Orano TN
7160 Riverwood Drive
Suite 200
Columbia, MD 21046
USA
Tel: 410-910-6900
Fax: 434-260-8480

August 12, 2022
E-61342

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Subject: Response to Request for Supplemental Information – Application for Amendment 18 to Standardized NUHOMS® Certificate of Compliance No. 1004 for Spent Fuel Storage Casks, Revision 1 (Docket No. 72-1004, CAC No. 001028, EPID: L-2022-LLA-0079)

Reference: Letter from Chris Allen (NRC) to Prakash Narayanan (TN Americas LLC), Acceptance Review of Amendment No. 18 to Certificate of Compliance No. 1004 for the Standardized NUHOMS® System – Supplemental Information Needed, dated August 5, 2022

TN Americas LLC (TN) hereby submits our response to the Request for Supplemental Information (RSI) and Observation (OBS) forwarded by the letter referenced above. Enclosure 1, herein, provides the responses to the RSIs and OBS.

The Proposed CoC 1004 Amendment 18, Revision 1 changes to the Standardized NUHOMS® System Updated Final Safety Analysis Report (UFSAR) changed pages are included as Enclosure 2. The new UFSAR changes associated with the RSI and OBS responses are indicated by italicized text and revision bars, and further annotated using gray shading of the changed areas and an indication of which RSI or OBS is associated with the changes.

Should you have any questions regarding this submittal, please do not hesitate to contact Mr. Douglas Yates at 434-832-3101 or me at 410-910-6859.

Sincerely,

A·Prakash

Prakash Narayanan
Chief Technical Officer

cc: Chris Allen, NRC DFM

Enclosures:

1. RSI/OBS and Responses
2. Proposed Amendment 18, Revision 1 Changes to the Standardized NUHOMS® System Updated Final Safety Analysis Report

Thermal RSIs

RSI 4.1:

Provide justification for removing Certificate of Compliance (CoC) No. 1004 Appendix A technical specification (TS) 4.4, “HSM Maximum Air Exit Temperature with a Loaded DSC.”

The requirements in the CoC No. 1004 Appendix A TS 4.4 have been included since the CoC No. 1004 initial issuance. The satisfaction of the limiting condition for operation maximum air temperature rise on exit from the horizontal storage module (HSM) gives a reasonable degree of assurance that adequate cooling is achieved. As described in the CoC No. 1004 Appendix A TS 4.4, these measurements shall be repeated on a daily basis after insertion into the HSM or every 24 hours following the occurrence of an accident event, until an equilibrium condition is achieved. It is not clear how the operating experience demonstrates that this requirement is no longer necessary considering this TS measurement demonstrates that the fabricated system as loaded, and following the occurrence of an accident event, provides a reasonable degree of assurance that adequate cooling is achieved.

The above information is necessary to comply with Title 10 of the *Code of Federal Regulations* (10 CFR) 72.236(f).

Response to RSI 4.1:

TN Americas LLC (TN) concurs with the assessment that the air temperature rise measurement provides a reasonable degree of assurance that adequate cooling is achieved. Extensive operating experience associated with measuring the system’s thermal performance did not exist when CoC 1004 was initially issued. Since a significant experience base did not initially exist, the HSM maximum air exit temperature data collection was prudent to ensure that the system was performing as designed after initial DSC loading and that adequate cooling was achieved.

Vast operating experience now exists and TN canvassing of general licensees, as well as TN experience, indicates that there is no known instance where a dry shielded canister (DSC) was unloaded from an HSM due to this surveillance. That experience led to TN not proposing a similar surveillance in CoC 1042, TN’s newest NUHOMS® technology design, and NRC review found this acceptable.

The air temperature rise measurement is influenced by the dimensions of the DSC and the HSM (such as the HSM cavity and inlet/outlet vents) and the heat load of the DSC that is being loaded.

Thermal performance of system components, as designed, is ensured by adherence to 10 CFR Part 72 Subpart G, Quality Assurance. Fabrication of DSCs and HSMs are in strict accordance with the governing codes and standards. Procurement and fabrication processes are controlled by an approved quality assurance program, thereby providing reasonable assurance that the fabricated systems function as designed. The small tolerances permitted during fabrication for these components will not create a measurable impact on the air temperature measurement.

Similarly, the heat load of a loaded DSC is based on the heat load of the individual fuel assemblies. The heat load of the fuel assemblies is developed based on approved quality assurance programs and appropriate candidates are selected for loading into a DSC by the general licensee. There are numerous administrative controls throughout the entire process that ensure the correct fuel assemblies are identified and loaded into the DSC.

