

From: Mallecia Sutton
Sent: Friday, June 16, 2023 9:19 AM
To: George Wilson
Cc: Ryan Sprengel; Andrew Proffitt
Subject: TerraPower: Natrium EI-NI Separation TR Audit Summary
Attachments: TerraPower Natrium EI-NI Separation TR Audit Summary Final.docx

Dear Mr. Wilson

Attached is the summary report of an audit conducted by U.S. Nuclear Regulatory Commission (NRC) staff (the staff) of the TerraPower topical report (TR) NATD LIC RPRT 0001, "Regulatory Management of Natrium Nuclear Island and Energy Island Design Interfaces" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML22277A824), submitted October 4, 2022. The TR contains a summary of the Natrium reactor plant design, interfaces, and safety features; and of TerraPower's process for classifying structures, systems, and components (SSCs); basic plant transient analyses; and evaluation of select NRC regulations relevant to Natrium's proposed nuclear island (NI) and energy island (EI). TerraPower requested NRC review and approval of the subject TR to "serve as a means, via reference, for Natrium reactor licensees to utilize the regulatory evaluation."

The purpose of the audit was to enable NRC staff to gain a better understanding of the analyses referenced in the TR and the extent to which they support the conclusions drawn in the TR regarding the independence of the Natrium NI and EI.

Thanks,

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SUMMARY REPORT FOR THE REGULATORY AUDIT OF
TERRAPOWER LLC TOPICAL REPORT NATD-LIC-RPRT-0001,
“REGULATORY MANAGEMENT OF NARIUM NUCLEAR ISLAND
AND ENERGY ISLAND DESIGN INTERFACES”

1.0 BACKGROUND AND PURPOSE

By letter dated October 4, 2022, TerraPower submitted topical report (TR) NATD-LIC-RPRT-0001, “Regulatory Management of Natrium Nuclear Island and Energy Island Design Interfaces” (Agencywide Documents Access and Management System (ADAMS) Accession No. ML22277A824) to the U.S. Nuclear Regulatory Commission (NRC). The TR contains a summary of the Natrium reactor plant design, interfaces, and safety features; and of TerraPower’s process for classifying structures, systems, and components (SSCs); basic plant transient analyses; and evaluation of select NRC regulations relevant to Natrium’s proposed nuclear island (NI) and energy island (EI).¹ TerraPower requested NRC review and approval of the subject TR to “serve as a means, via reference, for Natrium reactor licensees to utilize the regulatory evaluation.”

The purpose of the audit was to enable NRC staff to gain a better understanding of the analyses referenced in the TR and the extent to which they support the conclusions drawn in the TR regarding the independence of the Natrium NI and EI.

2.0 AUDIT REGULATORY BASES

The basis for the audit includes:

- Title 10 of the *Code of Federal Regulations* (10 CFR) 50.34, “Contents of applications; technical information.” Paragraph 50.34(a)(4) requires that applicants for a construction permit (CP), and subsequently for an operating license (OL) in (b)(4), provide an analysis and evaluation of the design and performance of SSCs of the facility with the objective of assessing the risk to public health and safety resulting from operation of the facility. In addition, this analysis must include the determination of the margins of safety during normal operations and transient conditions anticipated during the life of the facility and the adequacy of SSCs provided for the prevention of accidents and the mitigation of the consequences of accidents.
- 10 CFR 50.10, “License required; limited work authorization,” which requires, in part, that certain activities constituting construction on a site may not begin without an NRC license or authorization.
- 10 CFR 50.54(j), which requires, in part, that apparatus and mechanisms other than controls, the operation of which may affect the reactivity or power level of a reactor, shall be manipulated only with the knowledge and consent of an operator or senior operator licensed pursuant to 10 CFR Part 55, “Operators’ Licenses,” present at the controls.
- 10 CFR 50.65, “Requirements for monitoring the effectiveness of maintenance at nuclear power plants,” which requires a program to monitor the performance of certain SSCs and the maintenance thereof.

¹ The NI and EI are the portions of the plant containing the reactor and power generation systems, respectively.

- 10 CFR Part 50, Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,” which provides requirements for quality assurance programs.
- 10 CFR Part 55, which provides requirements for power reactor operator licensing.

3.0 AUDIT OBJECTIVES

The objective of the NRC staff’s audit was to gain a more detailed understanding of preliminary high-level transient analyses discussed in the TR and how the Sodium design and concept of operations will demonstrate compliance with 10 CFR 50.54(j) during power operations. The staff also sought to use the audit to identify any information relevant to these areas that required docketing to support the NRC staff’s safety evaluation.

4.0 SCOPE OF THE AUDIT AND AUDIT ACTIVITIES

The audit was conducted from January 23, 2023, to March 10, 2023, via the Microsoft Teams and the TerraPower electronic reading room (ERR). The staff conducted the audit in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, “Regulatory Audits,” Revision 1 (ML19226A2714).

Members of the audit team were selected based on their knowledge of the subject. Audit team members included:

- Reed Anzalone, Senior Nuclear Engineer, NRR (Audit Lead)
- Ben Adams, General Engineer, NRR
- Jesse Seymour, Senior Reactor Engineer, NRR

The staff audited several documents in TerraPower’s electronic reading room. These documents included an overview of the interface between the energy island and nuclear island, a summary of how TerraPower plans to operate the energy island, documentation of the analytical models that have been developed for various aspects of the Sodium plant, and preliminary transient analyses.

5.0 SUMMARY OF AUDIT OUTCOME

The staff made the following observations during the audit based on TerraPower’s preliminary design and analysis information:

- The documentation provided the staff with overviews of the design of the NI and EI, the types of transients TerraPower is considering in evaluating the interface between the NI and EI, how these transients progress, and the SSCs relied upon to mitigate the transients.
- TerraPower’s analyses supported its assertion in the TR that no EI SSCs are required to respond to mitigate any events impacting the NI, support safety-related (SR) SSCs, or ensure defense-in-depth (DID) adequacy.
- TerraPower’s analyses demonstrated that events that initiate on the EI can be detected and mitigated solely with NI SSCs, primarily due to the slow rate with which transients progress.

- TerraPower's analyses identified that the EI events with the most potential to directly affect the NI are those involving systems closest to the EI-NI interface, i.e., the portion of the thermal salt system on the energy island-side of the salt isolation valves, also known as the energy island salt system (ESS). Transients occurring on the EI farther from the EI-NI interface may affect the NI but would take a significant amount of time (on the order of hours) to propagate through the system due to the large thermal salt storage system and would ultimately have the same overall effect on the NI as an ESS transient.
- The NRC staff noted that the reactor air cooling system and intermediate air-cooling system are significant to the Sodium safety case and play a key role in demonstrating that the NI is separable from the EI. They are relied upon for all heat removal at low reactor powers, including during regular plant startup and shutdown.

The staff notes that the analyses provided by TerraPower in the audit were based on the design as it existed at the point in time at which they were conducted, and certain details were based on assumptions or may be subject to change in the future. Additionally, the analyses were also conducted with codes, methods, and models that may not yet have been subject to NRC review. These aspects of the analyses are reasonable considering the current pre-application state of the Sodium project.

No audit questions, open items, or requests for additional information were identified as a result of this audit. The staff does not believe at present that any of the information reviewed in the audit needs docketing to support the staff's safety evaluation.