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June 23, 2021
E-58840

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

Subject: Application for Amendment 3 to NUHOMS® EOS Certificate of Compliance No. 1042, Revision 1 (Docket 72-1042, CAC No. 001028, EPID: L-2021-LLA-0055) – Response to Request for Supplemental Information

References: [1] Letter from Christian Jacobs to Prakash Narayanan, "Acceptance Review of TN Americas LLC Application for Certificate of Compliance No. 1042, Amendment No. 3, to NUHOMS® EOS System (Docket No. 72-1042) – Request for Supplemental Information," dated May 20, 2021

[2] Letter E-58329, dated March 31, 2021, from Prakash Narayanan, Application for Amendment 3 to NUHOMS® EOS Certificate of Compliance No. 1042, Revision 0 (Docket 72-1042)

This submittal provides responses to the Request for Supplemental Information (RSI) forwarded by Reference [1] above. Enclosure 2 herein provides a proprietary version of the response to the RSI and Observation (OBS) items. Enclosure 3 provides a public version of these responses. Each RSI and OBS response has a section stating the impact of the response on the application, both Technical Specifications (TS) and updated final safety analysis report (UFSAR), indicating which sections, tables, etc., have been changed.

Enclosure 4 provides a listing of the CoC 1042 Amendment 3, Revision 1 TS changes, along with a justification, resulting from these RSI and OBS responses. Enclosure 5 provides a list of changed TS and UFSAR pages. Enclosure 6 provides a complete update to the TS, denoted as "Revision 1 to Amendment 3 Proposed Technical Specifications."

Enclosure 7 provides the UFSAR changed pages associated with this Revision 1 to the application for Amendment 3. Enclosure 8 provides the public version of the Enclosure 7 UFSAR changed pages.

For the UFSAR, replacement and new Amendment 3, Revision 1 pages are provided. The pages include a footer on each replacement or new page annotated as "72-1042 Amendment 3, Revision 1, June 2021" with changes indicated by italicized text and revision bars. The new changes associated with each RSI or OBS

response are further annotated with gray shading and an indication of which RSI or OBS is associated with the changes.

For the TS, Amendment 3 changes on Revision 1 pages are indicated by italicized text, revision bars, and gray shading and an indication of which RSI or OBS response is associated with the changes to distinguish them from the changes proposed in Revision 0 of the Amendment 3 application.

Enclosure 9 provides a listing of the computer files associated with CoC 1042 Amendment 3, Revision 1. Enclosure 10 contains the computer files associated with this amendment submittal. These files exceed the file size accepted by the NRC EIE application and Enclosure 10 is therefore being submitted separately. Since Enclosure 10 contains entirely proprietary information, no public version is provided.

Amendment 3 proposes a graded approach for certain changes, which had been submitted as an entirely proprietary document in the initial application, identified as Enclosure 10, titled "Graded Approach Evaluation." Based on OBS 4-11, a public version of the Graded Approach Evaluation is provided as Enclosure 11.

Certain portions of this submittal include proprietary information, which may not be used for any purpose other than to support the NRC staff's review of the application. In accordance with 10 CFR 2.390, TN Americas LLC is providing an affidavit (Enclosure 1), specifically requesting that this proprietary information be withheld from public disclosure. The submittal also includes security-related information.

Should the NRC staff require additional information to support review of this application, please do not hesitate to contact Mr. Glenn Mathues at 410-910-6538, or by email at Glenn.Mathues@orano.group.

Sincerely,

Prakash Narayanan
Chief Technical Officer

cc: Chris Jacobs (NRC), Senior Project Manager, Storage and Transportation Licensing Branch Division of Fuel Management

Enclosures:

1. Affidavit Pursuant to 10 CFR 2.390
2. RSIs and Responses (Proprietary)
3. RSIs and Responses (Public)
4. List of New CoC 1042 Amendment 3, Revision 1 Technical Specification Changes and Justifications
5. List of Changed TS and UFSAR Pages Involved in CoC 1042 Amendment 3, Revision 1
6. Proposed Technical Specifications, CoC 1042 Amendment 3, Revision 1
7. CoC 1042 Amendment 3, Revision 1 UFSAR Changed Pages (Proprietary)
8. CoC 1042 Amendment 3, Revision 1 UFSAR Changed Pages (Public)
9. Listing of Computer Files Contained in Enclosure 10
10. Certain Computer Files Associated with Certificate of Compliance 1042 Amendment 3, Revision 1 (Proprietary) (contained on one hard drive)
11. Graded Approach Evaluation (Public)

AFFIDAVIT PURSUANT TO 10 CFR 2.390

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

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 that 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 Enclosures 2, 7, and 10, as listed below:

- Enclosure 2 - RSIs and Responses
- Enclosure 7 - Portions of certain updated final safety analysis report (UFSAR) chapters
- Enclosure 10 - Certain computer files associated with Proposed CoC 1042 Amendment 3, Revision 1

These documents have 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 portions of certain RSI responses, portions of the UFSAR, and analysis computer files, all related to the design of 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 dry spent fuel storage systems, 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 Americas 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 21st day of June, 2021.

Robert M. W

Notary Public

My Commission Expires ____/____/_____

ROBERT M. WARNER NOTARY PUBLIC MY COMMISSION EXPIRES NOV. 12, 2022 HARFORD COUNTY, MD

Enclosure 2 to E-58840

RSIs and Responses

Withheld Pursuant to 10 CFR 2.390

Thermal RSI and Observations:

RSI 4-1:

Provide the following thermal analysis files listed in Enclosure 7 of the application:

a. Section 4.9.8.2 (load case (LC) 3 in Table 4.9.8-1) Folder: \Thermal\EOS-89BTH-EOS-HSM\LC3 Input and output files for the bounding accident storage condition of the EOS-89BTH DSC in the EOS-HSM with heat load zone configuration (HLZC) 4.

b. Section A.4.5.6 (LC 2c in Table A.4-43) Folder: \Thermal\EOS-89BTH-HSM-MX\LC2c Input and output files for the bounding accident storage evaluation of the EOS-89BTH DSC in the EOS-HSM-MX with HLZC 4.

The input and output thermal analysis files in a., listed above, cannot be opened, it should be confirmed that the files are usable, and then provided again. The thermal analysis files in b., listed above, do not correspond to LC 2c; the files appear to correspond to LC 2b in Table A.4-43 of the UFSAR. The thermal analysis files that correspond to the accident conditions in LC 2c should be provided again.

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

Response to RSI 4-1:

ANSYS Error Report 2021-008 (Figure RSI 4-1-1 at the end of this response) identifies that in ANSYS Fluent Release 13.0 to Release 2020 R2, when using the Least Squares Cell Based gradient method and/or the Warped-Face Gradient Correction option, the results will not be accurate and the simulation may diverge if the following sequence is performed: initialize or run the calculation, perform certain boundary condition changes, and then continue the calculation. The boundary condition changes that produce this error are:

- Coupled wall to/from an interior, periodic, or porous jump
- Periodic to/from an external boundary condition (i.e., wall, symmetry, axis, degassing, exhaust fan, inlet vent, intake fan, interface, mass-flow, inlet, mass-flow outlet, outflow, outlet vent, overset, pressure far-field, pressure inlet, pressure outlet, or velocity inlet)

ANSYS suggested the following user action to be run on the uncorrected version of ANSYS Fluent: After changing the boundary condition, save the case/data files, and then reread them in the current session on a new Fluent session before continuing the calculation.

TN has used ANSYS Fluent Release 17.1 in thermal evaluations for the CoC No. 1042 Amendment 3 application. Load case (LC) 3 in Table 4.9.8-1 and LC 2c in Table A.4-43 of the UFSAR used the Least Squares Cell Based gradient method and involved the boundary condition change from interior to coupled wall on the blocked vents. Therefore, LC 3 in Table 4.9.8-1 and LC 2c in Table A.4-43 of the UFSAR are re-evaluated using the ANSYS suggested user action as discussed in the ANSYS Error Report 2021-008.

Item a:

UFSAR Section 4.9.8.2 (LC 3 in Table 4.9.8-1 of UFSAR): After the re-evaluation of LC 3, slight differences in the temperatures of key components are reported. Fuel assembly temperatures remain unchanged. A rise of 2 °F in maximum temperature is reported for the horizontal storage module (HSM) concrete, and 1 °F for the heat shield and support structure. The maximum temperatures for all the other components remain unchanged. Average component temperatures remained unchanged except for HSM concrete, which is increased by 1 °F. The average helium temperature determined for the EOS-89BTH DSC in the EOS-HSM with bounding HLZC 4 remains unchanged. All maximum temperatures and maximum internal pressures are within the design limits. Table 4.9.8-3 through Table 4.9.8-5 and Figure 4.9.8-4 in UFSAR Appendix 4.9.8 have been updated to reflect these changes. The new computer files from the re-evaluation of LC 3 are listed in Enclosure 9 and provided in Enclosure 10.

