From:	Michael Balazik
Sent:	Thursday, May 30, 2024 5:33 PM
To:	Benjamin Beasley; Lester Towell; rxt01a@acu.edu
Cc:	Stephen Philpott; Greg Oberson (He/Him); Richard Rivera; Brian Bettes; Ben Adams; Edward Helvenston
Subject:	Materials Degradation RCIs
Attachments:	Materials Degradation RCIs 2.pdf

Dear Dr. Towell:

By letter dated August 12, 2022 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML22227A201), as supplemented, Abilene Christian University (ACU) submitted a construction permit application for its proposed Molten Salt Research Reactor (MSRR) for U.S. Nuclear Regulatory Commission (NRC) staff review.

The NRC staff identified additional information needed to continue its review of the application, as described in the enclosed request for confirmation of information (RCI). Please provide a response to the RCI (confirming the information in the RCI or providing additional explanation or information, if necessary) or a written request for additional time to respond, including the proposed response date and a brief explanation of the reason, by June 14, 2024. Following receipt of the complete response to the
RCI, the NRC staff will continue its review.

If you have any questions regarding the NRC staff's review or if you intend to request additional time to respond, please contact me at (301) 415-2856 or by email at Michael.Balazik@nrc.gov, or contact Richard Rivera at (301) 415-7190 or Richard.Rivera@nrc.gov.

Best Regards,

Michael F. Balazik
Project Manager/Inspector
Non-Power Production and Utilization Facility Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
michael.balazik@nrc.gov | Tel: (301) 415-2856

Docket No. 05000610
EPID: L-2022-NFW-0002
Enclosure: As stated
cc: GovDelivery Subscribers

Concurrence on RCI

Office	**NRR/DANU/UAL2/BC**	**NRR/DANU/UNPL/PM**
Name	SPhilpott	MBalazik
Date	5/30/2024	5/30/2024

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Email Number: 2514

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Subject: Materials Degradation RCIs
Sent Date: 5/30/2024 5:33:03 PM
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From: Michael Balazik

Created By: Michael.Balazik@nrc.gov

Recipients:
"Stephen Philpott" <Stephen.Philpott@nrc.gov>
Tracking Status: None
"Greg Oberson (He/Him)" <Greg.Oberson@nrc.gov>
Tracking Status: None
"Richard Rivera" <richard.rivera@nrc.gov>
Tracking Status: None
"Brian Bettes" <Brian.Bettes@nrc.gov>
Tracking Status: None
"Ben Adams" <Christopher.Adams@nrc.gov>
Tracking Status: None
"Edward Helvenston" <Edward.Helvenston@nrc.gov>
Tracking Status: None
"Benjamin Beasley" <bgb23b@acu.edu>
Tracking Status: None
"Lester Towell" <ldt20a@acu.edu>
Tracking Status: None
"rxt01a@acu.edu" <rxt01a@acu.edu>
Tracking Status: None

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Materials Degradation RCIs 2.pdf	134434	

Options
Priority: Normal
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:

OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR CONFIRMATION OF INFORMATION

MOLTEN SALT RESEARCH REACTOR

CONSTRUCTION PERMIT APPLICATION

ABILENE CHRISTIAN UNIVERSITY

DOCKET NO. 50-610

Title 10 of the *Code of Federal Regulations* (10 CFR) 50.34(a) provides requirements for the information that shall be included in the preliminary safety analysis report (PSAR) submitted as part of a construction permit (CP) application. Paragraph 50.34(a)(3)(ii) states that the PSAR shall contain a description of the proposed facility's design bases and the relation of the design bases to the principal design criteria (PDC).

Section 3.1.2, "Molten Salt Research Reactor Design Criteria," of the Abilene Christian University (ACU) Molten Salt Research Reactor (MSRR) PSAR provides the PDC for the MSRR. The U.S. Nuclear Regulatory Commission (NRC) staff is evaluating the structural integrity of MSRR reactor system and FHS components against the following design criteria:

- PDC 1, "Quality standards and records," requires safety related (SR) structures, systems, and components (SSCs), to be "…designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed."
- PDC 14, "Reactor fuel salt boundary," requires the fuel salt boundary to "…be designed, fabricated, erected, and tested to have an extremely low probability of abnormal leakage, or rapidly propagating failure, or of gross rupture."
- PDC 30, "Quality of fuel salt boundary," requires fuel salt boundary components to "…be designed, fabricated, erected, and tested to quality standards appropriate with their function."
- PDC 31, "Fracture prevention of fuel salt boundary," requires the fuel salt boundary to have sufficient margin to minimize probability of rupture under all conditions and that the design reflect service temperatures and degradation of material properties under all conditions.
- PDC 32, "Inspection of fuel salt boundary," requires the fuel salt boundary to be designed to allow for inspection and provide for an appropriate surveillance program.
- PDC 61, "Fuel storage and handling and radioactivity control," requires containment of radioactivity.
- PDC 71, "Fuel salt composition control," requires systems to maintain the composition of the reactor coolant within specified design limits.

RCI 4.3-1

To provide reasonable assurance that the design bases for the reactor system and fuel salt boundary will satisfy the portions of PDC 1 and 30 cited above for the MSRR design, confirm

that:

1. All applicable portions of American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Section III Division 5 (as endorsed by Regulatory Guide 1.87, “High Temperature Reactors,” Revision 2), will be met for construction of the MSRR reactor system, or there will be an appropriate justification for any deviations from ASME Code requirements or NRC conditions. This commitment does not extend to quality assurance provisions. This is because ACU will implement a quality program consistent with ANSI/ANS-15.8, “Quality Assurance Program Requirements for Research Reactors,” as described in ACU’s NRC approved Quality Assurance Program Description topical report, rather than the NQA-1 standard specified in the ASME Code. ASME Code rules will be used for analyses and design. If it is determined that materials can degrade as a result of the MSRR environment, for instance via the Degradation Management Program (DMP), then an appropriate mitigation strategy will be developed and implemented (e.g., degraded material properties will be used as appropriate).

