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ABILENE CHRISTIAN UNIVERSITY

July 24, 2020

Docket Number: 99902088
Resent to DCD August, 2020

Mr. Ho Nieh
Director, Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Submittal of the NEXT Lab Molten Salt Research Reactor Licensing Regulatory Engagement Plan

Reference: Letter of Intent NL-2020-001 from Dr. Phil Schubert, President Abilene Christian University, to the NRC, dated March 20, 2020

Dear Mr. Nieh,

In the Reference letter, Abilene Christian University (ACU) NEXT Lab committed to submit a Regulatory Engagement Plan (REP) for its Molten Salt Research Reactor facility. Accordingly, this letter submits the REP covering the pre-application interactions with the NRC in support of the preparation of ACU NEXT Lab Molten Salt Research Reactor facility license application.

This REP is based on the Nuclear Energy Institute's (NEI's) technical report, "Guidelines for Development of a Regulatory Engagement Plan," NEI 18-06, Revision 0. This guidance document was prepared for use by applicants and potential applicants for advanced reactor licenses, whether a reactor developer or site applicant, and not Research Reactor facilities.

However, ACU NEXT Lab has adapted this guidance to its plans to prepare a license application for a Molten Salt Research Reactor facility that will advance the technology of molten salt reactors while educating the next generation of leaders in nuclear science and engineering.

Accordingly, only those elements of the NEI guidance document that could be applied to a Research Reactor facility were followed in preparing this REP. Those elements are reflected by the specific sections that make up the enclosed REP.

YGD1
NRR

If there are any questions or a need for additional information, please contact Dr. Rusty Towell at the address below, by telephone at (325) 674-2034, or by email at Rusty.Towell@acu.edu.

Respectfully,

Phil Schubert, Ed.D.
President

Enclosure: Regulatory Engagement Plan for Abilene Christian University's Molten Salt Research Reactor

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Regulatory Engagement Plan

(Pre-Application Phase)

Abilene Christian University's Molten Salt Research Reactor

1. Introduction/Purpose

Abilene Christian University (ACU) intends to design, license, construct and commission a Molten Salt Research Reactor (MSRR) with the purpose of advancing the technology of molten salt reactors while educating the next generation of leaders in nuclear science and engineering.

This Regulatory Engagement Plan (REP) is prepared to present aspects of the anticipated interactions with the U.S. Nuclear Regulatory Commission (NRC) during the licensing pre-application phase of the ACU MSRR Construction Permit (CP) application. The primary purpose of pre-application engagement is early identification and resolution of design and licensing issues that otherwise might adversely impact the licensing process.

This REP is based on the Nuclear Energy Institute's (NEI's) technical report, "Guidelines for Development of a Regulatory Engagement Plan," NEI 18-06, Revision 0. ACU has adapted this guidance to its plans to prepare a license application for a non-power Liquid Fueled Molten Salt Research Reactor.

1.1. Contact Information

ACU is located in Abilene, Texas, and is a privately owned non-profit educational institution, as defined in 10 CFR 170.3 and 171.5. ACU will own the MSRR and operating license. The ACU Nuclear Energy eXperimental Testing Laboratory (NEXT Lab) will complete the design, support licensing, manage construction and perform the commissioning of the reactor and the reactor facility.

Points of Contact:

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1.2. Project Structure

ACU is developing and deploying a molten salt research reactor with the purpose of significantly expanding molten salt reactor R&D infrastructure and developing a world-class educational pipeline that can broadly support US molten salt reactor design, development, deployment, and market penetration. This project will be carried out under a cooperative fuel agreement with the U.S. Department of Energy's Research Reactor Infrastructure (RRI) Program and supported through a collaboration with major U.S. Industry partners, National Laboratories, and universities for nearly all aspects of the research, design, licensing, construction, and operations. The consortium of universities includes ACU, University of Texas, Texas A&M University, and Georgia Institute of Technology.

1.3. Regulatory Strategy Application Type(s)

The ACU MSRR will be a utilization facility as described in 10 CFR 50.21(c) useful in the conduct of research and development activities of the types specified in Section 31 of the Atomic Energy Act (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 power operation at less than 1 MW_{th}. ACU is aware of the changes made to Section 104c of the 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.