Item b:

UFSAR Section A.4.5.6 (LC 2c in Table A.4-43 of UFSAR): After the re-evaluation of LC 2c, slight differences in the temperatures of key components are reported. The maximum fuel assembly temperature in the upper compartment is increased by 1 °F and remains unchanged in the lower compartment. The maximum concrete temperature is decreased by 12 °F. For the other components, maximum temperature changes are in the range of -12 °F to 5 °F. Average component temperature changes are in the range of -8 °F to 6 °F. The average helium temperature determined for the EOS-89BTH DSC in the HSM-MX with bounding HLZC 4 remains unchanged. All maximum temperatures and maximum internal pressures are still within the design limits. Table A.4-45 through Table A.4-47 and Figure A.4-34 in UFSAR Appendix A.4 have been updated to reflect these changes. The new computer files from the re-evaluation of LC 2c are listed in Enclosure 9 and provided in Enclosure 10.

As a result of ANSYS Error Report 2021-008, TN has initiated a Corrective Action Report (CAR) 2021-111 to investigate all previous ANSYS Fluent calculations that used Least Squares Cell Based gradient method and involved the boundary condition changes as described above.

Impact:

UFSAR Table 4.9.8-3 through Table 4.9.8-5 and Figure 4.9.8-4 in UFSAR Appendix 4.9.8, and Table A.4-45 through Table A.4-47 and Figure A.4-34 in UFSAR Appendix A.4 have been revised as described in the response.

The new computer files are listed in Enclosure 9 and provided in Enclosure 10.

ANSYS Inc. Class3 Error Report

Error Report No: 2021-008

Affected Programs/Applications

☐ ACP	☐ Circuit	☐ HFSS	☐ Simplorer
☐ ACT	☐ DesignModeler	☐ ICEMCFD	☐ SIwave
☐ Additive Prep	☐ DesignSpace	☐ Icepak	☐ SpaceClaim
☐ Additive Print	☐ DesignXplorer	☐ Maxwell	☐ SpaceClaim Direct Modeler
☐ Additive Suite	☐ Discovery	☐ Mechanical	☐ SPEOS
☐ AIM	☐ Discovery SpaceClaim	☐ Mechanical APDL	☐ Tgrid
☐ ANSYS Cloud	☐ EKM	☐ Medini Analyze	☐ TurboGrid
☐ ANSYS Viewer	☐ Electronics Desktop	☐ Minerva	☐ Twin Builder
☐ Aqwa	☐ EMIT	☐ optiSLang	☐ Vista AFD
☐ AqwaGS	☐ Energico	☐ PEmag	☐ Vista CCD
☐ AqwaWave	☐ Ensight	☐ PExprt	☐ Vista CCM
☐ Autodyn	☐ FENSAP-ICE	☐ Polyflow	☐ Vista CPD
☐ BladeEditor	☑ **Fluent**	☐ Q3D Extractor	☐ Vista RTD
☐ BladeGen	☐ Forte	☐ Reaction Workbench	☐ Vista TF
☐ CFD-Post	☐ Forte Monitor	☐ RSM	☐ VRXPERIENCE
☐ CFX	☐ Forte Simulate	☐ Savant	☐ Workbench
☐ Chemkin	☐ Forte Visualize	☐ Sherlock	

Affected Physics Areas

☐ Acoustics	☑ **Fluids**	☐ Optical	☐ Pre Processing / Geometry
☐ Electrical/Electronics	☐ Materials	☐ Post Processing / Display	☐ Structural Mechanics
☐ File / Database	☐ Meshing / Domain Decomposition		

Keywords:

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boundary condition change
Least Squares Cell Based gradient method
Warped-Face Gradient Correction option
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Description of Error:

When using the **Least Squares Cell Based** gradient method and/or the **Warped-Face Gradient Correction** option, the results will not be accurate and the simulation may diverge if the following sequence is performed: initialize or run the calculation, perform certain boundary condition changes, and then continue the calculation. The boundary condition changes that produce this error are:

- coupled wall to/from interior, periodic, or porous jump
- periodic to/from an external boundary condition (that is, wall, symmetry, axis, degassing, exhaust fan, inlet vent, intake fan, interface, mass-flow, inlet, mass-flow outlet, outflow, outlet vent, overset, pressure far-field, pressure inlet, pressure outlet, or velocity inlet)

Other Comments:

First Incorrect Version:
Release 13.0

Corrected In:
Release 2020 R2

Suggested User Action For Running on Uncorrected Version:

After changing the boundary condition, save the case / data files and then reread them in the current session or a new Fluent session before continuing the calculation.

Author Signature: Mohammad Azab 2/16/2021 1:09:02 PM
Development Review: Atul Verma - 2/17/2021 12:45:57 AM

Figure RSI 4-1-1
ANSYS Error Report 2021-008

Observation 4-1:

Describe how the lead gamma shielding thickness value of the EOS-TC125 transfer cask was chosen and used in the thermal analysis to provide a maximum peak cladding temperature (PCT) and maximum component temperature results.

The proposed change in the lead gamma shielding thickness of the EOS-TC125 transfer cask includes a variable thickness (i.e. from x inches to y inches). Based on this proposed variation, it is not clear how a bounding value (i.e. x or y) was chosen to provide a maximum PCT and maximum component temperatures in the thermal analysis. Note that the lead gamma shielding temperature should be below the lead melting point during normal, off-normal, and accident conditions based on the reduced lead thickness.

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

Response to Observation 4-1:

As indicated in updated final safety analysis report (UFSAR) Section 1.2.1.4, the EOS-TC125 lead gamma shielding thickness may vary between 3.12 and 3.56 inches when transferring the EOS-89BTH for a weight reduction of up to 11,210 pounds. UFSAR Section 4.9.8.3.2 has been revised to provide a discussion on the methodology used to determine the effective thermal properties for the lead gamma shielding used in the thermal evaluation. As discussed in Section 4.9.8.3.2, the nominal thickness of the lead gamma shielding is 3.19 inches in the thermal model in UFSAR Section 4.9.8.3.2. Increasing the lead gamma shielding thickness will enhance the heat capacity through additional material and, therefore, will improve the thermal performance of the EOS-TC125. Therefore, the thermal model in UFSAR Section 4.9.8.3.2 bounds the EOS-TC125 with thicker lead gamma shielding. UFSAR Section 4.9.8.3.6 has been added to evaluate the effect of further reduction in the lead gamma shielding thickness from 3.19 to 3.12 inches on the thermal performance of the EOS-TC125 TC loaded with EOS-89BTH DSC along with an update to the effective thermal properties for the lead gamma shielding.

Based on the discussion presented in UFSAR Section 4.9.8.3.6, the maximum and average component temperatures reported in Section 4.9.8.3.3 and transfer time limits reported in Section 4.9.8.3.4 remain valid. The lead gamma shielding temperatures remain below the lead melting point during normal, off-normal, and accident conditions based on the variable lead gamma shielding thickness.

Impact:

UFSAR Section 4.9.8.3.2 has been revised as described in the response.

UFSAR Section 4.9.8.3.6 and Tables 4.9.8-16 through 4.9.8-18 have been added as described in the response.

The computer files for Appendix 4.9.8.3.6 are listed in Enclosure 9 and provided in Enclosure 10.

Observation 4-2:

Clarify in Figure 11 of the NUHOMS® EOS System Technical Specifications (TS) whether the payload will be adjusted to maintain the total canister heat load within the specified limits in notes 1 and 2.

The NUHOMS® EOS System TS Figure 11 Note 1 describes that the maximum heat load for the EOS-89BTH DSC during storage is 48.2 kW in the EOS-HSM. The NUHOMS® EOS System TS Figure 11 Note 2 describes that the maximum heat load for the EOS-89BTH DSC during storage is 48.2 kW in the lower compartment of the HSM-MX and 41.8 kW in the upper compartment of the HSM-MX. However, utilizing the maximum per assembly decay heat and maximum number of fuel assemblies in each of the six zones as described in TS Figure 11 will result in the maximum decay heat per DSC (described in notes 1 and 2) being exceeded.

