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Abilene Christian University
Nuclear Energy eXperimental Testing Lab
ACU Box 28208, Abilene, Texas 79699-8208
acunextlab.org

January 26, 2024

Docket No. 50-610

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: Abilene Christian University Molten Salt Research Reactor Regulatory Engagement Plan, Revision 1

Abilene Christian University submitted regulatory engagement plans for the Molten Salt Research Reactor (MSRR) in May 2022 (ML22157A033) and July 2020 (ML20241A071). The previous engagement plan included descriptions of the MSRR and plans for submission of a construction permit application. The enclosed Revision 1 includes plans for pre-application activities and submission of an operating license application for the MSRR. The engagement plan identifies anticipated licensing submittals and is intended to aid Nuclear Regulatory Commission resource and schedule planning.

This letter and the enclosed engagement plan contain no commitments. The engagement plan does not contain any proprietary or commercially sensitive information and does not need to be withheld from public disclosure in accordance with 10 CFR 2.390. If you have questions or need additional information, please contact Benjamin Beasley at Benjamin.Beasley@acu.edu.

Respectfully,

Rusty Towell

Rusty Towell, PhD
Director of NEXT Lab

Enclosure: Regulatory Engagement Plan, Revision 1

Cc: Michael Wentzel, Chief, NRR Advanced Reactor Licensing Branch 2
Richard Rivera, Project Manager, NRR Advanced Reactor Licensing Branch 2
Edward Helvenston, Project Manager, NRR Non-Power Production and Utilization Facility Licensing Branch
Mohsin Ghazali, Project Manager, NRR Advanced Reactor Licensing Branch 2

Regulatory Engagement Plan

Abilene Christian University
Molten Salt Research Reactor

Revision 1

January 2024

Prepared by:
Abilene Christian University
Nuclear Energy eXperimental Testing Lab
ACU Box 28208
Abilene, TX 79699-8208

Enclosure

Regulatory Engagement Plan

for

Abilene Christian University's
Molten Salt Research Reactor

Revision 1

Date Published: January 2024

Title: **Regulatory Engagement Plan**	***Revision Number: 1***
Approved By: Rusty Towell, Director	**Signature:** Rusty Towell

REVISION HISTORY

Rev	Date	Reason for Revision	Prepared By
	7/24/2020	Pre-Application Phase	S. Vanderslice
0	5/31/2022	Construction Permit	T. Hill
1	1/26/2024	Updated with plans for the operating license application	B. Beasley

Contents

Acronyms and Abbreviations

10 CFR	Title 10 of the Code of Federal Regulations
ACU	Abilene Christian University
AEA	Atomic Energy Act
ASME	American Society of Mechanical Engineers
CP	Construction permit
GT	Georgia Institute of Technology
MSR	Molten Salt Reactor
MSRR	Molten Salt Research Reactor
NEIMA	Nuclear Energy Innovation and Modernization Act
NEXT Lab	Nuclear Energy eXperimental Testing Lab
NRC	Nuclear Regulatory Commission
NRRA	Natura Resources Research Alliance
REP	Regulatory Engagement Plan
SERC	Science and Engineering Research Center
TAMU	Texas A&M University
UT	University of Texas at Austin

REGULATORY ENGAGEMENT PLAN

1 LICENSING HISTORY AND STATUS

Abilene Christian University (ACU) submitted an initial Regulatory Engagement Plan (REP) for the Molten Salt Research Reactor (MSRR) pre-application phase to the Nuclear Regulatory Commission (NRC) on July 24, 2020 (ML20241A071). A REP for the MSRR construction permit (CP) application was submitted on May 27, 2022 (ML22157A033). A CP application dated August 12, 2022 (ML22227A201) was submitted and the application was accepted for review on November 18, 2022 (ML22313A097).

