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NUCLEAR REGULATORY COMMISSION
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FINAL SAFETY EVALUATION REPORT

DOCKET NO. 72-1004
TN AMERICAS LLC
CERTIFICATE OF COMPLIANCE NO. 1004
STANDARDIZED NUHOMS® SYSTEM
AMENDMENT NO. 17

SUMMARY

This safety evaluation report (SER) documents the U.S. Nuclear Regulatory Commission (NRC) staff's review and evaluation of the amendment request to amend Certificate of Compliance (CoC) No. 1004 for the Standardized NUHOMS® System. By letter dated June 11, 2020 (Orano, 2020a), as supplemented on September 11, 2020 (Orano, 2020b), TN Americas LLC (hereinafter referred to as the "applicant"), requested that NRC amend the CoC to include the following change:

- For the NUHOMS®-61BTH (hereafter 61BTH) Type 2 dry shielded canister (DSC), add Heat Load Zoning Configurations (HLZC) 11-13 and change the maximum assembly heat load from 1.2 kilowatts (kW) to 1.7 kW.

The amended CoC, when codified through rulemaking, will be denoted as Amendment No. 17 to CoC No. 1004.

The staff's evaluation is based on a review of the applicant's amendment application and whether it meets the applicable requirements of 10 CFR Part 72 for dry storage of spent nuclear fuel. The staff's evaluation focused only on modifications requested in the amendment as supported by the submitted revised Updated Final Safety Analysis Report (UFSAR) (see Agencywide Document Access and Management System [ADAMS] Accession No. ML20174A098) and did not reassess previous revisions of the UFSAR nor previous amendments to the CoC. In its review, the staff followed the guidance in NUREG-2215, "Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities" (NRC, 2020) and NUREG-2214, "Managing Aging Processes in Storage (MAPS) Report" (NRC, 2019).

1.0 GENERAL DESCRIPTION

The objective of this chapter is to review the changes requested to CoC No. 1004 for the Standardized NUHOMS® System to ensure that the applicant provided an adequate description of the pertinent features of the storage system and the changes requested in the application. The specific changes requested by the applicant are described and evaluated in the following sections of this SER.

2.0 PRINCIPAL DESIGN CRITERIA EVALUATION

The applicant did not propose any changes that affected the staff's previous evaluation of the principal design criteria that was provided in previous safety evaluations for CoC No. 1004, Amendments No. 1 through 11 and 13 through 16. Therefore, the staff determined that a new evaluation was not required.

3.0 STRUCTURAL EVALUATION

The applicant did not propose any changes that affected the staff's previous structural evaluation that was provided in previous safety evaluations for CoC No. 1004, Amendments No. 1 through 11 and 13 through 16. Therefore, the staff determined that a new evaluation was not required.

4.0 THERMAL EVALUATION

The objective of the staff's review of the applicant's thermal evaluation for Amendment No. 17 to the Standardized NUHOMS® System was to verify that the cask and fuel material temperatures will remain within the range of allowable values or criteria for normal, off-normal, and accident conditions. Specifically, the staff analyzed whether the temperatures of the fuel cladding will meet regulatory requirements throughout the storage period and will protect the cladding against degradation that could lead to gross rupture.

The staff reviewed the information provided in the amendment request to determine whether the Standardized NUHOMS® System continues to fulfill the acceptance criteria in Chapter 5 of NUREG-2215.

The changes requested by the applicant relevant to the thermal evaluation do not involve design changes to the major components of the Standardized NUHOMS® System, but, instead, are related to the authorized contents of the DSC. The following changes in the application that involve thermal consideration are described below:

- For the 61BTH Type 2 DSC, add HLZCs #11, #12, and #13 and change the maximum assembly heat load from 1.2 kW to 1.7 kW.

4.1 NUHOMS®-61BTH Type 2 DSC with HLZCs #11, #12, and #13

The applicant describes the thermal evaluation of the 61BTH Type 2 DSC with HLZCs #11, #12, and #13 in Section T.4.6.13 of the application. HLZCs #11 through #13 each have a maximum decay heat of 31.2 kW per DSC. The staff verified that HLZCs #11 through #13 are shown in Figures 1-25d through 1-25f of the Technical Specifications (TS). The staff also verified that Figure 1-25d of the TS for HLZC #11 showed that the maximum decay heat per assembly was 1.7 kW within Zone 6. Because the applicant determined the decay heat for HLZCs #11, #12, and #13 was bounded by those evaluated in Sections 4.4 and 4.5 of the UFSAR, the DSC shell temperature profiles in Section T.4.5 remain applicable. Because no other design change was made to the 61BTH canister, the applicant performed sensitivity studies of HLZCs #11, #12, and #13 using the normal storage condition with 100 °F ambient temperature and the vertical transfer condition with 120 °F ambient temperature with the 61BTH Type 2 DSC thermal model described in Section T.4.6 of the UFSAR.

The applicant performed three sensitivity studies of the 61BTH canister with HLZCs #11, #12, and #13. The applicant reported temperature results from the first sensitivity study, which evaluated maximum payloads in the inner zones, in Section T.4.6.13.1 of the application. According to the application, the results demonstrate that the maximum fuel and component temperatures for the 61BTH canister for normal storage (100 °F ambient temperature) with HLZCs #11, #12, and #13 remain at or below the design basis temperatures, with the exception of the rail temperature. The results demonstrate that the rail temperature increases by a few degrees Fahrenheit. The applicant stated that this does not affect the thermal or structural performance and the staff concluded this was acceptable because the increase in temperature was small and the applicant calculated temperature remained below the maximum allowable temperature limit.

