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January 31, 2022
E-62082

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

Subject: Submittal of Biennial Report of 10 CFR 72.48 Evaluations Performed for the NUHOMS® EOS System, CoC 1042, for the Period 01/30/20 to 01/31/22, Docket 72-1042

Reference Letter Prakash Narayanan (TN Americas LLC) to Document Control Desk (NRC) " Certificate of Compliance 1042, NUHOMS® EOS System Updated Final Safety Analysis Report (UFSAR), Revision 2, and Biennial Report of 10 CFR 72.48 Evaluations Performed for the Period 06/07/19 to 01/10/2020, Docket 72-1042," January 29, 2020 (E-53168)

Pursuant to the requirements of 10 CFR 72.48(d)(2), TN Americas LLC hereby submits the subject 24-month 10 CFR 72.48 summary report. Enclosure 2 provides a description of changes, tests, and experiments, including a summary of the 10 CFR 72.48 evaluation of each change implemented from 01/30/20 to 01/31/22, including indication as to whether the evaluations had associated Updated Final Safety Analysis Report (UFSAR) changes that have been or will be incorporated into the UFSAR for the CoC 1042 NUHOMS® EOS System.

This submittal includes proprietary information which may not be used for any purpose other than to support NRC staff review of the application. In accordance with 10 CFR 2.390, I am providing an affidavit (Enclosure 1) specifically requesting that you withhold this proprietary information from public disclosure. Accordingly, a public version of the summary report is provided as Enclosure 3.

Although the prior summaries enclosure indicated a period end date of 1/10/2020, no additional evaluations were approved prior to the 1/29/2020 submittal; therefore, the current submittal provides summaries for all evaluations approved within 24 months of the previous submittal.

Should you or your staff have any questions regarding this submittal, please contact Mr. Glenn Mathues by telephone at (410) 910-6538, or by e-mail at Glenn.Mathues@orano.group.

Sincerely,

A. Prakash

Prakash Narayanan
Chief Technical Officer

Enclosures:

1. Affidavit Pursuant to 10 CFR 2.390
2. Report of 10 CFR 72.48 Evaluations Performed for the NUHOMS® EOS System for the Period 01/30/20 to 01/31/22 (Proprietary Version)
3. Report of 10 CFR 72.48 Evaluations Performed for the NUHOMS® EOS System for the Period 01/30/20 to 01/31/22 (Public Version)

cc: Christian J. Jacobs (NRC SFM)
Earl Love (NRC IOB)

AFFIDAVIT PURSUANT
TO 10 CFR 2.390

TN Americas LLC)
State of Maryland) SS.
County of Baltimore)

I, Prakash Narayanan, depose and say that I am Chief Technical Officer of TN Americas LLC, duly authorized to execute this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and referenced in the paragraph immediately below. I am submitting this affidavit in conformance with the provisions of 10 CFR 2.390 of the Commission's regulations for withholding this information.

The information for which proprietary treatment is sought is contained in Enclosure 2 and is listed below:

- Enclosure 2, Portions of the biennial report of 10 CFR 72.48 evaluation summaries provided for the NUHOMS® EOS System.

This document has been appropriately designated as proprietary.

I have personal knowledge of the criteria and procedures utilized by TN Americas LLC in designating information as a trade secret, privileged, or as confidential commercial or financial information.

Pursuant to the provisions of paragraph (b) (4) of Section 2.390 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure, included in the above referenced document, should be withheld.

1) The information sought to be withheld from public disclosure involves certain design details associated with the UFSAR analyses, computer modeling inputs, calculations and fabrication details for the NUHOMS® EOS System, which are owned and have been held in confidence by TN Americas LLC.

2) The information is of a type customarily held in confidence by TN Americas LLC and not customarily disclosed to the public. TN Americas LLC has a rational basis for determining the types of information customarily held in confidence by it.

3) Public disclosure of the information is likely to cause substantial harm to the competitive position of TN Americas LLC because the information consists of descriptions of the design and analysis of a dry spent fuel storage system, the application of which provide a competitive economic advantage. The availability of such information to competitors would enable them to modify their product to better compete with TN Americas LLC, take marketing or other actions to improve their product's position or impair the position of TN America LLC's product, and avoid developing similar data and analyses in support of their processes, methods or apparatus.

Further the deponent sayeth not.

A. Prakash
____
Prakash Narayanan
Chief Technical Officer, TN Americas LLC

Subscribed and sworn before me this 26th day of January, 2022.

Diego Waines
____
Notary Public
My Commission Expires 07/30/2023

DIEGO WAINES
COMM. EXP.
NOTARY
PUBLIC
JULY 30, 2023
BALTIMORE COUNTY, MD

Enclosure 2 to E-62082

Report of 10 CFR 72.48 Evaluations Performed for the NUHOMS® EOS System for the Period 01/30/20 to 01/31/22 (Proprietary Version)

Withheld Pursuant to 10 CFR 2.390

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-020, Revision 1 – (incorporated into UFSAR Revision 3)

Change Description

A summary of Revision 0 of this Licensing Review (LR) was provided in a previous biennial summary report, E-54367, dated June 6, 2019, ML19157A047. Revision 0 was written against CoC 1042 Amendment 1 ongoing provisions prior to Amendment 1 becoming effective and addressed improving EOS-TC125 and EOS-TC135 Transfer Cask (TC) fabricability, dimensional control, and correction of editorial errors. The purpose of Revision 1 is to reconcile the Revision 0 conclusions with the final Amendment 1 provisions.

Evaluation Summary

The evaluation summary and conclusions in Revision 0 of this LR remain unchanged and are applicable to Revision 1.

All eight 72.48 evaluation criteria were met.

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-031, Revision 1 – (incorporated into UFSAR Revision 3)

Change Description

A summary of Revision 0 of this LR was provided in a previous biennial summary report E-54367, dated June 6, 2019, ML19157A047. Revision 0 was written against CoC 1042 Amendment 1 ongoing provisions prior to Amendment 1 becoming effective, and it addressed the optional design use of the flat plate support (FPS) rail structure for EOS-HSM and EOS-HSMS horizontal storage modules (HSM) of medium size fitted to store EOS-medium dry shielded canisters (DSCs). The purpose of Revision 1 is to reconcile the Revision 0 conclusions with the final Amendment 1 provisions.

Evaluation Summary

The evaluation summary and conclusions in Revision 0 of this LR remain unchanged and are applicable to Revision 1.

All eight 72.48 evaluation criteria were met.

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-045, Revision 1 – (incorporated into UFSAR Revision 3)

Change Description

A summary of Revision 0 of this LR was provided in a previous biennial summary report E-54367, dated June 6, 2019, ML19157A047. Revision 0 was written against CoC 1042 Amendment 1 ongoing provisions prior to Amendment 1 becoming effective and addressed design changes to the EOS-HSM-FPS side heat shield and axial retainer restraint as a result of using the FPS rail design option for the EOS HSM. The purpose of Revision 1 is to reconcile the Revision 0 conclusions with the final Amendment 1 provisions.

Evaluation Summary

The evaluation summary and conclusions in Revision 0 of this LR remain unchanged and are applicable to Revision 1.

All eight 72.48 evaluation criteria were met.

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-057, Revision 1 – (incorporated into UFSAR Revision 2)

Change Description

A summary of Revision 0 of this LR was provided in a previous biennial summary report, E-54367, dated June 6, 2019, ML19157A047. Revision 0 was written against CoC 1042 Amendment 1 ongoing provisions prior to Amendment 1 becoming effective, and it addressed the effect on cover gas impurities and design functions if, during DSC loading, up to two lubricated O-rings from the drain tube connector were lost in the DSC cavity and allowed to remain in the DSC. The purpose of Revision 1 is to reconcile the Revision 0 conclusions with the final Amendment 1 provisions.

Evaluation Summary

The evaluation summary and conclusions in Revision 0 of this LR remain unchanged and are applicable to Revision 1.

All eight 72.48 evaluation criteria were met.

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-077, Revision 0 and Revision 1 – (no associated UFSAR changes)

Change Description

The purpose of this change is to evaluate the NUHOMS® EOS-TC108, EOS-TC125, EOS-TC135, EOS-HSM, EOS-HSMS, and MATRIX (HSM-MX) for site-specific additional tornado basis design loads involving higher tornado wind speeds and additional missile spectra. The change is not intended to affect the original design basis tornado missile or wind loads provided in the UFSAR. The change adds additional missile and wind load cases to meet and bound the specific site licensing requirements. The purpose of Revision 1 is to reconcile the Revision 0 conclusions with the final Amendment 1 provisions.

Evaluation Summary

The detailed analysis demonstrates that the EOS-TC is structurally adequate for the additional site-specific missile loads and higher wind parameters. The EOS-TC is demonstrated to be stable on the transfer trailer for the combined effect of tornado wind and missile loads. Therefore, the EOS-TC is structurally adequate and remains stable on the trailer during transfer operations for the additional site-specific wind and missile loads.

Based on the evaluation, it is concluded that the EOS-HSM and HSM-MX are structurally adequate for the additional site-specific tornado wind and missile loads.

The original design basis tornado wind and missile loads are not changed and remain the same. Therefore, the licensing basis evaluation provided in the UFSAR remains the same. Analysis is performed to support additional site specific tornado wind and missile loads; therefore, FSAR change notice (FCN) markups are not required for the licensing review.

All eight 72.48 evaluation criteria were met.

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-080, Revisions 0 and 1 – (incorporated into UFSAR Revisions 2 and 3)

Change Description

Revision 0:

The purpose of this change is to evaluate an update to UFSAR Table 6-54 to correct errors in the EOS-89BTH DSC accident dose rates calculation. Fuel material and source term input errors have been corrected in the UFSAR included in the application for CoC 1042 Amendment 1, which was under review by the NRC when Revision 0 of this LR was written. The accident dose rates for the EOS-89BTH DSC in the EOS-TC125 and EOS-TC108 have increased due to this error correction. This change also corrects associated UFSAR text as necessary in Chapters 6, 11, and 12, to update the references made to the bounding results from Table 6-54.

Revision 1:

Revision 1 updates the references and clears the reconciliation to Amendment 1. The responses and conclusions of this LR Evaluation remain valid and unchanged with respect to the incorporation of Amendment 1 into the UFSAR. All of the FCN page markups for Revision 0 were incorporated into Revisions 2 and 3 of the UFSAR.

Evaluation Summary

The fuel assembly does not have a design function other than self-shielding provided by the fuel itself and the self-shielding is credited in the shielding calculation. The self-shielding has been altered by correcting the fuel assembly material composition. Any containment function provided by the fuel assembly cladding is out of the scope of this LR because it is unrelated to the shielding calculation.

The source term input represents the bounding source term for the EOS-89BTH DSC accident shielding calculation, which is part of the design bases to demonstrate the shielding function of the EOS systems.

The self-shielding has been altered by correcting the fuel assembly material composition. This change causes the accident dose rate to increase for the EOS-89BTH DSC in the EOS-TC125 and EOS-TC108. Also, correcting the neutron source term results in an increase of the accident dose rate for the EOS-89BTH DSC in the EOS-TC125 and EOS-TC108. As a result, the bounding accident dose rate of the EOS system described in the UFSAR has increased.

All eight 72.48 evaluation criteria were met.

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-098, Revisions 0, 1 and 2 – (to be incorporated into UFSAR Revision 4)

Change Description

The change assessed in this Evaluation involves the incorporation of operational restrictions imposed on the Matrix Loading Crane (MX-LC) for extreme weather conditions. Specifically, American Society of Mechanical Engineers (ASME) NOG-1, Section 4134(c), which prohibits the use of a Type I gantry crane under extreme weather conditions (i.e., tornado wind and missile conditions), and explicitly imposes administrative controls to place the crane in a secured position in advance of impending extreme weather conditions. The change also addresses and clarifies the seismic design requirements for the MX-LC and retractable roller tray (RRT) components relative to that described in the UFSAR, and the tornado design requirements for the MX-LC relative to the qualified configuration of the TC and the extent of analysis required.