Additionally, the strategic approach for the 10 CFR Part 50 license application process is intended to follow the guidance in NUREG-1537, Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors - Format and Content, that also encompasses activities regulated under different NRC requirements. 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." These activities are intended to include at least the following partial list of applicable requirements: 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," to receive, possess, use, and transfer Special Nuclear Material (SNM), 10 CFR Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material," 10 CFR Part 20, "Protection Against Radiation," 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and related functions," 10 CFR Part 55, "Operators' Licenses," and 10 CFR Part 73, "Physical Protection of Plants and Materials."

1.4. Summary Strategic Project Approach/Goals

While this project is currently in the conceptual design stage, ACU wishes to provide early notice of our plans for resource planning purposes and to begin dialogue with NRC staff to help assure the efficiency of the regulatory licensing process. It is ACU NEXT Lab's intention to provide the NRC

with as much information as is needed during the pre-application period so that the NRC will be fully informed as its review of the application begins.

We believe that a Liquid Fueled Molten Salt Reactor project, in a research reactor configuration, represents a first-of-a-kind project for the NRC. We are also intent on extending the footprint of the existing NEXT Lab to support broader research activities through construction of a new multi-use research facility on ACU property. We believe an early discussion of this research facility will improve our understanding of the regulatory intent of 10 CFR 50.10(a)(2) (x) and ensure that consensus is gained relative to the licensing path for the technology and facility. Accordingly, this presents an innovative regulatory approach with respect to the ACU 10 CFR Part 50 license application preparation and the NRC review of the license application.

ACU intends to prepare the license application in accordance with NUREG 1537 guidance. If during the pre-application process or the application preparation process ACU determines that exemptions from regulatory requirements or deviations or exceptions from guidance are called for, ACU will notify the NRC in a timely manner and initiate discussions with the appropriate NRC staff. The goal of ACU is to conduct highly informative pre-application activities and, based on feedback obtained from the NRC during the pre-application phase, submit a complete CP application that will be accepted for review by the NRC.

1.5. Background

The nuclear industry gained a degree of familiarity with Molten Salt Reactors following the June 1965 startup of the Oak Ridge National Laboratory (ORNL) Molten Salt Reactor Experiment (MSRE). The ORNL MSRE design incorporated a one region reactor with graphite moderator and circulating fuel. The moderator consisted of vertical stringers of graphite, which formed a cylindrical core within a reactor vessel. The fuel passed downward in an annulus between the graphite cylinder and the core barrel. It then flowed upward in channels formed between the stringers, out the top to a pump, through a heat exchanger, and back to the core. Exiting at nearly 663° C the fuel entered a sump-type fuel pump and was discharged through the shell side of the heat exchanger back to the core inlet. The MSRE design used light water for cooling the containment atmosphere, containment vessel, reactor shield, drain tank, primary pump, and containment penetrations. The MSRE operated for a period of four years and ORNL generated a substantial body of documents.

The ACU MSRR is a simplified version of the ORNL MSRE. Certain features of the ORNL MSRE are incorporated in the reactor design; however, because of design simplification and use of new technology there will be design differences between the ORNL MSRE and the ACU MSRR. Section 2.0 describes the intended configuration of the ACU MSRR and also several very important aspects of the design differences from the ORNL MSRE.

1.6. REP Approach

ACU plans to conduct a number of pre-application meetings that will cover unique or complex technical issues with the NRC beginning in the fourth quarter of the 2020 federal fiscal year. At this this time, the following meeting topics have been identified:

- Introductory meeting to discuss project scope and schedule,
- Environmental aspects of the facility site selection, multi-use facility and characterization,

- Licensing considerations for the use of high assay low enriched uranium (HALEU). The MSRR will use approximately 300 kg of nearly 20% enriched uranium. This discussion would include criticality, safety analysis methodology and transportation.
- Material control and fuel accounting considerations,
- Security Plan considerations, and
- Quality Assurance Program (QAP)

The meetings identified above may result in the need for additional meetings and/or submittals.

The REP will be kept current during the licensing phase and ACU will notify the NRC of any changes/revisions.

