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March 28, 2024

Docket No. 50-610

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

Subject: Abilene Christian University Construction Permit Application
Response to Request for Additional Information 1

On December 21, 2023, the Nuclear Regulatory Commission issued two Requests for Additional Information (RAIs) to Abilene Christian University related to the construction permit application for the Molten Salt Research Reactor (ML23348A196). The response to RAI 1 is provided below and is supplemented in Enclosure 1. PSAR changes associated with the response to RAI 1 will be submitted with Revision 2 of the PSAR.

Response to RAI 1

RAI 1a. The "separate letter" is not referenced in the PSAR. Identify (and docket, as appropriate) the "separate letter."

Response: The letter conveying proprietary design information was submitted on January 24, 2024 (ADAMS accession number ML24024A009). Updates to the proprietary design information for consistency with this RAI response are enclosed with this letter.

RAI 1b. PSAR, Revision 1, Table 3.1-1, "Cross Reference to Preliminary Safety Analysis Report Sections," identifies design criteria applicable to the fuel handling system (FHS). Identify which design criteria ensure adequate structural and mechanical integrity of the safety-related components in the FHS.

Response: Integrity of safety-related components in the FHS is assured by compliance with Design Criterion 61.

> *Criterion 61: Fuel storage and handling and radioactivity control*
> *The fuel storage and handling, radioactive waste, and other systems which may contain radioactivity shall be designed to assure adequate safety under normal and postulated accident conditions. These systems shall be designed (1) with a capability to permit appropriate periodic inspection and testing of safety related SSCs, (2) with suitable shielding for radiation protection, (3) with appropriate containment, confinement, and filtering systems, (4) with a passive residual heat removal capability having reliability and testability that reflects the safety related*

temperature control, and (5) to prevent significant reduction in fuel storage cooling under accident conditions.

Structural and mechanical integrity is assured as part of element (3), which requires the containment of radioactivity. Consistent with criterion 61, the FHS is designed for inspection. Integrity is also assured through the use of salt-bearing nickel components in the non-safety-related coolant salt system as a lead specimen for nickel components in the safety-related FHS. Criterion 61 was established specifically for the FHS, which is consistent with Appendix A of Regulatory Guide 1.232, "Guidance for Developing Principal Design Criteria for Non-Light-Water Reactors." As suggested by the advanced reactor design criteria of Regulatory Guide 1.232, criteria related to the integrity of the reactor system are not applied to the FHS.

RAI 1c. In addition to the PSAR statement that the vessel is resistant to hydrofluoric acid exposure, the NRC staff requests further information regarding the construction of the fuel salt purification vessel and associated piping to ensure that it will provide adequate structural and mechanical integrity during the operating life. Describe the bases that will be used to demonstrate that the materials from which FHS components are fabricated will appropriately withstand operational conditions (e.g., load cycles, time at temperature).

Response: The fuel salt purification vessel will be constructed from UNS N02201 (Ni-201) low-carbon nickel. The vessel will be designed in accordance with the 2021 edition of the ASME Code Section VIII, Division 1. ACU plans to implement the lethal service rules of ASME Code Section VIII for salt purification vessels. At the temperatures required for fuel salt purification (roughly 625 °C), pure nickel is resistant to corrosive attack by hydrogen fluoride and hydrofluoric acid. The fuel salt purification vessel will experience load cycles and time at temperature that are a small fraction of the allowable values in Section VIII, Division 1. The associated piping system, including its supports, will be designed to B31.3-2020, which is supplemented by Section III, Division 5 at high temperatures. Details of the service conditions and design requirements are provided in Appendix A to this RAI response.

RAI 1d. In addition to identifying the ASME codes, including the version of the code, that will be assigned to FHS components, the NRC staff requests further information regarding the codes' selection to ensure that components will not be affected by degradation mechanisms that go undetected prior to a loss of capacity to perform their safety functions. Describe the bases that will be used to demonstrate that those codes are appropriate for the components and the conditions to which they are applied. State if and how any supplemental analyses, in addition to those directed by the selected code, would be used to address potential

degradation mechanisms, including creep, fatigue, and other time-dependent or high-temperature phenomena.

