

Project Title: Antares R1 Mark-0 Reactor Experiment

Project Description and Purpose:

Proposed Action

The Antares R1 Mark-0 Reactor Project at Idaho National Laboratory (INL) involves deploying and operating the Antares R1 Mark-0, a small, high-temperature heat pipe reactor configured for zero-power criticality testing. This version of the reactor is not equipped with power conversion or heat removal systems and is designed to serve as a validation platform for advanced nuclear reactor technologies. The primary objective of this project is to demonstrate the feasibility, safety, and efficiency of the reactor design under various operational conditions.

The reactor will be installed below grade level, inside a pit, on the east side of the high bay of the Sodium Components Maintenance Shop (SCMS) building MFC-793 at the INL Materials and Fuels Complex (MFC) and commissioned over a period of less than six months, followed by an operational phase lasting less than one month. The pit walls and floor will provide radial and lower axial shielding and concrete blocks will be installed across the top of the pit for additional shielding during operations. During this time, the reactor will not produce measurable thermal output, as it is limited to zero-power criticality testing. It will use High-Assay Low Enriched Uranium (HALEU) Tri-structural isotropic (TRISO) fuel.

Antares plans to use the HALEU TRISO fuel for the Antares R1 Mark-0 reactor, which is planned to be operational by July 2026. Following completion of Mark-0 activities, the fuel will be retained in storage. The Antares R1 Mark-1 reactor will utilize the same fuel and is planned to be operational in 2027. To the maximum extent practicable, the fuel will continue to be used by Antares to support both reactor projects and potentially additional future activities.

Consistent with the HALEU Agreement between Antares and Department of Energy (DOE), *“If Antares terminates this Agreement, it shall forfeit its Right-of-Use and remain liable for all accrued fees and the full cost of disposition of any used Leased Material and material held in long-term storage at an appropriate location.”* In accordance with the Other Transaction Agreement (OTA) between Antares and DOE, *“The Awardee is solely responsible for handling and disposal of any hazardous substances and wastes arising from activities under this agreement. This includes used fuel removal and management of used nuclear fuel until either a final disposition pathway is available and/or DOE assumes ownership of the used fuel through negotiations at either the Awardee site or another negotiated location.”*

Accordingly, Antares retains responsibility for the material if it is classified as used nuclear fuel and requires long-term storage.

The project will follow established safety programs and procedures to ensure safe handling of the TRISO fuel compacts, fuel assembly, reactor fueling activities, and reactor operations. In addition, to prevent any unexpected criticality event, safety features are included such as a manual SCRAM and an automatic trip function system to safely shut down the reactor.

After operations conclude, the reactor will undergo a decommissioning phase, also expected to last less than six months.

Following the cooling period, the reactor will be defueled and deconstructed where used fuel and moderator blocks will be removed, packaged into standard DOE canisters, and transferred to appropriate storage or disposal locations in accordance with all applicable federal, state, and local regulations. Additional reactor components will be characterized and managed according to their waste classification, including potential transuranic (TRU) and/or Low-Level waste. All waste streams have current disposition paths. Mixed waste is not expected. Used Nuclear Fuel (UNF) will be managed in a compliant manner by storing the UNF in an approved cask and configured to be ready for transportation. Disposition efforts will commence when a final repository path is identified. Throughout the lifecycle, safety measures such as functional containment, radiation protection, and fire protection strategies will be implemented, with further procedural and administrative controls developed as the design matures.

This document analyzes all actions necessary to perform the proposed work, including the installation, operation, and decommissioning of the Antares R1 Mark-0 reactor that is anticipated to be in the MFC-793 pit.

Operational Parameters

This section provides a summary of the anticipated components and activities associated with the implementation of the Antares R1 Mark-0 project. The project is expected to include a range of design and operational elements that support its technical, safety, and environmental objectives. These elements are described to offer a clear understanding of the project’s scope, including expected emissions, waste streams, and other relevant considerations.

The table below summarizes the key parameters and characteristics of the anticipated project. These parameters reflect the expected operational envelope for Antares R1 Mark-0 and serve as a reference for understanding the scale and nature of project activities. Should project activities evolve beyond these expectations, additional review under the National Environmental Policy Act (NEPA) may be required to ensure continued compliance with applicable environmental regulations.

Table 1 Overview of Anticipated Antares R1 Project components and Operational Parameters

