



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

OFFICE OF NUCLEAR REACTOR REGULATION
REGULATORY AUDIT REPORT
PRINCIPAL DESIGN CRITERIA TOPICAL REPORT
TERRESTRIAL ENERGY USA, INC.
DOCKET NO. 99902076

1.0 BACKGROUND

By letter dated December 29, 2023, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML24053A171), Terrestrial Energy USA, Inc. (TEUSA), submitted Revision B of the topical report (TR) titled, "Principal Design Criteria for IMSR Structures, Systems, and Components," for the U.S. Nuclear Regulatory Commission (NRC) staff's review and safety evaluation. The TR describes the development of the principal design criteria (PDCs) to be used for future license applications referencing the TEUSA's Integral Molten Salt Reactor (IMSR) design, also referred herein as IMSR400.

The NRC staff provided its audit plan to TEUSA on April 8, 2024 (ML24095A305), to support an audit using TEUSA's electronic reading room (eRR). At the conclusion of the audit, the NRC staff held an audit exit meeting on July 2nd, 2024, with TEUSA to discuss the audit results, conclusions, and next steps for the TR review.

2.0 AUDIT REGULATORY BASES

The basis for the audit is the regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," Section 50.34, "Contents of applications; technical information". The regulation in 10 CFR 50.34(a)(3)(i) requires, in part, that an applicant requesting a construction permit to build a power reactor provide PDCs for the facility. Similar regulatory requirements exist for design certifications, combined licenses, standard design approvals, and manufacturing licenses as described in 10 CFR 52.47(a)(3)(i), 10 CFR 52.79(a)(4)(i), 10 CFR 52.137(a)(3)(i), and 10 CFR 52.157(a), respectively. The PDCs establish the necessary design, fabrication, construction, testing, and performance requirements for structures, systems, and components (SSCs), important to safety, that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public.

3.0 AUDIT PURPOSE AND OBJECTIVES

The purpose of the audit was to enable the NRC staff to: (1) efficiently gain an understanding of the detailed information supporting the TR, (2) verify information, and (3) identify information that needs to be docketed to support the development of the safety evaluation.

Enclosure

4.0 SCOPE OF THE AUDIT AND AUDIT ACTIVITIES

During the review of the initial submission of the TR, on August 16, 2023, the NRC staff shared with TEUSA its preliminary review results and remaining questions. TEUSA provided formal responses to the questions during a closed meeting held on September 28, 2023 (ML23303A188). Subsequently, the NRC staff and TEUSA agreed to have an audit (ML24095A307) of TEUSA's documents supporting the information in the TR.

During the audit, TEUSA made the following documents available in the eRR:

- IMSR 400-22500-DD-001, "Irradiated Fuel System"
- Presentation material "Graphite Behavior in the IMSR"
- IMSR400-08420-MQP-001, "Graphite"
- IMSR400-22110-SC-001, "Reactor Vessel Safety Classification"
- IMSR400-22122-SC-001, "Safety Classification of the Moderator System"
- IMSR400-30000-DG-015, Revision 1, "Reactor Physics"
- IMSR400-30200-ASD-042, "Flownex Simulation Model for CoreE1-t Using MCNP data"
- IMSR400-30203-ASD-012, "CFD Analysis for Core E-1t Orifice in Year 0, 3.5, and 7"
- IMSR400-30500-DD-002, "IMSR400 Core Unit Physics"
- Presentation material "Interface Off-gas IrFS Containment Presentation for US NRC Audit - 24 04 18"
- IMSR400-30800-AR-001, Revision 3, "Safety Analysis Postulated Initiating Events List"
- Presentation material "Presentation on Control of Reactivity"
- Presentation material "Presentation on IMSR Power Transient Simulations"
- 2024-03-28, "I&C Overview"
- IMSR400-24500-BD-001, Revision 0, "Plant Control and Monitoring System"
- IMSR400-24500-DD-001, Revision 1, "Plant Control and Monitoring System"
- IMSR400-24500-SC-001, Revision 0, "Plant Control and Monitoring System"
- IMSR400-30000-DG-004, Revision 1, "Safety Classification Process"

In addition, TEUSA made its responses to the audit questions available in the Terrestrial eRR to facilitate the audit, where the NRC staff directed its focus.

The audit followed the guidance in the Office of Nuclear Reactor Regulation Office Instruction LIC-111, "Regulatory Audits" (ML19226A274).

Members of the audit team are listed below.

Name	Role
Matthew Gordon	Audit Leader, Lead Technical Reviewer
Christopher Adams	Technical Reviewer
Joseph Ashcraft	Technical Reviewer
Hanh Phan	Technical Reviewer, Project Lead
Lucieann Vechioli Feliciano	Project Manager
Adrian Muñiz	Project Manager
Michelle E. Vega Rodriguez	Associate Project Manager

On July 2, 2024, the NRC staff held an audit exit meeting with TEUSA and summarized the audit purpose, activities, and high-level results. The NRC staff requested the following information to be docketed to support the NRC staff's safety evaluation:

- Responses to audit Questions 2, 3, 12, & 13 (graphite and shutdown rod channels)
- Response to TEUSA-12 audit question
- Revisions to TEUSA-20 through 25
- TEUSA to remove references to the “reactor protection system” in several PDCs (e.g., TEUSA-12, TEUSA-15, etc.).

5.0 SUMMARY OF OBSERVATIONS

During the audit, the NRC staff reviewed the documents in the eRR and provided questions to TEUSA via Box for discussions during the audit meetings. TEUSA posted the NRC staff's questions and the associated written responses into the eRR to support the audit meetings between the NRC and TEUSA staff. During these meetings, the NRC and TEUSA staff discussed the questions and responses. The summary of the NRC staff's main observations is described below.

- The approach to PDCs 12 and 20 through 25 is affected by the safety classification of instrumentation and control (I&C) systems. TEUSA discussed its approach to I&C systems, including additional details in Revision B to the TR.
- TEUSA provided additional information regarding the irradiated fuel system to aid the NRC staff in their understanding of the cover gas and off-gas connections.
- TEUSA clarified the safety classification of the graphite moderator and shutdown rod channels.
- TEUSA discussed its deviation from the SFR-DC 26 language and its approach to satisfying TEUSA-26. TEUSA clarified that the graphite moderator will not be subject to PDC 36, Inspection of Emergency Heat Removal.

- TEUSA clarified that the shutdown rod channels in the graphite moderator will be subject to PDC 32, "Inspection of Primary Fuel Salt Boundary."

6.0 REQUESTS FOR ADDITIONAL INFORMATION RESULTING FROM AUDIT

At the conclusion of the audit, TEUSA committed to submit a revision to its TR to reflect some of the audit question responses as discussed above. The NRC staff is currently reviewing this revision submitted on July 22, 2024 (ML24204A092) and will determine if there is a need for requests for additional information.

7.0 OPEN ITEMS AND PROPOSED CLOSURE PATHS

There are no open items as a result of this audit.