The MX-LC is a Type I gantry crane, as defined in ASME NOG-1, which provides rules for the design, manufacture, testing, inspection, shipment, storage, and erection of electric overhead and gantry multiple girder cranes with top running bridge and trolley used at nuclear facilities. ASME NOG-1 covers three types of cranes (Type I, II and III), where the Type I crane has the most stringent design requirements, and applies to a crane used to handle a critical load; in this case, the loaded EOS-TC. Per ASME NOG-1, the Type I crane is required to be designed and constructed so that it will remain in place and support the critical load during and after a seismic event, but does not need to be operational after that event. Single-failure-proof features are specified in ASME NOG-1 in such a way that any credible failure of a single component will not result in the loss of capability to stop and hold the critical load.

The MX-LC is comprised of the following subcomponents: a lower boom consisting of four towers with gantry boxes that ride on crane rails in the horizontal x-direction parallel to the face of the HSM, an upper boom which is installed over the lower boom towers and extends in the vertical z-direction via four jacking screws, and two lifting links that attach the upper boom to the TC skid and ride along the upper boom in the horizontal y-direction in the axial direction of the HSM-MX compartment.

The MX-LC is used to position the TC skid in the proper position to dock the TC to the HSM-MX at the designated compartment (either upper or lower compartment) of the HSM-MX for the purpose of inserting the DSC into the HSM-MX or withdrawing it from the HSM-MX. The TC skid with the attached TC is transferred from the transfer trailer (TT) or self-propelled modular transporter (SPMT) to the MX-LC, where the lifting links are connected to the TC skid and the TC skid is subsequently detached from and lifted off the TT/SPMT. Operationally, the MX-LC travels along the face of the HSM-MX on rails positioned on the independent spent fuel storage installation (ISFSI) apron, lifts the TC skid to the proper height, and docks the TC to the HSM-MX.

The RRT consists of a pair of roller assemblies that are installed in the designated compartment of the HSM-MX prior to docking the TC to the HSM-MX. The RRT uses hydraulic cylinders to position the rollers in the extended position for inserting or withdrawing the DSC where the DSC moves along the rollers, and in the retracted position for landing the DSC on the front and rear support plates of the HSM-MX once fully inserted, or for lifting the DSC off the front and rear support plates when withdrawing the DSC from the HSM-MX.

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-098, Revisions 0, 1 and 2 – (con't)

Consistent with the requirements of Technical Specification (TS) 5.2 regarding lifting controls, both the MX-LC and RRT are important-to-safety (ITS) components under 10 CFR Part 72 since they are credited lifting and handling devices for the loaded TC and DSC, respectively.

The single-failure-proof design requirements of ASME NOG-1 screened in for Evaluation to address the portions of NOG-1 involving single-failure-proof design requirements that are not relevant to the design of the MX-LC. Other than those single-failure-proof design requirements, the balance of NOG-1 portions that are not relevant to the design of the MX-LC screened out for evaluation.

All eight 72.48 evaluation criteria were met.

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-101, Revisions 0, 1, and 2– (no associated UFSAR changes)

Change Description

Revision 0:

The purpose of this change is to evaluate the repair disposition for a Supplier Non-Conformance Report (SNCR) for EOS 125-ton cask #1; specifically the cask top cover plate bolt hole at the 123.75° location has a damaged portion of thread to the tapped hole for the helicoil insert.

Revision 1:

Revision 1 revises the disposition from “Repair” to “Use-As-Is” to match the final disposition on the SNCR. Initially, the approach was to repair the damaged thread hole, but was changed to accept the out of tolerance condition as is, based on a calculation. There were no changes to any of the responses and/or conclusions to this evaluation.

Revision 2:

Revision 2 to this LR updates the licensing references, uses the latest LR forms, and clears the reconciliation required block with respect to Amendment 1 and Amendment 2 for CoC 1042. The responses and conclusions to this LR Evaluation remain valid and unchanged.

Evaluation Summary

The damaged portion of the threads could weaken this threaded connection; however, a calculation has been prepared to show that with one bolt completely removed, the stress in the closure bolts, top cover plate, and top ring do not exceed design allowable stresses under any condition.

Per the calculation, stresses in the closure bolts are not changed for normal conditions with only 15 bolts installed. Likewise, the closure bolt fatigue analysis, which is based on normal stress, is not affected by removal of one of the sixteen bolts.

The calculation also evaluated stresses for the closure bolts, top cover plate, and top ring during an accident condition and found that the stresses in the cask remain below design limits with the proposed change.

All eight 72.48 evaluation criteria were met.

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-130, Revisions 0, and 1 – (to be incorporated into UFSAR Revision 4)

Change Description

Revision 0:

There are two changes associated with this evaluation.

Change 1 revises the HSM-MX thermal model with the EOS-37PTH DSC with two full-width upper compartments and one full-width lower compartment to evaluate the thermal effect of low speed wind with all the outlet vents open during normal storage conditions. This is in response to NRC request for additional information RAI 4-6 under Amendment 1 to CoC 1042 and NRC observation OBS-T1P as a result of NRC review of TN's pending application for Amendment 2 to CoC 1042. During their review of the Amendment 2 application, the NRC staff questioned the validity of the assumption used in the analytical model for the closed windward outlet vent. The staff review is documented in Section 4.2.4.2.1.1 of the SER for Amendment 1. The SER for Amendment 1 states that the full middle unit thermal model, which includes two full-width upper compartments and one full-width bottom compartment with an unblocked (open) windward outlet vent, should be used as the design basis model for future design changes that are compliant with 10 CFR 72.48. Therefore, this activity changes the UFSAR associated with Amendment 1 to be consistent with the latest model provided in the Amendment 2 application as reviewed by the NRC.

For Change 2, the rebar configuration within the HMS-MX was optimized as a cost saving measures and Change 2 reviews HSM-MX concrete structural components reinforcement requirements taking into account the optimized rebar configuration.

Revision 1:

Revision 1 to this LR updates the licensing references, uses the latest LR forms, and clears the reconciliation required block with respect to Amendment 1 for CoC 1042. The responses and conclusions to this LR Evaluation remain valid and unchanged.

Evaluation Summary

The design criteria for the HSM-MX are identical to those defined in UFSAR Chapter 2. The code classification and criteria remain the same as the original and are not affected.

Thermal

Change 1 revises the HSM-MX thermal model with two full-width upper compartments and one full-width lower compartment to evaluate the thermal effect of low speed wind with all outlet vents open during normal storage conditions. This change affects the temperature distribution on the HSM-MX and is evaluated in Calculation EOS01-0448, Revision 2.

The thermal model is the same as that described in UFSAR Section A.4.5.7.3, except that the analysis considers the upstream side outlet vent of the top compartment as open. All the other settings of the model descriptions are similar as discussed in UFSAR Section A.4.5.7.3.

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-130, Revisions 0, and 1 – (con't)

Change 2 is to the thermal model of the HSM-MX with two full upper and one full lower DSC with all outlet vents open meets the intended thermal design function as described in the UFSAR.

Structural

Thermal Stress Analysis:

Proposed Change 1 affects the temperature distribution on the HSM-MX and, therefore, impacts the thermal stresses. The thermal stress evaluation is provided in Calculation EOS01-0277, Revision 2. Proposed Change 2 defines an optimized rebar configuration impacting the HSM-MX tornado basis missile analysis and the demand-to-capacity ratios of reinforcement concrete structural components, which are evaluated in Calculations EOS01-0277, Revision 2 and EOS01-0278, Revision 2, respectively.

The analysis is performed in Calculation EOS01-0277, Revision 2 determines the thermal stresses using the same methodology described in the UFSAR. To evaluate the effects of thermal loads on the HSM-MX, heat transfer analyses for a range of normal ambient temperatures (-20 °F and 100 °F) are performed with a DSC heat load of 50 kW. The temperature distribution for the worst-case zoning configuration, heat load, and ambient conditions are used in the analysis.

Tornado Missile Analysis:

As the rebar configuration is optimized in the HSM-MX, the tornado missile load case is affected. Therefore, the analysis of concrete components for the missile loading is performed in Calculation EOS01-0277, Revision 2, using the same methodology as described in the UFSAR. The local damage evaluation is independent of the rebar configuration and, therefore, is not impacted, so the damage evaluation provided in UFSAR Section A.3.9.4.10.5.1 remains the same and applicable.

HSM-MX Concrete Components Analysis:

The HSM-MX concrete components are analyzed in calculation EOS01-0278, Revision 2, for the optimized rebar configuration. The method of evaluation is the same as described in UFSAR Section A.3.9.4.10.1.

The concrete design loads are multiplied by load factors and combined to simulate the most adverse load conditions. The load combinations listed in UFSAR Table A.3.9.4-5 are used to evaluate the concrete components. The thermal stresses of HSM-MX concrete components used in the load combination results are based on thermal results that bound those reported in Calculation EOS01-0448.

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-130, Revisions 0, and 1 – (con't)

The thermal model of HSM-MX with two full-width upper compartments and one full-width lower compartment with all outlet vents open meets the intended thermal design function as described in the UFSAR. The global response of HSM-MX is within deformation limits meeting the ductility requirement for the tornado basis missile loads. Comparison of the results with the corresponding design capacity for the optimized rebar configuration shows that the design strength of the HSM-MX is greater than the strength required for the most critical load combination.

All eight 72.48 evaluation criteria were met.

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-134, Revision 0– (to be incorporated into UFSAR Revision 4)

Change Description

The purpose of this change is to include ASME SA-517 grades A, B, E, F, and P material to basket grid plates (structural steel) for NUHOMS® EOS-37PTH basket and NUHOMS® EOS-37PTH damaged/failed fuel basket.

Evaluation Summary

This change is to include American Society of Mechanical Engineers (ASME) SA-517 grades A, B, E, F, and P material to basket grid plates (structural steel) for NUHOMS® EOS-37PTH basket and NUHOMS® EOS-37PTH damaged/failed fuel basket per a DCR. The change does not adversely impact the DSC structural, shielding, criticality or confinement design functions. Only the thermal design functions could be impacted.

The change is analyzed in a thermal calculation. The computational fluid dynamics (CFD) analysis provided in UFSAR, Section 4.2.1 conservatively use **[ ]** thickness for the basket grid plates instead of center steel basket plates of **[ ]** peripheral steel basket plates that supports the R90 transition rails. The thermal calculation compares the effective thermal conductivities for the composite basket plates with a different material thickness of steel basket plates. The analysis shows that the effective conductivities used in the CFD model in the parallel direction are conservative, while the effective conductivities used across the thickness of the plates are overestimated by less than **[ ]** for center basket plates and around **[ ]** for basket plates adjacent to transition rails. The basket plates adjacent to transition rails have much less effect on the maximum fuel cladding temperature, which occurs in the middle fuel assemblies. The proposed change will have an insignificant effect on the

maximum fuel cladding temperatures. Therefore, the proposed change has a negligible effect on the thermal design functions of EOS-37PTH basket described in UFSAR.

All eight 72.48 evaluation criteria were met.

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-142, Revisions 0, 1, and 2– (portions incorporated into UFSAR Revision 3 and portions to be incorporated into UFSAR Revision 4)

Change Description

Revision 0:

The purpose of this change is to revise the bottom chamfers on the inner top cover plate and outer top cover plate, and reduce the top shield plug (TSP) overall diameter to 74.00 inches minimum.

Revision 1:

Revision 1 is an editorial update to the FCN markups (drawings and FSAR pages) to utilize Revision 2 of the EOS UFSAR. There were no changes to any of the values or text in the FCN markups from Revision 0 to Revision 1.There were no changes to the Screening responses or conclusions from Revision 0 to Revision 1. There were no changes to the Evaluation responses or conclusions from Revision 0 to Revision 1.