Based on the staff's review of Section T.4.6.13.1 of the application, because the maximum fuel and component temperatues remain at or below the design basis temperatures and the thermal or structural performance is not affected during normal storage, the staff finds the thermal and structural performance to be acceptable. The staff reviewed Figures 1-25d through 1-25f of the TS and found the description of the sensitivity study within Section T.4.6.13.1 of the application to be consistent with the zone decay heat limits in Figures 1-25d through 1-25f of the TS. The applicant also demonstrated that the transfer time limits for a 61BTH Type 2 DSC with HLZC #7 in Section T.4.5.4 of the UFSAR were also applicable to a 61BTH Type 2 DSC with HLZCs #11, #12, and #13. In addition, the applicant concluded, and the staff finds it acceptable, that because the maximum temperatures are lower for the 61BTH DSC with HLZCs #11, #12, and #13, there is no adverse effect on the internal pressure. Therefore, the applicant concluded, and the staff determines that the design basis pressures reported in Tables T.4-16, T.4-20, and T.4-24 of the UFSAR for normal, off-normal, and accident conditions remain applicable for the 61BTH DSC with HLZCs #11, #12, and #13.

The applicant reported temperature results from the second sensitivity study, which evaluated maximum payloads in the outer zones, in Section T.4.6.13.2 of the application. According to the application, the results indicate that the maximum fuel and component temperatures for the 61BTH canister for normal storage with HLZC #11, the bounding HLZC in this case, with 100 °F ambient temperature. remain at or below the design basis temperatures, with one exception. The exception is the DSC shell which increases by 1 °F. The applicant stated that this 1 °F increase did not affect the thermal or structural performance. Based on the staff's review of Section T.4.6.13.2 of the application, the staff finds that the DSC shell thermal and structural performance to be acceptable because the increase in temperature was small and the temperature remained below the maximum allowable temperature limit. The staff reviewed Figure 1-25d of the TS and found the description of the sensitivity study within Section T.4.6.13.2 of the application to be consistent with zone decay heat limits in Figure 1-25d of the TS.

In Section T.4.6.13.3 of the application, the applicant described results from the third sensitivity study, which evaluated the storage of damaged and failed fuel assemblies. According to the applicant, HLZCs #11, #12, and #13 only allow for up to 16 damaged fuel assemblies, as compared to HLZCs #1 through #10 which allow for up to 61 damaged fuel assemblies, with the bounding evaluation based on HLZC #7. The staff found the loading of up to 16 damaged fuel assemblies in HLZCs #11, #12, and #13 to be consistent with the limitation on damaged fuel assemblies allowed to be loaded, as captured in Note 4 in Figure 1-25 of the TS. The applicant concluded, based on the results in Section T.4.6.13.1 of the application, that HLZC #7 remains bounding for HLZC #11, #12, and #13; therefore, no additional evaluation is required. In addition, the applicant previously evaluated accident conditions temperatures in Section

T.4.6.11 of the FSAR using various combinations of intact and damaged fuel assemblies, including 45 intact and 16 damaged fuel assemblies and up to 61 damaged fuel assemblies.

Based on the staff's review of Section T.4.6.13.3 of the application, the staff finds that HLZC #7 remains bounding for HLZC #11, #12, and #13. The staff's finding is based on the bounding temperature results provided in Section T.4.6.13.1 of the application which remain below the maximum allowable temperature limits. Also, based on the staff's review of Section T.4.6.11 of the FSAR, which included the applicant's evaluation of up to 61 damaged fuel assemblies, the staff finds that the applicant's thermal evaluation remains bounding for HLZC #11, #12, and #13 because in Section T.4.6.11 the accident conditions case with 61 damaged fuel assemblies provided the maximum temperature results.

The applicant described in Section T.4.6.13.3 of the application that HLZCs #11, #12, and #13 allow for up to 4 failed, and up to an additional 12 damaged, with the remainder intact boiling water reactor (BWR) fuel assemblies. The applicant evaluated HLZC #7 with failed and damaged fuel assemblies in Section T.4.6.9 of the UFSAR. The applicant concluded HLZC #7 remains bounding and because the same locations are considered in HLZCs #11, #12, and #13 for loading failed and damaged fuel assemblies, with the remainder intact fuel assemblies, no additional analysis is necessary. Based on the staff's review of Section T.4.6.13.3 of the application, the staff finds this to be acceptable because, since the same fuel locations are considered in HLZCs #11, #12, and #13 for loading failed and damaged fuel assemblies, the analysis in HLZC #7 remains bounding.

4.2 Findings

F4.1 Structures, systems, and components (SSCs) important to safety are described in sufficient detail in the UFSAR to enable an evaluation of their thermal effectiveness in accordance with 10 CFR 72.236(f) and 10 CFR 72.236(h). Storage container SSCs important to safety remain within their operating temperature ranges in accordance with 10 CFR 72.236(a) and 10 CFR 72.236(b).

F4.2 The Standardized NUHOMS®-61BTH Type 2 DSC, as amended with HLZCs #11, #12, and #13 and changes to the maximum assembly heat load to 1.7 kW, within the horizontal storage module (HSM) or horizontal storage module high seismic option (HSM-H) systems is designed with a heat-removal capability, verifiably and reliably consistent with its importance to safety. The storage container is designed to provide adequate heat removal capacity without active cooling systems in accordance with 10 CFR 72.236(f).

