



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

PRELIMINARY SAFETY EVALUATION REPORT

**DOCKET NO. 72-1042
TN AMERICAS LLC
CERTIFICATE OF COMPLIANCE NO. 1042
NUHOMS® EXTENDED OPTIMIZED STORAGE SYSTEM
AMENDMENT NO. 5**

SUMMARY

This safety evaluation report (SER) documents the U.S. Nuclear Regulatory Commission (NRC) staff's review and evaluation of the request to amend Certificate of Compliance (CoC) No. 1042 for the NUHOMS® Extended Optimized Storage (EOS) system. By letter dated February 26, 2025 (Agencywide Documents Access and Management System Accession No. ML25057A456), as supplemented on August 28, 2025 (ML25240B483), TN Americas LLC, from here on referred to as the "applicant," requested that the NRC amend the CoC No. 1042 to include the following changes:

Change No. 1:

Addition of a new heat load zone configuration (HLZC) for the EOS-37PTH, HLZC 14, which allows an increase in the maximum heat load of the EOS-37PTH to 54 kW per dry shielded canister (DSC) for storage in the EOS-Horizontal Storage Module (HSM) and transfer operations in the EOS-Transfer Casks (TC)125/135. HLZC 14 is only permitted in Basket Type 4HA introduced in Amendment No. 4 to CoC No. 1042 with anodized aluminum. No physical changes are considered for this basket type in this application. An optional support spacer is considered for the flat plate support variant of EOS-Horizontal Storage Module (HSM) as described in the application (EOS-HSM-FPS).

Change No. 2:

Editorial corrections are included as part of this amendment application:

- Section 2.4.2.1 of the updated final safety analysis report (UFSAR) has been revised to clarify that the heat load for any single assembly is 4.3 kW for the EOS-37PTH DSC. This is an editorial correction based on HLZC 12 included as part of application for Amendment No. 4 to CoC No. 1042.
- Note 3 of figure 2-3m (Heat Load Zone Configuration 13 for the EOS-37PTH DSC) has been revised to enhance readability.
- Technical specification (TS) figures 1A and 1J have been revised to clarify the location of HLZC 1 and 10 for EOS-37PTH. For figure 1A, a note was added to indicate HLZC 1 is now described in UFSAR chapter 2, figure 2-3a. For figure 1J, a note was added to indicate HLZC 10 is now described in the UFSAR chapter 2, figure 2-3j.

- TS section 4.4.4 - Alternatives to Codes and Standards, under the table column 'Justification and Compensatory Measures' for reference American Society of Mechanical Engineers (ASME) code section NB-5520 be revised to invoke Table NCA-7100-2, as opposed to the current listing of NCA-7000-1.

Change No. 3:

Clarification regarding acceptance criteria for minor surface imperfections on high-strength low-alloy (HSLA) basket plates within the UFSAR.

The amended CoC, when codified through rulemaking, will be denoted as Amendment No. 5 to CoC No. 1042. This SER documents the staff's review and evaluation of the proposed amendment. The staff followed the guidance of NUREG-2215, "Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities," (ML20121A190) when performing technical reviews of spent fuel storage and transportation packaging licensing actions.

The staff's evaluation is based on a review of the applicant's application and whether it meets the applicable requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 72 for dry storage of spent nuclear fuel (SNF). The staff's evaluation focused only on modifications to the CoC, and TS requested in the amendment as supported by the submitted revised UFSAR (see ML25057A456) and did not reassess previous revisions of the UFSAR nor previous amendments to the CoC.

1.0 GENERAL INFORMATION EVALUATION

The objective of this chapter is to review the changes requested to CoC No. 1042 for the NUHOMS® EOS 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 staff finds that the description of the proposed changes requested by the applicant are adequate to allow staff's detailed evaluation as documented in the following SER sections (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 15, 16, and 17). Note that SER sections 2, 13, and 14 are only applicable to site specific license reviews and are not applicable to CoC evaluations.

2.0 SITE CHARACTERISTICS EVALUATION FOR DRY STORAGE FACILITIES

This section is not applicable to CoC evaluations.

3.0 PRINCIPAL DESIGN CRITERIA EVALUATION

The staff's objective in reviewing the principal design criteria related to the structures, systems and components (SSCs) important to safety (ITS) is to ensure that they comply with the relevant general criteria established in 10 CFR Part 72. The staff reviewed and evaluated the information provided by the applicant and determined that the following changes are applicable to the principal design criteria evaluation:

Change No. 1 Part 1: the addition of a new HLZC for the EOS-37PTH, HLZC 14, which allows an increase in the maximum heat load of the EOS-37PTH to 54 kW per DSC for storage in the EOS-HSM and transfer operations in the EOS-TC125/135.

The NRC staff reviewed the changes to the UFSAR, CoC and TSs associated with the CoC No.

1042 NUHOMS® EOS Amendment No. 5 application. The staff review was conducted using the guidance in chapter 3 of NUREG-2215, Revision 1, “Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities,” to ensure adequate materials performance under normal, off-normal, and accident-level conditions. The objective of the principal design criteria review is to determine whether the NUHOMS® EOS system with the proposed amendments continues to meet the regulatory requirements in 10 CFR 72.236.

3.1 Change No. 1: EOS-37PTH HLZC 14

The applicant provided a revision to UFSAR chapter 2, “Principal Design Criteria,” to include the new HLZC 14 for the EOS-37PTH DSC. The revisions to UFSAR chapter 2 included the addition of figure 2-3n, “Heat Load Zone Configuration 14 for the EOS-37PTH DSC,” which includes the following information and notes:

- a maximum decay heat per DSC of 54 kW
- the HLZC is not applicable to damaged or failed fuel assemblies
- applicable TC and allowable EOS-HSM type combinations
- restrictions on fuel assembly type, and
- references to system configuration information provided in UFSAR chapter 1, “General Information,” and TS, section, 2.1 “Fuel to be Stored in the EOS-37PTH DSC.”