Revision 2:

Revision 2 to this LR clears the “Reconciliation Required” checkmark in Block 4 for Amendment 1 only, updates the licensing references in Block 4, and uses UFSAR Revision 3 pages for the FCN markup for the changes. Revisions 0 and 1 of this LR are applicable to Amendment 0, and most FCN changes have been incorporated into Revision 3 of the UFSAR. Revision 2 of the LR is applicable to Amendment 1. In Amendment 1, the source terms for the EOS-37PTH DSC in the EOS-TC125/135 changed, and the HSM-MX was added to the UFSAR, but all Amendment 1 calculations were performed using the old TSP design. Therefore, the calculation was revised consistent with Amendment 1 scope to update the necessary UFSAR dose rate and exposure tables for transfer of the modified EOS-37PTH DSC within the EOS-TC125/135 to the EOS-HSM or HSM-MX.

Evaluation Summary

The proposed design change request is for reducing the NUHOMS® EOS-37PTH DSC TSP diameter to 74.00 inches minimum as a revised design in lieu of specifying a diameter of 74.32 inches with a radial gap dimension of 0.09 ± 0.03 inch. This change does not impact the DSC thermal, criticality or confinement design functions as described in the UFSAR and, therefore, screened out. Only the structural and shielding functions could be impacted.

REPORT OF 10 CFR 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® EOS SYSTEM FOR THE PERIOD 01/30/20 to 01/31/22 (Public Version)

LR 721042-142, Revisions 0, 1, and 2– (con't)

Shielding:

The NUHOMS® EOS-37PTH DSC system consists of the NUHOMS® EOS-HSM for storage and the EOS-TC108, 125, and 135 for transfer of the EOS-37PTH DSC. A sensitivity study on dose rates and occupational exposure produced by the EOS-37PTH DSC with the reduced diameter TSP while undergoing loading operations and storage was performed with the design basis source. These changes to the transfer condition have no effect on storage dose rates because the modified component is loaded facing the rear of the EOS-HSM, which is far from the vents where the dose rates are a maximum.

While the proposed activity has an adverse effect, the increase is localized in the region near the TSP gap, and the effect on maximum dose rates and radiation exposure to operating personnel during loading and transfer operations is 2% or less. The dose rates and exposure provided for loading and transfer operations are not governed by the TS. Additionally, since there is no effect on the storage dose rates, the design remains well within the 72.104 and 72.106 limits.

Structural:

The impact of the revised TSP is considered negligible based on the following:

1. The revised TSP geometry has a [ ] minimum diameter, which correlates to a maximum [ ] TSP-DSC shell radial gap. The maximum radial TSP-DSC gap for the existing geometry is [ ]. When compared to a revised maximum gap of [ ] , the effect on the DSC Shell stresses from a [ ] delta is expected to be minimal.

2. The change in geometry to remove the step in the TSP side profile more closely reflects the straight profile used in the DSC finite element model (FEM) as shown in the Figure 3.9.1-2 of the UFSAR, and therefore, more closely reflects the behavior and reactions of the various components as analyzed in the UFSAR.

3. As described in the side drop on cask rails discussion in UFSAR Section 3.9.1.2.7.7, the small radial gaps between the shield plugs and the DSC shell are set to zero, since these gaps will close. The increased radial gap size does not change this assumption, since the DSC shell-TSP gap of the revised geometry remains less than that of the TSP-lifting lug gap. Figure 3.9.1-26 of the UFSAR indicates that the areas of highest stresses are located at the bottom of the DSC where the shell impacts the rails and the gap closes. Therefore, since the same assumption applies to the revised TSP geometry, the area where the highest stresses are expected to be similar, and since the dead weight has a large impact on the stress results, the reduced weight would reduce DSC shell stresses.

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LR 721042-142, Revisions 0, 1, and 2– (con't)

To validate this justification, a sensitivity study was performed to understand the magnitude of the change in the radial gap. The sensitivity study was performed using the FEM described in Section 3.9.1.2.7.7 of the UFSAR where all details are identical except the radial gap between the TSP and the DSC shell is varied between [ ].

The results of the sensitivity study in both the horizontal and the vertical orientations show that there is negligible impact on the shell stresses resulting from the TSP design change. Therefore, the acceptance criteria as defined in Chapter 2 of the UFSAR are met, and structural aspects of the DSC shell confinement are maintained.

All eight 72.48 evaluation criteria were met.

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LR 721042-143, Revision 0 – (incorporated into UFSAR Revision 3)

Change Description

The purpose of this activity evaluates a design change for the EOS-DSC lifting lug weld assembly per design change requests. The design change is proposed as a fabrication improvement to provide better access for welding and to reduce the distortion in the DSC shell during welding operations. The change involves modifying the lifting lug plate geometry (for reduced area) and reconfiguring its weld to the DSC shell by reducing the weld size and changing the weld configuration.

Evaluation Summary

The lifting lug plate does not perform any thermal, shielding, confinement or criticality design functions. Therefore, the evaluation considers the structural design functions only.

The impact on the lifting lug plate to the DSC shell weld stresses is evaluated by a calculation. There is no change to the evaluation methodology provided in the UFSAR. In the revised design, the lifting lug plate geometry has a smaller area than the current design. The analysis uses the forces and moments for the connection and applies them to the proposed design to calculate the weld stresses.

The bounding stress results from the structural analyses indicate that the maximum stress ratios increased from 0.31 to 0.66. The calculated stress ratio is still below 1.0 and, therefore, satisfies the ASME code criteria.

Therefore, the proposed design change to the DSC lifting lug assembly and its associated welds is structurally adequate for all storage conditions, DSC transfer operations and DSC insertion into the HSM, and meets the intended structural design function as described in the UFSAR.

All eight 72.48 evaluation criteria were met.

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LR 721042-146, Revision 0 and 1 – (incorporated into UFSAR Revision 2)

Change Description

This purpose of this change is as follows:

To update Section 4.5.11 of the UFSAR regarding boiling of water within the TC/DSC annulus.

To clarify the operating procedures in Sections 9.1.3, 9.1.4, and 9.2.2 of the UFSAR to provide additional guidance on managing the TC/DSC annulus water level during loading and unloading operations.

Evaluation Summary

The change as presented under Revision 0 of this LR was to update Section 4.5.11 of the UFSAR regarding boiling of water within the TC/DSC annulus. The words "to prevent boiling" were deleted. The second change is to delete the words "open atmosphere" and to add the words "the annulus between the DSC and TC." These changes were incorporated into Revision 2 of the UFSAR.

Revision 1 of this LR included this evaluation based on a Non-Cited Violation issued to a general licensee.

The changes to Section 4.5.11 of the UFSAR, as discussed above, indicate that the water within the TC/DSC annulus could be boiling and, therefore, the DSC shell temperature can exceed the boiling temperature of water. The impact of boiling water within the TC/DSC annulus affecting the maximum fuel cladding and DSC component temperatures is discussed below.

Section 4.5.11 of the UFSAR presents the maximum fuel cladding and DSC component temperatures during loading operations for both the EOS-37PTH and EOS-89BTH DSCs. Based on this evaluation and the maximum temperatures listed in Table 4-32 of the UFSAR the maximum fuel cladding temperature for the EOS-37PTH DSC is **[ ]** with a corresponding maximum DSC Shell temperature of **[ ]**. Similarly the maximum fuel cladding temperature for the EOS-89BTH DSC is **[ ]** with a corresponding maximum DSC Shell temperature of **[ ]**. The maximum DSC shell temperature in the active fuel region is higher than the boiling temperature of water. A similar behavior is also observed for the EOS-89BTH DSC.

The maximum DSC shell temperatures for both EOS-37PTH and EOS-89BTH DSCs are higher than the boiling water temperature during vacuum drying operations. The maximum cladding temperature during loading/unloading operation is bounded by the maximum fuel cladding temperature for vacuum drying operation. Hence, the peak cladding (a fission product barrier) temperatures remain within limits of CoC 1042 .Therefore, the proposed change would not have any adverse effect on the thermal design functions described in the UFSAR.

All eight 72.48 evaluation criteria were met.

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LR 721042-192, Revision 0 – (no associated UFSAR changes)

Change Description

This purpose of this change is the evaluation of a fabrication nonconformance which involves the EOS-TC125 TC and a reduction in the ram access penetration ring thickness.

Evaluation Summary

The fabrication deviation around the ring periphery affects the overall thickness of the ring with a reduction in overall ring thickness. For the TC structural design function, the reduction in thickness results in a slight increase to the stresses in the ram access penetration ring. Structural evaluations for the TC were performed that concluded that the stresses for the ram access penetration ring still remain below the ASME Code limits, and meet all the structural criteria discussed in the UFSAR.

The shielding for the TC was evaluated for the effect that the reduction in thickness of the ram access penetration ring has on the shielding design function, as described in UFSAR Chapter 6, Section 6.3. The MCNP5 program is used to perform detailed three-dimensional near-field dose rate calculations for the TC. The area of the ram access penetration ring is small in relation to the area of the bottom of the cask. This may result in slight increase in the dose rate that is highly localized.

The reduction in thickness of the ram access penetration ring was accommodated by introducing a root gap between the ring and the bottom neutron shield plate outer panel. The bottom neutron shield was installed at the nominal thickness and the minimum thermal gap was achieved. Therefore, the effect on the shielding design function is limited to a slight dose rate increase due to the reduction in the thickness of the ram access penetration ring component.

Regarding the thermal design function of the TC, the heat load remains the same and the temperature distribution or the thermal gradients are not affected by the changed activity. Therefore, the thermal design functions of the TC described in the UFSAR remain unaffected by this change.

The TC does not perform any criticality design functions and is not a confinement boundary. Therefore, the criticality design function of the TC described in the UFSAR remains unaffected by this change.

The operational interface with the ram access bottom cover is not affected because there is no deviation to the dimensions for the diameter and depth of the recess for the bottom cover plate, the sealing surface or bolt torques, and functionally, the cover will be leak tested.

All eight 72.48 evaluation criteria were met.

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LR 721042-203, Revision 0 – (to be incorporated into UFSAR Revision 4)

Change Description

The purpose of this change is to limit the lowest internal pressure of the DSC to 0.75 Torr during vacuum drying operations. If, however, the internal pressure drops below 0.75 Torr, the DSC should be pressurized with helium above 3 Torr, after which vacuum drying operations can be resumed. This change alters the vacuum drying procedure by introducing a procedural control limiting the minimum internal pressure to 0.75 Torr.

Evaluation Summary

There are no adverse effects on the design functions of the EOS-37PTH or the EOS-89BTH DSCs. This change is a procedural enhancement in support of the vacuum drying process and has a positive impact on controlling the heat transfer function.

All eight 72.48 evaluation criteria were met.

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LR 721042-227, Revision 0 – (no associated UFSAR changes)

Change Description

The purpose of this change is the evaluation of a nonconformance where the EOS TC was not backfilled after a campaign that ended in December 2019. Backfill is required per Section 10.3.1 of the UFSAR. The neutron shield tank was drained at the end of the campaign, but was not backfilled with argon or nitrogen until July 7, 2020 during annual cask maintenance. Standard ISO-9223 provides corrosion rates that can be used to conservatively estimate the loss of material due to corrosion.

Evaluation Summary

The outer shell is fully coated, but it is conservatively assumed that this plate experienced corrosion. The outer shell is a 1-inch thick plate that has a standard plate under tolerance allowance. The sketch attached to the evaluation shows that the minimum measured thickness of the outer shell during fabrication was **[ ]**. Even with the reduction in thickness, this plate will remain within tolerance for the nominal dimension. The neutron shield panel does have areas around the weld seams where it is uncoated. The measured thickness of the neutron shield panel was **[ ]**. Even with the reduction in thickness, this plate will remain within tolerance for the nominal dimension.

This nonconformance has no effect on the shielding design function of the EOS TC or neutron shield tank. Shielding calculations note that the outer shell thickness is a key modeled dimension in the calculations. The outside portion of the outer shell is part of the interior of the neutron shield tank. As stated above, this evaluation shows the outer shell was not reduced below the tolerance for this nominal plate thickness, so there is no impact to the assumptions in the calculation and the shielding design function.

