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

U.S. NUCLEAR REGULATORY COMMISSION STAFF'S FEEDBACK REGARDING THE TERRESTRIAL ENERGY USA, INC. WHITE PAPER TITLED: "MODELING AND SIMULATION ACTIVITIES RELATED TO SOURCE TERM FOR IMSR DESIGN BASIS ACCIDENTS" (EPID: L-2024-LRO-0014)

SPONSOR INFORMATION

Sponsor: TERRESTRIAL ENERGY USA, INC. (TEUSA)

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Docket /Project No.: 99902076

DOCUMENT INFORMATION

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Submittal Agencywide Documents Access and Management System (ADAMS) Accession No.: ML24117A109

Purpose of the White Paper: TEUSA stated that the purpose of this white paper is to summarize the methodology, key parameters, and generic model of a molten salt reactor to calculate the radiological source term that is to be used for the radiological consequence analysis following a postulated design basis accident.

Action Requested: TEUSA requested the U.S. Nuclear Regulatory Commission (NRC) staff's feedback and observations regarding the information discussed in the white paper titled: "Modeling and Simulation Activities Related to Source Term for IMSR Design Basis Accidents" (TEUSA Document #TR240419) for the following:

- The design detail and modeling efforts for the key components associated with the primary loop and reactivity calculations.
- The reference Terrestrial Energy, Inc. calculation that is incorporated in the white paper.
- The NRC staff's view regarding specific data and information that would need to be collected through testing and research and development pertaining to reactor and fuel performance in order to provide sufficient confidence in the mechanistic approach.

FEEDBACK AND OBSERVATIONS

The feedback and observations regarding this white paper are preliminary and subject to change. The feedback and observations are not regulatory findings regarding any specific licensing matter and are not official agency positions.

Note: [[ ]] denotes proprietary information.

1. Section I, “Purpose,” states that the elements of this white paper follow the guidance outlined in Regulatory Guide (RG) 1.203, “Transient and Accident Analysis Methods.” However, during the public meeting held on June 20, 2024, (ML24179A177), TEUSA clarified that it is not committed to following RG 1.203, which is not required. If TEUSA does not follow RG 1.203, it should provide a sufficient basis to demonstrate that its methods and solutions conform with the applicable regulatory requirements for the issuance of a permit or license.

2. During the June 20, 2024, public meeting, TEUSA clarified its request that the NRC staff provide feedback on whether this white paper contains sufficient design information for the NRC staff to perform an independent assessment. This is, in part, addressed in Items 5, 6, and 7. If the NRC staff eventually determines that independent calculations are necessary for its safety evaluation in support of a future licensing action, it expects that more detail would be needed, especially for the fuel salt flow path and surroundings important to decay heat calculations. Section V, “Evaluation Model Development and Assessment Process,” provides some geometric information (e.g., dimensions) for the core (tables 4 and 5), **[[ ]]** (table 4), **[[ ]]** (table 7), **[[ ]]** (table 7), and primary heat exchanger (table 9). The NRC staff could get this information through normal processes such as a regulatory audit.

3. Any user, including TEUSA, intending to apply a generic modeling approach for the NRC staff’s evaluation, would need to demonstrate and justify that the model is sufficiently representative of its design and account for any attributes of its design that are not included in that model. Section V states that the methodology is limited to pool type molten salt reactors, low enriched uranium, graphite moderated core region, and fuel salt with no lithium or beryllium. TEUSA acknowledges this issue in Section V, which states that an applicant would have to confirm that the model addresses any unique phenomena specific to its design.

4. During the June 20, 2024, public meeting, the NRC staff and TEUSA staff discussed the limited amount of publicly available information regarding fuel salt composition as it relates to calculating source terms. TEUSA requested feedback regarding what test data is essential to obtain or what kinds of simulations can instead be performed. The NRC staff expects the Phenomena Identification and Ranking Table (PIRT) process to inform an applicant on what testing should be performed, and consideration should also be given to publicly available information regarding the types of tests done by other applicants (e.g., fuel qualification testing). Additionally, information regarding how fission products are transported in and released from the molten salt and what properties (e.g., viscosity) affect flow and the corrosion of components is useful. The simulations that TEUSA is referring to would need to be discussed in a future submittal. As discussed in RG 1.203, separate effects and integral test data are needed to show that an evaluation model can accurately

predict system behavior. A code-to-code comparison also can be used to demonstrate that an evaluation model can accurately predict system behavior.

5. Section V.1.4, “Regulatory Guide 1.203 Step 4 - Identify and Rank Key Phenomena and Processes,” discusses two PIRTs - a thermal-hydraulics (TH) PIRT and a reactor physics PIRT. **[[** **]]**

6. This item concerns appendix B: “Discussion of the PIRT activities related to Thermal Hydraulics Experimental Uncertainties” and section V.2.5, “Regulatory Guide 1.203 Step 9 - Determine Experimental Uncertainties as Appropriate.”

    a. **[[** **]]**

7. This item concerns section V.2.5, “Regulatory Guide 1.203 Step 9 - Determine Experimental Uncertainties as Appropriate,” which lists parameters directly relating to fission product release, including fission product vapor pressure and solubility in salt, uncertainties in chemical speciation, and uncertainties in bulk liquid and vapor mass transport. A future submittal should consider addressing the following questions:

    a. Where are the data for liquid and gas diffusivities obtained?

    b. Where is the information regarding Henry’s coefficients obtained?

    c. Are there data for **[[** **]]**?

    d. **[[** **]]**

    e. What distributions are proposed for the different uncertainty parameters? What is the technical basis for the chosen distribution shapes, modes, and lower and upper bounds, if applicable?

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