F4.3 The spent nuclear fuel (SNF) cladding is protected against degradation leading to gross ruptures under normal conditions by maintaining the cladding temperature for 40 years below 400 °C (752 °F) in a helium gas environment. Protection of the cladding against degradation is expected to allow ready retrieval of the SNF for further processing or disposal in accordance with 10 CFR 72.236(g), 10 CFR 72.236(l), and 10 CFR 72.236(m).

F4.4 The SNF cladding is protected against degradation leading to gross ruptures under off-normal and accident conditions by maintaining the cladding temperature below 570 °C (1,058 °F) in a helium gas environment. Protection of the cladding against degradation is expected to allow ready retrieval of spent fuel for further processing or disposal in accordance with 10 CFR 72.236(g), 10 CFR 72.236(l), and 10 CFR 72.236(m).

F4.5 The staff concludes that the thermal design of the Standardized NUHOMS®-61BTH DSC, as amended, within the HSM or HSM-H systems is in compliance with 10 CFR Part 72, and that the applicable design and acceptance criteria have been satisfied. The evaluation of the thermal design provides reasonable assurance that the Standardized NUHOMS®-61BTH DSC within the HSM or HSM-H systems will allow safe storage of SNF for a licensed (certified) life of 40 years. This conclusion is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices.

5.0 CONFINEMENT EVALUATION

The objective of the staff's review of the applicant's confinement evaluation for Amendment No. 17 to the Standardized NUHOMS® System is to verify that the system continues to fulfill the acceptance criteria listed in Chapter 9 of NUREG-2215. Specifically, the staff analyzed whether the reported temperatures and pressures for the revised loading pattern throughout the storage period will remain bounded by the acceptance criteria. The applicable regulatory requirements are found in 10 CFR 72.236(b), 10 CFR 72.236(f), 10 CFR 72.236(g), and 10 CFR 72.236(h).

5.1 Changes to Heat Load Zoning Configurations

The changes requested by the applicant relevant to the confinement evaluation do not involve design changes to the major components of the Standardized NUHOMS® System, but, instead, are related to the authorized contents of the DSC. The following changes in the application that involve confinement consideration are described below:

- For the 61BTH Type 2 DSC, add HLZC 11-13 and change the maximum assembly heat load from 1.2kW to 1.7kW.

Since the thermal evaluation provided by the applicant did not indicate any safety significant increase in internal temperatures or pressures, nor were there any design changes of the Standardized NUHOMS® Storage System, and because there is sufficient margin between the design pressures and the calculated maximum pressures for normal, off-normal and accident conditions, he staff finds that previous confinement safety conclusions are still valid

There were no other changes requested in the amendment application requiring an evaluation of the confinement criteria related to the SSCs important to safety to ensure compliance with the relevant general criteria established in 10 CFR Part 72.

5.2 Findings

F5.1 On the basis of review of the proposed changes as discussed in Section 5.0 of this SER and the submitted documents, the staff concludes that the proposed changes have no negative impact on the confinement system and that the Standardized NUHOMS® System continues to meet the confinement requirements of 10 CFR 72.236.

6.0 SHIELDING EVALUATION

The applicant requested to amend CoC No. 1004 for the Standardized NUHOMS® System design to add three new HLZCs #11, #12, #13 for the 61BTH Type 2 DSC and increase the Type 2 DSC maximum assembly heat load from 1.2 kW to 1.7 kW. The objective of this shielding review is to evaluate whether the shielding features of the Standardized NUHOMS® System design as amended will continue to provide adequate protection to workers and the public from radiation from the proposed contents.

The staff reviewed the applicant's safety analyses for the requested changes to the CoC following the guidance provided in NUREG-2215. The staff evaluated the proposed addition of a simplified, bounding source term for the 61BTH Type 2 DSC. Type 1 fuel qualification tables (FQTs) originally had bounding uranium loading of 0.198 metric ton of uranium (MTU). To reduce penalty, the applicant developed FQTs at 0.170 MTU and NRC-approved interpolation along the range. This added flexibility but also complexity. To reduce complexity, the applicant used a single, bounding Type 2 source term to develop a single FQT for this amendment. The applicant does not intend general licensees to apply interpolation or extrapolation to the Type 2 FQT. The staff's review focused on whether the Type 2 source terms bound those of the prior, NRC-approved amendments, and whether the applicant's new dose rates are reasonable.

6.1 Shielding Design Description

Aside from the contents of the DSC, the applicant proposed no changes to the design criteria and design features of the Standardized NUHOMS® System in this amendment.

6.2 Radiation Source Definition

The applicant has not proposed any changes to the radioactive contents in this amendment. The applicant developed a new set of source terms for the 61BTH Type 2 DSC based on the bounding heat load configuration shown in UFSAR Figure T.5-1a. The Type 2 DSC source determination consists of a single bounding source which is unrelated to the Type 1 DSC source terms. The applicant developed a new Type 2 DSC source term to bound all Type 1 and Type 2 configurations (i.e., HLZC 1-13) using a new 4-zone analysis. The applicant's analysis of the bounding HLZC assumed the following: (1) a maximum heat generation rate per fuel assembly higher than the maximum heat allowed for any single assembly in any HLZC, (2) both the peripheral region and the total DSC with a heat generation rate in excess of the 31.2 kW limit, and (3) the heat generation rate for the inner zones in excess of the 0.48 kW per assembly limit. The staff finds the applicant's assumptions acceptable since they are conservative as they will result in a higher calculated dose rate.