This change has no effect on the structural design function of the EOS TC or neutron shield tank. Both the outer shell and neutron shield panel thicknesses are considered in the structural evaluation of the TC. As stated above, this evaluation shows the outer shell and neutron shield panel were not reduced below the tolerance for this nominal plate thickness, so there is no impact to the assumptions in the calculation and the structural design function.

All eight 72.48 evaluation criteria were met.

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LR 721042-228, Revisions 0 and 1 – (to be incorporated into UFSAR Revision 4)

Change Description

Revision 0

The purpose of this change is to determine the transfer time limit for the EOS-TC125 loaded with the EOS-37PTH DSC with 30 kW maximum heat load in heat load zone configurations (HLZCs) numbers 4, 5, and 6.

Revision 1

Revision 1 to this this LR includes the evaluation that determines the transfer time limits for the EOS-TC125 loaded with the EOS-37PTH DSC with maximum heat load of 34.4 kW in HLZC #8 and 31.2 kW in HLZC #9.

Evaluation Summary

As shown in UFSAR, Table 4.9.6-7 and Table 4.9.6-11, for the EOS-37PTH DSC with HLZCs # 4, 5, 6, 8, and 9, the time limit for normal/off-normal transfer operations is 8 hours. This is to ensure that the maximum fuel cladding temperatures for HLZCs #4, 5, 6, 8, and 9 remain below the design basis temperature determined for HLZC #1. The time limit for transfer operations is determined based on the EOS-37PTH DSC in EOS-TC125 with the maximum allowable heat load of 50 kW. If the maximum heat load of a DSC is less than 50 kW, a new time limit can be determined to provide additional time for transfer operations using the same methodology as described in the CoC 1042 Generic Technical Specifications for Amendment 1, Section 3.1.3 to ensure that the maximum fuel cladding temperatures remain below the design basis temperature.

A thermal analysis was performed using the same methodology as that described in the UFSAR. For HLZC #4, 5, and 6 the heat load is reduced from a maximum of 50 kW to 30 kW resulting in extending the time limit for completing the transfer operation to 96 hours. The heat load is reduced from a maximum of 46.4 kW to 34.4 kW in HLZC #8 and from a maximum of 37.8 kW to 31.2 kW in HLZC #9 resulting in extending the time limit for completing the transfer operation to 48 hours in HLZC #8 and 72 hours in HLZC #9. HLZC #4A represents the bounding HZLC for the maximum heat load of 30 kW among HZLCs #4, 5 and 6. A comparison of the maximum temperatures between the design basis (with 50 kW) and the temperature determined in the calculation with 30 kW for HLZC #4A, with 34.4 kW for HLZC #8, and with 31.2 kW for HLZC #9 were developed for normal and off-normal conditions, respectively.

All the component maximum temperatures remain below the design basis temperatures except for the EOS-TC125 neutron shields for HLZC # 4A. The average temperature of the neutron shields at 96 hours for LC # 1-TR is [ ] higher than the design basis evaluation with HLZC # 1. However, the neutron shield temperatures for LC # 1-TR still have a significant margin to their corresponding temperature limits. Therefore, a slight increase in temperature has no impact on the design function of the neutron shields with a 96-hour time limit for normal/off-normal transfer operations. The evaluation indicates that the average temperatures for fuel cladding and helium gaps for normal and off-normal transfer operations with HLZC #4A are bounded by the design basis evaluation.

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LR 721042-228, Revisions 0 and 1 – (con't)

The maximum temperature of all components remains below the design basis temperature except for the EOS-TC125 neutron shields for HLZC #8A. The average temperature of the neutron shields at 48 hours for LC # 1H8-TR is [ ] higher than the design basis evaluation with HLZC #1. However, the neutron shield temperatures for LC #1H8-TR still have a significant margin to their corresponding temperature limits. Therefore, a slight increase in temperature has no impact on the design function of the neutron shields with a 48 hour time limit for normal/off-normal transfer operations. The average temperatures for fuel cladding and helium gaps for normal and off-normal transfer operations with HLZC #8A are bounded by the design basis evaluation.

The maximum temperature of all components remains below the design basis temperature except for the EOS-TC125 neutron shields and lead gamma shield for HLZC #9A. The average temperature of the neutron shields at 72 hours for LC #1H9-TR is [ ] higher than the design basis evaluation with HLZC #1. However, the neutron shield temperatures for LC # 1H9 TR still have a significant margin to their corresponding temperature limits. Therefore, a slight increase in temperature has no impact on the design function of the neutron shields with a 72-hour time limit for normal/off-normal transfer operations. The maximum temperature of the lead gamma shield at 72 hours for LC #1H9-TR is [ ] higher than the design basis evaluation with HLZC #1. However, the lead gamma shield temperature for LC #1H9-TR still has a significant margin to its corresponding temperature limit. Therefore, a slight increase in temperature has no impact on the design function of the lead gamma shield with a 72-hour time limit for normal/off-normal transfer operations. The average temperatures for fuel cladding and helium gaps for normal and off-normal transfer operations with HLZC # 9A are bounded by the design basis evaluation.

The proposed change has an insignificant effect on the normal and off-normal transfer operations of the EOS-37PTH DSC with a maximum heat load of 30 kW (HLZCs #4, 5, and 6) and a time limit of 96 hours, 34.4 kW and a time limit of 48 hours for HLZC #8, and 31.2 kW and a time limit of 72 hours for HLZC #9 for completion of DSC transfer operations without air circulation. These derived time limits include a 5-hour recovery time as specified in the action statement for TS 3.1.3, in the event that the transfer cannot be completed within the allotted time. Accordingly, the time limits for completion of transfer for the EOS-37PTH DSC under TS LCO 3.1.3 are 91 hours for HLZCs # 4, 5, and 6 with a maximum heat load of 30 kW, 43 hours for HLZC #8 with a maximum heat load of 34.4 kW, and 67 hours for HLZC #9 with a maximum heat load of 31.2 kW. Therefore, the proposed change has a negligible effect on the thermal design functions of EOS-37PTH DSC described in the UFSAR.

All eight 72.48 evaluation criteria were met.

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LR 721042-236, Revision 0 – (to be incorporated into UFSAR Revision 4)

Change Description

The purpose of this change is the evaluation of a nonconforming condition (NCR) associated with the fabrication of an EOS-37PTH basket. The TN design drawing and associated UFSAR drawing require attachment hardware to be installed for the R45 basket transition rails which is typical at all locations. The design intent behind the attachment hardware is to fasten the R45 transition rails to the egg crate basket and to provide structural support for the basket. The subject NCR results in reducing the number of R45 basket transition rail screws installed in the nonconforming EOS-37PTH basket.

The free-path test performed subsequent to the basket insertion failed at certain fuel compartments adjacent to the R45 transition rails, apparently due to protruding flathead attachment screws. The associated remote visual inspection performed as part of the investigation process for the NCR indicates that the screw holes in the inward facing side of the basket plates at the locations with protruding screws lacked the countersink feature specified for the basket plate, so the attachment screws could not be installed flush to the surface of the basket plate. The symmetry of the condition suggests that some of the basket plates associated with the protruding screw heads were most likely installed backwards, so that the countersink hole faced outward from the fuel compartment rather than inward to accept the flathead screw. To resolve the condition and eliminate the obstruction, the protruding screws are to be removed per the NCR repair disposition.

Evaluation Summary

The NUHOMS® EOS-37PTH storage system consists of the NUHOMS® EOS-HSM (EOS-HSM/HSMS and HSM-MX) for storage, the EOS-TC108, EOS-TC125 and EOS-TC135 for transfer, and the EOS-37PTH DSC itself. The system is designed for the transfer and storage of spent fuel loaded in the DSC using the TC for transfer operations and the HSM for storage at the ISFSI site.

The change addresses a reduction in the number of R45 basket transition rail screws in the EOS-37PTH basket. The nonconforming condition does not impact the DSC thermal, shielding, criticality, or confinement design functions. Only the structural design function could be impacted.

The R45 transition rails are connected to the basket compartment by two rows of screws in the DSC axial direction. The R45 rail section located at the top of the basket represents the shortest section, by length, with the least number of attachment screws. The structural calculation considers a bounding worst-case condition, assuming that one screw is missing from the R45 basket rail in-lieu of four or five screws, with both screws assumed missing at the top location.

The structural calculation conservatively increased the basket stress values determined in the existing structural calculations for the bounding load combinations by a factor of **[**

] and demonstrated that the nonconforming basket meets the allowable ASME code limits.

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LR 721042-236, Revision 0 (con't)

The stress ratios are <1; therefore, the reduced number of R45 rail attachment screws is acceptable for normal, off-normal, and normal conditions of transport (NCT).

As discussed in the calculation, the existing side drop accident analyses consider configurations with and without rail attachment screws. The side drop analysis without screws bounds the proposed change. No significant preload (torque) is applied to the screws. This ensures, in the vertical orientation (end drop loads), the rails are free to move within the slotted/oversized holes. Therefore, the reduced number of rail attachment screws does not adversely affect accident side and end drop scenarios.

All eight 72.48 evaluation criteria were met.

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LR 721042-242, Revision 0 – (to be incorporated into UFSAR Revision 4)

Change Description

The purpose of this change is the evaluation of a correction to the lower inlet shield block in the lower compartment of the HSM-MX that was modeled as air instead of concrete in the thermal CFD model. A corrective action report (CAR) was issued to properly identify the lower inlet shield block as a concrete component in the thermal analysis model. The calculation was revised to address the proposed change. In that calculation, the load case for the normal hot condition is determined to be the bounding case for the identified condition since it results in the highest fuel cladding temperature for the lower compartment of the HSM-MX. It is noted that the accident condition results are not affected since the accident assumes the inlet vents are fully blocked in such a way that the modeling error would have no effect on the resulting accident temperatures.

Evaluation Summary

The change does not adversely impact the HSM-MX structural or shielding design functions. The effect on the thermal design functions of the HSM-MX system including the stored EOS-37PTH DSC are discussed below.

Load cases for normal hot storage conditions and for off-normal hot storage conditions listed in Table A.4-14 of the UFSAR incorrectly modeled the lower inlet shield block in the lower compartment as part of the air domain. This modeling error reduces the resistance to air flow for the lower compartment and could result in underestimated component temperatures. While the load case for blocked vent accident storage conditions also utilizes the same model, there is no impact since the inlet vents are modeled as blocked. In addition, the load case in Table A.4-22 of the UFSAR, for HLZCs #8 and #9 and the load case in Section A.4.5.7.3 for HLZC #7 also incorrectly modeled the lower inlet shield block to be air and not as concrete.

A thermal calculation evaluated the thermal performance of HSM-MX with the lower inlet shield block modeled as concrete and compares the results to the existing evaluation that utilized the incorrectly modeled lower inlet shield block to determine the temperature differences. Furthermore, since the lower inlet shield block modeling error only affects the airflow into the lower compartment, the load case that results in the highest fuel cladding temperature in the lower compartment is modified to incorporate the concrete properties of the lower inlet shield block in order to determine the bounding impact.

For the analysis, a review of the various load cases provided in the UFSAR indicates that load case LC# 1e-S listed in Table A.4-16 is the bounding load case since it results in the highest fuel cladding temperature for the lower compartment. Therefore, this load case is modified to include the lower inlet shield block with concrete material properties. No other changes are included in the thermal analysis model.

The analysis concluded that with the lower inlet shield block correctly modeled as concrete, the maximum temperatures increased for the various components within the lower compartment as shown in Table A.4-40, Table A.4-41, and Table A.4-42. However, based on the evaluation, the temperature increases are limited and do not affect the overall performance of the EOS-37PTH DSC stored in the lower compartment of the HSM-MX.

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LR 721042-242, Revision 0 (con't)

The proposed change results in a slight increase in component temperatures, but the allowable limits are not exceeded. Therefore, the proposed change does not affect the overall thermal design function of the EOS System described in the UFSAR.