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

Response to Observation 4-2:

As noted in Observation 4-2, Notes 1 and 2 of Figure 11 of the TS specify the limits on the maximum heat load allowed within the EOS-89BTH DSC based on the storage module. In addition, this figure also provides limits on the maximum allowable heat loads in each fuel compartment and zone.

Specific instructions to adjust the heat load are not included in this figure since it is a maximum heat load configuration (MHLC), and is not directly intended for loading the EOS-89BTH DSC. As described in Section 2.2 “Thermal Parameters” of the TS, individual heat load zoning configurations (HLZCs) developed based on the restrictions in MHLC (i.e., Figure 11 of the TS) shall be used for loading operations. These individual HLZCs are included in Section 2.4.3.2 of the UFSAR.

As shown in UFSAR Figure 2-2d through Figure 2-2f for HLZCs 4 through 6, the sum of individual zones exceeds the total heat load limits for HLZCs 4, 5, and 6, respectively. For these HLZCs, instructions are provided to adjust the total heat load to the maximum limit permitted per Figure 11 of the TS. This will ensure that the limits specified in Note 1 and Note 2 of Figure 11 of the TS are satisfied.

Impact:

No change as a result of this observation.

Observation 4-3:

The NUHOMS® EOS System TS Figure 4F note 1 states, "Adjust the payload to maintain total DSC heat load within the specified limit," which is 31.2 kW and found in the table that is located below Figure 4F. However, when adding the maximum decay heat per zone for each of the six zones, the total is 31.18 kW, which is already less than 31.2 kW specified in the table. Therefore, for the NUHOMS® EOS System TS Figure 4F, if the per assembly decay heat values are correct, the payload to maintain the total DSC heat load does not need to be adjusted, and then note 1 does not appear to be necessary. In this case, the payload should not be adjusted to exceed 31.18 kW while also remaining below 31.2 kW.

This information is needed to determine compliance with 10 CFR 72.236(a).

Response to Observation 4-3:

Figure 4F of the Technical Specification (TS) has been updated to remove Note 1 since the sum of the total heat per zone among the various zones results in a heat load that is less than 31.2 kW.

Impact:

TS Figure 4F has been revised as described in the response.

Proprietary Information on Pages 7 through 13
Withheld Pursuant to 10 CFR 2.390

Observation 4-8:

Provide clarification for a statement in Section 4.9.1.2 of the UFSAR based on the proposed changes to the amendment.

It is not clear in the application what proposed change in the amendment the following statement from the UFSAR is connected to, “The bounding effective specific heat based on GE1/2/3 FA and bounding effective density based on Switzerland- KKL BWR 10/15 FA are listed in Table 4.9.1-7 and also summarized in Section 4.2.1.”

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

Response to Observation 4-8:

The specific heat and densities of the bounding fuel assemblies in the EOS-89BTH Dry Shielded Canister (DSC) were not included in the previous amendments. The above statement in the UFSAR Section 4.9.1.2 refers to the addition of the specific heat and density information of fuel assemblies in the EOS-89BTH DSC, which are needed for the transient load cases listed in Table 4.9.8-1 and Table 4.9.8-8 of UFSAR Section 4.9.8.

Impact:

No change as a result of this observation.

Observation 4-9:

Provide clarification in Section 4.9.8.3 of the UFSAR if the water is boiling in the annulus during transfer operations. Similarly, provide clarification in the application if the water is boiling in the annulus during vacuum drying.

It is not clear from the application if water is boiling in the annulus during transfer operations or during vacuum drying. The presence of water in the annulus provides heat transfer to maintain component temperatures below allowable limits.

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

Response to Observation 4-9:

Water is present within the TC/DSC annulus during loading operations and is drained prior to the initiation of the transfer operations (transfer operations begin when the cask is in a horizontal position on the transfer trailer).

Thermal evaluation for loading operations, which include the vacuum drying operations for both the EOS-37PTH and the EOS-89BTH Dry Shielded Canisters (DSCs), are presented in Section 4.5.11 of the UFSAR. Since there are no physical changes to the EOS-89BTH DSC, there are no changes to the loading procedures or the vacuum drying operations as a result of this application.

As discussed in Section 4.5.11, it is considered that during loading and vacuum drying operations the water in the TC/DSC annulus is at 223 °F, which is the boiling temperature of water. This boiling temperature of water accounts for the higher boiling point, due to the height of the water column at approximately the mid-section of the TC/DSC annulus.

As described in Section 4.5.11, the thermal evaluation for vacuum drying operations is based on steady-state analysis with the TC/DSC annulus water temperature equal to water boiling temperature of 223 °F and a helium environment within the DSC cavity. Based on this evaluation, the maximum fuel cladding temperature at 48.2 kW during vacuum drying operations is 653 °F, as listed for the initial condition of Load Case (LC) 1 in Table 4.9.8-9 of the UFSAR.

Section 4.9.8.3.1 of the UFSAR is updated to clarify the section in which loading and vacuum drying operations are discussed.

Impact:

UFSAR Section 4.9.8.3.1 has been revised as described in the response.

Proprietary Information on This Page
Withheld Pursuant to 10 CFR 2.390

Observation 4-11:

Consider whether all, or portions of the, “Graded approach evaluation,” in Enclosure 10 could be made public.

At this time, all of Enclosure 10 that describes the, “Graded approach evaluation,” that is related to proposed change # 7 is proprietary. Given that all of the information in Enclosure 10 is labeled proprietary, this might necessitate public, and non-public SERs.

This information is needed to determine compliance with 10 CFR 72.20.

Response to Observation 4-11:

The Graded Approach Evaluation presented is updated to clarify the relevant non-proprietary information. This updated document is included as Enclosure 11.

Impact:

No change as a result of this observation.

Criticality RSIs:

RSI 6-1:

Revise the application to provide the locations of short and long partial-length rods in the ATRIUM 11 fuel assembly, and to discuss how this fuel was modeled in the criticality analysis.

The applicant requested that the ATRIUM 11 fuel assembly be added as an allowable fuel type for storage in the EOS 89BTH canister. Table 2-3 of the UFSAR provides the assembly design characteristics for the ATRIUM 11 fuel assembly design, including the numbers and lengths of the full length, short partial-length, and long partial-length rods. However, the UFSAR does not show the location of the short and long partial-length rods in the assembly lattice. The UFSAR should be revised to include this information. Additionally, the criticality chapter of the UFSAR does not describe how the ATRIUM 11 assembly was modeled. The UFSAR should be updated to describe whether the partial-length rods were modeled actual length, full length, or missing, and if the central water rod channel is modeled as designed or replaced by water, and demonstrate that the assembly configuration modeled is conservative.

This information is needed to ensure compliance with the criticality safety requirements in 10 CFR 72.124 and 72.236(c).

Response to RSI 6-1:

Figure 7-31 is added to Updated Final Safety Analysis Report (UFSAR) Chapter 7 to illustrate the numbers and lengths of the full length, short partial-length, and long partial-length rods. Figure 7-27 is modified to add views of the 100 and 92 rod lattices. In addition, a sensitivity analysis is performed and documented in UFSAR Section 7.4.3 C to provide the basis for the bounding lattice model employed for determining the maximum enrichments for ATRIUM 11 fuel type loaded in the EOS 89BTH Dry Shielded Canister (DSC). The sensitivity analysis encompasses the ATRIUM 11 fuel design characteristics including non-uniform, and uniform pitch, and numbers and lengths of the full length, short partial-length, and long partial-length rods (new UFSAR Figure 7-31). The results of the sensitivity analysis, new UFSAR Table 7-82, show the bounding ATRIUM 11 lattice is that with uniform pitch of 1.195 cm and 92 rods. UFSAR Table 7-43 has been revised to report the maximum enrichments for ATRIUM 11 fuel type. UFSAR Figure 7-28 has been revised to update the ATRIUM 11 illustration in the short loading configuration with 88 fuel assemblies.

Note that UFSAR Table 7-4, Table 7-43a, and Figure 7-30 have been revised to update the results for GNF2 and ABB-10-C short loading configurations to remove the zircaloy channel in the empty compartments and to modify the empty compartments in the short loading configuration with 84 fuel assemblies. UFSAR Section 7.4.4, Section 7.5.3 and Table 7-44 have been updated to report the k_{eff} of the most reactive case for boiling water reactor (BWR) fuel.