2. Technology Summary

The MSRR will be located in a multi-use research facility. The proposed MSRR can be subdivided into the following major subsystems:

1. Reactor subsystem: components within the reactor containment
2. Fuel handling subsystem: fuel salt loading/unloading, storage, and chemical processing
3. Off-gas subsystem: filters, vents, air handling units, exhaust
4. Thermal management subsystems: primary heat removal and auxiliary heat removal
5. Experimental access subsystems: components that enable access to samples
6. Instrumentation and Controls subsystems

Reactor configuration: The MSRR is a loop with a reactor vessel, a heat exchanger, a fuel pump, and experimental access points. The reactor subsystem contains the following components:

- Reactor vessel
- Reactor containment vessel
- Reactor working fluid pump
- Primary HX system
- Experimental access systems
- Drain tank
- Internal shield

The preconceptual facility lay out is shown in Figure 1.

The reactor subsystems are shown in Figure 2.

Referring to Figure 2, the reactor containment vessel is 20 feet tall and 10 feet in diameter. The reactor vessel inside the reactor containment vessel is 6 feet tall and 4.5 feet in diameter and is surrounded by a 6 inch internal concrete shield. The reactor containment vessel is located in a below grade trench within the facility. The lower reactor containment vessel head is surrounded by a small pool of water to remove decay heat under normal and accident conditions including loss of normal electrical power.

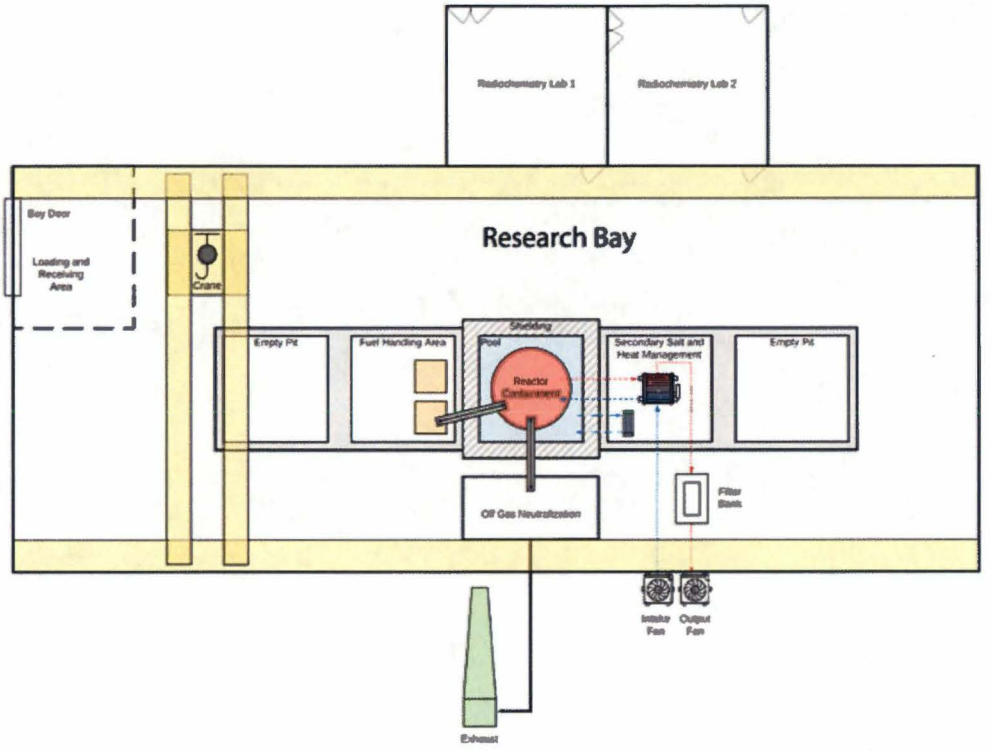

Figure 1: Shown here is a preconceptual layout of the system in a pre-existing multi-use facility research bay.