The applicant generated the source terms with the ORIGEN-ARP module of SCALE 6.0 with the ge7x7-0 cross-section library. Staff finds the use of ORIGEN-ARP acceptable since the code has a long history of use for spent fuel burnup calculations and is well vetted. Oak Ridge National Laboratory created the ge7x7-0 library for distribution with SCALE 6.0, and it is based on ENDF/B-V cross-section data. The library data spans a burnup range from 0 to 72 GWd/MTU, which covers the range evaluated by the applicant (6 – 62 GWd). The library enrichment data ranges from 1.5 to 6.0 wt.% ^{235}U, which covers the upper end of enrichment the applicant evaluated (0.7 – 5.0 wt.% ^{235}U). The staff finds this acceptable since the applicant determined the bounding burnup-enrichment (BE) combinations to be within the scope of the library. The applicant used a constant specific power with no downtime in its depletion analysis and adjusted cycle length to achieve desired burnup. This approach has been shown to maximize the calculated source term and the staff finds it acceptable.

All sources are generated using a uranium loading of 0.170 MTU rather than 0.198 MTU. Pressurized-water reactor (PWR) studies which varied MTU from 0.492 to 0.380 showed that, for a fixed decay heat, lower uranium mass "shortens the cooling times and reduces selfshielding for the same fuel assembly envelope." The net effect is an increase in dose rates. The dose rate effect is less pronounced for BWR because the relative difference in mass is smaller. The applicant explicitly computed source terms for all BE combinations for each zone at both 0.198 and 0.170 MTU. The applicant's calculated dose rates were larger with lower uranium loadings, with an approximately 5% increase in effective dose rates. The staff finds the uranium loadings used to determine the source term acceptable since the applicant calculated the dose rates from both uranium mass loadings and explicitly determined the uranium mass that led to a bounding dose rate.

The applicant places additional restrictions on fuel below the minimum enrichment for the burnup evaluated and labels it "unanalyzed fuel" (UF). The applicant places administrative limits on a maximum of four UF assemblies in peripheral locations per DSC. In addition, five analyzed assemblies must separate any two UF assemblies, and the applicant requires an additional 0.2-year minimum cooling time for UF. Prior staff's review found the additional cooling time acceptable when added to a 3-year cooling requirement. Since the reduction in radioactivity will be greater in a 0.2-year additional cooling time period at 1 year compared to 0.2-year additional cooling time period at 3 years, the staff finds the applicant's 0.2-year addition to minimum cooling time acceptable. The applicant showed that the number of BWR UF is relatively small, and with the limits on the number and spacing in any peripheral basket location, the impact of UF on dose rates is likely small; therefore, the staff finds the applicant's UF limits acceptable.

6.2.1 Gamma Sources

The applicant selected fixed decay heats of 0.5 kW and 1.0 kW per assembly, depending on the zone, and adjusted the cooling time for each BE combination to determine the sources for zones 1, 2, and 3. The staff finds this acceptable since it is higher than the maximum heat limits in its respective zone. For Zone 4, the applicant determined the bounding source term by selecting a fixed, minimum cooling time, and increased that cooling time as the corresponding burnup increased. The staff reviewed the sample response functions the applicant provided and finds the applicant's methodology is adequately detailed to determine the maximum response over the entire evaluated range, and therefore acceptable.

Light element masses are consistent with those used to generate the 61BTH Type 1 DSC sources. The applicant selected a cobalt impurity level consistent with older fuel which has higher cobalt impurity levels. The staff reviewed UFSAR Table T.5-7 and finds the cobalt impurity levels consistent with the recommendations of Regulatory Guide 3.54, "Spent Fuel Heat Generation in an Independent Spent Fuel Storage Installation," Revision 2 (NRC, 2018). Since the end hardware ^{60}Co source term may peak at a different burnup than the fuel gamma activity, the applicant maximized the activated hardware source separately from the fuel. The applicant performed an ORIGEN-ARP calculation for the bottom end fitting, active fuel, plenum, and top end fitting using the light element masses for each region. The staff finds this acceptable since it maximizes the source term along the length of the fuel assembly.

Reconstituted fuel assemblies may contain up to 10 irradiated stainless-steel rods, with up to 4 reconstituted assemblies allowed per DSC. In prior Type 1 DSC source term evaluations, the applicant determined that 5 additional years of cooling are required with the maximum of 40 rods per DSC at 0.54 kW per assembly. This is the maximum allowed heat load per assembly at any location. While the correlation is not constant, the activation source tends to increase with heat load, and the staff finds the applicant's use acceptable. The applicant applied the same additional cooling time requirement to the Type 2 DSC. The minimum cooling time for the Type 1 DSC is 3 years, whereas the minimum for Type 2 is 1 year. The staff finds the 5-year extension to the applicant's minimum cooling time acceptable since radioactive decay is most rapid early in the cooling period, thus extending cooling time from 1 to 6 years will result in a larger reduction in radiation source strength than from 3 to 8 years of cooling time from the prior analysis.