Technical Specifications (TS) Table 8 has been updated to report the maximum lattice average initial enrichments and minimum B-10 areal densities. TS Table 8A has been deleted and the updated ATRIUM 11 results have been added to TS Table 8. TS Figure 10 has been updated to modify the empty compartments in the short loading configuration with 84 fuel assemblies.

Impact:

UFSAR Section 7.4.3 C, Section 7.4.4, Section 7.5.3, Table 7-4, Table 7-43, Table 7-43a, Table 7-44, Table 7-82, Figure 7-27, Figure 7-28, Figure 7-30 and Figure 7-31 have been revised as described in the response.

TS Table 8 and Figure 10 have been revised and Table 8A has been deleted as described in the response.

<u>Procedures and Acceptance Test RSIs:</u>

RSI 9-1:

Provide supplemental information to clarify the (1) sequencing of the helium leak testing of the dry shielded canister (DSC) and the nondestructive examination (NDE) of the outer top cover plate (OTCP) welds, and (2) repair of inner top cover plate (ITCP) weld if a leak is identified when the outer top cover plate (OTCP) structural weld is performed using single pass high amperage gas tungsten arc welding (HA-GTAW).

Provide a justification for conducting the helium leak test prior to performing NDE to verify the integrity of the OTCP weld. The applicant's proposed changes to the updated final safety analysis report (UFSAR) Section 9.1.4, "DSC Sealing Operations," steps 3 and 4 indicate that the helium leak test can be performed after the single pass HA-GTAW weld is completed but prior to NDE of the single pass weld (which is identified in step 6). As written, the procedures imply that the helium leak test can be conducted prior to the required NDE of the OTCP to DSC shell weld when the HA-GTAW process is used.

In addition, provide supplemental information to clarify how a general licensee or their contractors will remove the single pass HA-GTAW weld as indicated in Step 5 if the helium leak test results do not meet the requirements in Technical Specification 5.1.2.f and repair of the ITCP weld is necessary. For the multi-pass GTAW method, only the root pass of the OTCP to DSC shell weld would need to be removed to gain access to the ITCP weld to conduct a repair. It is not clear to the staff that a general licensee or their contractors would have the necessary equipment and experience to successfully remove the 0.5 inch thick OTCP weld without altering the OTCP or the DSC in such a way that could prevent the reinstallation of the OTCP. As an alternative, revise the procedures to require the helium leak test to be conducted using a test head before installing and welding the OTCP using the HA-GTAW method. The use of the test head is listed currently stated as an alternative in step 4.

This information is needed to determine compliance with the requirements of 10 CFR 72.236(j).

Response to RSI 9-1

TN Americas LLC (TN) is aware of one case where the inner top cover root pass had to be cut out due to leak test failure. The leak was due to material defects in the siphon and vent block near the shell; the siphon and vent block had been machined from thick plate with the rolling direction through the confinement boundary. The EOS Dry Shielded Canister (DSC) does not have a siphon and vent block. The vent port plug may be made from bar stock, with the processing direction through the confinement boundary, but defects of the type and size found in thick plate are unlikely in small diameter stainless bar stock. There is no record of the field weld of the inner cover to the shell failing. There have been occasions where a slow leak of an incompletely-seated quick connect fitting blows out the end of a port cover weld root pass, but this has been detected visually or by penetrant testing (PT) at the time of the port cover root pass.

Furthermore, were it necessary to remove the outer top cover plate after completion of the single pass HA-GTAW weld, a portable lathe can be delivered to site to remove the cover. TN has already performed this service for a power plant that installed and welded a NUHOMS® 32P inner top cover assembly in a cocked position. The cover weld was cut out with the lathe, and both cover and shell were suitable for re-use. In the EOS HA-GTAW case, the removed outer

cover would need to be re-welded using conventional GTAW, but the machine would be available on site since it is used for the inner cover weld.

During this repair, the DSC is in a safe condition, with water in the annulus, and helium in the DSC. The loss of helium due to a small leak will not be sufficient to affect the heat transfer in the DSC, and is therefore a commercial risk, not a safety risk. Consequently, TN does not believe it necessary to make the use of the temporary test cover mandatory, but will recommend it.

Impact:

UFSAR Section 9.1.4 has been revised as described in the response.

RSI 10-1:

Provide supplemental information on the NDE of the OTCP to the DSC shell weld by ultrasonic testing (UT) to clarify the following: (1) qualification requirements of the NDE technique and procedure, and (2) justification or demonstration of the ability to detect/identify/size flaws at any location on the OTCP structural weld to ensure that the sum of depth of aligned defect subtracted from measured weld thickness will be greater than or equal to 0.30" using a weld quality factor of 1.0, as stated in UFSAR Section 10.1.3.1.

The applicant's proposed change to UFSAR Section 10.1.3.1 "DSC" does not include or reference details of the UT technique or include a demonstration that supports that the UT procedure will be sufficient for the detection of welding flaws in the OTCP to DSC shell weld using either multipass GTAW welding or the HA-GTAW welding such as ASME Section V Article 14 "Examination System Qualification" with a justification for the level of rigor. Further, the proposed changes do not address or reference NDE personnel qualification requirements to that specific technique for flaw detection/identification/sizing.

This information is needed to determine compliance with the requirements of 10 CFR 72.236(b) and (e).

Response to RSI 10-1:

TN Americas LLC (TN) will develop and demonstrate an automated phased array ultrasonic testing (UT) procedure from the top face of the cover plate. The procedure will conform to American Society of Mechanical Engineers (ASME) Section V, Articles 4 and 23, SE-2700, and endorsed by an American Society for Nondestructive Testing (ASNT) Level III. Personnel requirements of NB-5500 apply, with the alternative to use versions of SNT-TC-1A later than those specified in Table NCA-7100-1.

The examination procedure is capable of detecting the flaws outlined in ASME III Subsection NB-5330. The procedure will be qualified as required by ASME Section III, NB-5112 and ASME Section V, T-421.2. The current objective of TN is to demonstrate the ability to detect any discontinuity of 1 mm in height. The procedure will measure the depth of penetration of the outer top cover plate weld to ensure the specified throat thickness is met. The UT setup will be tested on a calibration block with various machined discontinuities at the minimum size at a variety of locations and orientations.

Because these commitments are embedded in the Code of Construction cited in the proposed Technical Specifications (TS), and no Code alternatives to them are proposed, no change to the SAR is required, except a correction to the alternative to editions of SNT-TC-1A.

Table NCA-7100-1 ASME 2010 edition with 2011 amendments invokes the 2006 edition of SNT-TC-1A. The current code alternative incorrectly states that the 2006 version may be used in lieu of the 1992 version.

Impact:

TS Section 4.4.4 has been revised as described in the response.

List of New CoC 1042 Amendment 3, Revision 1 Technical Specifications
Changes and Justifications

Changed Technical Specifications (TS) Area and Page Number	Justification
Table of Contents, List of Tables, and List of Figures	Updated
Section 4.4.4 (Page 4-6)	As described in the response to Acceptance Test RSI 10-1, the CODE REQUIREMENT column and the JUSTIFICATION AND COMPENSATORY MEASURES column for ASME CODE SECTION NB-5520 has been revised to reflect the correct alternative to NB-5520.
Table 8 (Page T-9)	As described in the response to Shielding RSI 6-1, Table 8 has been revised to reflect the maximum lattice average initial enrichments and minimum B-10 areal densities.
Table 8A (Page T-10)	As described in the response to Shielding RSI 6-1, Table 8A has been deleted and the updated information has been added to Table 8. Note that this table was added under Revision 0 of the application for Amendment 3. Table 9 is now shown on this page, Page T-10.
Figure 4F (Page F-19)	As described in the response to Thermal OBS 4-3, Note 1 has been removed.
Figure 10 (Page F-29)	As described in the response to Shielding RSI 6-1, Figure 10 has been revised.

List of TS and UFSAR Pages
Involved in CoC 1042 Amendment 3, Revision 1

Technical Specifications Pages
4-6
T-9
F-19
F-29

UFSAR Pages			
2-22	4.9.8.18	4.9.8-45	7-179
4-5	4.9.8-22	4.9.8-46	7-180
4-146	4.9.8-23	7-36	7-182
4-147	4.9.8-24	7-37	7-183
4-152	4.9.8-25	7-38	9-12
4-159	4.9.8-30	7-43	A.4-95
4-162	4.9.8-33	7-48	A.4-96
4.9.8-10	4.9.8-35	7-107	A.4-97
4.9.8-11	4.9.8-36	7-108	A.4-163
4.9.8-16	4.9.8-37	7-109	A.4-164
4.9.8-17	4.9.8-38	7-151	A.4-165

Enclosure 6 to E-58840

Proposed Technical Specifications, CoC 1042
Amendment 3, Revision 1

Revision 1 to Amendment 3 Proposed Technical Specifications

CoC 1042

APPENDIX A

NUHOMS® EOS SYSTEM GENERIC TECHNICAL SPECIFICATIONS

Amendment *3*

List of Tables

List of Figures

1.0 USE AND APPLICATION

1.1 Definitions

---NOTE---

The defined terms of this section appear in capitalized type and are applicable throughout these Technical Specifications and Bases.