The applicant also added HLZC 14 to UFSAR table 2-10, “Time Limits for Transfer by HLZC,” which shows a transfer time limit of 8 hours. The applicant updated multiple sections and tables, including the addition of new tables in the UFSAR chapter 3, “Structural Evaluation,” applicable to the new HLZC 14 for the EOS-37PTH DSC. The applicant also added a new appendix 4.9.10, “Thermal Evaluation of EOS-37PTH DSC for HLZC 14,” to UFSAR chapter 4, “Thermal Evaluation.”

In addition, the applicant made corresponding changes to TS, section 3.1, “DSC Fuel Integrity,” and TS, figure 12 “Maximum Heat Load Configuration 1 for EOS-37PTH DSC (MHLC-37-1) Transferred in the EOS-TC125/135 AND Stored in the EOS-HSM.”

Based on the information provided by the applicant in the UFSAR and revisions to the TS, the staff determined that the applicant described the principal design criteria and specifications for the new HLZC 14 with the EOS-37PTH DSC. Therefore, the staff determined that the information provided by the applicant meets the regulatory requirements in 10 CFR 72.236(a) and (b). The staff review of the applicant’s evaluation for structural, thermal, shielding, material, operating procedures, acceptance test and maintenance programs, and TS changes are provided in the corresponding sections of this SER.

3.2 Evaluation Findings

The staff finds that the descriptions of the dry storage system (DSS) characteristics are such that appropriate design criteria and bases for the DSS could be defined and evaluated. The staff concludes that the principal design criteria for the DSS are acceptable with regard to meeting the regulatory requirements in 10 CFR Part 72. This finding is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices. Chapters 3 through 16 of the SER present a more detailed evaluation of the design criteria and an assessment of compliance with those criteria. Some of the key findings from the staff’s review of Amendment No. 5 include:

- F3.1 The UFSAR and docketed materials adequately define the bounding conditions under which DSS is expected to operate in accordance with the requirements of 10 CFR 72.236.
- F3.2 The UFSAR and docketed materials meet the regulatory requirements for design bases and criteria for thermal consideration as given in 10 CFR 72.236(f).
- F3.3 The UFSAR and the docketed materials relating to the design bases and criteria meet the general requirements as given in 10 CFR 72.236(b).

4.0 STRUCTURAL EVALUATION

The objective of the structural review is to ensure that the applicant has performed adequate structural analyses to demonstrate that the system, as proposed, is acceptable under normal, off-normal operations, and accident conditions, including natural phenomena events. In conducting this evaluation, the staff focused its review on whether the system will maintain confinement, subcriticality, shielding, and retrievability of the fuel, as applicable, under credible loads.

The applicant submitted three proposed changes to revise the updated UFSAR for the NUHOMS® EOS system. The staff reviewed the information provided and found the following change is the most relevant that required structural evaluation:

Change No. 1:

Addition of a new HLZC for the EOS-37PTH, HLZC 14, which allows an increase in the maximum heat load of the EOS-37PTH to 54 kW per DSC for storage in the EOS-HSM and transfer operations in the EOS-TC125/135. HLZC 14 is only permitted in Basket Type 4HA introduced in Amendment No. 4 to CoC No. 1042 with anodized aluminum. No physical changes are considered for this basket type in this application. An optional support spacer is considered for the flat plate support variant of EOS-HSM as described in the application (EOS-HSM-FPS).

This section of the SER documents the NRC staff's structural evaluations to verify that the structural performance of the NUHOMS® EOS system meets the regulatory requirements of 10 CFR Part 72.

4.1 Evaluation for Addition of a New HLZC 14 for the EOS-37PTH in the EOS-HSM and EOS-TC125/135

The applicant proposed adding a new HLZC 14 for the EOS-37PTH that allows an increase in the maximum heat load of the EOS-37PTH from 50 kW to 54 kW in the DSC of the EOS-HSM system and the EOS-TC125/135 TCs. The addition of HLZC 14 is the only proposed change and there is no structural design change proposed in this proposed Change No. 1.

The applicant evaluated the EOS-DSC shell structure, EOS-37PTH basket structure, EOS-HSM structure, and EOS-TC structure with the heat load of 54 kW and presented the results in the UFSAR, Revision 5. Below is a brief discretion of the analysis and the NRC staff's review findings.

4.1.1 EOS-DSC Shell Structural Analysis

The applicant performed a structural analysis for the EOS-DSC shell structure with the proposed HLZC 14 (i.e., 54 kW) using the ANSYS finite element (FE) code. The methodology, acceptance criteria and assumptions for the FE analysis remain the same as those documented in the UFSAR, Revision 4 (Reference 2), which was previously reviewed and accepted by the NRC staff, except for the heat load change from 50 kW to 54 kW.

The applicant compared the temperature gradients associated with the 54 kW heat load with those associated with the 50 kW heat load and found that there is not a substantial effect on the thermal stresses of the EOS-DSC shell assembly by the heat load increase. Tables 3.9.1-7 through 3.9.1-12a, 3.9.1-16, and 3.9.1-16a show the calculated safety margin for all components of the EOS-DSC shell structure under the load combinations that demonstrate their abilities to accommodate any marginal increase in thermal stress due to the heat load increase from 50 kW to 54 kW by adding HLZC 14.

The NRC staff reviewed the results of the analysis in the tables and found that the calculated stress ratios (SRs), where SR is defined as a ratio of the induced maximum stress intensity due to the applied loads with respect to the allowable stress intensity of the component, are all less than 1.0, indicating that the components of the EOS-DSC shell structure have design strength that can resist the applied load combinations. Based on the review of the analysis results, the NRC staff determines that the results of the structural analysis demonstrate that the DSC shell structure has design strength against the heat load increase from 50 kW to 54 kW, therefore, the NRC staff concludes that the proposed addition of HLZC 14 is acceptable.