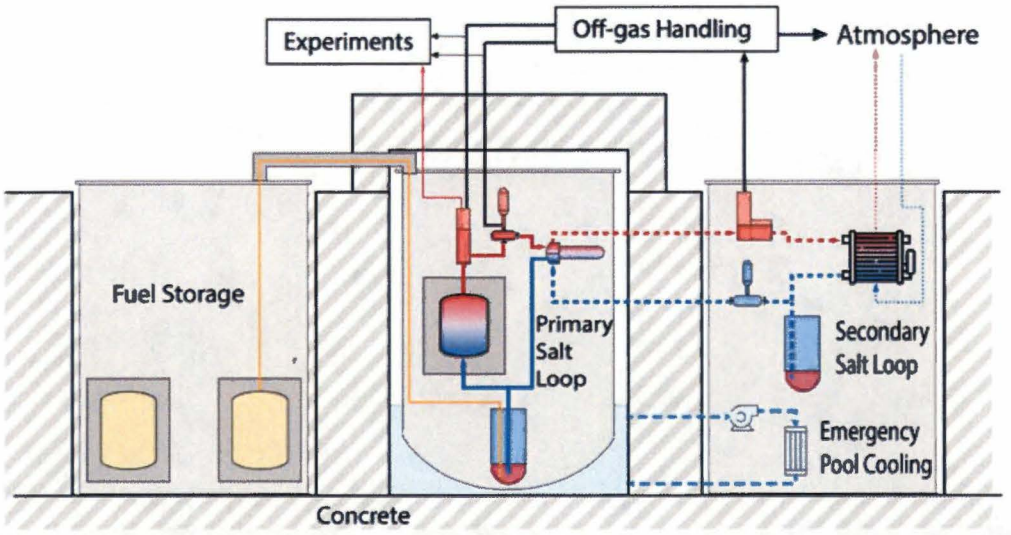

Figure 2: Shown here is a plan view of the pre-conceptual layout of the reactor system in the subterranean space of the multi-use facility research bay.

Conceptual Design Characteristic Summary

- Reactor Parameters: The MSRR design will employ a lower power density, lower reactivity coefficients, similar containment atmosphere, and lower pressure drop than the MSRE and will by similarity exhibit satisfactory safety performance. The design analysis and modeling will confirm the design basis.
- Size: The MSRR is a graphite moderated fluoride salt flowing fluid reactor designed for a thermal power of 1 MW_{th}. The reactor primary system will be configured in a loop. A secondary loop will be used to remove the reactor thermal power. The final heat sink will be air. The MSRR will have forced primary flow for full power operations.
- Fuel: The baseline fuel composition is LiF-BeF_2-UF_4. The lithium will be enriched to greater than 99.99%. HALEU (~19.9%) will be used.
- Experimental Access Points: The MSRR will have several systems for sampling the fuel salt, the salt/gas interface, and the gas effluent. Each of these systems has a prototype or a development strategy, and all potential release pathways will be evaluated. Large scale actinide extraction will not be undertaken. The extraction equipment shall be limited by design to assure only laboratory scale sample size extraction.
- Fuel handling system (FHS): The MSRR design employs Defense-In-Depth (DID) to ensure barrier protection. The FHS will be designed with physical barrier protection. Because the FHS is a supporting auxiliary system located external to the MSRR reactor containment vessel, the FHS will need its own suitably designed containment. Interfaces between the fuel handling system and the reactor will be defined in the design of systems, structures, and components. The fuel handling system is connected to the reactor subsystem through the drain tank. The FHS design prevents the possibility of establishing an alternative core configuration within the system.
- Heat Removal: Reactor power will be rejected through a heat exchange system to the atmosphere. It is anticipated that the secondary loop will be a molten salt. This loop is not necessary for decay heat removal, which is through the drain tank. Reactor containment vessel system atmosphere may be actively cooled outside the reactor containment vessel, necessitating air transport into and out of the reactor containment vessel. Cooling when the reactor containment vessel is isolated, such as during an accident, will be completely passive. The reactor containment vessel outer wall is cooled by natural circulation developed by thermal radiation, conduction, and natural circulation within the reactor containment vessel. It is anticipated that the lower portion of the reactor containment vessel will be surrounded by a pool of water at near standard temperature and pressure conditions. Water level is designed to be below the reactor containment vessel penetrations, precluding water ingress into the reactor containment vessel.
- Moderation: nuclear grade graphite blocks will be used to provide internal flow control and neutron moderation. A simplified diagram of the reactor vessel is provided below in Figure 3; the reactor vessel is 6 feet tall and 4.5 feet in diameter.