Term	Definition
ACTIONS	ACTIONS shall be that part of a Specification that prescribes Required Actions to be taken under designated Conditions within specified Completion Times.
BLEU FUEL	Blended Low Enriched Uranium (BLEU) FUEL material is generated by down-blending high enriched uranium (HEU). Because the feedstock contains both unirradiated and irradiated HEU, fresh BLEU fuel has elevated concentrations of U-232, U-234, and U-236.
CONTROL COMPONENTS (CCs)	Authorized CCs include Burnable Poison Rod Assemblies (BPRAs), Thimble Plug Assemblies (TPAs), Control Rod Assemblies (CRAs), Control Element Assemblies (CEAs), Control Spiders, Rod Cluster Control Assemblies (RCCAs), Axial Power Shaping Rod Assemblies (APSRAs), Orifice Rod Assemblies (ORAs), Peripheral Power Suppression Assemblies (PPSAs), Vibration Suppression Inserts (VSIs), Flux Suppression Inserts (FSIs), Burnable Absorber Assemblies (BAAs), Neutron Source Assemblies (NSAs) and Neutron Sources. CCs not explicitly listed are also authorized as long as external materials are limited to zirconium alloys, nickel alloys, and stainless steels. Non-fuel hardware that are positioned within the fuel assembly after the fuel assembly is discharged from the core such as Guide Tubes or Instrument Tube Tie Rods or Anchors, Guide Tube Inserts, BPRA Spacer Plates or devices that are positioned and operated within the fuel assembly during reactor operation such as those listed above are also considered to be authorized CCs.

(continued)

1.1 Definitions (continued)

DAMAGED FUEL	DAMAGED FUEL assemblies are fuel assemblies containing fuel rods with known or suspected cladding defects greater than hairline cracks or pinhole leaks. The extent of damage in the fuel assembly, including non-cladding damage, is to be limited so that a fuel assembly maintains its configuration for normal and off-normal conditions. The extent of cladding damage is also limited so that no release of pellet material is observed during inspection and handling operations in the pool prior to loading operations. DAMAGED FUEL assemblies shall also contain top and bottom end fittings. DAMAGED FUEL assemblies may also contain missing or partial fuel rods.
DRY SHIELDED CANISTER (DSC)	An EOS-37PTH DSC, EOS-89BTH DSC, and 61BTH Type 2 DSC are sealed containers that provide confinement of fuel in an inert atmosphere.
FAILED FUEL	FAILED FUEL is defined as ruptured fuel rods, severed fuel rods, loose fuel pellets, fuel fragments, or fuel assemblies that may not maintain configuration for normal or off-normal conditions. FAILED FUEL may contain breached rods, grossly breached rods, or other defects such as missing or partial rods, missing grid spacers, or damaged spacers to the extent that the assembly may not maintain configuration for normal or off-normal conditions. FAILED FUEL shall be stored in a failed fuel canister (FFC).
FUEL BUILDING	The FUEL BUILDING is the site-specific area or facility where the LOADING OPERATIONS take place.
FUEL CLASS	A FUEL CLASS includes fuel assemblies of the same array size for a particular type of fuel design. For example, WEV 17x17, WEO 17x17, and ANP Advanced MK BW 17x17 fuel assemblies are part of a WE 17x17 FUEL CLASS.

(continued)

1.1 Definitions (continued)

HORIZONTAL STORAGE MODULE (HSM)	An HSM is a reinforced concrete structure for storage of a loaded DSC at a spent fuel storage installation. Where the term "HSM" is used without distinction, this term shall apply to both the EOS-HSM and HSM-MX. The term EOS-HSM refers to the base unit for storage of a single DSC as a single piece (EOS-HSM) or as a split base (EOS-HSMS). The term MATRIX (HSM-MX) refers to the two-tiered staggered structure for storage of the DSCs.
INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI)	The facility within a perimeter fence licensed for storage of spent fuel within HSMs.
INTACT FUEL	Fuel assembly with no known or suspected cladding defects in excess of pinhole leaks or hairline cracks, and with no missing rods.
LOADING OPERATIONS	LOADING OPERATIONS include all licensed activities on a DSC in a TC while it is being loaded with fuel assemblies. LOADING OPERATIONS begin when the first fuel assembly is placed in the DSC and end when the TC is ready for TRANSFER OPERATIONS (i.e., when the cask is in a horizontal position on the transfer trailer.) LOADING OPERATIONS do not include DSC transfer between the TC and the HSM.
LOW-ENRICHED OUTLIER FUEL (LEOF)	LOW-ENRICHED OUTLIER FUEL is PWR and BWR fuel with enrichments below the minimum enrichment specified in Table 7A and Table 18, respectively.
RECONSTITUTED FUEL ASSEMBLY	A RECONSTITUTED FUEL ASSEMBLY is a fuel assembly where one or more fuel rods are replaced by low enriched uranium or natural uranium fuel rods or non-fuel rods.
STORAGE OPERATIONS	STORAGE OPERATIONS include all licensed activities that are performed at the ISFSI, while a DSC containing fuel assemblies is located in an HSM on the storage pad within the ISFSI perimeter. STORAGE OPERATIONS do not include DSC transfer between the TC and the HSM.

(continued)

1.1 Definitions (continued)

TRANSFER CASK (TC)	A TRANSFER CASK (TC) (EOS-TC108, EOS-TC125, EOS-TC135, and OS197/OS197H/OS197FC-B/OS197HFC-B) consists of a licensed NUHOMS® System TC. When used without distinction, the term EOS-TC includes the EOS-TC108, EOS-TC125, and EOS-TC135. The term OS197 includes the OS197/OS197H/OS197FC-B/OS197HFC-B. The TC is placed on a transfer trailer for movement of a DSC to the HSM.
TRANSFER OPERATIONS	TRANSFER OPERATIONS include all licensed activities involving the movement of a TC loaded with a DSC containing fuel assemblies. TRANSFER OPERATIONS begin after the TC has been placed horizontal on the transfer trailer ready for TRANSFER OPERATIONS and end when the DSC is at its destination and/or no longer horizontal on the transfer trailer. TRANSFER OPERATIONS include DSC transfer between the TC and the HSM.
UNLOADING OPERATIONS	UNLOADING OPERATIONS include all licensed activities on a DSC to unload fuel assemblies. UNLOADING OPERATIONS begin when the DSC is no longer horizontal on the transfer trailer and end when the last fuel assembly has been removed from the DSC. UNLOADING OPERATIONS do not include DSC transfer between the HSM and the TC.

1.0 USE AND APPLICATION

1.2 Logical Connectors

PURPOSE

The purpose of this section is to explain the meaning of logical connectors.

Logical connectors are used in Technical Specifications (TS) to discriminate between, and yet connect, discrete Conditions, Required Actions, Completion Times, Surveillances, and Frequencies. The only logical connectors that appear in TS are <u>AND</u> and <u>OR</u>. The physical arrangement of these connectors constitutes logical conventions with specific meanings.

BACKGROUND

Several levels of logic may be used to state Required Actions. These levels are identified by the placement (or nesting) of the logical connectors and by the number assigned to each Required Action. The first level of logic is identified by the first digit of the number assigned to a Required Action and the placement of the logical connector in the first level of nesting (i.e., left justified with the number of the Required Action). The successive levels of logic are identified by additional digits of the Required Action number and by successive indentions of the logical connectors.

When logical connectors are used to state a Condition, Completion Time, Surveillance, or Frequency, only the first level of logic is used, and the logical connector is left justified with the statement of the Condition, Completion Time, Surveillance, or Frequency.

EXAMPLES

The following examples illustrate the use of logical connectors:

<u>EXAMPLE 1.2-1</u>

ACTIONS:

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. LCO (Limiting Condition for Operation) not met.	A.1 Verify… <u>AND</u> A.2 Restore…	

In this example the logical connector <u>AND</u> is used to indicate that when in Condition A, both Required Actions A.1 and A.2 must be completed.

