



## Department of Energy

### Idaho Operations Office

1955 Fremont Avenue  
Idaho Falls, ID 83415

**Subject:** U.S. DEPARTMENT OF ENERGY FINDING OF NO SIGNIFICANT IMPACT FOR THE ENVIRONMENTAL ASSESSMENT FOR THE MICROREACTOR APPLICATIONS RESEARCH, VALIDATION AND EVALUATION PROJECT AT IDAHO NATIONAL LABORATORY (CLN211621)

**Agency:** U.S. Department of Energy (DOE)

**Action:** Finding of No Significant Impact (FONSI)

**Summary:** The U.S. Department of Energy (DOE) prepared an Environmental Assessment (EA) to evaluate potential impacts of design and demonstration of the Microreactor Applications Research Validation and Evaluation Project (MARVEL) reactor at the north high bay of Idaho National Laboratory's (INL's) Transient Reactor Test (TREAT) facility Reactor building. The MARVEL reactor will have a power level of approximately 20-kW electric ( $kW_e$ ) and is a sodium cooled, High-Assay Low-Enriched Uranium thermal reactor design, utilizing Stirling engines to generate power.

A "No Action" alternative analysis was performed for the MARVEL reactor in the EA. Under this analysis, existing operations and activities at the INL would continue, and the MARVEL microreactor project would not be implemented. 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.

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 and gave agencies the discretion to apply them to ongoing NEPA processes (85 Fed. Reg. 137, 2020). The EA for the MARVEL microreactor was started prior to the effective date of the revised CEQ regulations, and DOE has elected to complete the EA pursuant to the CEQ regulations at 40 CFR 1508.9(b) (1978, as amended 1986 and 2005).

**Analysis:** Based on the analyses in the EA, the proposed action will not significantly affect the human environment as defined by NEPA.

The term “significantly” and the significance criteria are defined by CEQ Regulations for implementing NEPA at 40 CFR 1508.27. The significance criteria relevant to the proposed action are addressed and the applicable corresponding analyses in the EA are referenced below.

- 1.) Beneficial and adverse impacts (40 CFR 1508.27 (b)(1)):** Potential impacts to air quality, historical and cultural resources, ecological resources, soils, and public health and safety were fully analyzed. Analysis also addressed potential impacts related to hazardous materials and waste management, spent nuclear fuel, and intentionally destructive acts. The analyses demonstrated that there will be no significant impacts from implementing the proposed action.
- 2.) Public health and safety [40 CFR 1508.27 (b)(2)]:** Potential impacts to public and worker health and safety from operations were analyzed. Potential impacts from noise, exposure to chemicals, and occupational injuries are and would continue to be regulated to protect human health. The proposed action is not anticipated to adversely affect worker or public health and safety.
- 3.) Unique characteristics of the geographical area [40 CFR 1508.27 (b)(3)]:** The facility modifications and operations proposed as part of the proposed action would occur in existing facilities. The MARVEL microreactor does not require construction of new facilities or additional land use or ground disturbance. Therefore, the activity will not affect any unique characteristics of the area.
- 4.) Degree to which effects on the quality of the human environment are likely to become highly controversial [40 CFR 1508.27 (b)(4)]:** DOE used state-of-the-art scientific methods, technology, and qualified experts to assure the accuracy and quality of the impacts analyses and to provide confidence in the results of this assessment. There are no substantive technical or scientific issues related to the proposed action that are not understood, quantified, and validated. Since the impacts to the quality of the human environment were determined to be minimal, DOE proposes a Finding of No Significant Impact.
- 5.) Uncertain or unknown risks on the human environment [40 CFR 1508.27 (b)(5)]:** The risks associated with the proposed action are well-defined. Hazard evaluations are performed to support each phase of the MARVEL microreactor’s design efforts. 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 applicable to the MARVEL microreactor design. This approach provides reasonable assurance of meeting the requirements for protection of the public, worker, and environment for the MARVEL microreactor design. All resource areas were screened and carefully analyzed before critical areas were identified for detailed analysis in the EA. All analyses used accepted methodologies and input values and were based on conservative assumptions to ensure the results adequately bounded the potential impacts to human health and the environment.
- 6.) Precedent for future actions [40 CFR 1508.27 (b) (6)]:** The proposed action does not set a precedent for future action that may have significant effects or represent a decision in principle about a future consideration on the INL Site.

**7.) Cumulatively significant impacts [40 CFR 1508.27 (b) (7)]:** The calculated impacts to the critical resource areas from implementing the proposed action were individually insignificant. The additive impacts from implementing the proposed action to those manifested from past, ongoing, or reasonably foreseeable future projects or programs on and adjacent to the INL were evaluated and also determined to be insignificant.

**8.) Effect on cultural or historic resources [40 CFR 1508.27 (b) (8)]:**

The MARVEL microreactor was reviewed for cultural and archeological impacts under section 106 of the National Historic Preservation Act. Of the three historic properties present within the area of potential effect, modifications to meet the needs of the proposed action will occur only within the TREAT Reactor building. The proposed use of the storage pit and indicated modifications to the TREAT Reactor Building are consistent with the ongoing research and development activities associated with science and engineering at INL. Placing and operating the MARVEL microreactor in proximity to the TREAT Reactor will not affect the historic property. Therefore, the proposed action will have no adverse effects to historic properties.