Therefore, the controls used during the fabrication of the systems and determination of the heat load for a given DSC make the air temperature rise measurement redundant considering the same measurements have been taken for hundreds of systems.

It is important to note that the requested removal of this initial temperature measuring requirement would not result in the removal of any physical temperature monitoring equipment and thermal performance would continue to be ensured by the HSM Thermal Monitoring Program governed by CoC 1004 Appendix B Technical Specification 4.3.6. Additionally, after initial DSC loading, dose rates are also measured and compared to limits contained in CoC 1004 Appendix A ITE 3.3 to validate system functionality.

The surveillance activities (visual or temperature monitoring) required per the HSM Thermal Monitoring program will ensure that licensees identify any potential conditions that could result in a blocked vent condition and the subsequent corrective actions to clear the blockage. Once the blocked vent conditions are cleared the system is restored to its original state and there are no other factors that could negatively impact the thermal performance.

Impact:

No change as a result of this RSI.

Criticality RSIs

RSI 7.1

Provide information about the cross section data used to perform the criticality analyses.

The applicant's submittal indicates that a new computer code version was used to perform the analyses for the proposed amendment. Given the differences in the code versions, the staff expects that the analyses use different cross section data as well. However, the submittal does not include information in this regard. The cross section data are a key part of the analysis method and use of appropriate cross section data is very important to ensuring the analyses demonstrate subcriticality in accordance with the regulatory requirements and following accepted practices as described in the standard review plan (NUREG-2215, Chapter 7 – see Section 7.5.4.1).

This information is necessary to determine compliance with 10 CFR 72.124(a) and (b) and 10 CFR 72.236(c).

Response to RSI 7.1:

All the runs with SCALE 6.0 employ the same cross-section library, 44-group ENDF/B-V, as those performed previously with SCALE 4.4. Clarification has been added to UFSAR Appendix P, Section P.6.6.4.

Impact:

UFSAR Section P.6.6.4 has been revised as described in the response.

RSI 7.2

Provide a benchmark analysis for the new analysis with the new code and cross section data.

The applicant's submittal includes criticality analyses with a significantly updated computer code version and very likely new cross section data. Thus, a new benchmark analysis is needed to demonstrate the applicant's ability to use the new code and cross section data, understand the uncertainties in the applicant's analyses, and determine any bias and bias uncertainty that applies to the applicant's use of that code and data. The submittal appears to imply that because the new analyses are a comparison of the k-effectives for currently approved basket types in the 24PTH DSCs and the newly proposed basket type for the same DSCs, that a benchmark analysis is not needed. As stated in Section 7.5.4.3 of the standard review plan (NUREG-2215):

> "Computer codes for criticality calculations should be benchmarked against critical experiments. A thorough comparison provides justification for the validity of the computer code, its use for a specific hardware configuration, its use for the SNF to be stored, the neutron cross sections used in the analysis, and consistency in modeling by the analyst."

The benchmark analysis is a key component to ensuring the criticality analysis demonstrates that the analyzed cask system is subcritical in accordance with the regulatory requirements.

This information is necessary to determine compliance with 10 CFR 72.124(a) and (b) and 10 CFR 72.236(c).

Response to RSI 7.2:

The benchmarking of SCALE 6.0 has been addressed in new UFSAR Section P.6.5.3, to point to UFSAR Appendix M, Section M.6.5.3, which presents the comprehensive benchmarking of SCALE 6.0 and the USL determination.

A statement has been added at the end of Section P.6.6.4 to indicate all the Type 3D k_{eff} values are below the SCALE 6.0 upper subcritical limit.

Impact:

UFSAR Section P.6.5.3 has been added and Section P.6.6.4 has been revised as described in the response.

Criticality Observations

OBS 7.1

Clarify if borated aluminum is an allowed option for the neutron absorber material in the proposed Type 3 basket.

Section P.6, including Table P.6-1 appear to indicate that borated aluminum is an allowed option for the neutron absorber material in the newly proposed Type 3 basket. However, Section P.9.1.7 and Note 1 of Table P.9-1 indicate that borated aluminum is not an option for the Type 3 basket. This may also have implications for the criticality analysis models.

This information is necessary to determine compliance with 10 CFR 72.124(a) and (b) and 10 CFR 72.236(c).

Response to OBS 7.1:

UFSAR Appendix P.6 indicates the collective term B-Al refers to borated-aluminum alloy and aluminum/B_4C metal matrix composite (MMC) as fixed neutron poison material. UFSAR Appendix P, Section P.6.3.1 clarifies that the “fixed poison in the calculation is based on B-Al poison” and 90% credit is taken (alternatively 75% credit is taken when Boral® is used as fixed poison). While MMC is the only neutron poison material option for the Type 3 basket, as specified in UFSAR Table P.9-1, the sensitivity criticality analysis for the Type 3 basket employs B-Al for consistency with the Type 1/2 basket analysis. Clarification is provided in UFSAR Appendix P, Section P.6.6.4 and Table P.6-1.

