Request for Supplemental Information (non-proprietary)

By letter dated February 15, 2018, TN Americas LLC (TN) submitted to the U.S. Nuclear Regulatory Commission (NRC) an application for Certificate of Compliance No. 1042, Amendment No. 1 to the NUHOMS® EOS System, pursuant to the requirements of Part 72 of Title 10 of the *Code of Federal Regulations* (10 CFR 72).

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

Criticality/Shielding RSIs:

RSI 1-1
Provide parameters that explicitly define the requested new contents to be stored in the NUHOMS EOS system.

The applicant provides some general parameters, such as general fuel array sizes (e.g., 17x17, 15x15 PWR fuel), that are to be stored in the requested new baskets and basket configurations in the revised safety analysis report (SAR) and proposed revision of the certificate of compliance. However, these parameters are not sufficient to characterize the fuel for the safety analyses. For example, criticality and shielding analyses need the fuel assembly geometry, rod and cladding length and diameters, rod pitch, and depletion parameters to determine the neutron multiplication factor and the neutron and gamma sources per the regulatory requirements of 10 CFR 72.236(a), 10 CFR 72.124, and 10 CFR 72.236(d). Although the applicant indicates in Section 2.2 of the SAR that the fuel characteristics are provided in Table 2-4 of the SAR, the staff was unable to find this table. The applicant needs to provide parameters, such as fuel assembly geometry, rod and cladding length and diameters, and rod pitch that can unambiguously define the fuel designs that are allowed to be stored in the EOS system as well as the parameters used to perform its safety analyses of the cask system design within Chapters 6 and 7 of the SAR so that the staff may determine if the safety analyses are bounding for the proposed allowable contents.

This is consistent with the acceptance criteria and review guidance provided in NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems." Specifically, Section 6.5.2 of NUREG-1536 states, "The review confirms that the applicant examined all fuel designs and burnup conditions for which the cask system is to be certified, to ensure that the bounding fuel type and values are used." Section 7.5.2 of NUREG-1536 references NUREG-1745 which states in Section 2.0 "Approved Contents" that the "list is intended for intact fuel. As a result, the list may need to be modified if damaged fuel or fuel debris is stored in the cask."

The staff needs this information to proceed with its review to determine if the NUHOMS EOS system with the requested new contents meets the regulatory requirements of 10 CFR 72.124 and 10 CFR 72.236(d).

RSI 1-2
Provide drawings with dimensions and potential manufacturing tolerances for the new basket design.

The amendment incorporates a new Basket Type (Type 4) to allow for damaged and failed fuel compartments as well as a low-conductivity, low-emissivity poison plate basket option (Type 5). The applicant provides drawings for the new basket type. However, these drawing do not include dimensions and potential manufacturing tolerances. In particular, the drawings do not include information on the basket cells that are designated to hold failed fuels. Because the dimensions and associated tolerances are critical parameters in criticality and shielding safety analysis models, the applicant needs to revise the drawings to include these data. This is consistent with the acceptance criteria and review guidance provided NUREG-1536. Specifically, Section 6.5.3.1 of NUREG-1536 states: "The reviewer should verify that the model dimensions and materials are consistent with those specified in the cask drawings presented in Chapter 1, "General Information Evaluation" of the SAR. Voids, streaming paths, and irregular geometries should be accounted for or otherwise treated in a conservative manner." Section 7.5.3.1 of NUREG-1536 states, "Tolerances for poison material dimensions and/or concentrations should be defined, and the most reactive conditions should be used in the criticality analysis."

The staff needs this information to proceed with its review to determine if the NUHOMS EOS system with the requested new contents meets the regulatory requirements of 10 CFR 72.124 and 10 CFR 72.236(d).

RSI 6-1
Provide inspectable parameters for fuel and Non-Fuel Hardware (NFHW) that correlate the radiation source terms with the decay heat limits or parameters that characterize the radiation source terms as a function of enrichment, burnup and cooling time for all of the new requested contents and loading patterns.

In Chapter 6 of the revised SAR, the applicant provides neutron and gamma sources for some combinations of enrichments, burnup and cooling times. However, it is not clear how the source terms are related to the decay heat limit. It is not clear whether these data bound all potential combinations of enrichments, burnup and cooling times for all requested new fuels, including failed fuels, and other non-fuel hardware contents. Because these parameters are critical for shielding design, fuel selection and qualification for the licensees, and the NRC inspectors to verify whether the selected fuels and NFHW qualify for storage in the NUHOS EOS system based ISFSI, the applicant needs to provide these data in the SAR. This is consistent with the acceptance criteria and review guidance provided in NUREG-1536. Specifically, Section 6.5.2 "Radiation Source Definition" of NUREG-1536 states: "The reviewer should examine the description of the design-basis fuel in Chapter 2, "Principal Design Criteria" of the SAR to verify that the applicant calculated the bounding source term. The review confirms that the applicant examined all fuel designs and burnup conditions for which the cask system is to be certified, to ensure that the bounding fuel type and values are used." Section 6.5.2.1, "Initial Enrichment" of NUREG-1536 states: "However, the staff should not attempt to use specific source terms as bases for establishing operating controls and limits for cask use because these are not readily inspectable parameters. The fuel assembly initial enrichment, burnup, and cooling time are more appropriate for use as loading controls and limits."