4.1.2 EOS-37PTH Basket Structural Analysis:

The applicant performed a structural analysis for the EOS-37PTH basket structure with the proposed HLZC 14 (i.e., 54 kW) using the ANSYS FE code and hand calculations. The methodology, acceptance criteria and assumptions for the FE analysis remain the same as those documented in the UFSAR, Revision 4, which was previously reviewed and accepted by the NRC staff, except the heat load increases from 50 kW to 54 kW.

The applicant presented the results of its analysis in table 3.9.2-3. The table shows that all calculated SRs are less than 1.0. The NRC staff reviewed the results of the analysis in the tables and confirmed that all calculated SRs for the EOS-37PTH basket components are less than 1.0, indicating that the basket components have design strength that can resist the applied load combinations. Based on the review of the analysis results, the NRC staff determines that the results of the structural analysis demonstrate that the EOS-37PTH basket structure has design strength against the heat load increase from 50 kW to 54 kW, therefore, the NRC staff concludes that the proposed addition of HLZC 14 is acceptable.

4.1.3 EOS-HSM Structural Analysis

The applicant performed a structural analysis for the EOS-HSM structure using the ANSYS FE code. The methodology, acceptance criteria and assumptions for the FE analysis remain the same as those documented in the UFSAR, Revision 4, which was previously reviewed and accepted by the NRC staff, except the heat load increases from 50 kW to 54 kW.

The applicant presented the results of its analysis in table 3.9.4-13d, table 3.9.4-14e (EOS-HSM-FPS), and table 3.9.4-29f, which show the highest demand/capacity (D/C) ratios for shear

forces and moments of the EOS-HSM components for the 54kW heat load condition. The NRC staff reviewed the results of the analysis in the tables and found that all calculated D/C ratios are less than 1.0, indicating that the EOS-HSM structural components have design strength that can resist the applied load combinations. Based on the review of the analysis results, the NRC staff determines that the results of the structural analysis demonstrate that the EOS-HSM structure has design strength against the heat load increase from 50 kW to 54 kW, therefore, the NRC staff concludes that the proposed addition of HLZC 14 is acceptable.

4.1.4 EOS-TC Structural Analysis

The applicant evaluated the structural performance of the EOS-TC under the heat load 54 kW condition. The applicant first compared the temperature distributions of the EOS-TC125 loaded with the EOS-37PTH under the heat load 54 kW condition with the EOS-TC125 loaded with the EOS-37PTH under the heat load 50 kW condition, where the temperature distributions are from the results of the thermal analysis documented in chapter 4, "Thermal Evaluation," of UFSAR, Revision 5. The applicant stated that the temperatures for the EOS-TC125 loaded with the EOS-37PTH under the heat load 54 kW condition are shown to be comparable to those temperatures for the EOS-TC125 loaded with the EOS-37PTH under the heat load 50 kW condition such that there is not a meaningful impact on thermal stress. As a result, the applicant concluded that the results of the EOS-TC structural analysis with the heat load of 54 kW remain the same as those documented in the UFSAR, Revision 4, which was previously reviewed and accepted by the NRC staff.

The NRC staff reviewed the applicant's statements regarding the thermal stress analysis and confirmed that the increase heat load from 50 kW to 54 kW does not significantly affect the temperature changes, thereby, it does not affect the structural performance of the EOS-TC structure. Therefore, the NRC staff determines that the applicant's proposed addition of HLZC 14 is acceptable.

4.2 Revisions of Technical Specification

The NRC staff reviewed the TS sections 1.0 and 4.0, where the structural systems are described. Based on the NRC staff's review of sections 1.0 and 4.0 in the TS, the NRC staff finds that the information provided in the TS regarding the structural system is consistent with the information provided in the application and therefore is acceptable.

4.3 Evaluation Findings

The NRC staff reviewed and evaluated the applicant's statements and representations in the application. Based on review and evaluations, the NRC staff concludes that the proposed addition of HLZC 14 to the EOS-37PTH in the EOS-HSM and EOS-TC125/135 is acceptable. This conclusion is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, standard review plans, applicable codes and standards, and accepted engineering practices.

Some of the key findings from the staff's review of Amendment No. 5 include:

F4.1 The UFSAR adequately describes the SSCs that are important to safety, providing the structural analyses in detail to allow evaluation of their structural effectiveness.

F4.2 The applicant has met the requirements of 10 CFR 72.236(b). The SSCs ITS are designed to accommodate the combined loads of normal, off-normal, and accident conditions with an adequate margin of safety. Stresses at various locations of the SSCs ITS for design loads are determined by analyses. Total stresses for the combined loads of normal, off-normal, and accident conditions are acceptable and are found to be within the limits given in applicable codes, standards, and specifications.

4.4 References

1. Orano, "Application for Amendment 5 to NUHOMS® EOS Certificate of Compliance No. 1042, Revision 0 (Docket 72-1042)," dated February 26, 2025, with:
 - a. Enclosure 2 - Description, Justification, and Evaluation of Amendment 5 Changes
 - b. Enclosure 4 - Proposed Technical Specifications, CoC 1042 Amendment 5, Revision 0
 - c. Enclosure 5 - Proposed Amendment 5, Revision 0 Changes to the NUHOMS® EOS System Updated Final Safety Analysis Report (Proprietary and Security Related Version)
2. Orano, "NUHOMS® EOS System Updated Final Safety Analysis Report," Docket Number 72-1042, Revision 4, June 2022, ML22168A023.

5.0 THERMAL EVALUATION

The NRC staff's thermal review of Amendment No. 5 for the NUHOMS® EOS storage system aims to ensure that the cask components and fuel material temperatures remain within allowable limits under normal, off-normal, and accident conditions. This portion of the review also confirms that the cask thermal design has been evaluated using acceptable analytical techniques and/or testing methods. The review was conducted under the regulations described in 10 CFR 72.236, which identify the specific requirements for the regulatory approval, fabrication, and operation of spent fuel storage cask designs. The application was also reviewed to determine whether the NUHOMS® EOS storage system design fulfills the acceptance criteria listed in sections 2, 5, and 15 of NUREG-2215, "Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities."

