Request for Additional Information (non-proprietary)

By letter dated March 31, 2021, as supplemented June 23, 2021, August 4, 2021, and September 3, 2021, TN Americas LLC (TN) submitted to the U.S. Nuclear Regulatory Commission (NRC) an application for Certificate of Compliance (CoC) No. 1042, Amendment No. 3, to the NUHOMS® EOS System, pursuant to the requirements of Part 72 of Title 10 of the *Code of Federal Regulations*.

This request for additional information (RAI) identifies additional information needed by the NRC staff in connection with its review of this amendment application. Each RAI below describes information needed by the staff to complete its review of the subject application.

Principal Design Criteria RAIs:

RAI 2-1. Provide the following additional information to describe and support the requested amendment Change #8 that waives the fabrication pressure test required in American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section III, NB-6000 for the EOS-37PTH dry shielded canister (DSC) and the EOS-89BTH DSC with a single piece bottom forging:

1. Revisions to the NUHOMS® EOS Updated Final Safety Analysis Report (UFSAR) Section 1.2.1.1 to describe the ASME NB-6000 code alternative for the EOS-37PTH DSC similar to those provided in UFSAR, Section 1.2.1.2 for the EOS-89BTH DSC.

2. Revisions to drawing EOS01-1001-SAR that identifies the requested code alternative for the EOS-37PTH DSC with a single piece bottom forging.

3. Revisions to drawing EOS01-1006-SAR that identifies the requested code alternative for the EOS-89BTH DSC with a single piece bottom forging.

4. Revisions to UFSAR Section 2.4.1 which states that the DSC shell and bottom end assembly confinement boundary weld made during fabrication of the DSC is in accordance with the subsection NB of the ASME code.

UFSAR Section 2.4.1 states, “The confinement boundary weld between the DSC shell and inner top cover (including drain port cover and vent port plug welds) and structural attachment weld between the DSC shell and outer top cover plate are in accordance with alternatives to the ASME code as described in Section 4.4.4 of the Technical Specifications.” However, the application did not include revisions to UFSAR Section 2.4.1 to address the requested code alternative to the NB-6000 pressure test for the EOS-37PTH and the EOS-89BTH DSCs with a single piece bottom forging.

5. A description of the NDE requirements for the single piece bottom forging to shell weld, including the required radiographic testing (RT) image quality indicator (IQI) used and the RT acceptance criteria. Indicate whether the root pass is examined by penetrant testing (PT) and provide the PT acceptance criteria.

This information is needed to determine compliance with 10 CFR 72.236(b), (f) and (l).

RAI 2-2. Provide revisions to UFSAR Chapter 2 to describe and support the requested amendment Change #6 that reduces the transfer time to 8 hours for the EOS-37PTH with heat load zoning configuration (HLZC) 1 and 2. The application included changes to UFSAR Section 2.4.3 that references Technical Specifications (TS) limiting condition of operation (LCO) 3.1.3 which specifies transfer time limits for the EOS-89BTH DSC. UFSAR Section 2.4.3 does not include revisions that address the reduced transfer time for the EOS-37PTH DSC identified in TS LCO 3.1.3.

This information is needed to determine compliance with 10 CFR 72.236(b) and (f).

Structural RAIs:

RAI 3-1: Provide the following information with respect to the applicant's proposed two changes, (1) heat load capacity increases, and (2) additional heat load zone configurations (HLZCs):

(i) Identify any changes made (i.e., design functions and criteria, mechanical and thermal properties, stress and strain criteria with associated limits, methodologies, and assumptions) due to the heat load capacity increases or temperature changes based on additional applicant developed HLZCs to the structural design and analysis of the dry shielded canisters (DSCs), transfer casks (TCs), fuel baskets (FBs) and fuel cladding (FC);

(ii) If changes are made as described in (i), indicate whether safety evaluations for the structural design and analysis of the DSCs, TCs, FBs and FC with those changes are performed;

(iii) If no such safety evaluations as described in (ii) are performed, provide justification for not evaluating the DSCs, TCs, FBs and FC with any changes in (i) above in Chapter 3, "STRUCTURAL EVALUATION," of the UFSAR; and

(iv) Elaborate on the structural design functions that shall be considered based on the methodology in Chapter 3 of the UFSAR when there is an impact of temperature changes on the structural system, and specify the methodologies that are used from Chapter 3 of the updated final safety analysis report (UFSAR).