RCI 4.3-2

To demonstrate how the design bases for the reactor system satisfy PDC 14, 31, and 71 for the MSRR design, confirm that:

1. The results of the corrosion and environmentally assisted cracking testing described in ACU’s response to NRC’s request for additional information, dated April 30, 2024 (ML24121A272), will inform the final design parameters for the MSRR.
2. The effect of graphite in the reactor system will be accounted for in the design of the MSRR through corrosion allowances specified for MSRR components.
3. The solubility of alloying elements (e.g., chromium) in molten salt, as a function of temperature, will be accounted for in the MSRR corrosion allowances.
4. For any degradation mechanism for which a preliminary evaluation was provided in response to audit questions, that mechanism will be fully evaluated via the DMP and an appropriate mitigation strategy will be identified and implemented.
5. Properties of weld metals, weldments, and base metals (e.g., material composition, microstructure, stress state) will be considered in the evaluations performed in the DMP.
6. Consistent with ASME Code Section III Division 5, HBB-3241(b), the potential for nonductile failure will be determined by the DMP, and if plausible, appropriate mitigation measures will be implemented. The effects of embrittling degradation mechanisms will be considered on other materials properties (e.g. creep and creep-fatigue) regardless of whether nonductile failure is plausible.
7. The DMP will account for all potential stresses that could affect the progress of degradation mechanisms (including secondary/thermal stresses).
8. The DMP will address the uncertainties in data and the significance of data from environmental conditions (e.g., temperature, fluence, molten salt composition, stresses) or material properties (e.g., grade of stainless steel, weld metal, weldment) that may not be representative of the MSRR when determining a mitigation strategy. If data uncertainties or non-representative environmental conditions could affect the ability of the fuel salt boundary to maintain barrier integrity consistent with PDC 14, 31, and 71, the DMP mitigation strategies will appropriately address such challenges.

9. Helium generation in irradiated metallic SR components will be calculated, and then evaluated in the DMP. If it is concluded that helium generation results in degradation that is credibly expected to challenge the integrity of SR metallic materials exposed to irradiation, mitigation strategies will appropriately address it.
10. Any tests or mitigation measures for stress relaxation cracking (SRC) will be applicable and justified for determining susceptibility to SRC for the specific MSRR service conditions.

RCI 4.3-3

To demonstrate how the design bases for the reactor system will satisfy the requirement in PDC 32 to have an appropriate material surveillance program, confirm that:

1. No aspect of the preliminary design will preclude the placement and retrieval of surveillance coupons from a location that bounds the environmental conditions of the MSRR, if such coupons are determined necessary by the DMP to manage or mitigate a degradation mechanism that could impact barrier integrity of the fuel salt boundary consistent with PDC 14, 31, and 71.

RCI 4.3-4

To demonstrate how the design bases for the reactor system will satisfy the requirement in PDC 32 to have an appropriate material surveillance program, confirm that ACU will perform an evaluation to 1) determine if surveillance coupons need to be retrieved during operations, 2) the types of data to be collected via coupons, and 3) the periodicity of retrieval; if determined to be necessary by the DMP.

RCI 4.3-5

To demonstrate how the design bases for the fuel handling system (FHS) satisfy PDC 61 for the MSRR design, confirm that:

1. All SR components in the FHS (including piping) covered under Section VIII, or B31.3, will be treated consistent with rules in UW-2(a), for lethal service, and all butt-welded joints will be fully radiographed consistent with UW-51.
2. The corrosion allowance for the FHS and any data used to generate this corrosion allowance will be applicable to the FHS conditions (e.g., high-temperature hydrofluoric acid exposure).
3. The difference in weight between the fuel salt and coolant salt will be analyzed to determine its effect on stresses and, if the effect is not negligible, measures will be taken to assure that the coolant salt system is still ‘leading’ the FHS in terms of degradation.
4. Effects on corrosion due to both 316H SS and Ni-201 being present in the system will be evaluated and incorporated into the design of the FHS or shown to be mitigated.
5. All SR parts of the FHS that may experience degradation which could challenge FHS barrier integrity will be physically inspectable and details of any inspection plans, as determined to be needed by the DMP, will be provided along with any other needed performance monitoring/surveillance measures in an operating license (OL) application.

RCI 4.2-1

To demonstrate how the design bases for the graphite core components will be met for the MSRR design, confirm that:

1. All potential failures of graphite components and the potential for these failures to impact the ability of SR components to perform their function will be evaluated and that no SR functions will be impaired by graphite component failure.
2. A description of which, if any, ASME Code Section III, Division 5 rules for graphite will be used for the MSRR, and the basis for which rules were used, will be provided in an OL application.

RCI 9.6-1

To demonstrate how the design bases for the gas management system (GMS) satisfy its ability to perform a safety function for the MSRR design, confirm that:

1. Changes in gas properties will not affect the ability of the GMS to perform its safety function(s).
2. Anhydrous hydrogen fluoride gas will be appropriately handled and there is sufficient basis for release limits.

RCI-PSAR-1

Confirm that: Relevant information associated with the RCIs above will be incorporated in the Final Safety Analysis Report (FSAR) to be submitted for an MSRR OL application. For example, the final design in the FSAR application will 1) reflect the commitments in the RCIs above and 2) be informed by the results of additional evaluations and testing discussed in the RCIs above. In addition, the results of evaluations and testing that inform the final design will be summarized in the OL application, as appropriate.