The staff needs this information to proceed with its review to determine if the NUHOMS EOS system with the requested new contents meets the regulatory requirements of 10 CFR 72.236(d).

RSI 6-2
Demonstrate how the failed fuel retains its geometric shape that is consistent with the assumption used in the shielding analyses or provide shielding analyses consistent with the potential fuel geometry changes during operations.

The new basket type (Type 4) allows for storage of failed fuel in the canister. However it is not clear how the geometric shape of the failed fuel is retained, in particular with consideration of the fact that the basket is loaded in vertical position and then turned into horizontal position when it is moved and eventually stored in the concrete module. The applicant needs to provide information on how the geometric shape is retained by the cask design and provide appropriate shielding analyses consistent with the potential changes of fuel geometry during normal, off normal, and accident conditions with the specific design feature, including the operations, of the system. The staff needs this information to perform its evaluation of the shielding design of the NUHOMS EOS system per the acceptance criteria of NUREG-1536, "Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility," which states: "If the applicant has requested storage of damaged fuel assemblies, ensure that the applicant has adequately described the proposed damage assemblies. If the fuel assemblies are damaged to the extent that reconfiguration of the fuel into a geometry different from intact fuel assemblies can occur, ensure that the applicant provides appropriate close assessments for normal, off-normal and accident conditions." NUREG-1536 further states: "On the basis of experience, comparison to similar systems, or scoping calculations, the reviewer should make an initial assessment of whether the dose rates appear reasonable and whether their variation with location is consistent with the geometry and shielding characteristics of the cask system." The staff needs this information to perform its evaluation of the shielding design of the NUHOMS EOS system per the acceptance criteria of NUREG-1536.

The staff needs this information to proceed with its review to determine if the NUHOMS EOS system with the requested new contents meets the regulatory requirements of 10 CFR 72.236(d).

Materials RSIs

RSI 8-1
Explain how the use of basket end caps and a modified basket is an acceptable alternative to the use of a failed fuel can for the storage of failed fuel described in UFSAR, Section 1.2.3.1 (ML18053A234). Explain how loading of failed fuel will be accomplished without dispersing fuel fragments into other basket cells that are not intended for the storage of damaged or failed fuel. In addition, describe how a general licensee will determine whether the fuel should be classified as damaged fuel or failed fuel. The descriptions in the Technical Specifications (TS) Section 1.1 are not consistent with NUREG-1536 Revision 1 Section 8.4.17.2 Fuel Classification. It is not clear in the TS or the UFSAR how a general licensee will determine if fuel assemblies with greater than hairline cracks or greater than pinhole leaks could be handled by normal means and whether such assemblies should be classified as damaged fuel or failed fuel.

The NRC staff note that NUREG-1536, Revision 1, Section 8.6, "Supplemental Information for Methods for Classifying Fuel" contains the following information:

C. Canning Damaged Fuel

Spent fuel that has been classified as damaged for storage must be placed in a can designed for damaged fuel, or in an acceptable alternative. The purpose of a can designed for damaged fuel is to (1) confine gross fuel particles, debris, or damaged assemblies to a known volume within the cask; (2) to demonstrate that compliance with the criticality, shielding, thermal, and structural requirements are met; and (3) permit normal handling and retrieval from the cask. The can designed for damaged fuel may need to contain neutron-absorbing materials, if results of the criticality safety analysis depend on the neutron absorber to meet the requirements of 10 CFR 72.124(a).

The basket and end caps described in the amendment application appear to be sufficient to (1) confine gross fuel particles, debris, or damaged assemblies to a known volume within the cask and (2) to demonstrate that compliance with the criticality, shielding, thermal, and structural requirements are met but it is unclear how the basket and end caps are an acceptable alternative that would (3) permit normal handling and retrieval from the cask because as stated in the amendment TS, failed fuel cannot be handled by normal means. It is noted that the amendment application defines retrievability as removing a dry shielded canister (DSC) loaded with spent fuel assemblies from the storage location consistent with Option C in ISG-2 Revision 2 (ML16117A080).

This information is necessary to assure compliance with 10 CFR 72.236(a), (h) and (m).