Impact:

UFSAR Section P.6.6.4 and Table P.6-1 have been revised as described in the response.

Enclosure 2 to E-61342

Proposed Amendment 18, Revision 1
Changes to the Standardized NUHOMS® System
Updated Final Safety Analysis Report

administrative margin is from Reference [6.3]. Results from the USL evaluation are presented in Table P.6-47.

The criticality evaluation used the same cross section set, fuel materials and similar material/geometry options that were used in the 121 benchmark calculations as shown in Table P.6-46. The modeling techniques and the applicable parameters listed in Table P.6-48 for the actual criticality evaluations fall within the range of those addressed by the benchmarks in Table P.6-46.

P.6.5.2 Results of the Benchmark Calculations

The results from the comparisons of physical parameters of each of the fuel assembly types to the applicable USL value are presented in Table P.6-48. The minimum value of the USL is determined to be 0.9411 based on comparisons to the limiting assembly parameters as shown in Table P.6-48.

P.6.5.3 Benchmarking of SCALE 6.0

The benchmarking of SCALE 6.0 is presented in Appendix M, Section M.6.5.3. The benchmarking uses the ENDF/B-V cross-section library and NITAWL. The USL value of 0.9404 was determined which incorporates the code bias and bias uncertainties including an administrative safety margin of 0.05.

All Indicated Changes are in response to RSI 7-2

P.6.6.4 Type 3 Basket Sensitivity Analysis

The Type 3 basket features an alternate design compared to the Type 1 or 2 baskets. The Type 3 basket has a larger minimum compartment width and a higher poison loading than the Type 1 or 2 baskets. It is demonstrated in Table P.6-13 for the Type 1 or 2 baskets that reactivity decreases as the compartment width increases. Therefore, k_{eff} will decrease for the Type 3D basket when compared with the Type 1C/2C basket. All enrichment limits developed for the Type 1C/2C basket may be conservatively applied to the Type 3D basket, and this conclusion is verified with the following sensitivity analysis.

Methodology

Sensitivity cases are developed for intact, damaged, and failed fuel to explicitly demonstrate that reactivity decreases for the Type 3D basket compared to the Type 1C/2C basket. Because the Type 1C/2C basket analysis was performed with SCALE 4.4, which is no longer installed, SCALE 6.0 [6.4] is used in this sensitivity study. To allow a direct comparison between the Type 1C/2C basket and Type 3D basket results without computer code biases, all Type 1C/2C basket cases are first rerun using SCALE 6.0, and the Type 1C/2C basket SCALE 6.0 results are compared to the Type 3D basket SCALE 6.0 results.

All SCALE 6.0 reruns use the same resonance shielding and neutron cross section library used in the SCALE 4.4 inputs, which are NITAWL and 44-group ENDF/B-V library, respectively. The benchmarking performed for SCALE 6.0 is provided in Section P.6.5.3.

The CSAS5 (KENO V.a) control module of the SCALE 6.0 program is used to calculate the effective multiplication factor (k_{eff}) of the system. The CSAS5 control module allows simplified data input to the functional modules BONAMI, NITAWL, and KENO V.a. These modules process the required cross sections and calculate the k_{eff} of the system. BONAMI performs resonance self-shielding calculations for nuclides that have Bondarenko data associated with their cross sections. NITAWL applies a Nordheim resonance self-shielding correction to nuclides having resonance parameters.

Description of the KENO Model for the Type 3 basket

This section describes the details of the KENO input used in the analysis. The KENO model of the Type 3 basket is developed based on the design provided in the drawings in Section P.1.5. The material description, KENO V.a parameter data, and unit cells for fuel rods, instrument tubes, and guide tubes are taken from the base cases (described under Section P.6.4.2, K).

The poison plates that form the egg crate structure are modeled in such a way that the plates fit together tightly. In reality, the plates have slots to fix the vertical and horizontal plates that are slightly wider than the total plate thickness. These small gaps at the slots are conservatively not considered in the KENO model developed for Type 3 basket since these gaps would be filled with borated water, which would decrease the reactivity. The egg crate is formed by a set of horizontal and vertical plates crossing each other, which forms the wall of the compartment. In this discussion, "horizontal" is parallel to the x-axis, while "vertical" is parallel to the y-axis. The minimum width of the compartment is 8.9 inches.