All eight 72.48 evaluation criteria were met.

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LR 721042-248, Revisions 0 and 1 – (no associated UFSAR changes)

Change Description

Revision 0:

The purpose of this change is the evaluation of a fabrication NCR, which documents a condition of an under thickness measurement on the outer shell of the EOS TC. There is a localized area on the outer shell to top ring weld where the as-welded thickness is 0.953 inch.

The EOS-TC125/135 UFSAR drawing specifies the outer shell to be a 1.00-inch thick plate and welded to the forging by a complete joint penetration weld. Per the code of construction (ASME Section III Subsection NF-4427(b)), the thickness of the weld metal shall not be [ ] inch below the thickness of the plate, or [ ]. The as-built thickness of the weld is [ ], which violates this requirement.

Revision 1:

Revision 1 to this evaluation provides additional information as to why ASME code requirements are not violated and expands the discussion regarding the methods of evaluation described in the UFSAR, used in the safety analyses or to establish design bases (i.e., Screening Question C and Evaluation Criterion 8). The conclusions (yes or no) to the questions in the applicability, screening and evaluation forms remain unchanged except for Screening Question C where the conclusion is revised to "yes," and the methods of evaluation are addressed in Evaluation Criterion 8.

Evaluation Summary

Structural:

A calculation analyzes the structural impact of this change. [ ] This change will impact the side drop stresses in Table 3.9.5-1 of the UFSAR and cause an increased stress; however, the calculation shows that the maximum stress ratios as 91.55% and 89.71% for the side drop load case (compared to 90% and 87%), so the change is acceptable and will not cause a violation of the design requirements. Note that the details of the analysis of the TC shell for normal/off-normal load cases are not discussed in the UFSAR where the description is limited to the loading conditions and analytical Code criteria for the design of the TC.

This change meets the Code of Construction, ASME Section III, Subsection NF, 2010 Edition, 2011 Addenda.

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LR 721042-248, Revisions 0 and 1 (con't)

The design drawing requirements for the weld and plate thickness is defined by the material specification which allows [ ] under thickness. This requirement exceeds Code requirements for the weld and exceeds Code requirements for the base metal wherever analysis per NF-3000 would allow a thinner material thickness. The condition described in the NCR meets Code requirements.

Shielding:

A calculation analyzes a [ ] reduction in the inner shell thickness. This change for the outer shell has the same impact on radial shielding as a reduction in inner shell thickness, so this calculation can be used to evaluate changes in dose rates as a result of this change. Note that this nonconformance for the outer shell is highly localized and is limited to the [ ] length of weld near the top ring, so this consideration is conservative. The nonconformance of the outer shell thickness will not affect the existing maximum TC125/135 dose rates under normal and off-normal conditions calculated beyond the uncertainty of the MCNP computer code employed for the shielding analysis, which is approximately 5% uncertainty; therefore, the effect is negligible. The nonconformance of the outer shell thickness has a negligible effect (less than the uncertainty of approximately 5%) on the maximum accident dose rate since the loss of neutron shield and lead slump considered for accident condition results in a maximum total dose rate dominated 80% by the neutron component as shown in the calculation.

Note that the [ ] reduction in thickness analyzed bounds this change, even when considering the cumulative effect of this NCR and of another NCR on the inner shell thickness for this TC. The localized reduction in the EOS-TC125 shell thickness [ ] meets shielding and structural design functions described in the UFSAR.

All eight 72.48 evaluation criteria were met.

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LR 721042-250, Revision 0 – (no associated UFSAR changes)

Change Description

The purpose of this change is an evaluation the effect of a standoff wall (i.e., Jersey barrier or Baffle) placed in front of the EOS-HSM-FPS (flat plate support rail option for EOS-HSM) inlet opening and the effect of flow resistance and air temperature on the EOS-37PTH DSC, fuel cladding and the EOS-HSM-FPS. The change does not adversely impact the HSM structural or shielding design functions. The effects on the thermal design functions of the HSM system including the stored DSC are discussed below.

Evaluation Summary

The analysis model utilizes a wall height of [ ] at a distance of [ ] from the front face of the EOS-HSM to support the installation of a contemplated wall height of 48 inches at a distance of 48 inches from the EOS-HSM. The mesh of the ambient domain in front of the EOS-HSM does not lend itself to this kind of analysis. A distance of [ ] was selected as anything beyond that location would require refining the thermal model. Therefore, locating the Jersey barrier at [ ] from the face of the HSM represents the most expedient manner to accomplish the analysis and yields conservative results with very little change to calculated peak fuel cladding temperature.

The maximum fuel cladding temperature limit for normal conditions is 752 °F v/s 1058 °F for off-normal and accident conditions. Due to the higher temperature limit for off-normal and accident conditions and the fact that the off-normal and accident conditions do not include the bounding wind condition, only the normal storage conditions are evaluated in the thermal calculation. HLZC #1 (LC #1) with maximum heat load of 50 kW per DSC and the maximum heat load per fuel assembly in each zone is the bounding HLZC among all HLZCs. Additionally HLZC #2 (LC #1b) with maximum heat load of 41.8 kW per DSC is also considered for the analysis as the bounding wind scenario without wind deflectors.

The methodology used in this evaluation is identical to the methodology described in UFSAR, Section 4.4.2.3. The calculation accounts for the standoff wall in front of the inlet vent openings. The flow pattern of air around the inlet vents of the HSM depends on the height of the standoff wall and distance between the inlet vents and standoff wall. Thickness of the standoff wall has no significant effect on air flow pattern around the inlet vents of the HSM. Therefore, the thickness of the standoff wall is ignored and is modeled as a thin wall. No other changes are included in the thermal analysis model.

The results concluded that there were slight increases in temperatures for the DSC shell temperature, maximum cladding temperature and maximum concrete temperature. This behavior is expected as the standoff wall placed in front of the HSM inlet opening affects the air flow and temperatures. The maximum fuel cladding temperature remains below the allowable limits. Therefore, there is a negligible impact on the thermal performance of the HSM and DSC components. The small temperature increases observed do not affect the material properties. The temperature increases have an insignificant effect on calculated thermal stresses. Therefore, there is no impact on the thermal performance of these components, and does not affect the overall thermal design function of EOS System described in the UFSAR.

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LR 721042-250, Revision 0 (con't)

All eight 72.48 evaluation criteria were met.

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LR 721042-254, Revision 0 – (to be incorporated into UFSAR Revision 4)

Change Description

The purpose of this change is an evaluation of an alternative bottom forging single piece assembly for the EOS DSCs.

The bottom assembly of the NUHOMS® EOS-37PTH and 89BTH DSC (EOS-DSC) shell is composed of an inner bottom cover plate (IBCP),a bottom shield plug and an outer bottom cover plate (OBCP) resulting in a total thickness of **[ ]**. The EOS-DSC alternate 1-bottom forging is a design option which replaces the individual IBCP, bottom shield plug and OBCP components. This alternate 1-bottom forging is a single piece assembly made from the same ASME material, as previously incorporated on the UFSAR drawing for the EOS-37PTH DSC, and is now incorporated on the UFSAR drawing for the EOS-89BTH DSC. The option to utilize an alternate forging material is also added in this LR for both the EOS-37PTH and 89BTH DSCs. This evaluation is to demonstrate the structural adequacy of the EOS-DSC assembly with the alternate 1-bottom forging using the nominal mechanical properties of these forging materials at the minimum specified tensile strength of 70 ksi.

Evaluation Summary

The NUHOMS® EOS-DSC system consists of the NUHOMS® EOS-HSM, EOS-HSMs and Matrix (EOS-MX) for storage, the EOS-TC108 and EOS-TC125/135 for transfer.

This change is to address the structural adequacy of the EOS-DSC assembly with an alternate single piece bottom forging as a design option which replaces the individual IBCP, bottom shield plug and OBCP components. The change does not impact the DSC thermal, shielding or criticality design functions. Only the structural and confinement functions could be impacted.

A structural calculation was performed to support this change for the EOS-DSC. The density assumed in the calculation for stainless steel material is the same as that assumed for carbon steel so that there is no change in the weight of the alternate bottom forging in comparison to the current three piece component design, since both design options are 8 inches thick.

The analysis performed in this calculation uses the FEM described in UFSAR, Section 3.9.1.2.3. ANSYS 17.1 software, which is the same as that described in Section 3.9.1.7 of the UFSAR, is used in the calculation. As provided on the UFSAR drawing, the alternate single piece bottom forging is made from an ASME material. The option to utilize this forging material is added in this LR. The calculation uses these material properties in the analysis and incorporates those properties in new UFSAR Table 8-5a together with the applicable ASME allowables in new UFSAR Table 3.9.1-5a. There is no change to the evaluation methodology described in the UFSAR.

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The ANSYS FEM is modified by replacing the OBCP, bottom shield plug, and IBCP with the alternate single piece bottom forging as shown in new UFSAR Figure 3.9.1-1a. The thickness of the alternate single piece bottom forging is the same as the combined thicknesses of the IBCP, bottom shield plug, and OBCP. The alternate single piece bottom forging plate is connected to the DSC shell and the grapple ring assembly with full penetration welds.

The load cases of DSC insertion and withdrawal, cask side drop, and seismic loads on the DSC bottom end while located in the HSM-MX with the DSC simply supported at the front and back ends are considered as they are the bounding load cases for the option without the alternate one-bottom forging. In addition, the results of the dead weight and thermal load cases from the original analysis are determined to be applicable to the alternate one-bottom forging option without change.

For the alternate one-bottom forging, stress intensities are compared with ASME code allowables and the resulting stress ratios for the bounding load combinations are summarized in new UFSAR Table 3.9.1-16 when the DSC is horizontal in the EOS-TC. The maximum stress ratio of 0.45 occurs in the alternate one-bottom forging during a side drop. Stress intensities for the DSC with the three-piece bottom assembly remain bounding for the other components, with the exception of the side drop load case for the DSC shell confinement boundary where the stress intensity for P_m increases slightly.

ASME code allowables and the resulting stress ratios for the bounding seismic load combination are summarized in new UFSAR Table A.3.9.1-2a when the EOS-DSC is stored in the HSM-MX (Matrix). The maximum stress ratio is 0.28. Stress intensities for the DSC with the three-piece bottom assembly remain bounding for the other components.

For the components other than the alternate single-piece bottom forging, the calculation compares the bounding load combination stress ratios using the alternate single-piece bottom forging against the UFSAR stress ratios using the three-piece bottom assembly. As expected, a majority of the stress ratios remain the same, with slight reductions in some of the ratios. In only one case for LC #7A, the stress ratio increases from 0.55 to 0.56 (approximately 1%) for the DSC shell confinement boundary area. Therefore, the overall maximum stress ratios using the original EOS-DSC assembly (without alternate single-piece bottom forging option) are generally equal, or slightly higher, compared to the modified EOS-DSC assembly using the alternate single-piece bottom forging option.

All of the calculated stress ratios remain below 1.0 and, therefore, satisfy the ASME code criteria. As a result, the structural and confinement design functions are satisfied.

Since the alternate single-piece bottom forging is designated as an ASME NB component and is part of the confinement boundary, the confinement design function is ensured provided that the ASME NB Code criteria are satisfied.

Therefore, the proposed alternate single-piece bottom forging as a design option to the EOS-DSC is structurally adequate and meets the structural and confinement design functions for normal, off-normal, and accident conditions described in the UFSAR.

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LR 721042-254, Revision 0 – (con't)

All eight 72.48 evaluation criteria were met.

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LR 721042-273, Revision 0 – (to be incorporated into UFSAR Revision 4)

Change Description

The purpose of this change is an evaluation of fabrication improvement to the NUHOMS® EOS-TC125 to allow for unborated high density poly-ethylene (HDPE) to be used as an option to Borotron® neutron shielding material for the bottom neutron shielding material.