RSI 8-2
Provide a description of EOS-37PTH DSC payloads that contain the control components (CCs), identified in UFSAR, Section 2.2.1 (ML18053A234) and indicate whether these contents are consistent with the component materials previously reviewed and determined acceptable as described in NUREG-1536, Revision 1, Section 8.4.8.2, “Canister Contents.” Provide a detailed description of any component material that is not determined acceptable per NUREG-1536, Revision 1, Section 8.4.8.2.

This information is necessary to assure compliance with 10 CFR 72.236(a), (b) and (h).

RSI 8-3 (proprietary)
See Enclosure 2

RSI 8-4
Provide the procedure and specifically describe the loading and unloading steps for the damaged fuel and failed fuel. Address, as necessary, the testing of fission gases, radiation dose rates and ALARA practices, removal of top and bottom end caps and the recovery of failed fuel that cannot be handled by normal means. Based on a review of previous TN Americas CoCs, the procedures for removing damaged or failed fuel require additional steps that are not included in EOS UFSAR, Revision 1.

UFSAR 9.2.2 Removal of Fuel from the DSC (ML18053A234) states the following:

Note that the EOS-37PTH DSC will provide the retrievability function for damaged and failed FAs per ISG-2, Revision 2. However, if it is necessary to remove fuel from the DSC, intact and damaged fuel can be removed in a dry transfer facility or the initial fuel loading sequence can be reversed and the plant's spent fuel pool utilized.

Procedures for wet unloading of the DSC are presented here. Dry unloading procedures are essentially identical up to the removal of the DSC vent plug and drain port cover.

However, no procedures are provided for the removal of damaged or failed fuel.

This information is necessary to assure compliance with 10 CFR 72.236(h).

RSI 8-5
Clarify UFSAR, Table 8-10, "Material Properties, High Strength Low Alloy Steel" to identify the reference for Note 5 (ML18053A234).

Note 5 is included in the footnotes for Table 8-10 and specifies room temperature yield strength and ultimate strength requirements for ASTM A829 Grade 4130 steel. The yield strength and ultimate strength requirements listed in Note 5 are not consistent with the entries in Table 8-10. There is no reference or call out to Note 5 identified in the actual table.

This information is necessary to assure compliance with 10 CFR 72.236(b).

RSI 8-6
Clarify the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) code year and section for the basket structural components and identify the grades of the SA-517 materials used in the construction of the basket. UFSAR, Section 10.1.7, "High-Strength Low-Alloy Steel for Basket Structure" (ML18053A234) states:

The basket structural material shall be a High-Strength Low-Alloy (HSLA) steel meeting one of the following requirements A, B, or C:

A. ASTM A829 Gr 4130 or AMS 6345 SAE 4130, quenched and tempered at not less than 1050 °F. This material is qualified as described in [10-31].
B. ASME SA-517 Gr A, B, E, F, J, or P. This material is qualified by the material properties at elevated temperature in ASME Section II, Part D, which exceed the values of yield and ultimate strength in UFSAR Table 8-10.
C. Other HSLA steel, with the specified heat treatment, meeting these qualification criteria:

UFSAR requirement B identifies ASME SA-517 grades A, B, E, F, J and P. Technical Specification 4.4.2 (ML18053A233) identifies the ASME B&PV code 2010 with the 2011 addenda as the code for the DSC but there is no code identified for the basket. In the ASME B&PV code 2010 with the 2011 addenda, the specifications for ASME SA-517 do not identify a grade J. ASME SA-517 grades A, B, E, F, and P have lower allowable yield strengths (100 ksi) and ultimate strengths (115 ksi) compared to the 103.6 ksi yield strength and the 123.1 ksi ultimate strength identified in the next paragraph in UFSAR, Section 10.1.7 (ML18053A234) and also included in Note 5 of UFSAR Table 8-10. Except for grades A and B, the grades listed for SA-517 have different thicknesses and the yield and ultimate strength of these materials generally decrease as the thickness increases. Grade P (2.5 to 4 in) has a lower allowable yield and ultimate compared to grades A, B, E, and F. The ASME B&PV code 2010 with the 2011 addenda Section IID allowable yield strength for SA-517 grade P (2.5 to 4 in) as 90 ksi which is below the yield strength requirements in UFSAR Table 8-10 for temperatures from -20 to 200°F.

This information is necessary to assure compliance with 10 CFR 72.236(b) and (g).

Materials Observations

Observation 8-1
UFSAR, Section 2.2, 2nd paragraph (ML18053A234) states:

> *Damaged and failed fuel that meet the characteristics detailed in Table 2-2 and Table 2-4 are also acceptable for storage in the EOS-37PTH DSC in the appropriate compartments as shown in Figures 1F and 1H of the Technical Specifications [2-18].*

The staff notes that Table 2-4 has both PWR and BWR fuel assembly design characteristics and the amendment application does not seek the approval for the storage of damaged BWR fuel. The statement in UFSAR, Section 2.2, and the tables should be revised to be specific to PWR fuel.