6.2.2 Neutron Sources

The neutron source is particularly sensitive to enrichment. The applicant used data on approximately 139,000 BWR discharged fuel assemblies to develop empirical equations that determine minimum enrichment as a function of burnup. The applicant showed its data and empirical minimum enrichment function graphically in UFSAR Table T.5-29. In cases where the applicant used empirical equation to select an enrichment to be evaluated, the applicant rounded down to the nearest 0.1 wt%. The neutron source strength increases as enrichment decreases, and the staff finds the selection of the minimum enrichment in the evaluated band acceptable. The applicant used the same axial peaking as the Type 1 source terms based on typical axial burnup distributions for BWR assemblies and typical water density distribution that occurs during operation. The applicant generated gamma and neutron source terms for the axial zones as a function of burnup and moderator density. This will account for the non-linear generation of neutron-decaying isotopes that are sensitive to burnup and moderator density. The applicant's previously-approved methodology remains unchanged, and therefore the NRC staff finds it acceptable.

6.4 Shielding Model Specification

The applicant made no significant changes to the shielding model from previous amendments. The applicant developed dose response functions with bounding source developed for the burnup/enrichment/cooling-time (BECT) and loading zones. The applicant modeled the fuel as 4% enriched to account for subcritical multiplication in MCNP. The staff finds this acceptable because the subcritical multiplication at this enrichment bounds that of spent fuel.

6.4.1 Configuration of shielding and source

The applicant used the Type 1 DSC geometry with the Type 2 DSC source terms. The staff finds this acceptable since the Type 1 DSC has less shielding than the Type 2 and this will maximize the calculated dose rates. The applicant did not make many significant changes to the shielding configuration from previous amendments. The applicant modeled 1.5-inch gaps between HSM-H modules to evaluate effects of potential streaming paths. The applicant calculated average dose rates over the surface of a box that encloses the HSM-H. This surface includes the vent covers and gaps.

The applicant determined the source terms for the BECT combinations by first finding the cooling times for zones 1, 2, and 3. The applicant determined the source terms for Zone 4 with fixed decay times that are associated with burnup bands discussed in UFSAR Section T.5.2.6. The applicant assumed 2.1 kW and 2.2 kW per assembly for the OS197FC-B and HSM-H sources, respectively. The applicant's source term determination results in total DSC decay heat that exceeds the maximum allowable limit for every BECT combination. The staff finds it acceptable since the source strength tends to increase with heat generation and this will increase the applicant's calculated dose rates. The applicant ranked each zone separately for the OS197FC-B transfer cask (TC), the HSM-H overpack, and the light element gamma source to determine bounding BE combinations for each. The staff finds this acceptable since the maximum source may occur at different burnup, and the applicant's method will conservatively over-predict external dose rates. The bounding BECT combinations, which the applicant presented in UFSAR Section T.5.2.6, were then used to determine a bounding dose response function.

The applicant's source term for the OS197FC-B TC is maximized for neutrons since the accident condition in that case would assume loss of the neutron shield. The applicant assumed a maximum burnup of 62 GWd/MTU for all zones in the TC. Since the neutron shield is removed from the accident model and the neutron source is maximized, the staff finds the applicant's selection of the OS197FC-B source term for both normal and accident conditions to be conservative and, therefore, acceptable.

6.4.2 Material properties

The applicant presented the weights used to calculate material densities for active fuel, plenum, top, and bottom regions in the assembly in UFSAR Table T.5-6. This remains unchanged from a previous NRC-approved amendment.

6.5 Shielding Analysis

The applicant modeled reference sources in MCNP to compute rear, side, and front/roof corresponding dose rates as shown in UFSAR Figures T.5-5 through T.5-7b. The applicant presented these response functions in UFSAR Tables T.5-25a and T.5-25b. The applicant's methodology is unchanged from previous amendments.

6.5.1 Computer codes

The applicant modeled the DSC, TC, and overpack in MCNP 5 v 1.20. The applicant used continuous-energy cross-sections based on ENDF/B-VI Nuclear data. The applicant ran the MCNP in coupled mode (both neutron and gamma) to account for n-gamma reactions. Subcritical multiplication is handled automatically by the code. MCNP 5 is a 3-dimensional, Montel Carlo particle transport code that can model complex geometry, such as those found with the Standardized NUHOMS® System. The code and cross-section library have a long history of use in spent fuel storage applications, and staff finds their use here acceptable.

6.5.2 Flux-to-dose-rate conversion

The applicant used the ANSI/ANS 6.1.1-1977, "A Monte Carlo Calculation of Flux-To-Dose-Rate Conversion Factors for Energies Between 0.01 and 1.00 MeV," flux-to-dose rate conversion factors in its MCNP models to calculate dose rates. The staff finds this acceptable since it is consistent with the guidance in NUREG-2215.

6.5.3 Dose rates

The applicant presented its calculated dose rates in UFSAR Tables T.5-1 through T.5-5. The staff confirmatory analysis confirmed the applicant's dose rates for the Type 2 source term are reasonable.

6.6 Confirmatory Analysis

Staff evaluated a simplified system to evaluate the relative changes in dose rates between the Type 1 and Type 2 source terms. The staff modeled a series of nested cylinders comprised of the same material as the Type 1 DSC and the OS197FC-B TC, and concrete cuboids to represent the HSM. The staff modeled voids in the concrete to capture the localized dose rates at the roof vent. The staff used the MAVRIC code in the SCALE 6.2.3 package. The staff used a 46-group cross-section library based on ENDF/B-VII nuclear data.