Since acceptance of the application, the NRC staff has been reviewing the application and has opened several audits to obtain additional information. As of this writing, the NRC staff has transmitted over 300 audit questions to ACU and has held numerous audit meetings. A few major topics remain to be resolved. Those topics include ASME Code assignments to safety related components, management of reactor system degradations mechanisms, and assumptions for the maximum hypothetical accident.

This update to the REP will address activities to support the ongoing CP application review, plans to support construction inspection, and plans for operating license activities.

2 FACILITY DESCRIPTION

2.1 Abilene Christian University

ACU is an accredited non-profit educational institution that has been in operation since 1906. Fall 2023 marks the sixth consecutive year for a record number of students enrolling at ACU. ACU consistently achieves high status among 1,500 universities evaluated for the annual "U.S. News Best Colleges" edition.

The Nuclear Energy eXperimental Testing Laboratory (NEXT Lab) was established by ACU in 2015 to focus on Molten Salt Reactor (MSR) technology development and deployment. The mission of the NEXT Lab is to provide global solutions to the world's need for energy, water, and medical isotopes by advancing the technology of MSRs while educating future leaders in nuclear science and engineering.

NEXT Lab is part of the Natura Resources Research Alliance (NRRA) that includes Georgia Institute of Technology (GT), Texas A&M University (TAMU), and the University of Texas at Austin (UT). All three external collaborators have years of experience with research reactors. TAMU and UT have active research reactor licenses.

2.2 Purpose and Intended Use of the Reactor

The purpose of the MSRR is to accelerate the development and deployment of MSR

systems through foundational research while also developing a new pipeline for a nuclear qualified workforce. ACU's large capital investment in the MSRR will provide a world-class molten salt research facility that will be utilized by large numbers of students, staff, faculty, and outside collaborators. The intended use of the MSRR is to conduct research on molten salt systems, as well as to educate and train a new generation of engineers and scientists who will be uniquely prepared to contribute to the advancement and deployment of molten salt reactors and applications. The research will generate experimental MSR data to advance the understanding of:

- generation and migration of gases and vapors in a fluid-fueled fluoride reactor,
- fission product behavior, including migration through gas spaces,
- the behavior of delayed neutron precursors during normal and off-normal operating conditions,
- performance of materials in a fluoride salt environment,
- performance of materials in the combined high temperature, radiation, and salt environment,
- techniques for monitoring operation of a fluoride salt reactor, and
- fuel salt evolution during operation.

This information can be used in the design, software validation, licensing, and regulation of commercial MSRs.

2.3 Regulatory Application Type

The ACU MSRR will be a utilization facility as described in Title 10 of the Code of Federal Regulations (10 CFR), Section 50.21(c) that is useful in the conduct of research and development activities of the types specified in Section 31 of the Atomic Energy Act of 1954, as amended (AEA), and the activities will meet the 10 CFR 50.2 definition of research and development. The MSRR will not be a commercial and industrial facility as specified in paragraph (b) of 10 CFR 50.21 or in 10 CFR 50.22. Based on these activity tests and given that the proposed MSRR is not a testing facility, ACU is seeking to obtain a license under AEA Section 104c pursuant to 10 CFR 50.21(c) as a university research reactor facility with licensed power operation at up to 1 MW_{th}. ACU is aware of the changes made to Section 104c of the Atomic Energy Act (AEA) by the Nuclear Energy Innovation and Modernization Act (NEIMA) and believes that MSRR activities will be consistent with licensing under Section 104c of the AEA as amended by NEIMA.