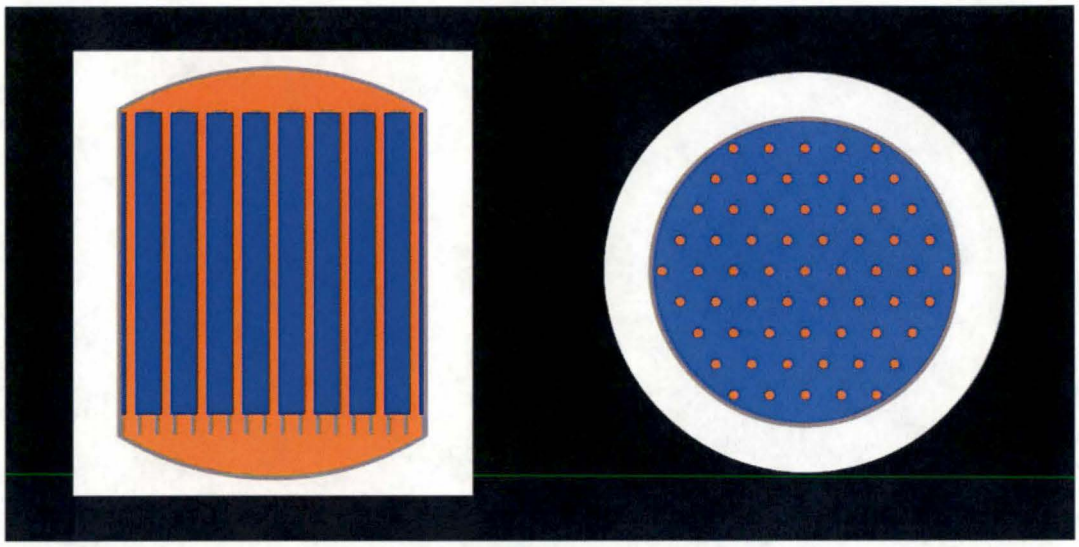

Figure 3: Shown here is the simplified preconceptual model of the core, vessel, and shield, where the graphite is blue, the fuel salt is orange, and the concrete internal shield is white.

- Reactor Containment Vessel/Research Bay Confinement: The reactor containment vessel system environment is ~90 kPa and ~60 °C which is maintained by actively moving large amounts of atmosphere into and out of the reactor containment vessel system. The primary loop is ~600 °C. All systems within the reactor containment vessel system must be coolable through natural convection and thermal radiation to the reactor containment vessel. Without water, the neutron spectrum streaming from the reactor vessel is harder (i.e. higher energy) than in a typical research reactor and could pose a radiation risk to electrical components. The reactor containment vessel/research bay confinement system design is a novel approach to radionuclide retention, and ACU intends to employ a functional radionuclide containment system.
- Fuel Cycle Considerations: The MSRR will employ a once through fuel cycle that does not preclude the extraction of very small samples (nano-sampling). The fuel will come on site premixed and ready to be loaded into the core. It will leave in the same manner. At no stage will the uranium or plutonium be separated or extracted in quantities beyond laboratory scale measurements. The extraction equipment shall be limited by design to assure only laboratory scale sample size extraction, in contrast to production facilities licensed under 10 CFR Part 50.
- Reactivity Control: Reactor protection system trip setpoints will be determined after the core design and transient modeling is complete and will consider ISA-RP67.04 "Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation" along with other appropriate guidance. The system configuration includes design redundancy and diverse actuation; two independent SCRAM systems: control rods and the drain tank pressure. Control rods enter from the reactor vessel top and are enclosed in tubes which are welded to the reactor vessel. Fuel salt is maintained in the reactor vessel by the drain tank pressure. Loss of pressure will trigger fuel draining.
- The MSRR's primary mission is to facilitate R&D while also providing an outstanding educational and research capability at ACU. The MSRR can be used to examine reactor physics and thermal hydraulics feedbacks in support of MSR development and advanced computational tools, potentially supporting NEIMA. The MSRR will provide a platform to conduct experiments pertaining to mass transfer.