(continued)

1.2 Logical Connectors (continued)

EXAMPLES (continued)

EXAMPLE 1.2-2

ACTIONS:

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. LCO not met.	A.1 Stop… OR A.2 A.2.1 Verify… AND A.2.2 A.2.2.1 Reduce… OR A.2.2.2 Perform… OR A.3 Remove…	

This example represents a more complicated use of logical connectors. Required Actions A.1, A.2, and A.3 are alternative choices, only one of which must be performed as indicated by the use of the logical connector OR and the left justified placement. Any one of these three Actions may be chosen. If A.2 is chosen, then both A.2.1 and A.2.2 must be performed as indicated by the logical connector AND. Required Action A.2.2 is met by performing A.2.2.1 or A.2.2.2. The indented position of the logical connector OR indicates that A.2.2.1 and A.2.2.2 are alternative choices, only one of which must be performed.

1.0 USE AND APPLICATION

1.3 Completion Times

PURPOSE

The purpose of this section is to establish the Completion Time convention and to provide guidance for its use.

BACKGROUND

Limiting Conditions for Operation (LCOs) specify the lowest functional capability or performance levels of equipment required for safe operation of the facility. The ACTIONS associated with an LCO state Conditions that typically describe the ways in which the requirements of the LCO are not met. Specified with each stated Condition are Required Action(s) and Completion Times(s).

DESCRIPTION

The Completion Time is the amount of time allowed for completing a Required Action. It is referenced to the time of discovery of a situation (e.g., equipment or variable not within limits) that requires entering an ACTIONS Condition unless otherwise specified, providing the facility is in a specified condition stated in the Applicability of the LCO. Required Actions must be completed prior to the expiration of the specified Completion Time. An ACTIONS Condition remains in effect and the Required Actions apply until the Condition no longer exists or the facility is not within the LCO Applicability.

Once a Condition has been entered, subsequent subsystems, components, or variables expressed in the Condition, discovered to be not within limits, will not result in separate entry into the Condition unless specifically stated. The Required Actions of the Condition continue to apply to each additional failure, with Completion Times based on initial entry into the Condition.

EXAMPLES

The following examples illustrate the use of Completion Times with different types of Conditions and Changing Conditions.

EXAMPLE 1.3-1

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Required Action and associated Completion Time not met.	B.1 Perform Action B.1 AND B.2 Perform Action B.2	12 hours 36 hours

(continued)

1.3 Completion Times (continued)

EXAMPLES (continued)

Condition B has two Required Actions. Each Required Action has its own separate Completion Time. Each Completion Time is referenced to the time that Condition B is entered.

The Required Actions of Condition B are to complete action B.1 within 12 hours AND complete action B.2 within 36 hours. A total of 12 hours is allowed for completing action B.1 and a total of 36 hours (not 48 hours) is allowed for completing action B.2 from the time that Condition B was entered. If action B.1 is completed within 6 hours, the time allowed for completing action B.2 is the next 30 hours because the total time allowed for completing action B.2 is 36 hours.

EXAMPLES

EXAMPLE 1.3-2

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One system not within limit.	A.1 Restore system to within limit.	7 days
B. Required Action and associated Completion Time not met.	B.1 Perform Action B.1. AND B.2 Perform Action B.2.	12 hours 36 hours

When a system is determined to not meet the LCO, Condition A is entered. If the system is not restored within 7 days, Condition B is also entered and the Completion Time clocks for Required Actions B.1 and B.2 start. If the system is restored after Condition B is entered, Condition A and B are exited, and therefore, the Required Actions of Condition B may be terminated.

(continued)

1.3 Completion Times (continued)

EXAMPLES (continued)

EXAMPLE 1.3-3

ACTIONS

---NOTE---

Separate Condition entry is allowed for each component.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. LCO not met.	A.1 Restore compliance with LCO.	4 hours
B. Required Action and associated Completion Time not met.	B.1 Perform Action B.1. AND B.2 Perform Action B.2.	6 hours 12 hours

The Note above the ACTIONS Table is a method of modifying how the Completion Time is tracked. If this method of modifying how the Completion Time is tracked was applicable only to a specific Condition, the Note would appear in that Condition rather than at the top of the ACTIONS Table.

The Note allows Condition A to be entered separately for each component, and Completion Times tracked on a per component basis. When a component is determined to not meet the LCO, Condition A is entered and its Completion Time starts. If subsequent components are determined to not meet the LCO, Condition A is entered for each component and separate Completion Times start and are tracked for each component.

IMMEDIATE COMPLETION TIME

When “Immediately” is used as a Completion Time, the Required Action should be pursued without delay and in a controlled manner.

1.0 USE AND APPLICATION

1.4 Frequency

PURPOSE	The purpose of this section is to define the proper use and application of Frequency requirements
DESCRIPTION	Each Surveillance Requirement (SR) has a specified Frequency in which the Surveillance must be met in order to meet the associated Limiting Condition for Operation (LCO). An understanding of the correct application of the specified Frequency is necessary for compliance with the SR. The "specified Frequency" is referred to throughout this section and each of the Specifications of Section 3.0, Limiting Condition for Operation (LCO) and Surveillance Requirement (SR) Applicability. The "specified Frequency" consists of the requirements of the Frequency column of each SR, as well as certain Notes in the Surveillance column that modify performance requirements. Situations where a Surveillance could be required (i.e., its Frequency could expire), but where it is not possible or not desired that it be performed until sometime after the associated LCO is within its Applicability, represent potential SR 3.0.4 conflicts. To avoid these conflicts, the SR (i.e., the Surveillance or the Frequency) is stated such that it is only "required" when it can be and should be performed. With a SR satisfied, SR 3.0.4 imposes no restriction.

(continued)

1.4 Frequency (continued)

EXAMPLES

The following examples illustrate the various ways that Frequencies are specified:

EXAMPLE 1.4-1

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
Verify pressure within limit.	12 hours

Example 1.4-1 contains the type of SR most often encountered in the Technical Specifications (TS). The Frequency specifies an interval (12 hours) during which the associated Surveillance must be performed at least one time. Performance of the Surveillance initiates the subsequent interval. Although the Frequency is stated as 12 hours, an extension of the time interval to 1.25 times the stated Frequency is allowed by SR 3.0.2 for operational flexibility. The measurement of this interval continues at all times, even when the SR is not required to be met per SR 3.0.1 (such as when the equipment is determined to not meet the LCO, a variable is outside specified limits, or the unit is outside the Applicability of the LCO). If the interval specified by SR 3.0.2 is exceeded while the facility is in a condition specified in the Applicability of the LCO, the LCO is not met in accordance with SR 3.0.1.

If the interval as specified by SR 3.0.2 is exceeded while the facility is not in a condition specified in the Applicability of the LCO for which performance of the SR is required, the Surveillance must be performed within the Frequency requirements of SR 3.0.2 prior to entry into the specified condition. Failure to do so would result in a violation of SR 3.0.4.

(continued)

1.4 Frequency (continued)

EXAMPLES (continued)

EXAMPLE 1.4-2

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
Verify flow is within limits.	Once within 12 hours prior to starting activity AND 24 hours thereafter

Example 1.4-2 has two Frequencies. The first is a one-time performance Frequency, and the second is of the type shown in Example 1.4-1. The logical connector "AND" indicates that both Frequency requirements must be met. Each time the example activity is to be performed, the Surveillance must be performed prior to starting the activity.

The use of "once" indicates a single performance will satisfy the specified Frequency (assuming no other Frequencies are connected by "AND"). This type of Frequency does not qualify for the 25% extension allowed by SR 3.0.2.

"Thereafter" indicates future performances must be established per SR 3.0.2, but only after a specified condition is first met (i.e., the "once" performance in this example). If the specified activity is canceled or not performed, the measurement of both intervals stops. New intervals start upon preparing to restart the specified activity.

(continued)

1.4 Frequency (continued)

EXAMPLES (continued)

EXAMPLE 1.4-3

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
-------------------NOTE-------------------- Not required to be met until 96 hours after verifying the helium leak rate is within limit. --	
Verify EOS DSC vacuum drying pressure is within limit.	Once after verifying the helium leak rate is within limit.

As the Note modifies the required performance of the Surveillance, it is construed to be part of the "specified Frequency." Should the vacuum drying pressure not be met immediately following verification of the helium leak rate while in LOADING OPERATIONS, this Note allows 96 hours to perform the Surveillance. The Surveillance is still considered to be performed within the "specified Frequency."