**9.) Effect on threatened or endangered species or critical habitat [40 CFR 1508.27 (b)(9)]:** The analysis indicates no threatened or endangered species or critical habitat will be adversely impacted by the proposed action. Implementing the proposed action with identified controls will not result in any significant impacts.

**10.) Violation of Federal, State, or local law [40 CFR 1508.27 (b) (10)]:** The analysis indicates implementing the proposed action will not violate federal, state, or local laws.

**Determination:** Based upon the analysis presented in the attached EA, I have determined that the proposed action would not significantly affect the quality of the human environment. Therefore, preparation of an environmental impact statement is not required.

Attachment: Response to Public Comments on the Proposed FONSI

Issued at Idaho Falls, Idaho on this 12<sup>th</sup> day of November 2021.

**Robert D.  
Boston**

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D. Boston  
Date: 2021.11.12 08:40:10  
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Robert Boston  
Manager

Copies of the EA and FONSI are available from: Danielle Miller, Office of Communications, Idaho Operations Office, U.S. Department of Energy, 1955 Fremont Avenue, Idaho Falls, ID 83415, or by calling 208-526-5709.

For further information on the NEPA process contact: Jason Anderson, NEPA Compliance Officer, U.S. Department of Energy, 1955 Fremont Avenue, Idaho Falls, ID 83415, or by calling 208-526-0174.

## Response to Comments

This Response to Comments documents the Department of Energy's (DOE's) evaluation of comments received on the proposed Finding of No Significant Impact (FONSI) for the *Final Environmental Assessment (EA) for the Microreactor Applications Research, Validation and Evaluation (MARVEL) Project at Idaho National Laboratory* (DOE/EA-2146). The public review period for the proposed FONSI ended on July 8, 2021 and was open for 31 days. Although DOE and Council on Environmental Quality (CEQ) regulations do not require responses to comments on a proposed FONSI, DOE is providing this document to increase public involvement in the National Environmental Policy Act (NEPA) process.

DOE received several comments from interested parties and groups and considered all comments received. The following pages contain DOE's responses to comments on the proposed FONSI for the final EA. Table 1 lists the individuals from whom comments were received and the commenter's affiliation (if provided).

Table 1. List of commenters and commenter's affiliation (if any).

<b>Commenter</b>	<b>Comment ID Number</b>	<b>Affiliation</b>
Steve Rady	1	N/A
Richard Provencher	2	N/A
Adam Stein	3	The Breakthrough Institute
Tami Thatcher	4-13	N/A
John Chatburn	14	State of Idaho
Ian Cotten	15	Snake River Alliance
Natalie Houghtalen	16	ClearPath

## Individual Comment Response

DOE received seven individual responses during the public review period. Three commenters supported the proposed FONSI for the final EA, two commenters were concerned about the quality of the EA's findings and stated that an Environmental Impact Statement (EIS) should be prepared, and two comments voiced opposition to nuclear energy. This comment period addressed the proposed FONSI for the final EA. Comments focusing on the analysis in the EA are noted and references are provided to where DOE previously addressed those issues in its response to public comments in the final EA. Table 2 provides DOE's responses to comments on a comment-by-comment basis.

Table 2. Response to comments.

Date/Name	Comment ID Number	Comment	DOE Response
06/07/2021 Steve Rady	1	<p>I wanted to voice my opposition to this project. Nuclear energy is not only more expensive than renewable energy but carries with it the problems of waste fuels. These existing waste fuel treaties are apparently worthless as all the nuclear waste in Idaho that was to have been disposed of in another state is still here. Why should Idahoans trust your department or DOE for that matter after failing to honor previous environmental assessments?</p> <p>Idaho's water and air quality are going to be the main drivers for tourism in the near future and nuclear power is not in the long term best interests of this state.</p>	DOE acknowledges your comments, thank you. DOE addressed similar comments in response to public comment #123 on pages A-58 through A-59 of the final EA.
06/08/2021 Richard Provencher	2	I have reviewed the FONSI for the Marvel Microreactor dated June 7, 2021 and concur with DOE's determination. I have also reviewed all DOE's responses to public comments and believe they were responsive to the comments, were comprehensive, and adequately considered	DOE acknowledges your comments, thank you.

		the input provided. For these reasons, I concur with DOE's FONSI and recommended path forward	
06/22/2021 Adam Stein (The Breakthrough Institute)	3	<p>Dear Mr. Kropp,</p> <p>We appreciate the opportunity to comment on the Environmental Assessment of the Microreactor Applications Research, Validation and Evaluation (MARVEL) reactor. The Breakthrough Institute is an independent 501(c)(3) global research center that identifies and promotes technological solutions to environmental and human development challenges. We advocate appropriate regulation and licensing of advanced nuclear reactors to enable the commercialization of innovative and economically viable emerging nuclear technologies, which we believe to represent critical pathways to climate mitigation and deep decarbonization. The Breakthrough Institute does not receive funding from industry.</p> <p>MARVEL is small, even in terms of microreactors, with a power level of less than 100 kilowatts of electricity. The sodium-potassium cooled, thermal microreactor using High-Assay, Low-Enriched Uranium (HALEU) is similar in</p>	DOE acknowledges your comments, thank you.