The applicant provided a statement in Section 2.4.3.1, "Methodology for Evaluating Additional HLZCs in EOS-89BTH DSC," in Chapter 2, "PRINCIPAL DESIGN CRITERIA," of the UFSAR, "*Based on the thermal evaluation in Step 2 and Step 3 (if applicable), the impact of temperature changes on structural design functions shall be considered based on the methodology in Chapter 3.*" There are no DSC structural design function changes reported in Chapter 3 due to the heat load capacity increases or the temperature changes based on additional applicant developed HLZCs.

This information is needed to determine compliance with 10 CFR 72.122(b) and 72.236(b).

RAI 3-2 (Proprietary): See Enclosure 2

Thermal RAIs:

RAI 4-1: Clarify how the ATRIUM-11 fuel assembly thermal properties are bounded by the bounding EOS-89BTH fuel assembly properties.

The staff reviewed the thermal properties (i.e., axial, and transverse thermal conductivity, specific heat, and density) for the ATRIUM-11 fuel assembly that were provided in the Standardized NUHOMS® Updated Final Safety Analysis Report (UFSAR) (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17094A720), as described in Section 4.9.1.2 of the EOS UFSAR. The Standardized NUHOMS UFSAR Section T.4.8.1.6 described that because the effective thermal conductivities were greater for the ATRIUM-11 fuel assembly than for the bounding fuel assembly, the bounding fuel assembly remained applicable. Similarly, as described in Section T.4.8.2 of the Standardized NUHOMS® UFSAR, the specific heat and effective density for the ATRIUM-11 fuel assembly were either the same as, or greater than that of the bounding fuel assembly, and therefore, the bounding fuel assembly remained appliable.

The staff compared the ATRIUM-11 fuel assembly properties to the EOS-89BTH bounding fuel assembly properties. The staff found that the ATRIUM-11 fuel assembly transverse thermal conductivity on page T.4-45a of the Standardized NUHOMS® UFSAR was not consistently greater than the EOS-89BTH bounding fuel assembly transverse thermal conductivity on page 4-16 of the UFSAR over the entire temperature range. The staff also found that the ATRIUM-11 axial thermal conductivity was not greater than the EOS-89BTH bounding fuel assembly axial thermal conductivity over the entire temperature range. The staff also found that the ATRIUM-11 effective specific heat in the Standardized NUHOMS® UFSAR on page T.4-46 was not consistently higher than the temperature dependent bounding effective specific heat values in the EOS Amd. 3 Table 4.9.1-7. Therefore, it is not clear how the ATRIUM-11 fuel assembly thermal properties are bounded by the bounding EOS-89BTH fuel assembly properties.

This information is needed to determine compliance with 10 CFR 72.236(f).

RAI 4-2: Clarify that for HLZCs that are asymmetric about the x-axis, the corresponding structural analyses are also addressed in item 1b) of Section 2.4.3.1 of the UFSAR.

As a follow-up to observation 4-6 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21126A036), and the clarification call on July 14, 2021 (ADAMS Accession No. ML21195A370), item 1b) of Section 2.4.3.1 of the UFSAR addresses thermal models for asymmetric HLZCs about the x-axis, but does not address the corresponding structural analyses. Depending on the degree of heat load asymmetry, asymmetric loading patterns could create unanalyzed thermal stresses in the basket and DSC. Addressing the corresponding structural analyses within item 1b) of Section 2.4.3.1, in addition to the impact of temperatures changes on the structural design functions that shall be considered based on the methodology in Chapter 3 as is already described within item 4) of Section 2.4.3.1, would provide reasonable assurance that the thermal models and corresponding structural analyses, e.g., basket and DSC stresses, capture the impact of the asymmetric HLZC on the EOS system.