Once the helium leak rate has been verified to be acceptable, 96 hours, plus the extension allowed by SR 3.0.2, would be allowed for completing the Surveillance for the vacuum drying pressure. If the Surveillance was not performed within this 96 hour interval, there would then be a failure to perform the Surveillance within the specified Frequency, and the provisions of SR 3.0.3 would apply.

2.0 FUNCTIONAL AND OPERATING LIMITS

2.1 Fuel to be Stored in the EOS-37PTH DSC

PHYSICAL PARAMETERS:	
FUEL CLASS	Unconsolidated B&W 15x15, WE 14x14, WE 15x15, WE 17x17, CE 14x14, CE 15x15 and CE 16x16 FUEL CLASS PWR fuel assemblies (with or without CCs) that are enveloped by the fuel assembly design characteristics listed in Table 1.
Number of FUEL ASSEMBLIES with CCs	≤ 37
Maximum Assembly plus CC Weight	1900 lbs
DAMAGED FUEL ASSEMBLIES:	
Number and Location of DAMAGED FUEL Assemblies	Maximum of 8 DAMAGED FUEL Assemblies. Balance may be INTACT FUEL, empty slots, or dummy assemblies. Number and Location of DAMAGED FUEL assemblies are shown in Figures 1F, 1H, 1J, and 1K. The DSC basket cells which store DAMAGED FUEL assemblies are provided with top and bottom end caps.
FAILED FUEL:	
Number and Location of FAILED FUEL	Maximum of 4 FAILED FUEL locations. Balance may be INTACT FUEL assemblies, empty slots, or dummy assemblies. Number and Location of FAILED FUEL assemblies are shown in Figures 1F, 1H, 1J, and 1K. FAILED FUEL shall be stored in a failed fuel canister (FFC).
Maximum Uranium Loadings per FFC for FAILED FUEL	Per Table 2
RECONSTITUTED FUEL ASSEMBLIES:	
• Number of RECONSTITUTED FUEL ASSEMBLIES per DSC	≤ 37
BLENDED LOW ENRICHED URANIUM (BLEU) FUEL Assemblies:	
• Number of BLEU FUEL Assemblies per DSC	≤ 37

(continued)

2.1 Fuel to be Stored in the EOS-37PTH DSC (continued)

<u>THERMAL PARAMETERS:</u>	
Heat Load Zone Configuration and Decay Heat Calculations	Limitations on decay heats are presented in the respective HLZC tables in Figures 1A through 1K. The maximum allowable heat loads may be reduced based on the thermal analysis methodology in the UFSAR. However, the maximum decay heat for each FA shall not exceed the values specified in the aforementioned figures. The licensee is responsible for ensuring that uncertainties in fuel enrichment and burnup are correctly accounted for in the decay heat calculations. For FAs with active fuel length shorter than 144 inches, reduce the maximum heat load per FA in each loading zone of the HLZCs using a scaling factor (SF) as shown below. $q_{Short\ FA} = q_{Bounding\ FA} \cdot SF,$ $SF = \frac{L_{a,Short\ FA}}{L_{a,Bounding\ FA}} \cdot \frac{k_{eff,Short\ FA}}{k_{eff,Bounding\ FA}}.$ Where, k_{eff}= Effective conductivity for FA, q = Decay heat load per assembly defined for each loading zone, L_a= Active fuel length, SF= Scaling factor (SF) for short FAs. The effective conductivity for the shorter FA should be determined using the same methodology documented in the UFSAR. For FAs with active fuel length greater than 144 inches, no scaling is required and the maximum heat loads listed for each HLZC are applicable.
Decay Heat per DSC	≤ 50.0 kW and as specified for the applicable heat load zone configuration

(continued)

2.1 Fuel to be Stored in the EOS-37PTH DSC (continued)

RADIOLOGICAL PARAMETERS:	
Maximum Assembly Average Burnup	62 GWd/MTU
Minimum Cooling Time	For all fuel, minimum cooling time as a function of burnup and enrichment per Table 7B.
Minimum Assembly Average Initial Fuel Enrichment	As specified in Table 7A as a function of assembly average burnup.
Maximum Planar Average Initial Fuel Enrichment	As specified in Table 4 as a function of minimum soluble boron concentration
Minimum B-10 Concentration in Poison Plates	As specified in Table 5
Number and location of LOW-ENRICHED OUTLIER FUEL (LEOF)	≤ 4 LEOF in the peripheral locations. A minimum of three non-LEOFs shall circumferentially separate LEOFs within the peripheral locations. No limitation for LEOF in the inner locations. The peripheral and inner locations are defined in Figure 3.
CONTROL COMPONENTS (CCs)	
Maximum Co-60 equivalent activity for the CCs.	As specified in Table 3

2.0 FUNCTIONAL AND OPERATING LIMITS

2.2 Fuel to be Stored in the EOS-89BTH DSC

PHYSICAL PARAMETERS: FUEL CLASS	INTACT unconsolidated 7x7, 8x8, 9x9, 10x10*,* *and 11x11* FUEL CLASS BWR assemblies (with or without channels) that are enveloped by the fuel assembly design characteristics listed in Table 6.
NUMBER OF INTACT FUEL ASSEMBLIES	≤ 89
Channel Hardware	*Channeled fuel may be stored with or without associated channel hardware.*
Maximum Uranium Loading	198 kg/assembly
Maximum Assembly Weight with a Channel	705 lb
RECONSTITUTED FUEL ASSEMBLIES:	
• *Limits for transfer in the EOS-TC125*	*Per Table 22*
• *Limits for transfer in the EOS-TC108*	*Per Table 23*
BLENDED LOW ENRICHED URANIUM (BLEU) FUEL ASSEMBLIES:	
• Number of BLEU FUEL Assemblies per DSC	≤ 89

(continued)

THERMAL PARAMETERS:	
Maximum Heat Load Configuration (MHLC) and *Decay Heat Calculations*	*Per Figure 2 for transfer in the EOS-TC108.* *Per Figure 11, which specifies maximum allowable heat loads in a six-zone configuration, for transfer in the EOS-TC125.* *Heat load zoning configurations (HLZCs) enveloped by the MHLC in Figure 11 are allowed for transfer in the EOS-TC125 and storage in the EOS-HSM or HSM-MX. Chapter 2, Section 2.4.3.2 of the UFSAR provides the specific HLZCs.* The maximum allowable heat loads may be reduced based on the thermal analysis methodology in the UFSAR. However, the maximum decay heat for each FA shall not exceed the values specified in *Figure 11*. The licensee is responsible for ensuring that uncertainties in fuel enrichment and burnup are correctly accounted for *in the decay heat calculations*. For FAs with active fuel length shorter than 144 inches, reduce the maximum decay heat for each FA in each loading zone of the HLZCs using a scaling factor (SF) as shown below. $q_{Short\ FA} = q_{Bounding\ FA} \cdot SF,$ $SF = \frac{L_{a,Short\ FA}}{L_{a,Bounding\ FA}} \cdot \frac{k_{eff,Short\ FA}}{k_{eff,Bounding\ FA}}.$ Where, k_{eff} = Effective conductivity for FA, q = Decay heat load per assembly defined for each loading zone, L_a = Active fuel length, SF = Scaling factor for short FAs. The effective conductivity for the shorter FA should be determined using the same methodology documented in the UFSAR. For FAs with active fuel length greater than 144 inches, no scaling is required and the maximum heat loads listed for each HLZC are applicable.
Decay Heat per DSC	*≤ 48.2 kW for EOS-TC125* *≤ 41.6 kW for EOS-TC108*

(continued)

RADIOLOGICAL PARAMETERS:	
Maximum Assembly Average Burnup	62 GWd/MTU
Minimum Cooling Time	*As specified as a function of burnup and enrichment per Table 21.* *1.0 year for EOS-TC125* *3.0 years for EOS-TC108; See Figure 2 for additional cooling times for HLZC 2 and 3 transferred in the EOS-TC108.*
Maximum Lattice Average Initial Fuel Enrichment	Per Table 8
Minimum B-10 Concentration in Poison Plates	Per Table 8
Minimum Assembly Average Initial Fuel Enrichment	*As specified in Table 18 as a function of assembly average burnup.*
Number and location of LOW-ENRICHED OUTLIER FUEL (LEOF)	*≤ 4 LEOF in the peripheral locations. A minimum of six non-LEOFs shall circumferentially separate LEOFs within the peripheral locations. No limitation for LEOF in the inner locations. The peripheral and inner locations are defined in Figure 8.*