The staff used the Zone 4 fuel region gamma source strength and spectrum provided by the applicant in UFSAR Tables T.5-18c and T.5-18g since that zone contributes most of the external dose. The staff also used the fuel region gamma source term the applicant provided in UFSAR Table T.5-16 for comparison using the HSM Model 80. The staff used the neutron source strength provided by the applicant in the same tables with a ^{252}Cf spontaneous fission spectrum. The staff used the ANSI/ANS Standard 6.1.1-1977 flux-to-dose rate conversion factors. The staff homogenized the UO_2 contents of the DSC cavity and ignored the basket to speed the calculation. The staff determined the applicant's results to be acceptable because staff's results showed a relative increase in dose rates that are reasonably close to those determined by the applicant.

6.7 Evaluation Findings

F6.1 The SAR provides specifications of the spent fuel contents to be stored in the Standardized NUHOMS 61-BTH Type 2 DSC in sufficient detail that adequately defines the allowed contents and allows evaluation of the DSS shielding design for the proposed contents. The SAR includes analyses that are adequately bounding for the radiation source terms associated with the proposed contents' specifications. (10 CFR 72.236(a))

F6.2 The SAR describes the structures, systems, and components (SSCs) important to safety that are relied on for shielding in sufficient detail to allow evaluation of their effectiveness for the proposed term of storage. (10 CFR 72.236(b) and 10 CFR 72.236(g))

F6.3 The SAR provides reasonable and appropriate information and analyses, including dose rates, to allow evaluation of the Standardized NUHOMS 61-BTH DSC compliance with 10 CFR 72.236(d). This evaluation is described in the radiation protection review (SRP Chapter 10B).

The staff reviewed the applicant's shielding analysis and source term determination. The staff finds the applicant's calculation of the Type 2 source term is conservative and is bounding of the fuel assemblies to be loaded in the Standardized NUHOMS® System. The staff calculations confirmed the applicant's dose rates are reasonable for the Type 2 source term and verified there is negligible impact to site area boundary dose rates. For these reasons, the staff finds reasonable assurance that the Standardized NUHOMS® System will continue to meet the radiation protection requirements in 10 CFR Part 72 and 10 CFR Part 20.

7.0 CRITICALITY EVALUATION

The applicant did not propose any changes that affect the staff's criticality evaluation provided in previous safety evaluations for CoC No. 1004, Amendments No. 1 through 11 and 13 through 16. Therefore, the staff determined that a new evaluation was not required.

8.0 MATERIALS EVALUATION

The objective of the staff's review of the applicant's materials evaluation for Amendment No. 17 to the Standardized NUHOMS® System was to verify that the design of the system ensures adequate materials performance under the service conditions introduced with the new HLZCs. Specifically, the staff analyzed potential thermal and radiation effects on mechanical properties and whether the applicant appropriately evaluated the impact of the new HLZCs on the time-limited aging analyses (TLAAs) and aging management programs (AMPs) that were previously approved in the renewed Standardized NUHOMS® CoC.

8.1 Mechanical Properties

Because the new HLZCs have the potential to introduce service conditions not previously considered, the staff reviewed the thermal and radiation exposures associated with the amendment to ensure that the applicant is using appropriate mechanical properties in its structural evaluations.

8.1.1 Thermal Effects

The thermal exposures are summarized in UFSAR Section T.4.6.13, where the applicant provided the component temperatures associated with the new HLZCs. The applicant's thermal analysis showed that component temperatures (e.g., for the fuel cladding, fuel basket materials, DSC shell) are generally lower than those associated with the previously approved HLZCs. In a few cases, the new configurations increased the DSC shell and fuel bask rail temperatures by up to 2 °F (1 °C) compared to the previously approved HLZCs. In those cases, the applicant demonstrated that the small increase in temperature associated with the new HLZCs do not impact the mechanical properties. The staff reviewed the applicant's information and verified that the temperatures remain below the materials' maximum allowable temperatures. As a result, the staff finds that the mechanical properties previously reviewed by the staff are acceptable for this amendment.

8.1.2 Radiation Effects

In UFSAR Section T.5.2.6, the applicant provided the radiation source terms associated with new HLZCs. As discussed in the amendment application (Orano, 2020a) and in a response to a request for additional information (Orano, 2020b), the applicant assessed the impact of the new source terms on radiation embrittlement of the structural materials by re-evaluating an embrittlement analysis that was previously performed to support the renewal of the Standardized NUHOMS® CoC. The applicant concluded that radiation levels from the new HLZCs are bounded by those that were previously found to be acceptable for the existing HLZCs. The staff reviewed the applicant's analysis and confirmed that the radiation exposures of the structural materials remain significantly below levels that may cause embrittlement. As discussed in NUREG-2214 (NRC, 2019), neutron fluence levels greater than approximately 10^{19} neutrons/square centimeter are required to produce a measurable degradation of the mechanical properties, and the applicant demonstrated that the cumulative neutron fluence for the NUHOMS® system is substantially below that threshold. Therefore, the staff finds that the mechanical properties used in the applicant's structural evaluations remain acceptable.

8.2 Management of Aging Degradation

In Enclosure 9 of the amendment application (Orano, 2020a), the applicant evaluated the impact of the new HLZCs on the existing TLAAs and AMPs of the renewed Standardized NUHOMS® CoC. In accordance with the guidance in NUREG-2215, the staff reviewed the application to ensure that the applicant appropriately evaluated the need to revise (1) the scope of SSCs subject to aging management, (2) the aging management review for applicable aging mechanisms and effects, and (3) the TLAAs and AMPs to ensure that they remain effective to manage the aging of all SSCs.

