

TERRAPOWER, LLC – NATD-FQL-PLAN-0004 REVISION 0
“FUEL AND CONTROL ASSEMBLY QUALIFICATION”
AUDIT PLAN
(CAC/EPID NO.00431 L-2023-TOP-0017)

Applicant: TerraPower, LLC (TerraPower)
Applicant Address: 15800 Northup Way, Bellevue, WA 98008
Plant Name(s) and Unit(s): Natrium
Project No(s): 99902100

Background:

By letter dated January 25, 2023, TerraPower submitted topical report (TR) NATD-FQL-PLAN-0004 Revision 0, “Fuel and Control Assembly Qualification” (Agencywide Documents Access and Management System (ADAMS) Accession No. ML22277A824) to the U.S. Nuclear Regulatory Commission (NRC) staff. The TR describes TerraPower’s efforts to qualify fuel and control assemblies for use, including results that have been completed and ongoing plans to complete additional activities that will be required to fully qualify the fuel and control assemblies. On March 28, 2023, the NRC staff found that the material presented in the topical report (TR) provides technical information in sufficient detail to enable the NRC staff to conduct a detailed technical review (ML 23086C087).

TerraPower has requested the NRC staff’s review and approval of its proposed qualification methodologies, acceptance criteria, manufacturing parameters, evaluation methods and models, use of legacy data, and planned testing, as described in the enclosed topical report, are adequate to qualify fuel and control assemblies for the Natrium reactor. The topical report will be used by applicants of the TerraPower sodium-cooled fast reactor (SFR) design for future licensing submittals under Title 10 of the *Code of Federal Regulations* (CFR) Part 50 “Domestic Licensing of Production and Utilization Facilities” to design, license, construct, and operate the Natrium reactor. The applicant’s overall licensing methodology follows the technology-inclusive, risk-informed, and performance-based approach outlined in Regulatory Guide (RG) 1.233 “Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light Water Reactors.”

Purpose:

The purpose of the audit is for the NRC staff to gain a more detailed understanding of TerraPower’s fuel and control assembly qualification efforts for the Natrium reactor and how the Natrium fuel and control assembly designs and qualification will support or demonstrate compliance with NRC regulations as discussed below, particularly 10 CFR 50.43 “Additional standards and provisions affecting class 103 licenses and certifications for commercial power” and 50.34 “Contents of applications; technical information.” A secondary purpose of the audit is to identify any information that will require docketing to support the NRC staff’s safety evaluation. Therefore, the NRC staff is requesting access to TerraPower documents associated with the fuel and control assembly design and qualification efforts as discussed in the TR. The

NRC staff will summarize its observations in an audit report to be provided to TerraPower, as discussed below.

Regulatory Audit Basis:

The basis for the audit includes:

- 10 CFR 50.43, “Additional standards and provisions affecting class 103 licenses and certifications for commercial power,” specifically:
 - 10 CFR 50.43(e)(1)(i), which requires a demonstration of the performance of each safety feature of the design through either analysis, appropriate test programs, or a combination thereof. Nuclear fuel plays a key role in the safety functions of reactivity control, heat removal, and confinement of radioactive material. Control assemblies similarly affect reactivity control and must not impede removal. Thus, the qualification efforts discussed in the TR, which are intended to identify the safety features and the appropriate testing and analysis needed to demonstrate them, are expected to form a portion of the compliance demonstration relative to this regulation. The staff notes that while construction permit (CP) applicants are not required to meet 10 CFR 50.43(e), compliance with this regulation must be demonstrated prior to issuance of an operating license (OL). Thus, this requirement is relevant for TerraPower in the long term even if not strictly necessary for the short-term goal of construction permit issuance.
 - 10 CFR 50.43(e)(1)(iii), which requires sufficient data on the safety features of the design to assess the analytical tools used for safety analyses over a sufficient range of normal operating conditions, transient conditions, and specified accident sequences, including equilibrium core conditions. The TR includes a discussion of the operating envelope of Sodium fuel and control assemblies, the analytical tools planned for analysis of the fuel and control systems, and data (from both historical and planned testing) to support the qualification of analytical models.
- 10 CFR 50.34, “Contents of applications; technical information,” specifically:
 - 10 CFR 50.34(a)(1)(ii)(D), which requires applicants to perform a safety assessment of the facility, including “[t]he safety features that are to be engineered into the facility and those barriers that must be breached as a result of an accident before a release of radioactive material to the environment can occur.” As part of this assessment applicants must evaluate postulated fission product release. The fuel system represents multiple fission product barriers that must be evaluated as part of this assessment.
 - 10 CFR 50.34(a)(3)(i) and (ii), which require applicants for construction permits to provide principal design criteria (PDC) for the facility and the design bases and their relation to the PDC, respectively. While the general design criteria (GDC) in 10 CFR 50 Appendix A are not directly applicable to non-light water reactors (non-LWRs) like Sodium, they do provide guidance in determining the PDC for such reactors. Additional guidance on PDC for non-LWRs is contained in Regulatory Guide (RG) 1.232, “Guidance for Developing Principal Design Criteria for Non-Light-Water Reactors,” which provides a set of generally applicable advanced reactor design criteria (ARDC), plus specific design criteria for sodium fast reactors and modular high temperature gas reactors (SFR-DC and MHTGR-DC, respectively). While these sources of guidance are not themselves requirements, they approximate the scope of what the NRC staff expects is needed to meet the PDC requirements. Various GDC or ARDC include design criteria that are addressed in part by the fuel and control systems, including:

- GDC/ARDC 2, “Design bases for protection against natural phenomena”
- GDC/ARDC 4, “Environmental and dynamic effects design bases”
- GDC/ARDC 11, “Reactor inherent protection”
- GDC/ARDC 12, “Suppression of reactor power oscillations”
- GDC/ARDC 10, “Reactor design”
- GDC/ARDC 26, “Reactivity control systems”
- GDC/ARDC 28, “Reactivity limits”
- GDC/ARDC 34, “Residual heat removal”
- GDC/ARDC 35, “Emergency core cooling system”

Regulatory Audit Scope:

The regulatory audit will follow the guidance in NRR Office Instruction LIC-111 “Regulatory Audits” (ML19226A274) and focus on information provided by TerraPower in the electronic reading room.

Information and Other Material Necessary for the Regulatory Audit:

The NRC requests TerraPower make available the information and/or experts necessary to respond to the audit questions included in the enclosure. These questions fall into the general categories of:

- Additional detail and context on the regulatory acceptance criteria, Sodium principal design criteria, and fuel system design criteria (including both damage and failure criteria), as well as the relationships between all of these criteria
- Additional detail on the manufacturing process and how it affects key fuel system performance characteristics.
- Additional detail on radionuclide retention requirements, and associated retention and release modeling approach and validation
- Additional detail on the phenomena identification and ranking table (PIRT) exercise(s) conducted by TerraPower
- Additional detail on the evaluation model
- Additional detail on certain fuel phenomena
- Clarification on aspects of the fuel and control assembly design
- General clarification of various subjects included in the TR

Team Assignments

Reed Anzalone	Senior Nuclear Engineer, Audit Lead, responsible for audit summary report preparation
Mallecia Sutton	Senior Project Manager, responsible for audit logistics

Logistics

Entrance Meeting	June 21, 2023, 11:00 a.m.
Exit Meeting	July 13, 2023, 4:30 p.m.

Audit meetings will take place in a virtual format, using Microsoft Teams or another similar platform. Audit meetings will be scheduled on an as-needed basis after the entrance meeting and once the NRC staff has had the opportunity to review any documents placed in the online reference portal. The audit will begin on June 13, 2023, and continue as necessary, with

activities occurring intermittently during the audit period. The audit period may be reduced or extended, depending on the progress made by the NRC staff and TerraPower in addressing audit questions.

Special Requests

The NRC staff requests that TerraPower ensure that their technical staff are available to answer questions during the audit. The NRC staff also requests that TerraPower provide access to supporting documents via the TerraPower online reference portal.

Deliverables

At the completion of the audit, the audit team will issue an audit summary within 90 days after the exit meeting but will strive for a shorter duration. The audit summary will be declared and entered as an official agency record in ADAMS and be made available for public viewing through the Publicly Available Records component of ADAMS.

If you have questions about this audit, please contact me at 301-415-0673 or by email at Mallecia.Sutton@nrc.gov.

Date: June 7, 2023

Sincerely,



Signed by Sutton, Mallecia
on 06/07/23

Mallecia Sutton, Sr. Project Manager
Advanced Reactors Licensing Branch
Division of Advanced Reactors and Non-Power
Production and Utilization Facilities
Office of Nuclear Reactor Regulation