Evaluation Summary

Shielding Calculation EOS01-0533, Revision 0, was performed to support the proposed change to the TC bottom neutron shielding material. The analysis performed in this calculation uses the MCNP5 software version 1.40. Use of MCNP5 software version 1.40 was approved by NRC for the EOS-TC under CoC 1042 Amendment 0. The method of evaluation and the analytical model used for the analysis is the same as that described in Section 6.3 of the UFSAR, Revision 3, for CoC 1042. The analysis performed in the shielding calculation determines the dose rates and occupational exposure for loading and transfer operations for the TC using HDPE in place of Borotron® for the neutron shielding material, and the impact on cask bottom dose rates and occupational dose rates are evaluated.

The calculation determined that the decontamination and welding configurations are not affected by the change in the bottom shielding material, since the TC is in the vertical orientation for those activities. The TC is also in the vertical configuration for the most limiting accident conditions where the bottom neutron shielding material is not included in the shielding model, such that the change does not affect the site dose results of the accident analysis which is governed by the dose in the radial direction of the TC. Therefore, only the transfer configuration is evaluated in detail.

The normal transfer occupational exposure dose rates for the proposed unborated HDPE were compared to the original Borotron® neutron shielding material for the TC resulting in an increase of approximately 10% for the average TC bottom surface dose rate. The peak bottom dose rate that occurs at the ram access port is comparable between the two materials. The effect of this small change in bottom dose rate has a negligible impact on the overall occupational exposure determined in Section 11.2.1 of the UFSAR.

The dose rates and occupational exposure for loading and transfer operations are not addressed in the TS. The change in dose rates is limited to transfer operations. Since there is no effect on the storage or accident dose rates, the design margins to the 72.104 and 72.106 limits remain the same and are unaffected by the change.

Based on this discussion, it is concluded that the proposed change to the bottom neutron shielding material for the TC will have a negligible effect on shielding design functions described in the UFSAR.

All eight 72.48 evaluation criteria were met.

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LR 721042-284, Revision 0 – (no associated UFSAR changes)

Change Description

The proposed change involves the acceptance of a nonconforming condition for basket hardware on certain EOS-37PTH DSCs currently under fabrication where the mechanical test results for the screws used to attach the R45 and R90 rails to the basket do not satisfy the minimum ultimate tensile strength (S_u) and yield strength (S_y) requirements of the material specification. The minimum properties for this material are provided in UFSAR Table 8-14c where S_u = 140 ksi and S_y = 115 ksi at room temperature. The allowable stresses utilized in the structural analysis performed in UFSAR Appendix 3.9.2 are based on the minimum S_u and S_y values at the conservative design temperature of 550 °F. Furthermore, Note 9 of UFSAR Drawing EOS01-1011-SAR permits use of equivalent material for the attachment screws provided that the minimum tensile strength S_u = 120 ksi.

TNF NCR 2021-101 reports that the mechanical tensile testing results for the R45 and R90 rail attachment screws were unsatisfactory, with S_u ranging from 109 to 137 ksi for the nonconforming test coupons. The yield strengths (S_y) were less than the minimum with the lowest observed yield strength of 75 ksi.

Evaluation Summary

Although the EOS-37PTH basket performs structural, thermal, criticality and shielding design functions, the rail attachment screws only provide structural support to the basket assembly, and do not perform any thermal, criticality or shielding design function, are not part of the confinement boundary, and do not constitute a fission product barrier. Therefore, only the structural design function is addressed in this Evaluation.

The Quality Category for the rail attachment screws (Items 22 and 23) is provided in UFSAR Drawing EOS01-1011-SAR, Revision 3 as “C”, and the description of Category “C” is provided in UFSAR Section 14.2, which states that Category “C” items have a minor impact on safety, and that these items include structures, components, and systems whose failure or malfunction would not significantly reduce the packaging effectiveness and would be unlikely to create a condition adversely affecting public health and safety. **[**

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UFSAR Section 14.2 further defines how the TN graded quality program is applied to each Quality Category, and that Quality Category “C” items need only be purchased from a catalog as “off-the-shelf” items, **[**

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The rail attachment screws for a general licensee order were initially purchased as Quality Category "C" with no mechanical testing required, consistent with the above discussion and the licensing requirements under CoC 1042 Amendment 1. However, a general licensee contemplated use of these baskets under Amendment 2, [

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The basket analysis described in UFSAR Section 3.9.2, which determines the stresses for all design conditions remains unchanged. The change is limited to a determination of reduced allowable values in order to accept the nonconforming material condition. The design basis structural analysis of the EOS-37PTH basket component is performed in Calculation EOS01-0225 for normal/off-normal conditions, and Calculation EOS01-0226 for the TC drop accident. As discussed, the rail attachment screws are not credited to perform a structural design function for the TC drop accident. Calculation EOS01-0224, Revision 0 evaluates the effect of the reduced strength rail attachment screws on the structural analysis of the basket component for normal/off-normal loads, applying reduction factors to the allowable stresses based on the mechanical testing results. This calculation demonstrates that the limiting allowable stress reduction factor of [ ] remains above the minimum allowable stress reduction factor of [ ] for the rail attachment screws, to the extent that the calculated stresses determined in design basis calculation EOS01-0225 for normal/off-normal conditions are maintained within the reduced allowable stress values applied in Calculation EOS01-0224. Therefore, when evaluated for the reduced material strength, the rail attachment screws continue to satisfy structural design requirements using reduced allowable stress values, resulting in reduced structural design margins and, therefore, the baskets using the nonconforming screws are structurally adequate and the proposed change does not affect the overall design functions of EOS-37PTH basket assembly.

All eight 72.48 evaluation criteria were met.

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LR 721042-285, Revision 0 – (to be incorporated into UFSAR Revision 4)

Change Description

The change assessed in this evaluation is the addition of optional dose reduction features for use with the EOS-HSMS-FPS. The optional dose reduction features considered include:

- Increasing the height of the outlet vent cover (OVC) by 8.0 inches.
- Adding a 1.0-inch thick steel plate between the roofs of two adjacent storage modules within the outlet vent area.
- Adding a 1.0-inch thick steel plate to the wind deflector assembly.

Evaluation Summary

The Structural calculation performed for this change evaluates the impact on the EOS-HSM for the change. The method of evaluation used in this calculation is the same as described in the UFSAR Section 3.9.4. The ANSYS finite element model described in UFSAR Section 3.9.4.6 is used in the analysis by accounting for the increased weight from the three changes.

In addition, to accommodate the weight increase, the maximum fresh concrete density is limited to 148 lb/ft^3 for the OVC and the roof of the EOS-HSMS-FPS with the optional features. The resulting reinforced concrete density due to this limitation is within the bounds of the existing design wherein a range of concrete densities from 140 lb/ft^3 to 160 lb/ft^3 are evaluated with the bounding value used as appropriate for each discipline. As shown in Section 3.9.4 and Section 3.9.7 of the UFSAR, a range of densities are considered in the structural evaluation with each evaluation considering the most limiting condition. Similarly, the thermal and shielding evaluations are based on 140 pcf as noted in Section 4.4.2.2 and Section 6.3.1 of the UFSAR.

The weight increases only affect the seismic load on the EOS-HSMS-FPS because the dominant frequencies of the structure are lower, which increases the spectral accelerations corresponding to the response spectrum for the design basis seismic load (Section 2.3.4 of the UFSAR). Modal frequency analysis is performed on the modified EOS-HSM model. The concrete components need to be designed for the seismic accelerations corresponding to a damping of **[**

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The evaluation of the EOS-DSC is presented in Section 3.9.1 of the UFSAR. The seismic load considered in the evaluation of the EOS-DSC consists of the accelerations of 2g, 1g, and 1.25g in the transverse, vertical, and longitudinal directions, respectively, and they correspond to the X, Y, and Z directions of the EOS-HSMS, respectively. Since the increased seismic accelerations are lower they are bounded by the accelerations considered in the EOS-DSC evaluation. Therefore, the seismic analyses and results provided in the UFSAR for the EOS-DSC remain valid and bounding for the proposed change.

For the EOS-HSM, the spectral accelerations in the X, Y, and Z directions were increased and, therefore, the demand to capacity ratios calculated for the concrete components, heat shields, axial retainer, and DSC support structure are re-analyzed in the calculation.

Section 8.2 in the calculation analyzes the concrete component for the increased spectral accelerations. Based on the analysis it is found that the maximum demand to capacity (D/C) ratio for the concrete component is <1.0. Therefore, all of the concrete components of the EOS-HSM are structurally adequate under the changes in the forces and moments due to the design modifications.

Section 8.3 in the calculation analyzes the roof heat shield (RHS) and Side Heat Shield (SHS) for the increased spectral accelerations. Based on the analysis it is found that the maximum demand to capacity (D/C) ratio for RHS and SHS is <1.0. The maximum interaction ratio for combined axial and bending stress in the connection bolts is [ ], which is less than 1.0. The maximum bending moment in side heat shield panel is [ ], which is also less than the panel moment capacity of [ ]. Therefore, the RHS and SHS of EOS-HSM are structurally adequate for the proposed change.

Section 8.4 in the calculation analyzes the axial retainer for the increased spectral accelerations. The moment due to the load P= [ ]. The allowable flexural strength is [ ]. Therefore, the axial retainer of the EOS-HSM is structurally adequate for the proposed change.

Section 8.5 in the calculation analyzes the DSC support structure in the EOS-HSM for the increased spectral accelerations. The analysis shows demand to capacity ratio is < 1.0. Therefore, the DSC support structure of the EOS-HSM is structurally adequate for the proposed change.

Section 8.6 in the calculation performs stability evaluations of the EOS-HSM. The analysis shows that stability analyses due to tornado and flood loads as well as the sliding stability analysis due to seismic loads are not affected by the proposed change. For the overturning stability due to seismic loads, the analysis shows that the EOS-HSM is stable for accelerations of up to [ ] in the horizontal and vertical direction, respectively. Therefore, the EOS-HSM is structurally adequate for stability.

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As discussed in response to Question A of the Screening, Form 3.5-2, the erection hardware, such as the bolts and embedments to accommodate the thicker OVC and the steel plate between roofs of adjacent modules within the outlet vents along with the wind deflector structural analysis, are below the level of design function description for the HSM provided in the UFSAR.

Therefore, the proposed activity for the EOS-HSM is structurally adequate and meets the intended design functions of EOS System described in the UFSAR.

All eight 72.48 evaluation criteria were met.

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LR 721042-286, Revision 0 – (no associated UFSAR changes)

Change Description

The proposed change is to qualify the use of a shield bell, which will be placed on top of the EOS-TC125 top ring.

The shield bell is an annular carbon or stainless steel structure that sits on the TC top ring and extends along the outside, down to the neutron shield, without contacting either the neutron shield or cask trunnions. The TC shield bell temporarily adds 3.25-inch thick radial shielding to approximately the top 30 inches of the TC. The shield bell sits on the TC top ring and, therefore, the weight of the shield bell is applied to the top ring. The UFSAR drawings for the EOS-TC125 do not explicitly contain any supplemental shielding. UFSAR Section 9.1.3 specifies that temporary shielding may be installed as necessary to minimize personnel exposure.

The scope of this license review is limited to an assessment of the impact of using the shield bell and single piece composite lid shield on the credited design functions of the EOS-TC125 and the EOS-37PTH DSC, respectively. Furthermore, the shielding performance of the temporary shielding is not credited to provide any shielding effectiveness for the purpose of satisfying 10 CFR 72.104 or 72.106 dose limits.

Evaluation Summary

The proposed change allows the use of a shield bell for off-loading of spent fuel. Placement of the shield bell on the EOS-TC125 provides supplemental shielding during DSC loading operations. The change does not adversely impact the DSC structural, shielding, criticality, or confinement design functions while the shield bell is used with the EOS-TC125. The effect on the thermal design function is as follows.