This information is needed to determine compliance with 10 CFR 72.236(f).

RAI 4-3: Clarify the minimum blocked vent accident condition durations in item 2b) in Section 2.4.3.1 of the UFSAR, and the minimum transfer time limits in item 2c) in Section 2.4.3.1 of the UFSAR.

Section 5.1.3.1 of the NUHOMS® EOS System Technical Specifications (TS) specifies in multiple locations that: the EOS-HSM air vents are not blocked for more than 40 hours; the duration of a damaged or lost wind deflector will not exceed periods longer than 40 hours; and if measurements or other evidence indicate that the EOS-HSM concrete temperatures have exceeded the concrete accident temperature limit of 500 °F for more than 40 hours, the user shall perform an analysis and/or tests. This is similarly described in Section 5.1.3.2 of the TS for the EOS-HSM-MX, but for 32 hours. However, Section 2.4.3.1 of the UFSAR specifies that in item 2b) that the thermal evaluations based on the storage and transfer configuration described in item 1) of Section 2.4.3.1 of the UFSAR shall be performed for each new HLZC to demonstrate that the minimum blocked vent accident condition durations specified in Section 5.1.3.1 of the TS for EOS-HSM and Section 5.1.3.2 of the TS for EOS-HSM-MX are satisfied. Satisfying the minimum blocked vent accident condition durations could be interpreted as being longer than 40 hours for the EOS-HSM, or longer than 32 hours for the EOS-HSM-MX, which would not meet the TS. Therefore, the language in Section 2.4.3.1 of the UFSAR item 2b) should be clarified to avoid confusion within the methodology.

Similarly, in Section 2.4.3.1 of the UFSAR item 2c), it should be clear that the transfer time limit required per limiting condition for operation (LCO) 3.1.3 of the TS are satisfied (at the maximum heat load allowed per each HLZC). According to note 1 of LCO 3.1.3, if the decay heat is less than the 48.2 kW for the EOS-89BTH, a new transfer time limit can be calculated, using the same methodology in the UFSAR, to provide additional time for transfer operations; however, the calculated transfer time should not be less than the transfer time limit specified in LCO 3.1.3. Provided the decay heat is less than the maximum decay heat (given there are no other design changes to the DSC or transfer cask, or content changes), a transfer time limit for the HLZC that is greater than the transfer time limits in LCO 3.1.3 satisfies LCO 3.1.3; however, a transfer time limit that is less than the transfer time limits in LCO 3.1.3 does not satisfy LCO 3.1.3. Therefore, the language in Section 2.4.3.1 of the UFSAR item 2c) should also be clarified to avoid confusion within the methodology. Note, consideration should be given to Section B.4.5.6.4 of the UFSAR, in which the choice of transfer time limit considered additional margin to the temperature limit when determining the appropriate LCO 3.1.3 transfer time limit; this is especially relevant when a new HLZC shows allowable temperatures would be reached near the current LCO 3.1.3 8 hour transfer time limit using Figure 11 of the TS.

This information is needed to determine compliance with 10 CFR 72.236(f).

RAI 4-4: Clarify in Section 2.4.3.1 of the UFSAR how content changes that do not appear in the CoC or TS but do explicitly affect the thermal model would warrant a thermal review.

Content changes that do appear in the TS and/or the CoC would result in an amendment request and a thermal review with justification necessary to be provided by the applicant to demonstrate that the methodology in Section 2.4.3.1 is valid for the content changes. However, content changes that do not appear in the TS or CoC could also necessitate a thermal review; although, as Section 2.4.3.1 of the UFSAR is currently written, would not necessarily result in a thermal review. For example, if the fuel assembly effective thermal conductivity, density, or specific heat for an existing approved content is changed, that could affect the thermal model beyond changing the HLZC, and it is not clear from Section 2.4.3.1 of the UFSAR whether that content change would be thermally reviewed in an amendment request. Therefore, specifying in broad terms within the methodology described in Section 2.4.3.1 of the UFSAR how content changes would lead to a thermal review would provide reasonable assurance that the methodology in Section 2.4.3.1 is not obviating the need for a thermal review.