**U.S. Department of Energy- Idaho Operations Office
National Environmental Policy Act
Categorical Exclusion Determination**

| Parameter | Definition | Bounding Condition |
|-----------------------------|--|--|
| Thermal Output | Maximum thermal power generated by Antares R1 reactor | The Antares R1 Mark-0 is not anticipated to produce thermal energy |
| Electrical Output | Estimate of maximum electric generator output from Antares R1 reactor | The Antares R1 Mark-0 is not anticipated to produce electricity |
| Fuel Type | Reactor Fuel type | High Assay Low-Enriched Uranium (HALEU) Tri-structural isotropic (TRISO) particle fuel |
| Fuel Enrichment | Extent to which fuel has been enriched | < 20% enrichment |
| Fuel Amount | Amount of fuel to be used over the operational life of the reactor | < 120 kg |
| Commissioning Time | Maximum time to be spent commissioning the reactor | < 6 months |
| Operational Time | Maximum time to be spent with reactor operational | < 1 month |
| Decommissioning Time | Maximum time to be spent decommissioning and disassembling the reactor | < 6 months |
| Cooldown Time | Maximum time that the reactor will sit for on-site cool down prior to defueling | 30-180 days |
| Heat Transfer | Medium and mechanism used for transfer of reactor core heat to heat sink | Not applicable — the Antares R1 Mark-0 is a zero-power criticality test reactor and does not include a heat transfer system. |
| Heat Sink | Medium and mechanism used for conversion and/or dissipation of reactor core heat | Not applicable — the reactor does not generate thermal power and does not require a heat sink or power conversion system. |
| Water Consumption | | MFC 793 is capable of delivering 10 gpm at 40 psig |

Materials and Fuels Complex

The Antares R1 Mark-0 Reactor will be located at the INL, specifically at the SCMS building MFC-793 within the MFC. This facility has been selected due to its existing infrastructure and suitability for housing the reactor.

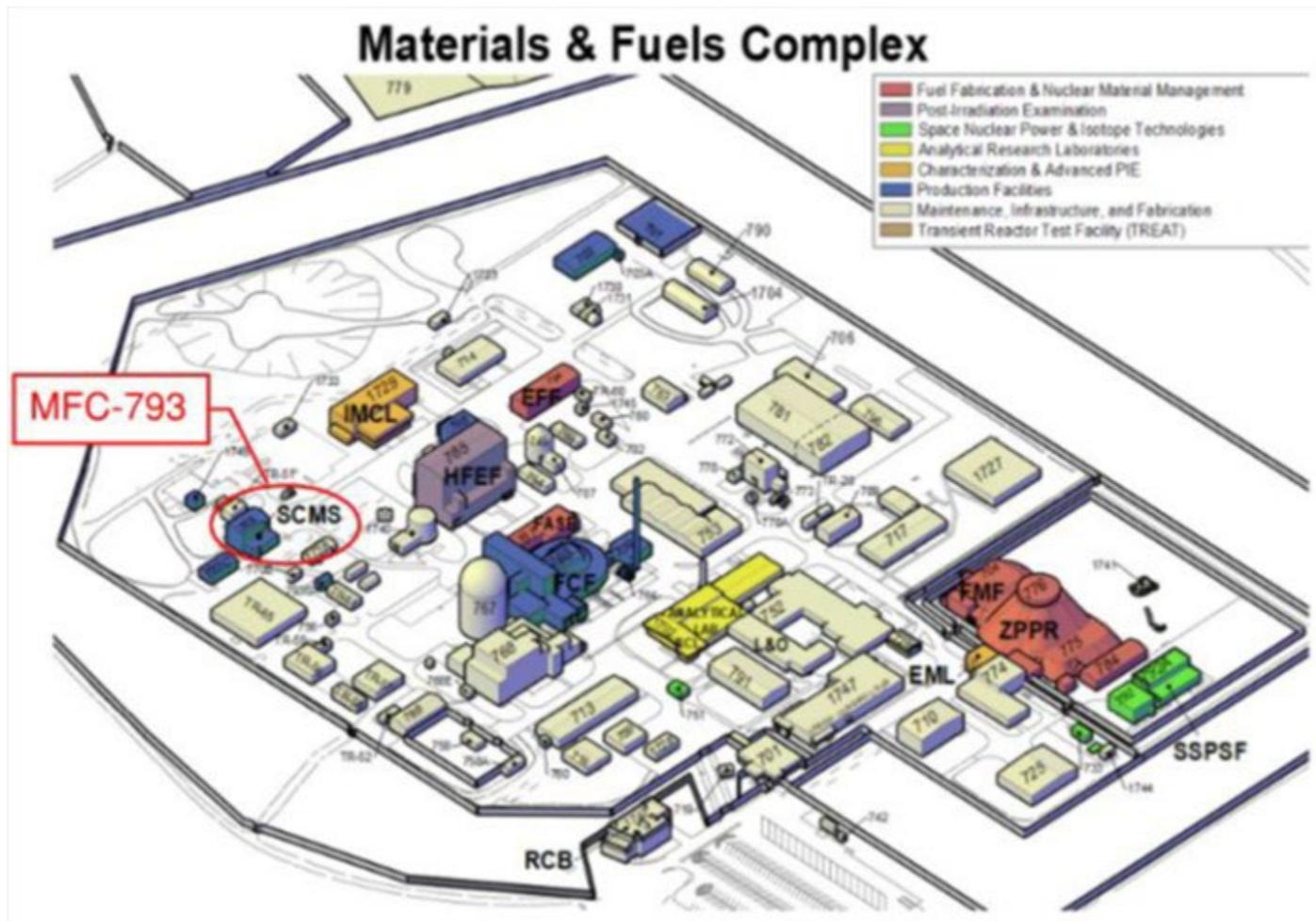


Figure 1: Sodium Cleaning and Maintenance Shop (SCMS) building MFC-793.