3. Regulatory Strategy

3.1. Initial Activities

The first activities in the regulatory path will be preparation of the Quality Assurance Program, identify candidate sites for the facility, and development of the Emergency and Security Plans.

- Preparation of the Quality Assurance Program will be informed by the applicable elements of ANSI/ANS-15.8-1995, "Quality Assurance Program Requirements for Research Reactors." NEXT Lab intends to submit the Quality Assurance Plan (QAP) for NRC review and approval ahead of the license application submittal.
- The site selection process will comply with the applicable requirements of 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," and informed by the applicable NRC guidance in NUREG-1537, chapters 11, 13, and Chapter 19, "Environmental Review (ER)." NEXT Lab site selection will be informed by guidance from the NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) and obligations described in 10 CFR Part 51 with respect to NEPA. The result of this process will be the selection of a site for the MSRR facility that will be appropriately justified in the license application.
- The Emergency Plan (EPlan) will be developed in compliance with the applicable requirements of 10 CFR Part 50 and follow the applicable guidance in NRC Regulatory Guide 2.6, "EMERGENCY PLANNING FOR RESEARCH REACTORS." The Security Plan will be prepared in compliance with the applicable requirements of 10 CFR Part 73, "Physical Protection of Plants and Materials," and informed by the guidance in RG 5.59, "Standard Format and Content for the Licensee Physical Security Plan for the Protection of Special Nuclear Material of Moderate or Low Strategic Significance." ACU is aware that the NRC has issued post 9/11 safeguards and security guidance and therefore will work to address new or additional guidance promulgated by the NRC. A meeting between ACU and the NRC to discuss Security Plan considerations is one of the pre application topics that has been identified.

The CP application will be composed of the PSAR, including but not limited to the Environmental Report (ER) and the preliminary Emergency Plan (EPlan).

3.2. Key Issues for Early Discussion

ACU Next Lab plans to conduct a number of pre-application meetings with the NRC beginning in September 2020 that will cover unique or complex technical issues. At this time, we believe the following meeting topics will improve our understanding of the regulatory framework and licensing process, and also provide an opportunity for the NRC to become informed of the Molten Salt Research Reactor design:

- Introductory meeting to discuss project scope and schedule,
- Licensing considerations under 10 CFR 50.10 for early construction
- Material control and accounting considerations for HALEU,
- Licensing considerations for Fuel qualification with the DOE RRI program.
- Facility site selection and characterization,

- Technical Reports and Topical Reports:
- Neutronics
- Accident analysis
- Thermal hydraulics
- Fuel Characterization
- Computational tool use and qualification
- Facility site selection, and aspects requiring NEPA documentation (e.g., an environmental report). This discussion will include site security and critical infrastructure requirements.
- Technology Readiness

NEXT Lab plans to prepare a Quality Assurance Program Description (QAPD) topical report early in the application preparation process and submit it by late 2020 for NRC review and approval.

ACU recognizes that other key unique or complex issues may be identified by ACU or the NRC as the pre-application interaction proceeds. ACU intends to address any additional key issues as they arise and work with the NRC to reach a timely resolution.

3.3. Testing

ACU intends to construct and operate component test stands and an integrated test system at the selected site location for the purpose of component testing and system evaluation while maturing and optimizing the fabrication processes. The integrated test system will use electrically heated non-nuclear salt (i.e. no fuel mixed salt).

No other pre-construction full system testing is planned at this time.

3.4. NRC Review Timeframes

A preliminary Level 1 schedule is shown in Figure 4 for information. ACU plans to present its license application preparation schedule during its first meeting with the NRC. At that time, the NRC will have information upon which to base its pre-baseline review schedule.