		<p>design to heat pipe based microreactors currently in development. The MARVEL reactor will provide currently unavailable R&amp;D opportunities for microreactor technologies and operational experience. Flexible operations will be tested, including load-following electricity demand to complement intermittent renewable energy sources and power applications such as water purification, hydrogen production, and heat for chemical processing.</p> <p>Based on the information presented in the Environmental Assessment<sup>1</sup> the Finding of No Significant Impact has been substantiated per the regulation. The Breakthrough Institute expresses support for the continuation of the MARVEL project sited inside the Transient Reactor Test Facility at Idaho National Laboratory.</p> <p>Sincerely,</p> <p>Dr. Adam Stein Senior Analyst The Breakthrough Institute</p>	
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07/03/2021 Tami Thatcher	4 - 13	Attached is my public comment submittal on the Department of Energy's Final Environmental Assessment.  Acknowledgement of receiving my comments would be appreciated.	Ms. Thatcher's comments are printed separately below, and Table 3 lists DOE's responses by comment as applicable.
07/08/2021 John Chatburn (State of Idaho)	14	Thank you for the opportunity to provide comments on the proposed Finding of No Significant Impact and Final Environmental Assessment (EA) for a proposal to construct the Microreactor Applications Research Validation & Evaluation (MARVEL) project microreactor inside Idaho National Laboratory's (INL's) Transient Reactor Test Facility (DOE/EA-2146).The following comments were developed in coordination with the Idaho Department of Environmental Quality and the Idaho Governor's Office of Energy and Mineral Resources.  Consistent with the intent of the 1995 INL Settlement Agreement, all spent nuclear fuel (SNF) generated due to MARVEL operations must be shipped out of the State of Idaho for ultimate final disposition following temporary dry storage.  The EA should contain a statement explaining the process associated with	DOE acknowledges the comments received from the State of Idaho, thank you.  Spent nuclear fuel (SNF) would be generated under this demonstration and managed (e.g., handled, treated, packaged, stored, and transported) in compliance with regulatory and permit requirements and agreements. SNF from this demonstration would be managed along with other SNF at the site until it is placed in an interim storage facility or a permanent repository. The SNF is expected to be compatible with the acceptance criteria for any interim storage facility or permanent repository. DOE remains committed to meeting its obligations to manage and, ultimately, dispose of SNF.  Thank you for the comment on air permitting, DOE will ensure this is accounted for. For reference, air permitting at INL is accomplished through the Air Permitting Applicability Determination (APAD) process, which documents the state and federal air regulatory requirements or exemption from air permitting requirements, as applicable, for proposed activities that have the potential for air emissions. This process is required for all activities that would create a new air pollution emission source, modify a Source, or otherwise emit regulated air pollutants.



		<p>determining the applicability of state and federal air permitting requirements.</p> <p>The State of Idaho supports the U.S. Department of Energy's promotion of advanced nuclear research and the use of advanced nuclear reactor technology at the Idaho National Laboratory (INL).</p> <p>Construction and operation of the MARVEL project at INL will increase jobs in the surrounding area and have a long-term beneficial impact on the Idaho economy.</p> <p>Idaho appreciates the opportunity to submit these comments. Please feel free to contact me should you have any questions or need of clarification.</p>	<p>The APAD identifies regulated air pollutants and the regulatory requirements that apply to current, proposed, and modified INL Sources and activities. DOE evaluates this information, in conjunction with project-specific information, to determine whether a permit is required or whether an exemption applies. The APAD is kept on file for the lifetime of the Source if the APAD documents an exemption from air permitting requirements. For stationary air emission sources whose emissions do not qualify for an exemption, in accordance with 40 CFR 61.96, an Approval to Construct for radionuclides must be obtained before commencing construction. Other agency approvals may be required in accordance with 40 CFR 60, 40 CFR 61, and 40 CFR 63. After completing the APAD or receiving any necessary permits, EPA approval, or completing other appropriate agency notifications, DOE develops necessary compliance methodologies and proceeds with the proposed activity according to applicable permits and other approvals.</p>
07/08/2021 Ian Cotten (Snake River Alliance)	15	<p>It was incredibly discouraging to read through the DOE's response to the public's comments of concern in the final EA. While the DOE may have been compliant with NEPA rules, the majority of responses were copied and pasted responses and/or dismissively replied that the concerns around the proposal were out of scope for the EA.</p>	<p>DOE acknowledges your comments, thank you. DOE addressed similar comments in the response to the EA public comment period. Regarding waste management, please refer to DOE's response to public comment #34 on page A-18 through A-19 of the final EA. DOE analyzed the potential environmental impacts related to hazardous materials and waste management, spent nuclear fuel, accidents, transportation, and intentionally destructive acts.</p> <p>Regarding the impacts of fuel shipment and transport, please refer to DOE's response to public comment #124 on pages A-114 through A-115 of the final EA. Section 3.9.2 of the EA discusses the</p>