8.2.1 Scope of SSCs Requiring Aging Management

The applicant stated that the amendment does not result in any changes to the design of the storage system; the amendment only added three new HLZCs to the 61BTH DSC. As a result, the applicant concluded that it did not need to revise the scoping evaluation that was performed for the renewal of the Standardized NUHOMS® CoC. The staff reviewed the amendment request and verified that the amendment does not add or remove any SSCs to the storage system or change the safety classification of any SSCs. As a result, the staff finds that the existing scope of components addressed by the aging management activities remains valid and, therefore, the applicant's aging management scoping determination is acceptable.

8.2.2 Aging Management Review

The applicant concluded that it did not need to revise the credible aging mechanisms and effects that were identified and addressed during the renewal of the Standardized NUHOMS® CoC. The applicant stated that the amendment does not introduce any changes to the materials, component geometries, or service environments.

The staff reviewed the amendment request and verified that the amendment does not introduce any changes to the component materials or geometries. In its review of potential effects of amendment changes on the material service environments, the staff considered whether the addition of the new HLZCs causes changes to thermal and radiation exposures that could affect material degradation. As documented above in SER Section 8.1, the staff notes that the temperature and radiation exposures associated with the new HLZCs are either bounded by, or only negligibly above, those already considered in the renewed CoC. As a result, the staff finds that the credible aging mechanisms and effects identified during the CoC renewal remains valid and, therefore, the applicant's aging management review is acceptable.

8.2.3 Time-Limited Aging Analyses

The applicant evaluated each of the TLAAs that were included in Appendix 3 of the CoC renewal application (AREVA, 2016) to determine whether the new HLZCs change any of the input parameters to those analyses, requiring the analyses to be updated. The staff notes that these analyses address a variety of potential long-term aging issues, such as thermally-induced fatigue, radiation effects (as discussed in SER Section 8.1.2), corrosion, and other material degradation mechanisms. For each TLAA, the applicant concluded that the TLAA in the renewal application remains bounding and applicable to the new conditions introduced in the amendment. The applicant based its conclusions on the fact that the amendment does not change the temperatures, radiation levels, internal pressures, or other parameters to values that were not already considered in the analyses.

The staff reviewed the applicant's evaluations of the TLAAs and independently verified that the range of input parameters considered in each of the analyses remains bounding for the storage system with the new HLZCs. Therefore, the staff finds that the previously approved TLAAs remain acceptable.

8.2.4 Aging Management Programs

The applicant stated that the AMPs described in Sections 3.5, 3.6, and 3.7 of the CoC renewal application (AREVA, 2016) remain applicable to the storage system with the new HLZCs. The applicant based its conclusion on the fact that the amendment does not change the design of the system, the scoping evaluation, or the aging management review (as described above).

The staff reviewed the applicant's evaluation on the applicability of the CoC renewal AMPs and independently verified that the amendment does not change the existing scope of components addressed by the aging management activities or introduce any changes to the component materials, geometries, or service conditions that would affect the aging mechanisms and effects requiring management. Therefore, the staff finds that the previously approved AMPs remain acceptable.

8.3 Findings

F8.1 The applicant has met the requirements in 10 CFR 72.236(g). The properties of the materials in the storage system design have been demonstrated to support the safe storage of SNF.

F8.2 The applicant has met the requirements in 10 CFR 72.236(h). The materials of the SNF storage container are compatible with their operating environment such that there are no adverse degradation or significant chemical or other reactions.

F8.3 The applicant has met the requirements in 10 CFR 72.236(a) and 10 CFR 72.236(m). SNF specifications have been provided and adequate consideration has been given to compatibility with retrieval of stored fuel for ultimate disposal.

The staff reviewed the application using applicable regulations, standard review plans, regulatory guides, codes and standards, and accepted engineering practices. Based on its review, the staff concludes that the Standardized NUHOMS® System design adequately considers material properties and management of aging degradation such that the design is in compliance with 10 CFR Part 72. The staff concludes that there is reasonable assurance that the Standardized NUHOMS® System will ensure the safe storage of SNF.

9.0 OPERATING PROCEDURES EVALUATION

The applicant did not propose any changes that affect the staff's operating procedures evaluation provided in previous safety evaluations for CoC No. 1004, Amendments No. 1 through 11 and 13 through 16. Therefore, the staff determined that a new evaluation was not required.

10.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM EVALUATION

The applicant did not propose any changes that affect the staff's acceptance tests and maintenance program evaluation provided in previous safety evaluations for CoC No. 1004, Amendments No. 1 through 11 and 13 through 16. Therefore, the staff determined that a new evaluation was not required.

11.0 RADIATION PROTECTION EVALUATION

The objective of the radiation protection evaluation is to determine whether the proposed changes comply with the applicable regulatory requirements for radiation protection and ensure that the proposed changes include reasonable consideration of, and facilitate licensees' compliance with, the requirements that licensees who use the storage system must meet.

11.1 Changes to Surface Dose Rates

The applicant determined surface dose rates in its MCNP analysis on the surface of a box that encloses the HSM. The applicant accounted for contribution from adjacent HSMs with reflective boundary conditions. Since the dose rate calculation on this box will account for localized variations (e.g., vent covers), the staff finds this approach acceptable. The applicant explicitly calculated the neutron and gamma spectra for each face as part of its dose rate analysis documented in Section 6 of this SER.