This information is needed to determine compliance with 10 CFR 72.236(f).

RAI 4-5: Clarify in Section 2.4.3.1 of the UFSAR and in the TS Figure 11 whether each new applicant developed HLZC will be evaluated by the applicant for a specific basket type based on the methodology in Section 2.4.3.1 of the UFSAR, and address if the thermally bounding neutron poison option is used in Section 2.4.3.1 of the UFSAR.

Table 1-2 and page 1-4 of the UFSAR each specify the basket type that is evaluated along with the specific HLZC (i.e., basket Type 1). It is not clear in Section 2.4.3.1 whether a specific basket type is also evaluated with a specific applicant developed HLZC as part of the methodology. The basket type does have a thermal influence on the thermal analysis model results, and therefore, not specifying a basket type for each applicant developed HLZC would be an unanalyzed condition. The basket type appears to be indicated by the use of the number 1 in the TS Figure 11, “Maximum Heat Load Configuration 1 for EOS-89BTH DSC (MHLC-89-1) Transferred in the EOS-TC125,” however, that could be more explicitly clarified.

For example, for the EOS-89BTH Type 1, 2, and 3 baskets there are three types of neutron poison options (as shown on page 1-4 of the UFSAR), and it should be clear in Section 2.4.3.1 of the UFSAR that the bounding option is used. Also, for example, the Type 4 basket in the EOS-37PTH has high and low emissivity and poison conductivity values (that does not appear to impact this amendment request); however, this specificity might be necessary to consider in a future amendment request.

This information is needed to determine compliance with 10 CFR 72.236(f).

RAI 4-6 (Proprietary): See Enclosure 2

Confinement RAI:

RAI 5-1: Clarify and update the NUHOMS® EOS Safety Analysis Report (SAR) language that references the pressure test according to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III, Subarticle NB-6300.

There are a number of instances in the NUHOMS® EOS SAR where the new text for Amendment 3 does not convey a clear intent as to the type of acceptance test that is referenced. For example, the new text in SAR Section 10.1.1.1 stated that "… the fabrication leak test may be waived." However, the next sentence refers to a "pressure test." The sentence that follows is clear and explicitly mentions the "… helium leak test of Section 10.1.2." Another example is found in the table entitled, "EOS-37PTH and EOS-89BTH DSC ASME Code Alternatives, Subsection NB," in Technical Specification Section 4.4.4 (page 4-7), which refers to a "fabrication leak test" and "pressure test." Likewise, the new text in SAR Section 3.9.1.2.7.2 entitled, "Fabrication Pressure and Leak Testing," focuses on a "pressure test." The differentiation between a helium leak test according to the American National Standards Institute (ANSI) N14.5 versus a "fabrication leak test" and "pressure test" is not easily discernible among these select SAR sections; this is to be corrected because the important to safety confinement boundary's pressure test and helium leak test per ANSI N14.5 are distinct acceptance tests with different purposes and sensitivities.

This information is needed to determine compliance with 10 CFR 72.236(d), (j), and (l).

Shielding RAIs:

RAI 6-1: Provide the design parameters for the ATRIUM 11 boiling water reactor (BWR) fuel assembly used in the source term and shielding calculations.

The applicant states that the GNF2 fuel assembly type is used to bound all fuel assembly types except for ABB-10-C and ATRIUM 11 class fuel, which are treated separately. However, the applicant did not provide information about the ATRIUM 11 fuel assembly class in the Shielding Chapter.

This information is needed for the staff to confirm compliance with 10 CFR 72.236(b) and 10 CFR 72.236(d).

RAI 6-2: Provide an ATRIUM 11 fuel assembly drawing or a picture showing the locations of the water rods and partial length rods.