The horizontal plates are modeled as one single length plate whose length is calculated manually. For example, the length of the plates (Al+MMC+SS) that spans 4 compartments, 4 thin (vertical) plates and 1 thick (vertical) plate each is calculated as (4x8.9" + 4x0.945" + 1x1.195") = 40.575 inches (see Figure P.6-27). The full length of the plate that spans all the 6 compartments, with only Al on the peripheral assemblies, is calculated as 59.001 inches. The lengths of the horizontal plates in the model are slightly shorter than the actual plates since the gaps are not considered.

The vertical plates are modeled as short segments with their length the same as the compartment width. These segments are then included in between two fuel compartments to form an array. These arrays are then placed as holes in the global unit. The overall length of the vertical plate at the center without considering the thickness of the horizontal plate that runs in between the vertical plates is calculated as (6x8.9" + 2x2.8345") = 59.069 inches. If the thicknesses of the horizontal plates are considered, the total vertical length in the model would be 64.67 inches.

The overall lengths of the plates in the KENO model are shorter than the actual plates and hence the total area of the poison plates modeled is reduced compared to the actual plates. This is conservative since the overall poison in the model is reduced compared to the actual basket.

While MMC is the only neutron material option for the Type 3D basket, the sensitivity cases model the fixed poison as B-Al for consistency with the Type 1C/2C basket evaluation. The thickness of the poison plate is 0.164 inches in the Type 3 basket. The poison content is 35 mg B-10/cm^2 (poison loading D). 90% credit is taken and hence in the KENO model 31.5 mg B-10/cm^2 is modeled. The boron and aluminum ratio in the poison plate is calculated based on this thickness and poison content values.

The transition rail is modeled using stainless steel material. This is based on the results of the transition rail region material study using the Type 1 basket, which demonstrated that the use of steel for transition rail material is most reactive. The Type 1 basket transition rail geometry is conservatively applied to the Type 3 basket KENO model. The other materials used for describing the canister and the cask are the same as in the base cases. Water fills the gap between the canister and cask.

The axial height modeled is 11.94 inches in the KENO model, with periodic boundary conditions applied to the top and bottom of the model. This boundary condition ensures the model is infinitely long in the axial direction. For failed fuel analysis, the length in the axial direction is changed to match the length used in the failed fuel analysis using the Type 1 basket.

In the damaged and failed fuel analysis, it is assumed that the maximum pitch is the optimum pitch value that leads to highest k_{eff}. The maximum pitch is calculated using the compartment width (W), the fuel rod's cladding radius (r) value and the number of fuel rods in a row (n). The compartment width value is 8.9 inches; however, for the optimum pitch calculation, 8.85 inches is considered to give a small gap between the peripheral row of fuel rods and the poison plates forming the walls of the compartment to avoid KENO overlap errors. The formula used to compute the maximum pitch value is (W-2r)/(n-1).

The material inputs are the same in the Type 3D basket models compared to the Type 1C/2C basket models with the exception of poison loading D, which is provided in Table P.6-8.

All Indicated Changes are in response to OBS 7-1

The criticality results obtained with the Type 3D basket are compared to the corresponding base case results. The difference between the two is calculated as:

$$Difference = k_{eff\text{-}T1/2} - k_{eff\text{-}T3}$$

A positive value of the difference indicates that the Type 1C/2C basket results bound the Type 3D basket results. All difference values presented in Table P.6-49, Table P.6-50, and Table P.6-51 indicate that reactivity decreases for the Type 3D basket. Therefore, all Type 1C/2C enrichment limits are bounding and may be conservatively applied to the Type 3D basket. Reactivity decreases for the Type 3D basket due to the larger poison loading and larger minimum compartment size compared to the Type 1C/2C basket. All the k_{eff} values shown in Table P.6-49, Table P.6-50 and Table P.6-51 for the Type 3D basket are below the SCALE 6.0 USL of 0.9404. Therefore, it is concluded that the NUHOMS®-24PTH DSC with the Type 3 basket is compliant with the criticality related portions of 10 CFR Part 72.

Table P.6-1
Minimum B10 Content in the Neutron Poison Plates

Basket Type	Minimum B10 Content for Boral® (mg/cm^2)	Minimum B10 Content for B-Al$^{(1)}$ (mg/cm^2)	B10 Content Used in Criticality Evaluation (mg/cm^2)
1A or 2A	9.00	7.00	6.3
1B or 2B	19.0	15.0	13.5
1C or 2C	40.0	32.0	28.8
3D	*N/A*	*35.0*	*31.5*

Notes:

(1) B-Al = Metal Matrix Composites and Borated Aluminum Alloys. *Type 3D basket only uses Metal Matrix Composites poison material.*