The following changes under Change No. 1 of Amendment No. 5 to the NUHOMS® EOS storage system are applicable to the thermal evaluation:

1. Increase in the maximum heat load of the EOS-37PTH DSC.
2. Addition of HLZC 14 for the EOS-37PTH which is applicable for transfer in the EOS-TC125/135 and storage in the EOS-HSM, excluding the EOS-HSM-HS (high seismic) variant.

5.1 Thermal Evaluation for Normal Conditions of Storage and Transfer Operations

The NRC staff reviewed the applicant's thermal evaluation of the NUHOMS® EOS storage system under normal storage and transfer conditions, considering the increased maximum heat load and the new heat load pattern. Based on the information provided in the application regarding the applicant's evaluation, the staff determined that the application is consistent with

guidance provided in NUREG-2215, section 5.4.4, which states that the applicant should present a thermal analysis that clearly demonstrates the storage system's ability to manage UFSAR specified heat loads and have the various materials and components remain within temperature limits. The staff found that the applicant has provided a thermal evaluation used to show that calculated maximum temperatures remain below the recommended limits described in the application, and therefore, meets the requirements of 10 CFR 72.236(f).

5.2 Off-Normal and Accident Events

The NRC staff evaluated the applicant's thermal analysis of the NUHOMS® EOS storage system during off-normal and accident events, focusing on the increased maximum heat load and the new heat load pattern. Based on the information provided in the application regarding the applicant's thermal evaluation, the staff determined that the application is consistent with guidance provided in NUREG-2215, section 5.4.4, that states that the applicant should present a thermal analysis that clearly demonstrates the storage system's ability to manage specified heat loads and have the various materials and components remain within temperature limits. The applicant demonstrated this ability by performing the calculations and demonstrating that the analysis results are lower than the recommended limit of 1058°F. Therefore, the staff concludes that the thermal evaluation during off-normal and accident events is acceptable because the thermal evaluation is consistent with NUREG-2215 and therefore meets the requirements of 10 CFR 72.236(f).

5.3 Confirmatory Analyses

The NRC staff reviewed the thermal models used by the applicant, verifying the code inputs, material properties, and boundary conditions in the calculation packages. The staff verified that the applicant's selected code models and assumptions were adequate for the flow and heat transfer characteristics prevailing in the NUHOMS® EOS storage system geometry and analyzed conditions. The staff reviewed the engineering drawings to verify that geometry dimensions were representative in the analysis models. The staff also reviewed the material properties presented in the UFSAR to verify that they were appropriately referenced and used.

The staff performed audit reviews of bounding configurations to verify that key thermal design parameters have been appropriately determined and correctly expressed as inputs into the thermal analysis, performed checks of energy and mass balances, and verified that the applicant's thermal analyses have adequately converged. In addition, the staff performed several sensitivity analyses by varying key assumptions to verify that the applicant had correctly characterized the heat transfer and flow type used in the analysis. The staff determined that the UFSAR reported maximum temperatures were below the allowable temperature limits. Based on the review of the applicant's analysis and sensitivity calculations, the staff determined that the applicant's thermal model and analysis are acceptable and bounding.

5.4 Evaluation Findings

- F5.1 UFSAR chapter 2 describes SSCs important to safety to enable an evaluation of their thermal effectiveness. SSCs important to safety remain within their operating temperature ranges.
- F5.2 The NUHOMS® EOS storage system is designed with a heat removal capability having verifiability and reliability consistent with its importance to safety. The NUHOMS® EOS

storage system is designed to provide adequate heat removal capacity without active cooling systems.

- F5.3 The spent fuel cladding is protected against degradation leading to gross ruptures under long-term storage by maintaining cladding temperatures below 752°F (400°C). Protection of the cladding against degradation is expected to allow ready retrieval of spent fuel for future processing or disposal.
- F5.4 The spent fuel cladding is protected against degradation leading to gross ruptures under off-normal and accident conditions by maintaining cladding temperatures below 1058°F (570°C). Protection of the cladding against degradation is expected to allow ready retrieval of spent fuel for future processing or disposal.
- F5.5 The staff concludes that the thermal design of the NUHOMS® EOS storage system complies with the design requirements of 10 CFR 72.236 and meets the applicable design and acceptance criteria. The evaluation of the thermal design provides reasonable assurance that the cask will allow for safe storage of SNF. This finding is reached, based on a review that considered the NRC regulations, appropriate regulatory guidance, applicable codes and standards, and accepted engineering practices.

6.0 SHIELDING EVALUATION

The objective of the shielding review is to determine whether the NUHOMS® EOS system with the proposed amendments continues to meet the regulatory requirements of 10 CFR 72.234(a) and 10 CFR 72.236(d).

The staff reviewed the information provided by the applicant and the following change is applicable to the shielding design:

Change No. 1:

Addition of a new HLZC for the EOS-37PTH, HLZC 14, which allows an increase in the maximum heat load of the EOS-37PTH to 54 kW per DSC for storage in the EOS-HSM and transfer operations in the EOS-TC125/135. HLZC 14 is only permitted in Basket Type 4HA introduced in Amendment No. 4 to CoC No. 1042 with anodized aluminum. No physical changes are considered for this basket type in this application.

6.1 Change No. 1: Addition of a new HLZC for the EOS-37PTH, HLZC 14

In the proposed Change No. 1, the applicant requested to add a new HLZC for the EOS-37PTH, HLZC 14, which allows an increase in the maximum heat load of the EOS-37PTH to 54 kW per DSC for storage in the EOS-HSM and transfer operations in the EOS-TC125/135. HLZC 14 is only permitted in Basket Type 4HA, which was introduced in Amendment No. 4 to CoC No. 1042 (ML25211A334). The applicant proposed no physical changes to this basket type in this application.