The applicant states that the GNF2 fuel assembly type is used to bound all fuel assembly types except for ABB-10-C and ATRIUM 11 class fuel, which are treated separately. However, the applicant did not provide information about the ATRIUM 11 fuel assembly class in the Shielding Chapter.

This information is needed for the staff to confirm compliance with 10 CFR 72.236(b) and 10 CFR 72.236(d).

RAI 6-3: Demonstrate that the ATRIUM 11 fuel assembly is bounded by the design basis BWR 7x7 fuel assembly.

The applicant states that the GNF2 fuel assembly type is used to bound all fuel assembly types except for ABB-10-C and ATRIUM 11 class fuel, which are treated separately. However, the applicant did not provide information about the ATRIUM 11 fuel assembly class in the Shielding Chapter.

This information is needed for the staff to confirm compliance with 10 CFR 72.236(b) and 10 CFR 72.236(d).

RAI 6-4: Provide burnup profile used for the ATRIUM 11 fuel assembly source term calculation and how partial length rods were treated in this calculation.

The applicant states that the GNF2 fuel assembly type is used to bound all fuel assembly types except for ABB-10-C and ATRIUM 11 class fuel, which are treated separately. However, the applicant did not provide information about the ATRIUM 11 fuel assembly class in the Shielding Chapter. The applicant should clarify what axial profile assumptions were used in the depletion analysis for the ATRIUM 11 fuel assembly, including how the short and long partial length rods were treated in the source term analysis.

This information is needed for the staff to confirm compliance with 10 CFR 72.236(b) and 10 CFR 72.236(d).

Acceptance Tests RAIs:

RAI 10-1. Provide the following additional information on the proposed phased array ultrasonic testing (UT) system for the detection of flaws in the multi-pass gas tungsten arc welding (GTAW) and single pass high amperage gas tungsten arc welding (HA-GTAW) outer top cover plate (OTCP) welds:

1. Clarify whether the proposed phased array ultrasonic testing (UT) system would be used to inspect the multi-pass gas tungsten arc welding (GTAW) as an alternative to the multi-level PT examination.

2. Describe the type, size, and orientation of the flaws that may be present in the OTCP weld(s) examined using the phased array UT system.

3. Describe the UT demonstration procedure including the mockup(s) for the OTCP weld(s) including the single-pass HA-GTAW weld and, if applicable, the multi-pass GTAW weld, a description of the type, size, and orientation of flaws in the that will be inserted into the OTCP weld mockup(s) to represent the flaws that may be present in the OTCP weld(s), the required probability of detection (POD) for the phased array UT of the OTCP weld(s), and how the POD will be determined.

It is not clear whether the phased array UT examination, conducted from the external surface of the OTCP, will be able to detect and size weld flaws such as lack of fusion. For the multi-pass GTAW OTCP weld, phased array UT was shown to be an acceptable method for lack of fusion flaws when the examination was conducted from the outer diameter of the DSC shell (ML16159A227). The phased array UT application reviewed by the NRC in ML16159A227 was determined to be acceptable because the procedure was qualified using a blind performance demonstration in accordance with ASME B&PV Code Section V, Article 14, T-1424(b) with Intermediate Rigor that qualifies the equipment, procedure, and data analysis personnel for the detection and dimensioning of welding fabrication flaws. The previous demonstration does not appear to be applicable to the phased array UT described in the current application because the proposed phased array UT would be conducted from the outer surface of the OTCP rather than the external surface of the DSC shell. Further, the weld joint geometry of the single-pass HA-GTAW OTCP weld appears to be a narrow grove weld. Lack of fusion flaws in the single pass HA-GTAW OTCP weld are likely to be oriented perpendicular to the exterior surface of the OTCP. Because of this likely flaw orientation, it is not clear that the proposed phased array UT method from the exterior of the OTCP will be able to detect and adequately size a lack of fusion flaw in the single-pass HA-GTAW OTCP weld.

This information is needed to determine compliance with 10 CFR 72.236(l).