The 10 CFR Part 50 license application intends to follow the appropriate guidance provided in:

- NUREG-1537, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors - Format and Content"
- ISG-2012, Interim Staff Guidance Augmenting NUREG-1537 Part 1 for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors
- Appendix A, "Part 1, Guidelines for Preparing and Reviewing Application for the

Licensing of Non-Power MSRs: Format and Content," of the ORNL/TM-2020/1478 report titled, "Proposed Guidance for Preparing and Reviewing a Molten Salt Non-Power Reactor Application" (ADAMS Accession No. ML20219A771)

ACU intends to embed several activities subject to different NRC requirements in the primary application in accordance with 10 CFR 50.31, "Combining Applications," and 10 CFR 50.32, "Elimination of Repetition." The application will include at least the following applicable requirements: 10 CFR Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material," 10 CFR Part 40, "Domestic Licensing of Source Material," 10 CFR 50, "Domestic Licensing of Production and Utilization Facilities," 10 CFR Part 55, "Operators' Licenses," and 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material."

2.4 Geographical Location of the Site

The MSRR will be housed inside the Science and Engineering Research Center (SERC) which is on the southeast corner of the ACU main campus in Abilene, Texas. The SERC is a 28,000-square-foot multi-level facility with space for research in chemistry, physics, and a variety of engineering disciplines. The reactor will be located below grade in a systems pit located in the SERC research bay.

3 REACTOR DESCRIPTION

3.1 General Description of the MSRR

The MSRR is a single region core, loop-type, thermal spectrum reactor with a fluoride-based fuel salt that flows through a graphite moderator and stainless steel fuel circuit components. A secondary loop with flowing fluoride-based cooling salt, designed to remove 1 MW_{th} of heat, will be used to cool the fuel circuit and expel the heat to the atmosphere. A schematic of the reactor system is provided in Figure 1. The MSRR is modeled after the 8 MW_{th} Oak Ridge National Laboratory Molten Salt Reactor Experiment and is designed to be passively safe. The MSRR relies on intrinsic properties of molten salts and engineered safety features to ensure safe and reliable operations. The reactor can be described as a series of interconnected subsystems that include fuel handling, primary salt loop, secondary cooling loop, gas management, biological shielding, and instrumentation and controls.

3.2 Safety Features/Functional Characteristics of the MSRR

There are a number of inherent safety features built into the design and materials of the MSRR. Given the low power of the reactor, the overall risk to people and the environment is limited by the small source term and the low fission product inventory. The MSRR is significantly different from the reactors licensed in the past by the NRC and has several unique safety features not found in most solid fuel systems. As an MSR, most of the inherent safety features are a result of the formulation and properties of the salts and the movement of the salts within the system.

The MSRR salts are highly ionic compounds that are chemically stable and are compatible with the MSRR structural materials. They do not react rapidly with moisture or air. Their chemical inertness eliminates the risk of fire or explosion due to chemical interaction. Molten salts have been used for years in non-nuclear industries as heat transfer media for their inertness and safety. The MSRR salts are stable to several hundred degrees above temperatures obtainable in the reactor and remain at low vapor pressure. Because the reactor is an inert liquid system at low pressure, safety demands on the MSRR design and the SERC facility are significantly reduced.

The MSRR fuel salt has a short and unobstructed path from the fuel loop to a drain tank, allowing the fuel salt to be completely drained in approximately one minute, even under power outages. The geometry and position of the drain tank ensure a noncritical configuration under all conditions when the entire fuel salt inventory is in it.

The reactor vessel is the only location where criticality can be reached and sustained in the MSRR. Unlike existing reactor types, only a fraction of the fuel participates in the sustained chain reaction at any given time, as the remainder is flowing through the rest of the primary circuit. The MSRR core is designed to have very low excess reactivity. Burned fuel can be made up through occasional fuel salt additions through an access tank. Control rods capable of controlling fission rate are also included in the MSRR design. The MSRR includes a shielding system designed to protect people and the environment from radiation.