Response: ASME Code Section III, Division 5 does not include pure nickel alloys. Because pure nickel must be used for the purification vessels, the 2021 Edition of Section VIII will be used. Because the fuel and coolant salt purifications will be conducted at roughly 625 °C, Section VIII, Division 1 must be used. The allowable stress values for Section VIII, Division 1 construction are provided in Table 1B of Section II, Part D. As shown in Mandatory Appendix 1 of Section II, Part D, the allowable stress values in the time-dependent range (Sc) consider creep (at a strain level of 0.01% per 1000 hours) and stress rupture (SRavg & SRmin) for a 100,000-hour life. Note that, depending on the need for purification, the actual service requirements for the fuel salt purification vessel at the operating temperature may only be around 100 hours during the 20-year life of the MSRR. If purification needs are significant, the vessel could be in service at the operating temperature for around 1,000 hours.

There is a lack of fatigue data for Ni-201. However, some type of fatigue assessment is needed so a fatigue screening analysis has been performed in accordance with paragraph 5.5.2.3 of Section VIII, Division 2, 2021 Edition. This screening analysis demonstrates that fatigue is not a concern for this low-cycle, thermally consistent vessel. Because the fuel salt purification vessel will be operated above the transition temperature where allowable stresses are governed by time-dependent creep properties, the coolant salt purification vessel will be used as comparable equipment in similar service to screen the fuel salt purification vessel. This use of the coolant salt purification vessel is described in Appendix B to this RAI response.

RAI 1e. PSAR Revision 1 states, as referenced above, that "[w]elding between SS316H and Alloy 201 will make use of a suitable material as defined by the appropriate code." However, the NRC staff notes that neither ASME Boiler and Pressure Vessel Code (BPVC) Section VIII, "Rules for Construction of Pressure Vessels," nor ASME B31.3, "Process Piping," include specific combinations of weld and base materials and they do not address high temperature degradation of weld metals. Therefore, the NRC staff requests further information about the welds, including the Alloy 201 to Alloy 201 welds, to ensure that they will provide adequate structural and mechanical integrity during the operating life. Describe the bases that will be used to demonstrate the weld material suitability, and the bases (e.g., allowable stress rupture values, tensile strength, etc.) that will be used to ensure that the weld materials will not be affected by degradation mechanisms, such as stress-rupture due to creep, that go undetected prior to a loss of components' capacities to perform their safety functions.

Response: The MSRR design will not have any Ni-201 to 316 stainless steel (316 SS) welds. The fuel and coolant salt purification vessels will be constructed entirely from Ni-201 including all nozzles and welded support structures. Vessel supports will be welded to the Ni-201 vessels but will be bolted to the 316 SS enclosure with an electrically insulating material between the two metals. Ni-201 piping or valves will be connected to 316 SS by flanged connections that have isolating flange kits to electrically separate the two metals. Custom flanges will be designed to ASME Section VIII, Division 1, Appendix 2. Details of the flange and isolating material will be provided in the operating license application.

All weld procedures will be qualified in accordance with ASME Code Section IX, with the Section IX Edition corresponding to the Code Edition governing the primary component. The vessels will be constructed using a TIG welding process using SFA 5.9 ERNi-1 weld rod per Section II, Part C. The ERNi-1 weld metal has the closest chemistry to Ni-201 of all the materials listed in SFA 5.14 of Section 2, Part C. The outlet nozzles leading from the purification vessels to the first isolation valve downstream will also be constructed from Ni-201. ACU will use a mechanical flanged joint on the outlet side of the isolation valve to transition to 316 SS piping.

RAI 1f. If ACU is relying on pre-existing data to demonstrate the adequacy of the FHS design, state what those data are and provide the bases for the determination that these adequately represent, as relevant, the materials and operating conditions of the FHS.