This new HLZC 14 is shown in figures 2-3n of the revised UFSAR. The applicant uses figure 12 of the TS to establish the limits on the total decay heat load of the DSC and the maximum heat load in each fuel compartment to qualify the various HLZCs.

The applicant developed a new “shielding HLZC” which is intended to be bounding of all HLZCs, 1 through 14. The shielding HLZC is provided in figure 6-19 of the TS and bounds the maximum

heat load configurations (MHLC), figure 12 of the TS. This shielding HLZC was previously approved in Amendment No. 4 of NUHOMS® EOS systems. The applicant modeled the hottest fuel distributed evenly around the periphery to ensure EOS-HSM inlet and outlet vent dose rates are maximized. The peripheral fuel assembly locations are defined in TS figure 3. The applicant also increased the heat load of the bounding fuel assembly to 5.0 kW/FA rather than 4.3 kW/FA for the existing MHLC. The shielding HLZC features 63.6 kW on the periphery and 98.3 kW within the entire DSC. These assumptions conservatively increase calculated dose rates, and staff find them acceptable for the shielding HLZC.

The staff recognized that the decay heat cannot uniquely define the allowable spent fuel contents for the purpose of shielding design since there are many different burnup, enrichment, cooling times (BECT) combinations that can produce the same decay heat but different source terms. The applicant developed a list of BECTs that can produce the decay heat and source terms. In this way, the allowable spent fuel contents are uniquely defined for both the decay heat limit and source term limits. The applicant used the decay heat limit for thermal analyses and the BECT to define the source terms used for the shielding analyses. The staff found this approach acceptable because the decay heat and the radiation source terms are not correlated according to R. Cumberland et. al., "A Study on the Relationship between Dose Rate and Decay Heat for Spent Nuclear Fuel Casks," Oak Ridge National Laboratory, June 17, 2020.

6.5 Evaluation Findings

The staff reviewed the proposed Change No.1 for the NUHOMS® EOS system and found that the proposed change is consistent with the results of the applicant's shielding and radiation protection analysis. The proposed Change No.1 will ensure that the NUHOMS® EOS system meets dose rate limits as required by 10 CFR 72.124(a) and 72.236(c).

Some key finds from this evaluation include:

- F6.1 The UFSAR provides specifications of the spent fuel contents to be stored in the EOS storage system in sufficient detail that adequately defines the allowed contents and allows evaluation of the DSS shielding design for the proposed contents. The UFSAR includes analyses that are adequately bounding for the radiation source terms associated with the proposed contents' specifications.
- F6.2 The UFSAR provides reasonable and appropriate information and analyses, including dose rates, to allow evaluation of the EOS storage system compliance with 10 CFR 72.236(d). The existing information and analysis results remain valid, and there is no change in the Radiation Protection Chapter for this amendment.
- F6.3 The UFSAR still provides reasonable and appropriate information and analyses, including dose rates, to allow evaluation of consideration of as low as reasonably achievable (ALARA) in the EOS storage system design and evaluation of occupational doses.

7.0 CRITICALITY EVALUATION

The staff reviewed the information provided by the applicant and found that none of the proposed changes affect criticality safety of the NUHOMS® EOS system.

8.0 MATERIALS EVALUATION

The staff reviewed and evaluated the information provided by the applicant requested in Amendment No. 5. The specific changes evaluated in this section include:

Change No. 1: the addition of a new HLZC for the EOS-37PTH, HLZC 14, which allows an increase in the maximum heat load of the EOS-37PTH to 54 kW per DSC for storage in the EOS-HSM and transfer operations in the EOS-TC125/135, and (2) an optional support spacer is considered for the flat plate variant of EOS-HSM as described in the application.

The NRC staff reviewed the changes to the UFSAR, CoC, and TSs associated with the CoC No. 1042 NUHOMS® EOS Amendment No. 5 application and evaluated the changes with respect to the 10 CFR Part 72 regulatory requirements identified in section 8.4, "Regulatory Requirements and Acceptance Criteria," and guidance and review procedures specified in NUREG-2215, "Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities," chapter 8, "Materials Evaluation," to ensure adequate materials performance under normal, off-normal, and accident-level conditions.

The areas of review covered in this SER included system design, engineering drawings, material selection and material properties, environmental conditions and material compatibility, cladding integrity, and fuel condition.

In addition to the guidance in NUREG-2215, the staff evaluated the engineered drawing and the description of the structures systems and components included in the NUHOMS® EOS Amendment No. 5 application using the information provided in NUREG/CR-5502, "Engineering Drawings for 10 CFR Part 71 Package Approval," and NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety."

8.1 Change No. 1, Part 1: New HLZC for the EOS-37PTH

The applicant stated that the addition of a new HLZC for the EOS-37PTH, HLZC 14, allows an increase in the maximum heat load of the EOS-37PTH to 54 kW per DSC for storage in the EOS-HSM and transfer operations in the EOS-TC125/135. In addition, the applicant stated that HLZC 14 is only permitted in the EOS-37PTH with Basket Type 4HA which was previously introduced in NUHOMS® EOS Amendment No. 4.

The applicant stated in UFSAR section 1.1, Introduction, that the Type 4H basket is fabricated from a coated steel plate for higher emissivity and higher conductivity poison plate. The 4HA Basket Type is a subset of the 4H basket where the aluminum basket plates are anodized. The applicant revised the description of the Type 4HA basket to state that anodizing is required when HLZCs with decay heats greater than 3.5 kW per fuel assembly or 50 kW per DSC are stored and made the corresponding change to UFSAR table 1-2, "System Configurations for the NUHOMS® EOS System and NUHOMS® MATRIX System." The increased emissivity value of the anodized coating for the Type 4HA basket is necessary for heat transfer. The applicant also revised safety analysis report (SAR) drawing EOS01-1010-SAR, "NUHOMS® EOS System Transportable Canister 37PTH Basket Assembly," with a note that indicates that anodizing is required for the A4HA and B4HA baskets and required for HLZCs with a maximum decay heat greater than 3.5 kW per assembly or 50 kW per DSC. The applicant included the required emissivity value in UFSAR drawing EOS01-1010-SAR and identified the anodized coating as an

important to safety category C item. No changes were made to the Boron content of the A4HA and B4HA baskets.