Sodium Components Maintenance Shop (MFC-793)

The Antares R1 Mark-0 reactor will be installed within Building MFC-793, located at the MFC. The reactor will be positioned on grade on the east side of the High Bay of the building. A temporary shield will be constructed around the reactor demonstration to provide radiation protection.

MFC-793 is a steel-framed, steel-sided facility with concrete foundations and floors. The High Bay area, which will house the reactor, measures approximately 39 feet by 64 feet and includes overhead clearance for a bridge crane with a 32-foot maximum hook height. The building also includes a south-side Equipment Annex, which contains office space, HEPA filtration, and an exhaust fan that supports ventilation for the High Bay. The High Bay will be repurposed to support reactor operations, including installation, testing, and shielding. In order to meet NDC-2 requirements, some structural modifications to Building-793 are necessary. These modifications are described in INL-25-027 R1 Antares Reactor Support R1 (MFC-793 Building Modifications to Support Reactor Demonstration).



Figure 2: CAD model of MFC-793 as it currently stands.

Environmental Aspects or Potential Sources of Impact:

Air Emissions

Prepare an APAD to identify potential air emissions and regulatory impacts

Discharging to Surface-, Storm-, or Ground Water

NA

Disturbing Cultural or Biological Resources

CULTURAL: This federal undertaking has been determined to have the potential to affect historic properties under 36 CFR 800.2. The project has been reviewed under ERPs 4546, 4658, 4673, and 4848.

With respect to this review, ERP 4673 - A Section 106 review was completed under CRMO project number (BEA-26-013) and resulted in No Historic Properties Affected. Please refer to Holds Points and Project Specific Instructions.

Generating and Managing Waste

See description of waste in Proposed Action

Releasing Contaminants

When chemicals are used during the project there is the potential for spills that could impact the environment (air, water, soil).

Using, Reusing, and Conserving Natural Resources

NA

Determination:

For Categorical Exclusions (CXs), the proposed action must not: (1) threaten a violation of applicable statutory, regulatory, or permit requirements for environmental, safety, and health, or similar requirements of Department of Energy (DOE) or Executive Orders; (2) require siting and

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construction or major expansion of waste storage, disposal, recovery, or treatment or facilities; (3) disturb hazardous substances, pollutants, contaminants, or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; (4) have the potential to cause significant impacts on environmentally sensitive resources (see 10 CFR 1021); (5) involve genetically engineered organisms, synthetic biology, governmentally designated noxious weeds, or invasive species, unless the proposed activity would be contained or confined in a manner designed and operated to prevent unauthorized release into the environment and conducted in accordance with applicable requirements, such as those listed in paragraph B(5) of 10 CFR Part 1021, Appendix B. The proposal has not been segmented to meet the definition of a categorical exclusion. Segmentation can occur when a proposal is broken down into small parts in order to avoid the appearance of significance of the total action. However, segmentation does not include proposals that are developed and potentially implemented over multiple phases where each phase results in a decision whether to proceed to the subsequent phase. There is no extraordinary circumstance related to the proposal that is likely to cause a reasonably foreseeable significant adverse effect or for which DOE does not know the environmental effect. Extraordinary circumstances are unique situations presented by specific proposals, including, but not limited to, scientific controversy about the environmental effects of the proposal; uncertain effects or effects involving unique or unknown risks; and unresolved conflicts concerning alternative uses of available resources.

References: B3.6 "Small-scale research and development, laboratory operations, and pilot projects"

Justification: For the DOE regulations regarding the application of categorical exclusions, including the full text of each categorical exclusion, see 10 CFR 1021.102 and Appendix B to 10 CFR Part 1021. Implementing guidance for categorical exclusions can be found in DOE's National Environmental Policy Act Implementing Procedures (June 30, 2025): (See full text in regulations and implementing procedures).

The proposal must fit within the classes of actions listed in Appendix B to 10 CFR Part 1021 and must satisfy the conditions that are integral elements of the classes of actions therein.

There are no extraordinary circumstances related to the proposal that may affect the significance of the environmental effects of the proposal. DOE or an applicant may modify the proposal to avoid reasonably foreseeable adverse significant effects such that the categorical exclusion would apply.

The proposal has not been segmented to meet the definition of a categorical exclusion.

B3.6 Small-scale research and development, laboratory operations, and pilot projects. Siting, construction, modification, operation, and decommissioning of facilities for small-scale research and development projects; conventional laboratory operations (such as preparation of chemical standards and sample analysis); and small-scale pilot projects (generally less than 2 years) frequently conducted to verify a concept before demonstration actions, provided that construction or modification would be within or contiguous to a previously disturbed or developed area (where active utilities and currently used roads are readily accessible). Not included in this category are demonstration actions, meaning actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment.

Approved by Jason L Anderson, DOE-ID NEPA Compliance Officer on: 1/26/2026