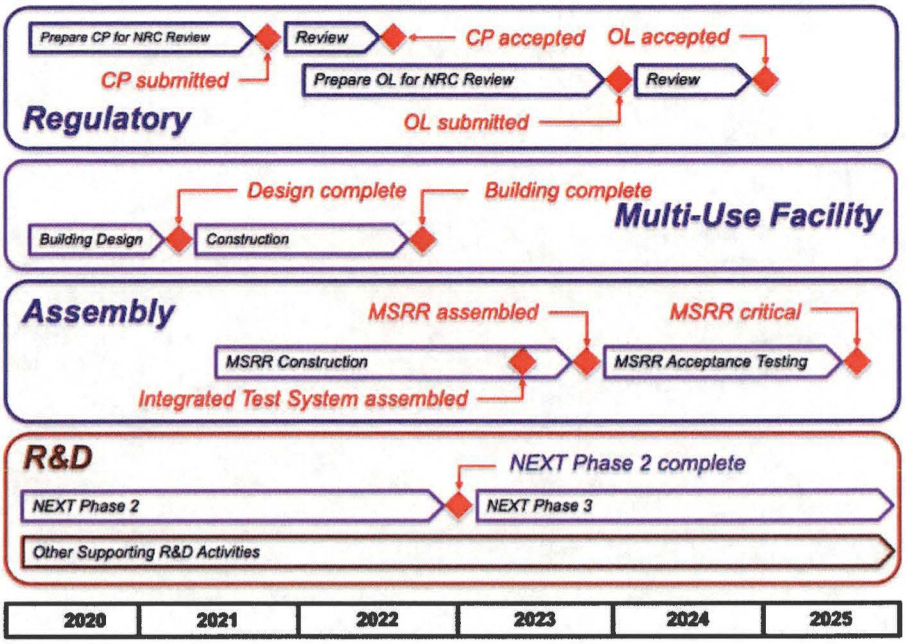

Figure 4: Shown here is a GANTT chart for the MSRR project.

4. Pre-application Engagement

4.1. Types and Frequency of Interactions

In addition to the pre-application meetings to discuss the technical issues identified in Section 3.2 and the submittal of the QAP during the pre-application phase, ACU expects to maintain consistent communication with the assigned NRC project manager.

4.2 Application Submittal

ACU intends to keep the NRC informed regarding its progress in preparing the CP application. ACU plans to begin holding discussions with the NRC concerning the submittal of the application during an initial drop-in visit later this calendar year. At that time ACU intends to begin discussions with the NRC regarding post-application submittal engagement, i.e., interactions during the NRC review period and methodology for review response and closure of NRC Requests for Additional Information (RAI).

4. 3 Applicable Site-Specific Issues

NEPA Consultations

During preparation of the site assessment and review ACU intends to consult with Federal, State, and local authorities. Such consultations may be associated with issuance of collateral permits, or with agency input to assessment of environmental impact. ACU anticipates these consultations may

include US Fish and Wildlife Agency, and State environmental agencies. ACU will provide early information on consultations during its first meeting with the NRC.

Pre-application Site Visits

ACU intends to support and schedule any visits the NRC may request during pre-application period.

4.4 Quality Assurance

ACU intends to present the Quality Assurance Plan as discussed in Section 1.6 and 3.2. This Quality Assurance program submittal is in advance of the application.

4.5 Site Selection and Site Characterization

ACU is aware that it is common for NRC staff to visit the location proposed for siting a new reactor, as well as the alternative sites considered during the site selection process. Such visits inform the NRC staff's understanding of the portion of environmental impacts associated with siting and site alternatives. ACU is currently engaged with an architectural firm to develop, plan and cost estimate a multi-use facility on campus at ACU. ACU will diligently work to inform the NRC of this process as a key issue and supports the NRC staff should the staff require audits of site characterization activities such as subsurface exploration, seismic and geotechnical evaluation, hydrologic testing, cultural resource investigations, etc. Such audits inform not only environmental documentation preparation but also facilitate familiarization in preparation for the safety review and identification of any issues that may need to be addressed prior to submittal of the application. ACU expects such audits may be combined with site visits.

4.6 Security/Critical Infrastructure

A meeting between ACU and the NRC to discuss Security Plan considerations is one of the pre-application topics that has been identified. ACU expects the discussion to include information on a site visit or evaluation/assessment in the context of critical infrastructure protection. ACU will coordinate such a visit with the NRC staff project manager.