The applicant updated the TS figures and tables that identify the approved contents of the EOS-37PTH including fuel assembly burnup, maximum heat load, transfer time limits, minimum cooling times, and the maximum number of irradiated stainless-steel rods per DSC and per reconstituted fuel assembly.

The applicant showed that the maximum component temperatures for the new HLZCs were below the maximum allowed temperatures. Time limits for the EOS-37PTH with the new HLZCs for a transfer operation with the EOS-TC125 with a maximum heat load of 54 kW and different load cases are included in UFSAR table 4.9.10-16, "Time Limits for Transfer Operations of EOS-37PTH DSC with HLZC 14 During Transfer Conditions in EOS-TC125."

The staff reviewed the information provided by the applicant in the UFSAR and TS to support this change. The staff determined that the new HLZC 14 in EOS-37PTH with Basket Type 4HA with individual assembly heat loads up to 4.3 kW and DSC heat loads up to 54 kW was acceptable because the applicant provided an analysis of component temperatures showing that maximum component temperatures were below allowable temperature limits under normal, off-normal, and accident conditions for (1) the EOS-37PTH using HLZC 14 during storage in the EOS-HSM and (2) during transfer operations with the EOS-TC125. The staff determined that the applicant has adequately specified the anodized coating requirements because the applicant provided a required emissivity value as well as testing requirements to verify the emissivity properties for the anodized coating.

8.2 Change No. 1, Part 2: Optional Support Spacer for the EOS-HSM Flat Plate Variant

The applicant provided revised drawing EOS01-3000-SAR, "NUHOMS® EOS-HSM Main Assembly," to include an optional support spacer block for the flat plate support DSC structure. The revised drawings contained a revised components list that added information on the material specifications and quality category for the spacer block and the associated hardware. Material properties for the spacer block were already included in the UFSAR.

The staff reviewed the changes to the UFSAR and determined that the materials changes associated with the inclusion of the optional spacer block were acceptable because the applicant included revised drawings with material specifications and item quality category. The staff verified that the materials properties for the added component were already incorporated into NUHOMS® EOS UFSAR.

8.3 Evaluation Findings

The staff concludes that the NUHOMS® EOS dry storage system design adequately considers material properties, environmental degradation and other reactions, fuel clad integrity, content retrievability, and material quality controls such that the design is in compliance with 10 CFR Part 72. The evaluation of these materials considerations provides reasonable assurance that the NUHOMS® EOS dry storage system will allow safe storage of SNF. This finding is reached based on a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices.

Some of the key findings from the staff's review of Amendment No. 5 include:

- F8.1 The applicant has met the requirements in 10 CFR 72.236(b). The applicant described the materials design criteria for SSCs important to safety in sufficient detail to support a safety finding.
- F8.2 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.
- F8.3 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.
- F8.4 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.

9.0 CONFINEMENT EVALUATION

There were no changes to the applicant's confinement section of the UFSAR requested in the amendment application.

10.0 RADIATION PROTECTION EVALUATION

The objectives of the radiation protection evaluation are to determine whether the design features and proposed operations meet the following criteria:

1. The radiation protection features with the proposed changes to the DSC design meet the NRC design criteria for protecting the general public and occupational workers from direct radiation.
2. The applicant has proposed engineering features and operating procedures for the DSC that will ensure occupational exposures will remain ALARA.
3. The radiation doses to the general public will meet regulatory standards during normal conditions, anticipated operational occurrences, and accidents.

For the CoC No. 1042 Amendment No. 5 application, the applicant demonstrated that the system will be able to meet the dose limit prescribed in 10 CFR 72.236(d) assuming that accident recovery is within 8 hours. Consistent with 72.212(b)(6), the user is required to review the UFSAR and, therefore, should be aware of the assumptions described in the UFSAR for the development of the radiation protection plan based on site specific characteristics and operation procedures. Because the staff has accepted this assumption in the review of Amendment No. 5 for the NUHOMS® EOS system, and there is no change in the assumption, the staff did not need to re-review the validity of this assumption.

10.1 Evaluation Findings

For this amendment, the UFSAR provides specifications of the spent fuel contents to be stored in the EOS storage system in sufficient detail that adequately defines the allowed contents and allows evaluation of the DSS shielding design for the proposed contents. The UFSAR includes analyses that are adequately bounding for the radiation source terms associated with the

proposed contents' specifications. The UFSAR provides reasonable and appropriate information and analyses, including dose rates, to allow evaluation of the EOS storage system compliance with 10 CFR 72.236(d), and there is no change in the Radiation Protection Chapter for this amendment. The UFSAR still provides reasonable and appropriate information and analyses, including dose rates, to allow evaluation of consideration of ALARA in the EOS Storage System design and evaluation of occupational doses.

11.0 OPERATING PROCEDURES AND SYSTEMS EVALUATION

The staff reviewed the information provided by the applicant and the following changes are applicable to the operating procedures evaluation:

Change No. 1:

Addition of a new HLZC for the EOS-37PTH, HLZC 14, which allows an increase in the maximum heat load of the EOS-37PTH to 54 kW per DSC for storage in the EOS-HSM and transfer operations in the EOS-TC125/135.

Change No. 2:

TS section 4.4.4 - Alternatives to Codes and Standards, under the table column 'Justification and Compensatory Measures' for reference ASME code section NB-5520 be revised to invoke Table NCA-7100-2, as opposed to the current listing of NCA-7000-1.