Response: ASME Code Section VIII lists Ni-201 for service temperatures up to 649 °C. In addition, Section II provides basic mechanical properties. Other relevant documents providing supporting background information include William D. Jenkins and Thomas G. Digges' "Effect of temperature on the tensile properties of high-purity Nickel" (1952) and William D. Jenkins, Thomas G. Digges, and Carl R. Johnson's "Creep of High-Purity Nickel" (1954). The design of the purification vessels will use construction details in accordance with the recommendations provided in Welding Research Council's "Bulletin 470 – Recommendations for Design of Vessels for Elevated Temperature Service" (2002).

RAI 1g. If it is necessary for ACU to acquire additional data to demonstrate the adequacy of the FHS design, describe the scope of such testing and state the purpose and schedule for the acquisition of those data (e.g., tensile strength, stress rupture values, etc.), as well as what bases will be used to determine that these adequately represent, as relevant, the materials and operating conditions of the FHS.

Response: During the pre-operational and operational periods, ACU will acquire information on Ni-201 performance through surveillance of the coolant salt purification vessel and associated components. The coolant salt system is

a completely non-nuclear system that will remove heat from the primary system's fuel salt through a heat exchanger. The coolant salt system will have a purification vessel with very close function, material, and design as the FHS's purification vessel. The coolant salt purification vessel will be instrumented to collect data on Ni-201 performance. ACU will use the salt-bearing Ni-201 portions of the Secondary Cooling System (coolant salt purification vessel (V-4004) and associated components) as a leading specimen to monitor the performance of Ni-201 components and assure the ability to safely operate the FHS (fuel salt purification vessel (V-1002) and associated components). The associated components include piping, welds, supports, and flanges. The coolant salt purification vessel and associated components will be operated so that they always lead the FHS purification vessel and associated components in time at elevated temperature, thermal cycles, sparging cycles, and salt exposure for the entire life of the FHS purification vessel. Appendix B of this response provides service requirements for the coolant salt purification vessel and describes the plan to use the coolant system as a lead specimen for the assessment of Ni-201 performance in the FHS.

RAI 1h. If ACU will rely on in-service methods (e.g., periodic surveillance or inspection) to confirm that the FHS continues to conform with the design criteria during the operating life, describe the scope of this in-service approach and state the bases for determining that those methods, including the frequency and techniques, will detect degradation prior to the loss of capacity for the affected components to perform their intended functions.

Response: The FHS will be designed and constructed to accommodate inspection of welds and other select areas. In addition to the data collected on the coolant salt purification vessel, the fuel salt purification vessel will be instrumented to measure creep strain that could occur. FHS components will be included in ACU's degradation management program that will use a Reliability and Integrity Management (RIM)-informed approach to determine methods of ensuring the reliability of specific SSCs of the MSRR. This program will be summarized in the operating license application. Operational controls and technical specifications will be developed that require a certain decay time in the reactor drain tank before the fuel salt is transferred to the fuel salt purification vessel, that limit the rate of temperature change, and that limit the number of thermal cycles and time at elevated temperature for Ni-201 components. These controls and technical specifications will be provided in the OL application.

To be consistent with the RAI 1 response and in response to audit questions, previously submitted proprietary information has been revised. A table giving the safety classification and ASME Code assignments for MSRR components is provided in Enclosure 2. A process flow diagram is provided in Enclosure 3. The flow diagram indicates where the ASME Code breaks will occur in various MSRR systems. Enclosure 4

provides the function, type, and service conditions of safety related valves. Because the flow diagram cannot reflect all details of the design, the Code assignments table and valve information table should be considered authoritative.

In addition to the updates to the previously submitted proprietary documents, the information responding to RAI 1 in Enclosure 1 is proprietary. Abilene Christian University and Natura Resources request that Enclosures 1 through 4 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390. An affidavit supporting the withholding request is provided in Enclosure 5. The proprietary information of Enclosures 1 through 4 is also identified as Export Controlled Information and must be protected in accordance with 10 CFR 810.

If there are further questions, please contact Benjamin.Beasley@acu.edu or Lester.Towell@acu.edu.

Recognizing that the responses above and the enclosures provide preliminary design information and that the final design may differ, I declare under penalty of perjury that the information is true and correct.