The MSRR relies on intrinsic properties of molten salts and engineered safety functions to ensure safe and reliable operations and includes:

- Small source term (low power, low burnup)
- Very low excess reactivity
- Strongly negative reactivity coefficient
- Redundant control rods to control criticality during normal operations
- Unobstructed path for fuel salt to drain during power outage
- Passive decay heat removal from the drain tank
- Defense in depth through multiple barriers minimizes release of fission products, if any, to the public and environment
- Located in a below grade vault, under a massive shielding system, that also adds a significant layer of protection from external events

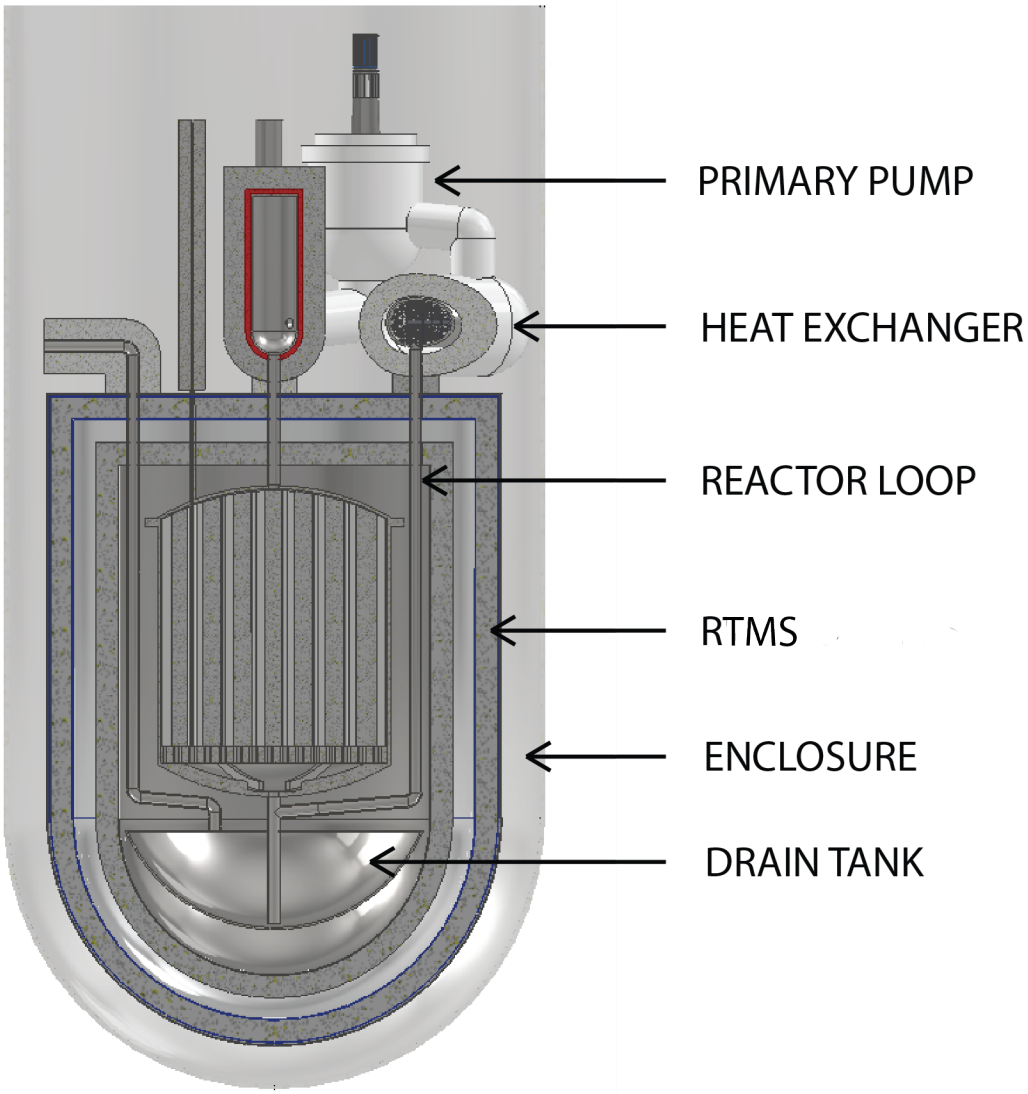

Figure 1 **Depiction of the MSRR reactor loop inside the reactor enclosure.**

4 CONSTRUCTION PERMIT ACTIVITIES

ACU will continue to support the NRC staff review of the CP application. ACU appreciates the beneficial communications that occur through the audit process. For any additional audit questions, ACU will strive to respond to the NRC within 30 days. Likewise, for any Requests for Confirmation of Information or Requests for Additional Information, ACU will strive to respond within 30 days. ACU endorses the use of regularly scheduled audit meetings and regularly scheduled project manager meetings. ACU also endorses the use of status tracking tools by both NRC and ACU and encourages the periodic synchronization of those tools. ACU has found the use of Box

and the electronic reading room as effective tools for exchanging information during audits.

ACU will review and provide comments, as appropriate, for the draft Environmental Assessment on the schedule requested. If a CP is to be prepared, ACU would appreciate the opportunity to review any proposed permit conditions. ACU will review any proposed permit conditions and respond to the NRC within 15 days. If ACU is allowed to review a draft safety evaluation or a draft permit, ACU will provide such review within 21 days or within the time requested by the NRC.

The development and implementation of the MSRR facility Quality Assurance Program for NEXT Lab began during the design phase and continues to be adopted by the MSRR project. The Program focuses on the development of appropriate controls that ensure the MSRR is properly designed, fabricated, and operated to meet regulatory and university requirements. The organizational and policy portions of the Program have been implemented. Design control is being implemented at ACU and through contractor quality assurance programs. Procurement controls will be implemented before the vendor selection process begins.

If other actions by ACU will accelerate the permitting process, the NRC is asked to identify those actions for ACU. Similarly, if other techniques or activities will improve communication, enhance the review, or expedite the process, the NRC is asked to make those suggestions.