The shield bell component is installed while the TC/DSC annulus is filled with water, and the heat transfer from the basket through the DSC shell and TC body is primarily in the radial direction, far removed from the shield bell located at the top end of the TC. In this load case (normal hot, vertical) the thermal performance is maintained in a steady-state condition. The shield bell does not obscure or hinder access to the top of the TC/DSC annulus for the purpose of replenishing the water inventory as needed. Furthermore, the shield bell is removed prior to draining the water from the TC/DSC annulus, which represents a more limiting configuration for thermal performance in the normal hot, vertical, transient condition, where component temperatures start to increase over the course of transfer operations. Therefore, it is apparent that the use of the shield bell under the described conditions does not represent the limiting load case for the thermal performance of the EOS-TC125. However, further analysis is performed to quantify the effect on component maximum temperatures of using the shield bell.

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The thermal analysis for the proposed change was analyzed. To evaluate the thermal impact of using a shield bell during loading operations, the design basis thermal evaluation for the EOS-37PTH DSC utilized for loading operations in Section 4.5.11 of the UFSAR is re-evaluated considering the radial surfaces covered by the shield bell as adiabatic. No other changes are considered in the thermal model used for the design basis thermal evaluation. The maximum temperatures for the EOS-TC125 with the EOS-37PTH DSC with a 50 kW heat load and the shield bell installed were determined and compared to the maximum temperatures reported in Table 4-32 of the UFSAR.

With the shield bell installed, the maximum fuel cladding temperature remains unchanged from the design basis value of 648 °F listed in Table 4-32 of the UFSAR. The maximum temperatures for other TC/DSC components show a small increase, but remain below the allowable limits. For the top ring, however, a temperature increase of [ ] is observed since the entire radial surface is assumed to be adiabatic. It should also be noted that the temperature of the top ring with the shield bell is [ ] and is lower compared to the bounding normal/off-normal transfer operation outside the fuel building. The maximum temperature for the top ring during the bounding condition is 259 °F as shown in Table 4-26 for LC #6a of the UFSAR. The top ring is made of carbon steel and this increase does not impact the thermal performance.

Based on the results, it is concluded that all thermal design criteria are satisfied and the thermal design function is maintained with the use of a shield bell during DSC loading operations.

All eight 72.48 evaluation criteria were met.

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LR 721042-290, Revision 0 – (to be incorporated into UFSAR Revision 4)

Change Description

The change is to address Error Report No. 2021-008 from ANSYS Inc., which notifies that some boundary condition (BC) changes when performed in certain sequences can give rise to errors when using ANSYS Fluent software. It was reported that when using the least squares cell based gradient method and/or the warped-face gradient correction option(s), the results will not be accurate. CoC 1042 UFSAR uses ANSYS Fluent software for thermal analysis. The reported error affects the ANSYS Release 13.0 through ANSYS Release 2020 R2. The thermal analysis performed for EOS-System uses ANSYS Release 17.1, which falls within the error reported range. As suggested in the error report, after changing the boundary conditions, the case/data files are saved and re-read in the current session or a new session before running the analysis.

Evaluation Summary

The thermal evaluations performed in the UFSAR, were reviewed to identify all evaluations which were impacted by the error report. The following thermal LC evaluations provided in the UFSAR were impacted by the change:

i. LC 2n, Normal storage of EOS-37PTH DSC in EOS-HSM in UFSAR Appendix 4.9.7.
ii. LC 3-S, Accident storage of EOS-37PTH DSC in HSM-MX in UFSAR Appendix A.4.
iii. LC 1e-S-E1 and 1e-S-E2, Normal storage of EOS-37PTH DSC in HSM-MX in UFSAR Appendix A.4.
iv. LC 1-3, Normal outdoor transfer operation of 61BTH Type 2 DSC in OS197 TC in UFSAR Appendix B.4.

In addition the following LC evaluations are provided in the CoC 1042 Amendment 3 application, currently under NRC review were also impacted:

v. LC 2c, Accident storage of EOS-89BTH DSC in HSM-MX in UFSAR Appendix A.4.5.6
vi. LC 7, Off-Normal outdoor transfer of EOS-89BTH DSC in EOS-TC125 in UFSAR Appendix 4.9.8.3.
vii. LC 3, Accident storage of EOS-89BTH DSC in EOS-HSM in UFSAR Appendix 4.9.8.2.

The changes are only limited to the procedure under which the simulation is analyzed using ANSYS Fluent software. Following the guidelines from the error report, after the boundary condition changes were made the case/data files were saved. The saved files are used in the current ANSYS Fluent session or a new session per user discretion and perform the analysis.

A total of seven thermal calculations were affected by the change. The Fluent analysis model inputs were modified to save the case/data file after BC changes and then re-read in the current session or a new session. No other modifications were made to the software model or analysis. The analysis and results for the affected load cases are discussed below.

Calculation EOS01-0440 is revised by re-analyzing the LC 2n (UFSAR Table 4.9.7-2) by modifying the Fluent input file. The results from this calculation show that none of the component temperatures are impacted except concrete temperatures. The concrete temperatures increased by 1 °F from 263 °F to 264 °F and remain below the temperature limit of 300 °F. The fuel assembly temperatures remained unchanged.

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Calculation EOS01-0437 is revised by re-analyzing the LC 3-S (UFSAR, Appendix A, Tables A.4-17) by modifying the Fluent input file. The results from this calculation show that a number of component temperatures in both the upper and lower compartments are impacted. The maximum temperature change of [ ] is observed for the maximum heat shield temperatures in the lower compartment. The concrete maximum temperature increased by [ ] and remains below the accident concrete temperature limit of [ ]. No changes in the maximum temperatures are reported for the fuel assemblies (FAs) in any of the compartments.

The average component temperatures of several components are also impacted. The increase in average temperature of [ ] is reported for the DSC shell. The average FA temperatures decreased by [ ]. The average helium temperature in the EOS-37PTH DSC cavity which is used to calculate the internal pressure only increased by [ ] for the short EOS-37PTH DSC and [ ] for the medium EOS-37PTH DSC. Slight increase in helium temperature will not affect the design basis pressure and remains bounded by the values presented in UFSAR Table 4-45. Therefore there is no impact on the thermal performance of the HSM-MX system loaded with the EOS-37PTH DSC due to these temperature changes since none of the component temperature limits are exceeded.

Calculation EOS01-0449 is revised by re-analyzing the LCs #2 and #3 (LCs #1e-S-E1 and #1e-S-E2 in UFSAR, Appendix A, Table A.4-31) by modifying the Fluent input file. The results from this calculation show that none of the component temperatures are impacted except the concrete maximum temperatures. Concrete maximum temperatures increased by [ ] for LCs #1e-S-E1 and #1e-S-E2, respectively. However, in both cases, the temperatures remained bounded by the concrete temperature limit of 300 °F.

Calculation EOS01-0453 is revised by re-analyzing the LCs #1 through #3 (UFSAR Table B.4-9) by modifying the Fluent input file. The results from this calculation show that none of the component temperatures are impacted and all temperatures remain unchanged. Therefore, no changes were made to the UFSAR Appendix B.4 chapters as a result of this analysis.

Calculations EOS01-0457, EOS01-0458, and EOS01-0459 were revised due to Error Report No. 2021-008 from ANSYS Inc. and the following tables were updated in CoC 1042 Amendment 3 application, currently under NRC review, based on the error report and submitted to NRC for review:

a. Table A.4-45, Table A.4-46, Table A.4-47, Table A.4-48 and Table A.4-49 for LC2c (Accident storage in HSM-MX) in Appendix A.4.5.6.
b. Table 4.9.8-12, Table 4.9.8-14 and Table 4.9.8-15 for LC 7 (Off-Normal outdoor transfer in EOS-TC125) in Appendix 4.9.8.3.
c. Table 4.9.8-3, Table 4.9.8-4 and Table 4.9.8-5 for LC 3 (Accident storage in EOS-HSM) in Appendix 4.9.8.2.

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Therefore, no further discussion is provided for these load cases in this evaluation.

The maximum increase in DSC shell maximum temperature is [ ] and concrete is [ ]. There are no changes in the maximum temperatures for the fuel cladding and basket plates. The basket transition rail maximum temperatures did not increase but decreased by a maximum of [ ]. The maximum increase in temperature for HSM heat shield is [ ]. There is no design basis temperature limit provided for the heat shields in UFSAR.

The maximum increase in the average temperatures for the DSC shell is [ ], cavity gas is [ ], the basket plate is [ ], the transition rail is [ ], and helium in both short and medium DSC is [ ]. The maximum temperature remains same for fuel assembly; however, the average decreased by [ ].

Based on this discussion, it is observed that the peak fuel cladding temperatures for any of the LCs due to the re-analysis and all component temperatures remain below the temperature limits. Therefore, the change does not substantially affect the thermal design functions described in the UFSAR for the EOS-System.

All eight 72.48 evaluation criteria were met.

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LR 721042-293, Revision 0 – (to be incorporated into UFSAR Revision 4)

Change Description

The change assessed in this evaluation is the storage of spent fuel assemblies (SFA) containing foreign material within a NUHOMS® EOS-37PTH DSC identified during an inspection at a general licensee site.

Evaluation Summary

The effect of the introducing foreign materials into the EOS-37PTH DSC is the basis for the discussions in this section. This evaluation considers the total estimated weight of the foreign material to be 0.004 lb, comprised of the following:

- The cumulative weight of paint, plastic, orex and metal (stainless steel) is 1.43 grams (0.003 lb) in Fuel Assembly S29.
- The cumulative weight of paint, plastic and orex is 0.15 grams (0.0003 lb) in Fuel Assembly S27.
- The cumulative weight of paint, plastic and orex is 0.23 grams (0.0005 lb) in Fuel Assembly T42.
- The cumulative weight of plastic and orex is 0.13 grams (0.0003 lb) in Fuel Assembly N20.

One concern due to the presence of foreign material is that it could vaporize or volatize, which would result in an increase in gas volume within the DSC. The presence of foreign material in the DSC creates a condition affecting DSC weight, internal pressure and inert environment (hydrogen flammability limits).

The melting point of the steel (e.g., 2100 °F to 2790 °F) is well above the maximum DSC internal component temperature that will be expected during vacuum drying and storage. The metal is stable and will not vaporize or volatize. Therefore, no contribution to gas volume from this foreign material is considered.

To calculate the added volume due to vaporization of the nonmetallic foreign materials, it is conservatively considered that the helium atmosphere inside the DSC is at 14.7 psia (0 psig), in order to maximize the impact of any contribution from the foreign materials. Considering that the nonmetallic foreign material fully converts into hydrogen, the maximum increase in gaseous volume is (0.004 lb) / (0.0052 lb/ft^3) = 0.77 ft^3 of hydrogen.

The proposed change affecting the structural, thermal, shielding, criticality and confinement design functions are discussed below.

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Structural:

Impact of Foreign Material on EOS-37PTH DSC Weight:

The allowable maximum assembly weight in the EOS-37PTH DSC is 1,900 lb, as provided in the TS Table in Section 2.1. The estimated weight of all the foreign material is considered as 0.004 lb. The maximum weight of the WE 17x17 spent fuel assemblies at the general licensee site plus rod cluster control assembly (RCCA) weight is 1,648 lb each. Taking into account of the weight of all the foreign material, the maximum total assembly plus RCCA weight would be 1,648+0.004 = ~1,648 lb, which remains below the allowable maximum assembly weight including the control component (CC) in the EOS-37PTH DSC as 1,900 lb. This small amount of foreign material weight does not change the DSC center of gravity location. Therefore, the added foreign material weight of 0.004 lb would not exceed the SFA payload weight limit of 1,900 lb provided in the TS and will not have any measurable impact on the total weight of the spent fuel assembly.

Impact of Foreign Material on EOS-37PTH DSC Internal Pressure:

The design pressure used for the EOS-37PTH DSC is listed in UFSAR, Section 3.9.1.2.7.3. The pressure values used in the analysis are 15 psig for Normal (Level A), 20 psig for Off-Normal (Level B) and 130 psig for Accident (Level D). The actual pressure values calculated for the EOS-37PTH DSC's are ~ 10.3 psig for Normal, ~18.8 psig for Off-Normal and ~119.9 psi for Accident conditions as provided in UFSAR Reference, Table 4-45.