		<p>All nuclear energy produces highly dangerous, radioactive waste. The US currently has no permanent radioactive waste repository. This means that every ounce of waste produced in this and all other nuclear projects that take place at INL is destined to be stored in perpetuity at INL, which sits directly atop the Snake River Aquifer. This subsurface body of water is of critical importance to Idaho and provides drinking water to more than 300,000 people and irrigation water for our state's richest agricultural regions. Continuing to add to the waste that is stored at INL is setting us up for catastrophe.</p> <p>The EA also notes that fuel for this reactor could be sourced as far away as France. The intercontinental transport of radioactive fuel unnecessarily puts the health of the environment and every community along the transport route at risk of contamination should an accidental release occur.</p> <p>In several comments, especially focused on groundwater, DOE responses mentioned that during normal operations there would be no impact to the environment. And littered throughout the EA are mentions of how safely this reactor will operate. Of</p>	<p>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 risks associated with the proposed action are well-defined. The analyses used accepted methodologies and input values and were based on conservative assumptions to ensure the results adequately bounded the potential impacts to human health and the environment.</p>
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		<p>course, project managers with the DOE intend for this reactor to operate as planned and for there to be no impact on the environment. But putting blind faith into a technology that exists only on paper and has no real-life operating experience is a reckless way to approach assessing potential environmental impacts. The public advocated for more research to be done on potential environmental impacts that MARVEL could have on the environment in the event of an unexpected failure.</p> <p>It is also important to look at proposals like MARVEL within the larger energy landscape as we look ahead. When looking toward our collective energy future, research and development of new technologies does not happen in a bubble and cost must be considered. Every federal dollar that is spent on nuclear energy research, development, and implementation is a dollar that cannot be spent on the development of actual renewable energy sources such as wind and solar. Nuclear energy is considerably more expensive than renewables, often by orders of several magnitudes.</p>	
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		<p>All of the safety concerns listed above should be considered in scope for this project, and the fact that the DOE refused to adequately acknowledge these concerns is disheartening. At the very least, our government should be willing to do their due diligence and prepare a more comprehensive EIS that assesses the potential health and safety impacts of this proposal in more depth.</p>	
<p>707/08/2021 Natalie Houghtalen (ClearPath)</p>	<p>16</p>	<p>ClearPath is grateful for the opportunity to express our support for the construction of the Microreactor Applications Research, Validation and Evaluation Project (MARVEL) in the Transient Reactor Test (TREAT) Facility at Idaho National Laboratory (INL). We would like to encourage the U.S. Department of Energy (DOE) to continue microreactor research and development activities in close partnership with external stakeholders and end users to maximize MARVEL's value.</p> <p>The MARVEL project is a collaboration between the DOE microreactor program and the National Reactor Innovation Center (NRIC) and will result in a 100 kW-thermal microreactor. The project will offer unique experimental capabilities to refine and</p>	<p>DOE acknowledges your comments, thank you.</p>

		<p>demonstrate microreactors for power applications, such as load following and microgrids, as well as other end use applications, such as water purification, industrial heat, and hydrogen production.</p> <p>Many U.S. companies are developing microreactors, and two companies intend to deploy commercial microreactors in North America within the next five years. By leveraging the unique experimental capabilities at MARVEL, companies can verify key design attributes which will increase consumer confidence in purchasing and licensing these high capacity factor, carbon-free energy sources for a variety of end use applications. Microreactors can be assembled in a factory and are easily transportable which can lead to success domestically, and make international deployment more feasible. MARVEL will be a key element as the U.S. works to reinvigorate leadership in nuclear energy</p>	
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The following comments were received from Tami Thatcher. Please note that numbers in brackets, e.g., [4], identify the Comment ID Number listed in Table 3. Table 3 also contains DOE's response to these comments from Ms. Thatcher.

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

**Comment submittal by Tami Thatcher, due July 8, 2021.**

Send comments to [marvel@id.doe.gov](mailto:marvel@id.doe.gov)

**SUMMARY STATEMENT**

The Department of Energy has made available its Final Environmental Assessment for the Microreactor Applications Research Validation and Evaluation (MARVEL) project microreactor to be placed inside the INL's Transient Reactor Test Facility (TREAT).<sup>1</sup> An *Environmental Assessment* is a short-sheeted version of an Environmental Impact Statement and this one is laden with an unacceptably high quantity of unsubstantiated claims.

I oppose the Department of Energy's MARVEL microreactor project and recommend that the No Action Alternative which is that the MARVEL microreactor project not be implemented. The MARVEL microreactor project should not be implemented because of the cost, nuclear accident risk and nuclear waste issues posed by the project. [4]

**BACKGROUND**

According to the Department of Energy, MARVEL is a sodium-potassium (NaK) cooled, thermal microreactor with a power level of less than 100 kilowatts of electricity, although the EA states it is expected to provide only 20 kilowatts of electricity. It is important to know, however, that the Department of Energy considers anything up to 20 megawatts-thermal (or 20,000 kilowatts-thermal) to be included in the category of "microreactor" and sweeping statements are made in the EA about any "microreactor."