Executed on March 28, 2024.

Rusty Towell
Rusty Towell (Mar 28, 2024 16:32 CDT)

Rusty Towell, PhD
Director of NEXT Lab

Enclosures:

1. Appendices to RAI 1 Response
2. MSRR Service Conditions – Revised
3. ASME Code Assignments Diagram Revision F
4. Safety Related Valve Description – Revised
5. Request for Withholding from Public Disclosure and Affidavit in Accordance with 10 CFR 2.390(a)(4)

Cc: Richard Rivera, Project Manager, NRR Advanced Reactor Licensing Branch 2
Edward Helvenston, Project Manager, NRR Non-Power Production and Utilization Facility Licensing Branch
Brian Bettes, Project Manager, NRR Advanced Reactor Licensing Branch 2

Enclosure 5
Request for Withholding from Public Disclosure and Affidavit
in Accordance with 10 CFR 2.390(a)(4)

Natura Resources (Natura) is funding the construction of the Abilene Christian University (ACU) Molten Salt Research Reactor (MSRR), and as part of the funding effort, is licensing to ACU the design of Natura's 1 MWth molten salt reactor. In addition, Natura has entered into sponsored research agreements with ACU and three other universities ("Other Universities") to assist in the development of the MSR system and the construction of the MSRR whereby Natura owns exclusive rights to the intellectual property developed under those sponsored research agreements. Under those agreements, the intellectual property developed is confidential for three years from development and considered trade secrets of Natura unless Natura has opted to publicly disclose and/or file a patent application on the technology. As owner of these exclusive proprietary and confidential rights, Natura is executing this affidavit to support the protection of those rights during the NRC review of the construction permit application submitted by ACU for the MSRR.

I, Jordan Robison, state:

1. I am the Vice President of Engineering and Program Management for Natura Resources. I have been specifically delegated the function of reviewing the information to be withheld and I am authorized to apply for the withholding of the information on behalf of Natura.

2. The information sought to be withheld, in its entirety, with this request is contained in Enclosures 1, 2, 3, and 4, which accompany this Affidavit.

3. Pursuant to the provisions set forth in 10 CFR § 2.390(b)(4), the following is provided for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

4. The request for withholding is based upon the following:

    a. The information sought to be withheld is owned and has been held in confidence by ACU, the Other Universities, and Natura as confidential and proprietary, trade secret information.

    b. The information is of a type that is customarily held in confidence by ACU, the Other Universities, and Natura based on the rationale described in this affidavit.

    c. The information is being transmitted to and, pursuant to 10 CFR 2.390, received by the NRC in confidence.

d. No public disclosure of the information has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or contractual agreements that provide for maintenance of the information in confidence.

e. The information requested to be withheld reveals specific distinguishing design aspects. The information consists of supporting data relative to a process, component, structure, tool, method, etc., and the application of the data secures a competitive economic advantage as described in paragraph 5.

f. Use by a competitor of the information requested to be withheld would reduce the competitor's expenditure of resources, or improve its competitive position, in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.

g. The information requested to be withheld may be the subject of patentable ideas for which Natura is still developing applications.

5. Public disclosure of the information sought to be withheld is likely to cause substantial harm to Natura's competitive position and foreclose or reduce the availability of profit-making opportunities. The accompanying information reveals distinguishing aspects about Natura’s proprietary molten salt reactor design.

   Natura has expended a considerable sum of money to fund significant research and evaluation to develop a basis for the design information, including that with ACU and the Other Universities. The precise financial value of the information is difficult to quantify, but it is a key element of the design basis for a Natura proprietary molten salt reactor design and, therefore, has substantial value to Natura.

   If the information were disclosed to the public, Natura's competitors would have access to the information without purchasing or entering into a license for the right to use it or having been required to undertake a similar expenditure of resources. Such disclosure would constitute a misappropriation of Natura's intellectual property and would deprive Natura of the opportunity to exercise its competitive advantage to seek an adequate return on its investment.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on March 28, 2024.

Jordan Robison
Vice President of Engineering and Program Management
Natura Resources