The staff's review of the applicant's TS associated with Change No. 1 noted the addition of determining new time limits for completion of DSC transfer if the maximum allowable heat load is less than 54 kW. This is consistent with the changes, as well as the staff's review, of the applicant's thermal evaluation, and is therefore acceptable.

For Change No. 2, the staff determined that the revised reference from Table NCA-7000-1 to Table NCA-7100-2 reflects the appropriate section of the ASME Code applicable to the justification being cited. This change ensures that the Technical Specifications accurately reference the correct table within ASME Section III, in accordance with the applicant's intended code basis and the staff finds this correction acceptable.

11.1 Evaluation Findings

The staff concludes that the operations descriptions, including procedures and guidance, for the operation of the NUHOMS® EOS system are in compliance with 10 CFR Part 72, and that the applicable acceptance criteria have been satisfied. The evaluation of the operations descriptions provided in the UFSAR offers reasonable assurance that the EOS system will enable the safe storage of spent fuel. This finding is based on a review that considered the regulations, appropriate regulatory guides, applicable codes and standards, and accepted practices. The key finding from the staff's review of Amendment No. 5 includes:

F11.1 The NUHOMS® EOS system is compatible with dry loading and unloading in compliance with 10 CFR 72.236(h). General procedure descriptions for these operations are summarized in chapter 9 of the applicant's UFSAR. Detailed procedures will need to be developed and evaluated on a site-specific basis.

12.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM EVALUATION

The staff's objective in reviewing the principal design criteria related to the SSCs important to safety is to ensure that they comply with the relevant general criteria established in 10 CFR Part 72. The staff reviewed and evaluated the information provided by the applicant and determined that the following changes are applicable to the acceptance test and maintenance program evaluation:

Change No. 1 Part 1: The addition of a new HLZC for the EOS-37PTH, HLZC 14, which allows an increase in the maximum heat load of the EOS-37PTH to 54 kW per DSC for storage in the EOS-HSM and transfer operations in the EOS-TC125/135.

Change No. 3: This change provides clarification regarding acceptance criteria for minor surface imperfections on HSLA basket plates within the UFSAR.

The applicant included a supplement to UFSAR chapter 10 to describe the acceptance test and maintenance program for the NUHOMS® EOS Amendment No. 5 application.

The NRC staff reviewed the changes to the UFSAR, CoC and TSs associated with the CoC No. 1042 NUHOMS® EOS Amendment No. 5 application. The staff review was conducted using the guidance in chapter 12 of NUREG-2215, Revision 1, "Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities," to reach reasonable assurance of adequate materials performance under normal, off-normal, and accident-level conditions.

12.1 Change No. 1, Part 1: New HLZC for the EOS-37PTH

The applicant revised UFSAR section 10.1.6, "Thermal Acceptance," to be consistent with the increase per assembly and total canister decay heat loads with the new HLZC 14 for the EOS-37PTH DSC. The applicant included revisions to the fuel basket specifications for the increased heat loads.

The staff reviewed the revisions to the EOS-37PTH design specifications associated with the increase per assembly and total canister decay heat loads with the new HLZC 14 and determined that the applicant has provided specifications for the design and analysis to show that content and component temperatures limits are not exceeded under normal, off-normal, and accident conditions. Therefore, the staff determined that the acceptance criteria for the new HLZC of the EOS-37PTH are acceptable.

12.2 Change No. 3: Acceptance Criteria for Minor Surface Imperfections on HSLA Basket Plates

The applicant revised the acceptance criteria in UFSAR subsection 10.1.7, "High-Strength Low-Alloy Steel for Basket Structure," to state that the HSLA basket shall also meet the following production acceptance criteria:

- Scratches and other surface imperfections up to 1/16-inch depth are acceptable. These scratches and imperfections must be at least three times the plate thickness away from other scratches and imperfections.

The staff reviewed the changes and determined that the revision to UFSAR subsection 10.1.7 and the applicant's description of minor surface imperfections on the HSLA steel basket plates enhance the clarity and objectivity of the acceptance process. Specifically, the UFSAR text

states that scratches and other imperfections up to 1/16 inch in depth are acceptable, provided they are located at a distance of at least three times the plate thickness from any adjacent imperfections. This quantitative criterion is consistent with the intent of applicable industry codes and standards, such as ASME Boiler and Pressure Vessel Code section III and is defined and are sufficiently limited to ensure that the ITS functions of the HSLA basket materials are maintained. Therefore, staff determined that the changes to the HSLA basket acceptance criteria are acceptable.

12.3 Evaluation Findings

The staff concludes that the acceptance tests and maintenance programs are in compliance with 10 CFR Part 72, and that the applicable acceptance criteria have been satisfied. The evaluation of the acceptance tests and maintenance program provides reasonable assurance that the NUHOMS® EOS system will allow safe storage of SNF throughout its licensed or certified period of storage. This finding is based on a review that considered the regulations, appropriate regulatory guides, applicable codes and standards, and accepted practices. The key finding from the staff's review of Amendment No. 5 include:

F12.1 SSCs important to safety will be designed, fabricated, erected, tested, and maintained to quality standards commensurate with the importance to safety of the function(s) they are intended to perform. Chapter 1 of the UFSAR identifies the safety importance of SSCs, and chapter 2 present the applicable standards for their design, fabrication, and testing in accordance with, 10 CFR 72.162, 10 CFR 72.234(b) and 10 CFR 72.236(b), (g), (j) and (l).

F12.2 The applicant or licensee, as appropriate, will examine and test, as needed, the DSS SSCs and features to ensure they do not exhibit any defects that could significantly reduce their confinement effectiveness. Chapter 10 of the SAR describe(s) this inspection and testing, in compliance with 10 CFR 72.236(l).