11.2 Findings

F11.1 Since the staff found the applicant's shielding analysis acceptable, the staff finds there is reasonable assurance that the Standardized NUHOMS® System will continue to meet the radiation protection requirements in 10 CFR Part 72 and 10 CFR Part 20.

12.0 ACCIDENT ANALYSIS EVALUATION

The applicant did not request changes to the principal design criteria related to the SSCs important to safety. For this reason, the staff finds the applicant complied with the relevant general criteria established in 10 CFR Part 72, and does not require an accident analysis evaluation of the principal design criteria. Internal pressures changes were investigated as part of the thermal evaluation and found to be either bounding, or non-safety significant for all cases, therefore no further confinement evaluation was necessary for accident conditions.

13.0 TECHNICAL SPECIFICATIONS

The staff reviewed the proposed amendment to determine that applicable changes made to the conditions in the CoC, and to the TSs for CoC No. 1004, Amendment No. 17 would be in accordance with the requirements of 10 CFR Part 72. The staff reviewed the proposed changes to the TS to confirm the changes were properly evaluated and supported in the applicant's revised safety analysis report. The applicant's proposed changes to the TS are as follows:

Table 13-1 - Conforming Changes to the Technical Specifications			
TS page	**TS Number**	**Description**	**Scope Item**
Cover Page	N/A	Amendment number changed to 17.	N/A
Table of Content	N/A	Table of Contents, etc. automated updates	N/A
1-3	1.1	Definition for UNANALYZED FUEL (UF) is added.	1
2-1	2.1.1	Updated pointer to ITE 4.4.	2
3-7	3.1.3	Addition of HLZC 11, 12, or 13 for the 61BTH DSC.	1
T-33	Table 1-1t	Changes made to certain parameters.	1
T-98, T-99	Table 1-4e	Updated table title to provide a more detailed description. Deleted unnecessary note below table.	1
T-100, T-101	Notes: Table 1-4e	Updated Table 1-4e notes.	1
T-102, T-103	Table 1-4f and notes	New Table 1-4f and notes for 61BTH DSC added.	1
T-104, T-105	N/A	Updated table deletion identifiers.	1
F-30	Figure 1-25	Added note for HLZC's 11-13.	1
F-34	Figure 1-25d	HLZC No. 11 for Type 2 61BTH DSC added.	1
F-35	Figure 1-25e	HLZC No. 12 for Type 2 61BTH DSC added.	1
F-36	Figure 1-25f	HLZC No. 13 for Type 2 61BTH DSC added.	1

The staff finds that the proposed changes to the TS for the Standardized NUHOMS® System conform to the changes requested in the amendment application and, as explained do not affect the ability of the cask system to meet the requirements of 10 CFR Part 72. The proposed changes provide reasonable assurance that the Standardized NUHOMS® System will continue to allow safe storage of SNF.

14.0 QUALITY ASSURANCE EVALUATION

The applicant did not propose any changes that affect the staff's quality assurance program evaluation provided in previous safety evaluations for CoC No. 1004, Amendments No. 1 through 11 and 13 through 16. Therefore, the staff determined that a new evaluation was not required.

15.0 CONCLUSIONS

The staff has performed a comprehensive review of the amendment application, during which the following requested changes to the Standardized NUHOMS® System were considered:

Add a NUHOMS®-61BTH (hereafter 61BTH) Type 2 dry shielded canister (DSC), heat load zoning configurations (HLZC) 11-13, and change the maximum assembly heat load from 1.2 kilowatts (kW) to 1.7 kW.

Based on the statements and representations provided by the applicant in its amendment application, as supplemented, the staff concludes that the changes described above to the Standardized NUHOMS® System do not affect the ability of the cask system to meet the requirements of 10 CFR Part 72. Amendment No. 17 for the Standardized NUHOMS® System should be approved.

Issued with Certificate of Compliance No. 1004, Amendment No. 17
On May 4, 2021.

Reference

AREVA, 2016. Non-Proprietary Certificate of Compliance Renewal Application for the Standardized NUHOMS® System Certificate of Compliance No. 1004 (Docket No. 72-1004) Revision 1, AREAVA Inc., October 2015. ADAMS Accession No. ML15295A349.

NRC, 2018. "Spent Fuel Heat Generation in an Independent Spent Fuel Storage Installation," Regulatory Guide 3.54, Revision 2, U.S. NRC, December 2018. ADAMS Accession No. ML18228A808.

NRC, 2019. "Managing Aging Processes in Storage (MAPS) Report," NUREG-2214, U.S. NRC, July 2019. ADAMS Accession No. ML19214A111.

NRC, 2020. "Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities," NUREG-2215, Final Report, U.S. NRC, April 2020. ADAMS Accession No. ML20121A190.

Orano, 2020a. Letter from Orano to NRC, "Application for Amendment 17 to Standardized NUHOMS® Certificate of Compliance No. 1004 for Spent Fuel Storage Casks, Revision 0 (Docket No. 72-1004)." June 11, 2020. This package contains 11 enclosures, and Enclosures 7 and 11 are Proprietary Information and Not Publicly Available. ADAMS Accession No. ML20174A089.

Orano, 2020b. Letter from Orano to NRC, "Response to Request for Additional Information – Application for Amendment 17 to Standardized NUHOMS® Certificate of Compliance No. 1004 for Spent Fuel Storage Casks, Revision 1." September 11, 2020. ADAMS Accession No. ML20255A206.