The impact of the foreign material upon EOS-37PTH DSC pressurization is assessed. The DSC free cavity volume (for medium DSC used at the general licensee site) is 360,147in^3 or 208.42 ft^3 as provided in UFSAR, Table 4-45. As determined above, the conservative estimate for additional gas volume from plastic foreign material is 0.77 ft^3. This results in a pressure increase of (0.77)/208.42 = 0.4%. In all cases, the pressure increase due to the foreign material (conservatively calculated) of 0.4% is less than the "available" margin between the calculated and design pressure. Therefore, the 0.4% increase in calculated pressure will not exceed the previously specified DSC design pressure limit with only minor impact on DSC pressure system.

Impact of Foreign Material on EOS-37PTH DSC Hydrogen Limits:

The hydrogen flammability limit of 4% is addressed by standard procedural requirements, in place on all DSC closure and opening operations that require monitoring for hydrogen as discussed in TS Section 5.4. If hydrogen levels are above the set limits of 2.4%, as provided in the UFSAR Chapter 9, Section 9.1.3 (Step 4), the DSC will be purged with helium to reduce the hydrogen concentration to acceptable limits prior to any welding/cutting. This ensures that the foreign material in the DSC will not adversely impact DSC pressure or flammability limit during welding.

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Impact of Foreign Material on EOS-37PTH DSC Corrosion (for DSC components and SFA)

The foreign materials of concern could induce corrosion of the DSC components and/or spent fuel assemblies in an environment that is conducive to corrosion (an environment with water, air or other electrolyte present). UFSAR Chapter 13, Section B.3.1.1, TS Bases, provides information about how the vacuum drying (VD) of the DSC reduces the quantity of water, air, or other oxidizing agents to 0.25 volume % or less. This level of concentration of oxidizing agents with the balance of the DSC free volume filled with inert helium gas will not support any significant corrosion in the DSC. Therefore, although the nonmetallic foreign materials in the DSC (paint, plastic, and orex) could potentially cause some corrosion in an air/water environment, the lack of an oxidizing agent in the DSC and the inert helium gas fill of 99.75% of the free volume of the DSC, will preclude any corrosion of the confinement boundary, basket (or other DSC components) or SFAs. Therefore, corrosion from the assessed amount of foreign material in a dry helium (inert gas) atmosphere is not a concern for the pressure boundary or for the fuel cladding.

Given that foreign material is placed within the EOS-37PTH DSC, there are three possible scenarios for the plastic foreign material:

The paint, plastic, and orex foreign materials did not melt/vaporize during VD operations and remain present at the start of HSM-MX storage. These materials are then present in an inert dry atmosphere (helium).

The paint, plastic, and orex foreign materials decomposed/melted during VD operations, but did not vaporize. Therefore, they remain as a solid, reconfigured piece of material.

The paint, plastic, and orex foreign materials melted and vaporized during VD operations and all that remains is residue.

In all three cases, if the material is in contact with the pressure boundary, other DSC components or the spent fuel assemblies (stainless steel, aluminum or zirconium), there is no concern of degradation due to corrosion, given the dry inert helium atmosphere within the DSC. Considering the extremely small quantity of foreign material (approximately 0.004 lb) and the inert dry helium atmosphere, a cladding breach would not occur. Even if a non-mechanistic, conservative assumption is made that the pin gas inventory is released, the release of fill gas is already an analyzed event, and this foreign material does not increase the severity of the event.

The DSC free cavity volume (medium EOS-37PTH DSC to be used at the general licensee site) is 360,147in^3 or 208.42 ft^3 as provided in UFSAR Table 4-45. The water inventory weight in the loaded EOS-37PTH DSC is 208.42*62.4 =13,005 lb. The total weight of non-metallic (paint, plastic and orex) foreign material for loading in a single DSC is estimated at 0.004 lb, which yields a concentration of (0.004 lb) / (13,005 lb) = 0.000052 ppm (parts per million). This extremely small concentration will not have any measurable impact on re-flooding operation. This is a conservative assessment for a re-flood condition. This quantity of non-metallic foreign material in an inert atmosphere within the EOS-37PTH DSC will not affect the design functions of the DSC or fuel cladding.

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As discussed above, the EOS-37PTH DSC will maintain structural integrity with the presence of foreign material. Therefore, the proposed change does not affect the EOS-37PTH DSC structural design function described in the UFSAR.

Thermal:

The volume of the foreign material is not sufficient to alter the DSC internal atmosphere and subsequently alter gaseous heat transfer. Any gas generated from a breakdown of the foreign material will only add to the internal atmosphere, i.e., the assumed helium for gaseous heat transfer is not reduced. Therefore, the proposed change does not affect the EOS-37PTH DSC thermal design function described in the UFSAR.

Shielding:

The introduction of foreign material into the DSC does not change the source term limits of the Fuel Qualification Table. The shielding analysis does not explicitly rely on the DSC internal gas environment. The volume of the foreign material is very small, contains no significant material susceptible to activation, so it will not significantly alter the long term source term. Therefore, the proposed change does not affect the EOS-37PTH DSC shielding design function described in the UFSAR.

Confinement:

The introduction of foreign material into the DSC does not have any adverse impact on the confinement capabilities of the DSCs since there are no new leak paths introduced. As stated previously, the foreign material will not adversely impact the stainless steel DSC pressure boundary. Therefore, the proposed change does not affect the EOS-37PTH DSC confinement design function described in the UFSAR.

Criticality:

The amount of foreign material will not create a criticality concern during loading or during storage as the DSC will be drained, successfully vacuum dried, and sealed. As discussed previously, the concentration of dissolved materials is very low, so it will not adversely change k_{eff}. There are no known mechanisms to breach the fuel cladding. Therefore, the proposed change does not affect the EOS-37PTH DSC criticality design function described in the UFSAR.

Based on the discussion above, it is concluded that the proposed change, which introduces foreign materials into the EOS-37PTH DSC, does not affect the structural, thermal, shielding, criticality and confinement design functions of the EOS System described in the UFSAR.

All eight 72.48 evaluation criteria were met.

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Change Description

The change addresses the impact of using the Greiner SEFIRO trailer with the EOS System in conjunction with the MX-LC transfer skid and the MX-LC loading crane. The EOS-37PTH DSC utilizes the EOS-TC125 TC to transfer the DSC into HSM-MX (Matrix), for dry storage of spent nuclear fuel using the Greiner SEFIRO trailer and MX-LC skid (hereafter referred to as DSC, HSM, trailer, and skid in this LR). The change addresses the key dimensional and weight differences between the originally assumed Greiner standard trailer against the Greiner SEFIRO trailer and its impact on the stability of the transfer skid due to seismic load, design basis tornado (DBT) wind pressure, and missile impact loads. The analysis conservatively use elevated DBT conditions, namely 360 mph tornado wind speed plus the augmented spectrum of DBT missiles as listed in Table 6 in Appendix A of Calculation EOS01-236. The seismic input accelerations used for the SEFIRO trailer seismic stability analysis bound the low seismic criteria of 0.30g in all three directions for the MX-LC previously evaluated in LR 721042-098.

Evaluation Summary

The effect on the structural design functions is discussed below.

Calculation EOS01-319 is performed to support the proposed change. The calculation evaluates the impact on the stability of the skid due to seismic load, DBT wind pressure, and missile impact loads on the EOS System. The method of evaluation is the same as that described in the original design basis Calculation EOS01-236 and provided in the UFSAR Sections 3.9.7.2.6.1.1, 3.9.7.2.6.2.1, 3.9.7.2.6.4, 3.9.7.2.6.5.1, and 3.9.7.2.6.5.2.

Stability analysis due to DBT Wind Pressure and Massive Missile Loads:

The stability analysis due to DBT wind pressure load is analyzed in Section 8.1 of Calculation EOS01-319. The analysis is the same as that described in UFSAR Section 3.9.7.2.6.1.1. Based on the analysis the overturning moment is [ ]. Therefore, the skid will be structurally stable against the DBT wind pressure loads.

The stability analysis due to massive missile impact load is analyzed in Section 8.2.1 of Calculation EOS01-319. The analysis is the same as that described in UFSAR Section 3.9.7.2.6.2.1. Based on the analysis the angle of rotation is [ ]. Therefore, the skid will be structurally stable against the massive missile impact loads.

Overturning analysis due to concurrent tornado loads is analyzed in Section 8.2.2 of Calculation EOS01-319. The analysis is the same as that described in UFSAR Section 3.9.7.2.6.5.1. Based on the analysis the angle of rotation is [ ]. Therefore, the skid will be structurally stable against the concurrent tornado loads.

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Time dependent analysis of the overturning due to concurrent tornado loads is analyzed in Section 8.3 of Calculation EOS01-319. The analysis is the same as that described in UFSAR Section 3.9.7.2.6.5.2. Based on the analysis the angle of rotation is [ ]. Therefore, the time dependent analysis ensures that the skid will be structurally stable against the overturning due to concurrent tornado loads.

Stability Analysis for EOS-TC due to Seismic Load

The stability analysis due to seismic load is analyzed in Section 8.4 of Calculation EOS01-319. The analysis is the same as that described in UFSAR Section 3.9.7.2.6.4, except that the seismic input accelerations used for the SEFIRO trailer seismic stability analysis bound the low seismic criteria of 0.30g in all three directions for the MX-LC previously evaluated in LR 721042-098. The original seismic analysis is performed using the design basis seismic accelerations at a horizontal acceleration (ah) of 0.45g and a vertical acceleration (av) of 0.30g, consistent with the seismic design criteria specified in UFSAR Section 2.3.4. The analysis in Calculation EOS01-319 is performed for a range of horizontal and vertical seismic accelerations [ ]. Table-1 in the calculation provides factors of safety against overturning due to seismic loads. Based on the analysis, the minimum acceptable factor of safety is [ ]. Therefore, when using the Greiner SEFIRO trailer, the TC is stable for maximum horizontal and vertical seismic accelerations up to 0.40g and 0.35g, respectively. These accelerations bound the low seismic criteria of 0.30g in all three directions for the MX-LC loading crane, such that the use of the Greiner SEFIRO trailer in conjunction with the MX-LC skid and loading crane is acceptable.

Based on the analysis, it can be concluded that when using the Greiner SEFIRO trailer in conjunction with the MX-LC skid and loading crane, the skid is structurally adequate and maintains its stability against the DBT wind pressure and massive missile impact loads. The factor of safety against overturning is greater than 1.1 for the individual DBT wind pressure and missile loads. Also, the angle of rotation (θ) due to the massive missile impact load, and concurrent tornado loads is less than the critical tipping angle ($1/3x\theta_{tip}$). The skid is stable for overturning under seismic accelerations up to [ ] horizontal and [ ] vertical as reported in Table-1 of Calculation EOS01-319, which bounds the low seismic criteria of 0.30g in all three directions for the MX-LC loading crane. The effects on the skid of overturning due to seismic loads that may exceed these accelerations are bounded by those due to the accident 65-inch drop condition as discussed in UFSAR Section 3.9.7.2.6.4. The distance from the bottom of the skid to the ISFSI pad when using the Greiner SEFIRO trailer remains below the 65-inch skid drop height, where the actual height is 63.96 inches as reported in Calculation EOS01-0319 Section 9.0. However, the use of the Greiner SEFIRO trailer in conjunction with the MX-LC skid and loading crane shall be limited to sites which are bounded by the seismic accelerations of [ ] horizontal and [ ] vertical as reported in Table-1 of Calculation EOS01-319.

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Therefore, the change does not affect the design functions of the EOS System described in the UFSAR, provided that the site-specific seismic criteria are bounded by the seismic accelerations reported in Table-1 of Calculation EOS01-319.

All eight 72.48 evaluation criteria were met.