This information is necessary to assure compliance with 10 CFR 72.236(a) and (b).

Observation 8-2
UFSAR Section 2.2, 9th paragraph (ML18053A234) states:

> *The NUHOMS® EOS-37PTH DSCs can also accommodate up to a maximum of four compartments with failed fuel, placed in cells located on the outer edge of the DSC as shown in Figures 1F and 1H of the Technical Specifications [2-18]. Failed fuel is defined in Section 2.1 of the Technical Specifications [2-18].*

The staff note that the definition of failed fuel is in Section 1.1 of the TS (page 1-2) (ML18053A233). Section 2.1 of the TS indicates how many failed fuel assemblies may be stored in the EOS-37PTH (page 2-1). The statement should be clarified to indicate what information in the TS is being referenced.

This information is necessary to assure compliance with 10 CFR 72.236(a) and (b).

Thermal Observations:

Observation 4-1
Provide justification for not performing daily visual inspection of HSM-MX wind deflectors, or modify TS 5.1.3.2.a and 5.5 to describe daily visual inspection of wind deflectors.

Section A.1.2.1 of the UFSAR states, “Wind deflectors are integrated to the outlet vent covers and installed on the top of the HSM-MX to mitigate the effect of sustained winds for high heat load DSCs.” TS5.1.3.1.a.ii describes daily visual inspection of wind deflectors which is required, per TS 5.5 for the EOS-HSM, for certain heat load, HLZC, and DSC conditions. Yet the HSM-MX is not addressed in TS 5.5 and there is no analogous TS to 5.1.3.1.a.ii in TS 5.1.3.2.a for daily visual inspection of wind deflectors on the HSM-MX. Alternatively, justification for not performing daily visual inspection of HSM-MX wind deflectors should be provided.

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

Observation 4-2
Provide additional description that addresses how the user will develop a daily temperature measurement program to verify the thermal performance of each HSM-MX System through the direct measure of the HSM-MX concrete temperature in TS 5.1.3.2.b.ii.

TS 5.1.3.2.b.ii. describes that the user shall establish in the program concrete measurement locations in the HSM-MX that are representative of the HSM-MX thermal performance and directly correlated to the predicted fuel cladding temperatures, air mass flow rates, and NUHOMS MATRIX System temperature distributions that would occur with the off-normal and accident blockage conditions, as analyzed in the UFSAR. It is not clear how the concrete measurement locations in the HSM-MX are chosen, and then how the concrete measurement locations are directly correlated to the predicted fuel cladding temperatures, air mass flow rates, and NUHOMS MATRIX System temperature distributions.

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

Observation 4-3
Provide a detailed list of the applicable thermal calculation package(s) for the thermal evaluation in Appendix A.4 of the UFSAR.

Appendix A.4 of the application provides a summary of the applicant's thermal evaluation for storage. Due to the new HSM-MX design and decay heat load, a detailed list of the thermal calculation package(s) for the thermal evaluation in Appendix A.4 of the application should be provided so that the staff will have a clear understanding of what is in the calculation package(s). In addition, the staff may request any or all of the documents during the review to assist in understanding the details of and provide justification for the applicant's thermal evaluation. The details and justification for the thermal evaluation should appear in the calculation package(s) and that information may assist the staff to more efficiently perform the review.

This information is needed to determine compliance with 72.236(f) and (l).

Observation 4-4 (Proprietary)
See Enclosure 2

Confinement Observation:

Observation 5-1
Provide information to clarify how the end cap with multiple through holes will contain any potential fuel debris if fuel were to rubblize due to unexpected events during on-site transfer or insertion of the DSC into EOS-HSM.

FSAR Section 5.1 Confinement Boundary states, "*For damaged and failed assemblies, top and bottom caps are provided to contain any potential fuel debris, such as broken rods, loose pellets, and/or pieces of cladding in the fuel compartment. The end caps fit snugly into the top and bottom of the fuel compartment. They are held in place by the fuel compartments and the inner bottom cover plate and the top shield plug during transfer and storage. The end caps have multiple through holes to permit unrestricted flooding and draining of the fuel compartments.*"

It’s not clear to staff that for damaged and failed assemblies loaded in DSC, the end caps with multiple through holes are able to contain the potential fuel debris, loose pellets and/or pieces of cladding if rubblized into tiny pieces (e.g., fines) due to unexpected events during on-site transfer or insertion of the DSC into EOS-HSM (horizontal storage modulus). Irradiated fuel debris escaping from the end caps of the fuel compartment could potentially cause a safety issue.

The applicant should provide information (e.g., configuration of end cap, size of holes, etc.) for clarification.

This information is needed to determine compliance of 10 CFR 72.236(e).