The program will use 150 kilograms of about 20 percent uranium-235 enrichment, with about 30 kg of uranium in 36 fuel pins. The design of the fuel and where the fuel will be made have not been determined. MARVEL's 30 kilograms (kg) or about 66 lbs of uranium-235 fuel in the reactor is significant — the rather inefficient atomic bomb dropped on Hiroshima contained only 64 kg of uranium-235.

The fuel material is to be a uranium-zirconium-hydride in stainless-steel cladding. Each fuel pin is about 38-in. long and will be sodium-bonded. MARVEL will be using

High-Assay Low-Enriched Uranium (HALEU) and use heat exchangers known as Stirling engines which are to be closed-cycle lead-bismuth heat exchangers, heated by the circulating NaK that cools the reactor.

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<sup>1</sup> Department of Energy, Final Environmental Assessment for the Microreactor Applications Research, Validation, and Evaluation (MARVEL) Project at Idaho National Laboratory, DOE/EA-2146, June 2021.  
<https://www.id.energy.gov/insideNEID/PDF/DOE%20EA-2146%20Final%20Environmental%20Assessment%20for%20the%20MARVEL%20Project%20at%20INL.pdf> and  
<https://www.id.energy.gov/insideNEID/PDF/CLN211013%20signed%20final.pdf>

The Department of Energy has stated they plan to have MARVEL operating by late 2022 or early 2023.<sup>2</sup> The costs of this boondoggle are going to be extraordinary.

#### UNIQUE, UNTESTED MARVEL FUEL [5]

The EA names two options 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.

The MARVEL microreactor fuel is supposed to use a new, undesigned fuel similar to TRIGA fuel, which according to a 2020 report, which may not perform well in accident conditions with elevated temperatures.<sup>3</sup> The INL even states that “Despite its use in previous experiments, its integrity over time under irradiation, thermal aging, and exposure to sodium need to be evaluated against MARVEL’s expected operating conditions and lifetime expectations” and “Because of the fission gas pressure, the likelihood of stress rupture needs to be evaluated.”<sup>4</sup>

Yet, the Department of Energy’s unspecified design, unspecified quality controls, and new and unique fuel for MARVEL, the Department of Energy’s Final EA makes the broad and unsubstantiated claim that: “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.”

#### MARVEL MICROREACTOR IS INHERENTLY UNSAFE [6]

The Department of Energy’s assertions about the MARVEL reactor and any microreactor being “inherently safe” are hubris and bordering on fraudulent.

Apparently, the Department of Energy has learned nothing from its past reactor accidents, particularly the Stationary Low Power Reactor 1 (SL-1) reactor accident in 1961.

A 1950s vintage documentary film by the AEC presenting the Boiling Water Reactor Experiments (BORAX) tests<sup>5</sup> states “The [BORAX] experimental reactor was built for the purpose of testing this self regulation [reactor power reduction due to steam formation] and its most important consequence—the inherent safety of the reactor. The reactor is inherently safe

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<sup>2</sup> Jess C. Gehin, Battelle Energy Alliance, Microreactor Research Development and Demonstrations at Idaho National Laboratory, INL/CON-21-61799-Revision-0, March 2021.

[https://inldigitallibrary.inl.gov/sites/STI/STI/Sort\\_33173.pdf#search=MARVEL](https://inldigitallibrary.inl.gov/sites/STI/STI/Sort_33173.pdf#search=MARVEL)

<sup>3</sup> Dennis D. Keiser, Jr. et al., Battelle Energy Alliance, LLC for the Department of Energy, *An Investigation of Liquefaction in Irradiated TRIGA Fuel Exposed to Relatively High Temperatures*, November 2020.

<https://www.osti.gov/biblio/1737565-investigation-liquefaction-irradiated-triga-fuel-exposed-relatively-high-temperatures> “The specimen tested at 1000°C still had over 75% of the cladding that was unreacted.”

<sup>4</sup> Adrian R. Wagner et al., Battelle Energy Alliance, LLC for the Department of Energy, *MARVEL Fuel System*, INL/EXT-21-61273, Rev. 1, January 2021.

[https://inldigitallibrary.inl.gov/sites/sti/sti/Sort\\_27532.pdf](https://inldigitallibrary.inl.gov/sites/sti/sti/Sort_27532.pdf)

<sup>5</sup> Borax – Safety experiment on a Boiling Water Reactor. Film produced by the Argonne National Laboratory.

Operated for the U.S. Atomic Energy Commission by the University of Chicago. circa late 1950s. The destructive BORAX-1 experiment was conducted in 1954 at the Idaho site.



against the accidental addition of any amount of excess reactivity ***which can be removed by the formation of steam before the power rises to a dangerous level.*** [Emphasis added]” The need to pay particular attention to the last caveat would be demonstrated again by the SL-1 accident that occurred at the Idaho National Laboratory due to extremely poor safety management by the Atomic Energy Commission which is now the Department of Energy.