13.0 WASTE MANAGEMENT EVALUATION

This section is not applicable to CoC evaluations.

14.0 DECOMMISSIONING EVALUATION

This section is not applicable to CoC evaluations.

15.0 QUALITY ASSURANCE EVALUATION

There were no changes to the applicant's quality assurance program requested in the amendment application.

16.0 ACCIDENT ANALYSIS EVALUATION

The staff's objective in reviewing the applicant's accident analysis evaluation related to the SSCs important to safety is to ensure that they comply with the relevant general criteria established in 10 CFR Part 72. The staff reviewed and evaluated the information provided by the applicant and determined that the following changes are applicable to the off-normal and accident analysis evaluation:

Change No. 1 Part 1: the addition of a new HLZC for the EOS-37PTH, HLZC 14, which allows an increase in the maximum heat load of the EOS-37PTH to 54 kW per DSC for storage in the EOS-HSM and transfer operations in the EOS-TC125/135.

The NRC staff reviewed the changes to the UFSAR, CoC and TSs associated with the CoC No. 1042 NUHOMS® EOS Amendment No. 5 application. The staff review was conducted using the guidance in chapter 16 of NUREG-2215, Revision 1, "Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities," to reach reasonable assurance of adequate protection under off-normal and accident-level conditions.

16.1 Off-Normal Events Evaluation

The applicant made no changes to the off-normal events evaluation.

16.2 Accident Events Evaluation

In UFSAR subsection 12.3.2, "Earthquake," the applicant revised the "Cause of Accident," description. These changes include referencing existing tables in UFSAR subsection 3.9.4, "EOS-HSM Structural Analysis," and revisions to table 3.9.8-2, "Spectral Acceleration Applicable to Different Components of EOS-HSM-SC for Seismic Analysis."

The staff reviewed the revisions to the applicant's Earthquake Cause of Accident analysis for the NUHOMS® EOS system using the guidance in NUREG-2215. The staff determined that the revised information remains consistent with the guidance in NUREG-2215, section 16.5.2 "Accidents," as the UFSAR revisions describe the following:

- a discussion of the cause of the event,
- the means of detection of the event,
- an analysis of the consequences (particularly any radiological consequences) and the protection provided by devices or systems designed to limit the extent of the consequences, and
- any corrective actions required of the operator.

For the revision to the earthquake accident analysis, the applicant's analysis demonstrate that design basis accident allowable stresses, temperatures, and pressures were not exceeded for the NUHOMS® EOS system. The revised analysis also shows that the effects and consequences of the earthquake accident do not cause significant degradation of the radiation shielding and confinement features and the storage system continues to meet the regulatory requirements of 10 CFR 72.236(d). Therefore, the staff determined that the applicant's revised analysis for earthquake accidents was acceptable.

16.3 Evaluation Findings

The staff reviewed the applicant's revised analysis for earthquake accident analysis for the NUHOMS® EOS system. The staff determined that the applicant's analyses of postulated accidents are acceptable as the applicant has provided analysis to show that the consequences of accident conditions are below the regulatory dose limits of 10 CFR 72.106. Some of the key findings from the staff's review of NUHOMS® EOS Amendment No. 5 application include:

- F16.1 Structures, systems, and components of the NUHOMS® EOS system are adequate to prevent accidents and to mitigate the consequences of accidents and natural phenomena events that do occur.
- F16.2 The SNF will be maintained in a subcritical condition under accident conditions.
- F16.3 Neither off-normal nor accident conditions will result in a dose to an individual outside the controlled area that exceeds the limits of 10 CFR 72.236(d).
- F16.4 No instruments or control systems are required to remain operational under accident conditions.

17.0 TECHNICAL SPECIFICATIONS EVALUATION

The staff reviewed the proposed amendment to determine that applicable changes made to the conditions in the CoC and to the TS for CoC No. 1042, Amendment No. 5, would be in accordance with the requirements of 10 CFR Part 72. The staff reviewed the proposed changes to confirm that the changes were properly evaluated and supported in the applicant's revised UFSAR. These modifications were found acceptable based on the staff's findings for the structural, thermal, shielding, criticality, materials, operating procedures, acceptance test and maintenance program, radiation protection, and accident analysis evaluation sections of this SER.

The staff finds that the proposed changes to the TS for the NUHOMS® EOS system conform to the changes requested in the amendment application and 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 NUHOMS® EOS system will continue to allow safe storage of SNF.

18.0 CONCLUSIONS

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

Change No. 1:

Addition of a new HLZC for the EOS-37PTH, HLZC 14, which allows an increase in the maximum heat load of the EOS-37PTH to 54 kW per DSC for storage in the EOS-HSM and transfer operations in the EOS-TC125/135. HLZC 14 is only permitted in Basket Type 4HA introduced in Amendment No. 4 to CoC No. 1042 with anodized aluminum. No physical changes are considered for this basket type in this application.

Change No. 2:

Editorial corrections are included as part of this amendment application:

- Section 2.4.2.1 of the UFSAR has been revised to clarify that the heat load for any single assembly is 4.3 kW for the EOS-37PTH DSC. This is an editorial correction based on HLZC 12 included as part of application for Amendment No. 4 to CoC No. 1042.
- Note 3 of figure 2-3m HLZC13 for the EOS-37PTH DSC has been revised to enhance readability.
- TS figures 1A and 1J have been revised to clarify the location of HLZC 1 and 10 for EOS-37PTH.

Change No. 3:

Includes clarification regarding acceptance criteria for minor surface imperfections on HSLA basket plates within the UFSAR.

Based on the statements and representations provided by the applicant in its amendment application, the staff concludes that the changes described above to the NUHOMS® EOS system do not affect the ability of the cask system to meet the requirements of 10 CFR Part 72. Therefore, Amendment No. 5 to CoC No. 1042 for the NUHOMS® EOS system should be approved.

Issued with CoC No. 1042, Amendment No. 5 on _____.