5 OPERATING LICENSE ACTIVITIES

5.1 Pre-application Activities

If a CP is granted to ACU, construction of the long lead time reactor components is likely to begin very soon after the permit is issued. ACU would like to begin planning to support construction inspection in advance of the issuance of a permit. Because the detailed design is still being prepared, construction schedules are not yet available. Once construction schedules are developed, they will be provided to the NRC and inspection arrangements can begin.

In anticipation of receiving a CP, ACU is preparing the following documents to submit to the NRC for review. A tentative schedule for submission and review of these documents is provided in Figure 2.

- A topical report on testing and methodology for qualification of fuel salt
- A white paper on a strategy for material accounting and control
- A white paper on calculation rigor and documentation

ACU desires to submit a high-quality license application. Another pre-application activity that ACU would like to pursue is early audits of draft Final Safety Analysis Report chapters. The audits would allow NRC reviewers to provide feedback on the completeness of the information and the level of detail needed for the license

application review. ACU will be flexible in the scheduling of chapter audits to support NRC staff availability. Details on an approach can be worked out once draft chapters are being composed. ACU will contact NRC licensing staff when chapter composition schedules are mature.

5.2 Schedules

Figure 2 shows the month for anticipated submission of licensing documents and the desired review schedule. ACU will inform the NRC of any changes to the anticipated submission schedules. The key document submission dates are:

- March 2024 - White paper on material control and accounting
- March 2024 – Topical report on fuel qualification methodology
- April 2024 – White paper on calculation rigor
- December 2024 – Operating license application

Figure 2

MSRR Licensing Schedule

	Duration (months)	2023			2024												2025												2026						
		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
NRC review of construction permit																																			
Complete design and evaluate it	12																																		
OL Pre-application (NRC review)																																			
Fuel qual methodology topical	14																																		
White paper on MC&A	2																																		
White paper on calc rigor	2																																		
Operational program development	9																																		
OL application preparation	10																																		
Construction of reactor	18																																		
NRC review of license application	18																																		
Legend																																			
NRC actions are green																																			
ACU actions are purple																																			