Interestingly, many of the BORAX tests increased reactivity by dropping the water temperature in the reactor tank. Investigators of the SL-1 accident would later comment that the SL-1 accident, with water initial temperature of 90 to 100 degree F increased the peak power by a factor of 10 what it would have been had the water been at saturation temperature. <sup>6 7</sup>

The narrator in the BORAX film states: “Extension of experimental data to such a condition was considered important **even though the accidental addition of so much excess reactivity to an operating reactor has almost negligible probability. Addition of so much reactivity is not easy, for unless the ejected control rod is very large and is moved rapidly, the reactor will shut itself down** by steam formation before the desired amount of reactivity has been added. [Emphasis added]”

The safety analysis for the SL-1 did not include consideration of any accident involving melting of fuel and release of fission products, let alone destruction of the reactor from a prompt criticality achieving a total energy release of 133 MW-sec. <sup>8</sup>

<sup>9</sup>The fuel cladding of the SL-1 reactor was twice as thick as the BORAX design—and other aspects of the fuel design had made it more susceptible to reaching a prompt critical condition than the BORAX reactor. It would be determined that the SL-1 reactor needed only 2.4 percent delta-K compared with the 3.3 percent delta-K reactivity insertion for the BORAX-1 destructive test. <sup>10</sup>

It was known with the BORAX experiments that movement of a rod of sufficient reactivity worth, in a few tenths of a second, could result in increasing the reactor power so rapidly that neutron population doubling occurred in milliseconds. Such rapid power increase in the fuel from fission heated the fuel plates in the SL-1 reactor “to a point near or above melting, depending upon location in the core. In the center regions of maximum neutron flux, the fuel within the plates experienced vaporization temperatures and burst the plate cladding. Thus, the spewing of hot vaporized fuel rapidly produced steam in the surrounding water. The steam was generated at a rate far faster than could be dissipated. . .”

This is the Department of Energy's experience with claiming their reactors were ***inherently safe*** and then causing a reactor accident due to gross safety mismanagement of the poorly designed, poorly fabricated and poorly managed SL-1 reactor. The remedy for the problem was to blame the SL-1 accident was due to the deliberate act by one of the crewmen. This lie is repeated in many college-level nuclear textbooks. The stuck control rod was overlifted during an

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<sup>6</sup> *ibid.* IDO-19313, p. 151.

<sup>7</sup> *ibid.* IDO-19300. p. 132 in contrast to IDO-19313, says the temperature in the reactor vessel was 73 F based on log entries, an even worse situation for providing heat transfer to reactor fuel plates.

<sup>8</sup> *ibid.* IDO-19300, p. 170.

<sup>9</sup> *ibid.* IDO-19311. Table III-I.

<sup>10</sup> *ibid.* IDO-19311. p. IV-25.

outage and anyone who has worked over a reactor top making manual lifts knows that the overlift of a stuck control rod was basically unavoidable. That reactor's design put so much reactivity worth into one rod and had no prevention for such an accidental overlift to occur.

#### MARVEL MICROREACTOR OFFSITE DOSES UNACCEPTABLE [7]

The stated accident dose from a MARVEL accident at the site boundary 6000 meters from the facility is stated to be 0.131 rem in Table 10 and stated to be 2.65 rem in Table 11, with no explanation of the difference and each described as "the highest postulated accident consequences." The radiation dose to the public from a radiological release from a MARVEL accident is unacceptable. [8]

With the 2.65 rem dose to the offsite public from a MARVEL accident, it should be understood that recommended limits on radiation exposure to an embryo or fetus should not exceed 200 mrem to the abdomen surface (ICRP) and not exceed 50 mrem/month (NCRP).<sup>11</sup>

The radiological release from a severe accident involving the MARVEL microreactor would depend on the fuel burnup at the time of the accident as well as the type of accident. The Final EA does admit that there are numerous ways that a MARVEL reactor may have an accident and release fission products and actinides. The ways a MARVEL microreactor can have an accident that would pose a risk to southeast Idaho include a natural phenomena hazard (seismic event), a failure of the control drives to insert, and intentional sabotage. A loss of adequate cooling has been deemed not to be able to cause an accident.

The Department of Energy's Final EA does not list the radionuclides that would be released due to a MARVEL severe accident, but it would be the usual large array of fission products including strontium-90 and cesium-137 and the plutonium-238, plutonium-239, plutonium-240, plutonium-241, curium-244, neptunium-237 and americium-241. The radiological release would yield not only plume passage doses, but also chronic radiation doses from breathing and ingesting these long-lived radionuclides, which become incorporated into the body.

The 2.65 rem at the site boundary from Table 11 does not fully explain the damage to radioactively contaminated farms and vehicles, which are not financially insured for radioactive contamination. This is in no way within acceptable levels of radioactivity to the public. The EA falsely portrays the accident dose as being a one-time dose, while omitting the chronic doses from inhalation and ingestion of radionuclides that will persist in the air, soil and water after an accident.

**1. 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 EA must explain the curie amount of each radionuclide that would be released in an accident and must explain the full economic impacts of such a release. [9]**

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<sup>11</sup> Eric J. Hall, *Radiobiology for the Radiologist*, Fifth Edition, Lippincott Williams & Wilkins, 2000. Table 15.4 Summary of Recommended Dose Limits.

