste volumes at INL, and these small volumes would be nearly indiscernible from current operations when combined with past, present, and reasonably foreseeable future actions. • NaK used as the primary coolant can become activated in a neutron flux with predominate activation products being short-lived. A minor amount of coolant activation products will be present due to activation of impurities in the coolant. It may be necessary to package the NaK in small containers to meet Department of Transportation (DOT) and vendor waste acceptance requirements. The treatment methods may include GeoMelt or water/steam deactivation. Primary system piping and components will need to be drained and free from NaK to be dispositioned as LLW. This LLW debris can be dispositioned using existing disposition paths. These components will also be packaged and treated using an appropriate treatment technology (GeoMelt or water/steam deactivation). Portions of the Stirling engines that are in the PCS must be demonstrated to be free of unreacted sodium or NaK and reactivity via water submersion with no hydrogen generated. The NaK-contaminated Stirling engines will be treated using GeoMelt or water/steam deactivation as

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		discussed above. The metal hazardous constituents can be treated at the same vendor as the NaK. The engines will be disposition as MLLW using existing disposition paths. Both GeoMelt and water/steam deactivation methods have been successfully demonstrated and completed at MFC and Perma-Fix in Richland, Washington. Spent Nuclear Fuel (SNF) is discussed in section 3.8. The EA states that 1) MARVEL microreactor SNF will be managed in existing INL facilities so far as the legal, regulatory, operational, and scheduling requirements for the transfer and storage of these fuels in existing facilities are met; 2) SNF debris would be securely stored with DOE's spent fuel and spent fuel debris inventory awaiting a future disposal facility, and 3) as with all SNF at present, the question of permanent disposition of SNF is directly dependent on the identification and licensing of a permanent repository for SNF in the United States. DOE prepared the EA and included all information necessary to determine the potential for significant environmental impact. DOE used state-of-the-art science, technology, and expertise to assure quality in the impacts analyses. DOE acknowledges that many different perceptions are represented in the comments received, but no comments were received that indicate any of the impact data presented in the EA should be reconsidered based on technical or scientific reasons.
128	The DOE provided no details on cumulative impacts	DOE evaluated the potential impacts to human health and the environment from the MARVEL microreactor project and the cumulative impact from past, present, and reasonably foreseeable future actions and found effectively no increase in cumulative impacts to the public or collocated workers from radioactive air emissions during normal operations, as discussed in Sections 3.2.1 and 3.9.1 of the EA. Information from which conclusions in the EA are derived was incorporated by reference in the EA. In addition, Section 3 of the EA notes that the MARVEL microreactor would not impact minority or low-income populations, ground or surface water, land use, noise, nor noticeably alter socioeconomic conditions in the seven county region around the INL Site. Because there are no impacts to these elements, cumulative impacts are not

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		anticipated. The impact of potential radioactive air emissions on terrestrial biota were assessed using RESRAD-BIOTA and a Level 1 screening analysis are documented in *The Analysis of Radiological Impacts to Terrestrial Biota in Support of the Environmental Assessment for the Microreactor Applications Research, Validation, and Evaluation (MARVEL) Microreactor at Idaho National Laboratory* (Claver & Case, 2020) and are discussed in Section 3.3.1 of the EA. Radionuclide soil concentrations around the TREAT reactor facility from potential air emissions were conservatively estimated and compared to Biota Concentration Guides (BCGs). Terrestrial BCGs are limiting concentrations of radionuclides in soil that would not cause dose rate criteria for protection of populations of terrestrial biota to be exceeded. The analysis shows that the limits established for protection of terrestrial biota would not be exceeded. The INL Site environmental surveillance programs collect and analyze samples or direct measurements of air, water, soil, biota, and agricultural products from the INL Site and off-Site locations in accordance with DOE Order 458.1, *Radiation Protection of the Public and the Environment*, DOEHDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*, and DOE-STD-1196-2011, *Derived Concentration Technical Standard*. The programs meet or exceed requirements within these governing documents and have been determined through technical review to effectively characterize levels and extent of radiological constituents in the environment and distinguish INL Site-related contributions from those typically found in the environment at background levels. The air sampling network covers a 9,000 square mile area in southeast Idaho and Jackson, Wyoming, with over 2,000 samples collected each year and analyzed for key radiological constituents associated with INL Site operations. In addition, radiological emissions from all INL facilities are measured or calculated in accordance with 40 CFR 61 Subpart H *National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities* (Subpart H - NESHAP) requirements. Agricultural products,

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		waterfowl, and game animals are sampled by the ESER contractor because of the potential transfer of radionuclides to people through food chains. Monitoring performed by DOE's INL Management and Operations (M&O) contractor; DOE's ESER contractor (independent from the M&O contractor); and the Idaho Department of Environmental Quality (DEQ) INL Oversight Program demonstrate that impacts from the INL are low and consistent with the emissions reported in annual INL radionuclide NESHAP reports. In addition, in accordance with the *Agreement in Principal between the Shoshone-Bannock Tribes and the United States Department of Energy* (2017), DOE funds and supports the maintenance and operation of an Environmental Monitoring Station ("EMS") on the Fort Hall Reservation. DOE supports the Tribes by committing Cooperative Agreement funds and other technical assistance, and supporting the partnership between the Tribes, the INL State Oversight Program, and the National Oceanic and Atmospheric Administration (NOAA). This includes the necessary accommodations to access the existing State/NOAA/INL monitoring network in accordance with DOE security requirements.