The EA incorrectly states that “INL maintains the necessary apparatus, equipment, and a stateoftheart 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.[10]**

#### MARVEL MICROREACTOR ACCIDENTS [11]

The EA discusses reactivity control for MARVEL using rotation of control drums but inadequate information is provided to determine the safety adequacy of this design.

In another document, it was stated that “Its reactor control systems will consist of four independent vertical control drums and a central shutdown rod.”<sup>12</sup> Nothing in the EA provides confidence in the reactivity control system safety of MARVEL.

The seismic design requirements for MARVEL remain unstated.

Seismic design category 2 of the TREAT building means that the building is vulnerable to large seismic events which would be unacceptable for a hazard category I reactor. MARVEL is stated to be less than a hazard category I reactor; however, it is erroneous to conclude that the facility is not vulnerable to seismic events.

The EA states: “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.”

This statement in the EA shows that the INL has not provided adequate seismic design criteria in place to protect Idaho from an accident. The truth of the matter is that at a likelihood greater than 1 in 100 years, a seismic event would cause failure of the building and any containers of spent nuclear fuel or the reactor. Using 150 years of seismic experience is inadequate to conclude that no impacts due to seismic events would occur.

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<sup>12</sup> Andrew Foss et al., Battelle Energy Alliance for the Department of Energy (NE), *NRIC Integrated Energy Systems Demonstration Pre-Conceptual Designs*, INL-EXT-21-61413, Rev. 1, April 2021. [https://inldigitallibrary.inl.gov/sites/sti/sti/Sort\\_27617.pdf](https://inldigitallibrary.inl.gov/sites/sti/sti/Sort_27617.pdf)  
See p. 8.

## INADEQUATE RADIATION HEALTH CONSEQUENCE DISCUSSION [12]

The final EA states: “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.”

The final EA provides an estimate of the latent cancer fatality for receiving a total lifetime dose of 1 rem, stating: “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.”

It would be far more useful to discuss the dose of the Department of Energy’s allowed 5 rem per year to an adult worker. If the worker’s career was to span 30 years, and the allowed dose were received each year, then the total radiation dose would be 5 rem times 30, or 150 rem. Then according to their accepted model, the lifetime probability of radiation-induced fatal cancer would be 0.0006 LCF/rem times 150, or 0.09 or 1 chance in about 11. The chance of severe heredity effects would be 20 percent of that, or 0.018 or about 1 chance in 56. And the increased health risk for non-cancer illnesses is simply not evaluated by the “effective dose” which uses tissue/organ weighting factors largely selected only based on the expected cancer mortality. So, the shortened life span is really not accounted for by the EA’s computations, and the Department of Energy apparently assumes that the people of Idaho don’t care about hereditary effects.

If the example uses its non-binding, discretionary 2 rem per year guidance value, that it does not enforce as a legal limit, for a worker receiving 2 rem/yr for 30 years, the radiation-induced fatal cancer would be 0.0006 LCF/rem time 2 rem times 30 years, or 0.036, or about 1 chance in 28.

I think the obvious pattern of deception in the Department of Energy’s final EA, is exemplified by the final EA’s use as an example, of 1 rem total lifetime dose causing 1 chance in 1,700 of a fatal cancer.

The Department of Energy’s repeated use antiquated terminology “Roentgen-equivalent- man” for rem leaves open for interpretation what level of absorbed dose forms the bases for the Department of Energy’s dose. A roentgen corresponds to 87.7 ergs per gram of air absorbed dose, whereas a rad corresponds to 100 ergs/gram. The EA leaves unstated whether it is still using Roentgens or whether it nows defines rem in terms of the definition of a sievert.

The latent cancer fatality risk used is a population average and the cancer fatality risk to women, children, embryos and fetuses is significantly higher than to adult men. Although not labeled as using the assumption of a low dose and low dose rate reduction factor, this assumption has not scientific basis. The latent cancer fatality uses the dose reduction factor based on the assumption that the consequences at lower doses are half of the consequences observed at higher doses, yet diverse studies have found that the dose reduction factor is not valid.



## UNSOLVED RADIOACTIVE WASTE PROBLEMS [13]

The radioactive waste management issues are unavoidable and the Department of Energy’s assertions about the radioactive waste are misleading and irresponsible. The Department of Energy asserts that it breaks no laws by creating a threat to human health and all life on Earth by continuing to make more radioactive waste and ignoring how much the problem is going to cost to solve, if the waste can actually be isolated from the biosphere for the time frame that the waste is hazardous, more than hundreds of thousands of years.

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.

Treatment of the MARVEL fuel requires using dilapidated and aging facilities at the Materials and Fuels Complex, which is already far behind in treatment of sodium bonded fuels.

The MARVEL EA relies on the existence of Yucca Mountain which has not been funded since 2010 and was never granted a license-to-construct. The Department of Energy is no closer to finding a solution to isolate spent nuclear fuel from the biosphere now than it was over 60 years ago.

Table 3. DOE response to comments from Ms. Tami Thatcher.

Comment ID Number	Comment	DOE Response
4	I oppose the Department of Energy’s MARVEL microreactor project and recommend that the No Action Alternative which is that the MARVEL microreactor project not be implemented. The MARVEL microreactor project should not be implemented because of the cost, nuclear accident	DOE acknowledges your comments, thank you.  DOE addressed similar comments in the response to the EA public comment period.

Comment ID Number	Comment	DOE Response
	risk and nuclear waste issues posed by the project.	
5	Unique, Untested MARVEL Fuel	<p>Regarding fuel, please refer to DOE's response to public comment #33 on pages A-15 through A-18 of the final EA. There is extensive physical property data for this fuel type to predict fuel performance. In addition, the analysis shows the MARVEL design has sufficient margins to safety limits. The substantive technical and scientific issues related to the proposed action are understood, quantified, and validated.</p>
6	Marvel Microreactor is inherently unsafe.	<p>Regarding comments related to SL-1, please refer to DOE's response to public comment #58 (pages A-96 through A-97) and #86 (Pages A-109 through A-110) of the final EA.</p> <p>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 risks associated with the proposed action are well-defined. 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 applicable to the MARVEL</p>

Comment ID Number	Comment	DOE Response
		<p>microreactor design. This approach provides reasonable assurance of meeting the requirements for protection of the public, worker, and environment for the MARVEL microreactor design.</p> <p>The analyses used accepted methodologies and input values and were based on conservative assumptions to ensure the results adequately bounded the potential impacts to human health and the environment.</p>
7	Marvel Microreactor Offsite Doses Unacceptable.	<p>Regarding offsite doses, please refer to DOE's response to public comment #81, 82, and 85 on pages A-107 through A-109 of the final EA. Worker and public safety are DOE's highest priority. DOE considered the latest available scientific information on the biology and physics of radiation exposure. The proposed action is not anticipated to adversely affect worker or public health and safety.</p>
8	<p>The stated accident dose from a MARVEL accident at the site boundary 6000 meters from the facility is stated to be 0.131 rem in Table 10 and stated to be 2.65 rem in Table 11, with no explanation of the difference and each described as "the highest postulated accident consequences." The radiation</p>	<p>Table 10 in the EA summarizes the dose impacts for the highest postulated accident consequences for the MARVEL microreactor. 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</p>

Comment ID Number	Comment	DOE Response
	dose to the public from a radiological release from a MARVEL accident is unacceptable.	sabotage resulting from the bounding releases from both reactors.
9	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 EA must explain the curie amount of each radionuclide that would be released in an accident and must explain the full economic impacts of such a release.	Regarding accident consequences, please refer to DOE’s response to public comment #56 on page A-95 of the final EA. DOE has documented the accident analysis for the proposed action, including potential amounts of radionuclides that could be released, in ECAR-5127, <i>Evaluation of the MARVEL Reactor Inhalation Dose Consequence</i> (Reiss 2021).
10	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.	Regarding emergency preparation, please refer to DOE’s response to public comment #55 on pages A-94 through A-95 of the final EA.
11	MARVEL Microreactor Accidents	Regarding reactivity control for MARVEL, please refer to comment #27

Comment ID Number	Comment	DOE Response
		<p>on pages A-66 through A-67 of the final EA.</p> <p>Seismic design criteria are discussed in Section 3.5, and the potential impacts from accidents are discussed in Section 3.9.2 of the EA and in the response to public comment #56 on page A-95 of the final EA. DOE evaluated 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 MARVEL microreactor in ECAR-5363, <i>MARVEL Environmental Assessment Inhalation Dose Consequence Calculations</i> (Reiss, 2021).</p> <p>The model and calculations for the reactor accident are documented in ECAR-5363, <i>MARVEL Environmental Assessment Inhalation Dose Consequence Calculations</i> (Reiss, 2021).</p> <p>The methodology for dose estimates is further detailed in (Reiss, 2021). The results from the RSAC accident consequence calculations are shown in Table 10.</p> <p>The risks associated with the proposed action are well-defined. The hazard evaluation of MARVEL microreactor events and associated operations provides reasonable assurance of meeting the requirements for protection of the public, worker, and environment for the MARVEL microreactor design.</p>

Comment ID Number	Comment	DOE Response
12	Inadequate Radiation Health Consequence Discussion.	Regarding radiation health consequences, please refer to DOE's response to public comment #62 on page A-99 of the final EA. DOE considered the latest available scientific information on the biology and physics of radiation exposure. The proposed action is not anticipated to adversely affect worker or public health and safety. DOE used state-of-the-art scientific methods, technology, and qualified experts to assure the accuracy and quality of the impacts analyses and to provide confidence in the results of the EA.
13	Unsolved Radioactive Waste Problems.	Regarding waste, please refer to DOE's responses to public comment #38 on page A-86 and #48 on pages A-90 through A-92 of the final EA. DOE analyzed the potential impacts to air quality, historical and cultural resources, ecological resources, soils, and public health and safety. The analysis addressed the potential impacts related to hazardous materials and waste management, spent nuclear fuel, and intentionally destructive acts.