2.0 FUNCTIONAL AND OPERATING LIMITS

2.3 Fuel to be stored in the 61BTH Type 2 DSC

PHYSICAL PARAMETERS:	
FUEL CLASS	INTACT or DAMAGED or FAILED 7x7, 8x8, 9x9, 10x10 or 11x11 BWR assemblies *(with or without channels)* that are enveloped by the fuel assembly design characteristics listed in Table 13
Number of INTACT FUEL ASSEMBLIES	≤ 61
Channel Hardware	*Chaneled fuel may be stored with or without associated channel hardware.*
Maximum Uranium Loading	198 kg/ assembly
Maximum Assembly Weight with a Channel	705 lbs
DAMAGED FUEL ASSEMBLIES:	
Number and Location of DAMAGED FUEL Assemblies	Maximum of 61 DAMAGED FUEL assemblies as shown in Figure 5. Balance may be INTACT FUEL, empty slots, or dummy assemblies. The DSC basket cells which store DAMAGED FUEL assemblies are provided with top and bottom end caps.
FAILED FUEL:	
Number and Location of FAILED FUEL	Maximum of 4 FAILED FUEL locations as shown in Figure 5 Balance may be INTACT FUEL assemblies, empty slots, or dummy assemblies. FAILED FUEL shall be stored in a failed fuel canister (FFC)
Maximum Uranium Loadings per FFC for FAILED FUEL	Table 14
RECONSTITUTED FUEL ASSEMBLIES:	
• Number of RECONSTITUTED FUEL ASSEMBLIES per DSC	≤ 61
• Maximum number of irradiated stainless steel rods per DSC	120

(continued)

• Maximum number of irradiated stainless steel rods per RECONSTITUTED FUEL ASSEMBLY	10
• Loading restrictions for locations within the basket	Inner and peripheral loading locations are defined in Figure 6. Inner Loading Locations: • RECONSTITUTED FUEL ASSEMBLIES may be loaded in any compartment within the inner locations. Peripheral Loading Locations: • RECONSTITUTED FUEL ASSEMBLIES with ≤ 5 irradiated stainless steel rods per fuel assembly may be loaded into all peripheral locations (i.e., not restricted). • RECONSTITUTED FUEL ASSEMBLIES with > 5 and ≤ 10 irradiated stainless steel rods per fuel assembly shall have at least one fuel assembly that does not contain irradiated stainless steel rods on each peripherally adjacent location (see Figure 7).
<u>BLENDED LOW ENRICHED URANIUM (BLEU) FUEL Assemblies:</u> • Number of BLEU FUEL Assemblies per DSC	≤ 61
THERMAL/RADIOLOGICAL PARAMETERS:	
Heat Load Zone Configuration and Fuel Qualification	Limitations on decay heats are presented in the respective HLZC tables in Figures 4A through 4J.
Maximum Assembly Average Burnup	62 GWd/MTU
Minimum Cooling Time	For all fuel, minimum cooling time as a function of burnup and enrichment per Table 19. For the peripheral fuel of HLZC 2, 4, 5, 6, 7, and 8 only, minimum cooling time as a function of burnup and enrichment per Table 20. The peripheral and inner locations are defined in Figure 6.

(continued)

Minimum Assembly Average Initial Fuel Enrichment	As specified in Table 18 as a function of assembly average burnup.
Decay Heat per DSC	≤ 31.2 kW
Maximum Lattice Average Initial Enrichment	Per Table 9, Table 10, Table 11 or Table 12
Minimum B-10 Concentration in Poison Plates	Per Table 9, Table 10, Table 11 or Table 12
Number and location of LOW-ENRICHED OUTLIER FUEL (LEOF)	≤ 4 LEOF in the peripheral locations. A minimum of five non-LEOFs shall circumferentially separate LEOFs within the peripheral locations. No limitation for LEOF in the inner locations. The peripheral and inner locations are defined in Figure 6.

2.0 FUNCTIONAL OPERATING LIMITS

2.4 Functional and Operating Limits Violations

If any Functional and Operating Limit of 2.1 or 2.2 or 2.3 is violated, the following ACTIONS shall be completed:

2.4.1 The affected fuel assemblies shall be placed in a safe condition.

2.4.2 Within 24 hours, notify the NRC Operations Center.

2.4.3 Within 60 days, submit a special report which describes the cause of the violation and the ACTIONS taken to restore compliance and prevent recurrence.

3.0 LIMITING CONDITION FOR OPERATION (LCO) AND SURVEILLANCE REQUIREMENT (SR) APPLICABILITY

LIMITING CONDITION FOR OPERATION

LCO 3.0.1	LCOs shall be met during specified conditions in the Applicability, except as provided in LCO 3.0.2.
LCO 3.0.2	Upon discovery of a failure to meet an LCO, the Required Actions of the associated Conditions shall be met, except as provided in LCO 3.0.5. If the LCO is met or is no longer applicable prior to expiration of the specified Completion Time(s), completion of the Required Action(s) is not required, unless otherwise stated.
LCO 3.0.3	Not applicable to a spent fuel storage cask.
LCO 3.0.4	When an LCO is not met, entry into a specified condition in the Applicability shall not be made except when the associated ACTIONS to be entered permit continued operation in the specified condition in the Applicability for an unlimited period of time. This Specification shall not prevent changes in specified conditions in the Applicability that are required to comply with ACTIONS, or that are related to the unloading of a DSC. Exceptions to this Specification are stated in the individual Specifications. These exceptions allow entry into specified conditions in the Applicability when the associated ACTIONS to be entered allow operation in the specified condition in the Applicability only for a limited period of time.
LCO 3.0.5	Equipment removed from service or not in service in compliance with ACTIONS may be returned to service under administrative control solely to perform testing required to demonstrate it meets the LCO or that other equipment meets the LCO. This is an exception to LCO 3.0.2 for the system returned to service under administrative control to perform the testing required to demonstrate that the LCO is met.
LCO 3.0.6	Not applicable to a spent fuel storage cask.
LCO 3.0.7	Not applicable to a spent fuel storage cask.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.0.1	SRs shall be met during the specified conditions in the Applicability for individual LCOs, unless otherwise stated in the SR. Failure to meet a Surveillance, whether such failure is experienced during the performance of the Surveillance or between performances of the Surveillance, shall be failure to meet the LCO. Failure to perform a Surveillance within the specified Frequency shall be failure to meet the LCO except as provided in SR 3.0.3. Surveillances do not have to be performed on equipment or variables outside specified limits.
SR 3.0.2	The specified Frequency for each SR is met if the Surveillance is performed within 1.25 times the interval specified in the Frequency, as measured from the previous performance or as measured from the time a specified condition of the Frequency is met. For Frequencies specified as “once,” the above interval extension does not apply. If a Completion Time requires periodic performance on a “once per . . .” basis, the above Frequency extension applies to each performance after the initial performance. Exceptions to this Specification are stated in the individual Specifications.
SR 3.0.3	If it is discovered that a Surveillance was not performed within its specified Frequency, then compliance with the requirement to declare the LCO not met may be delayed, from the time of discovery, up to 24 hours or up to the limit of the specified Frequency, whichever is less. This delay period is permitted to allow performance of the Surveillance. If the Surveillance is not performed within the delay period, the LCO must immediately be declared not met, and the applicable Condition(s) must be entered. When the Surveillance is performed within the delay period and the Surveillance is not met, the LCO must immediately be declared not met, and the applicable Condition(s) must be entered.
SR 3.0.4	Entry into a specified condition in the Applicability of an LCO shall not be made unless the LCO's Surveillances have been met within their specified Frequency. This provision shall not prevent entry into specified conditions in the Applicability that are required to comply with ACTIONS or that are related to the unloading of a DSC.

3.1 DSC Fuel Integrity

3.1.1 Fuel Integrity during Drying

LCO 3.1.1 Medium:

Helium shall be used for cover gas during drainage of bulk water (blowdown or draindown) from the DSC.

Pressure:

The DSC vacuum drying pressure shall be sustained at or below 3 Torr (3 mm Hg) absolute for a period of at least 30 minutes following evacuation.

APPLICABILITY: During LOADING OPERATIONS but before TRANSFER OPERATIONS.

ACTIONS:

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. If the required vacuum drying pressure cannot be obtained.	A.1 A.1.1 Confirm that the vacuum drying system is properly installed. Check and repair the vacuum drying system as necessary. <u>OR</u> A.1.2 Establish helium pressure of at least 0.5 atm and no greater than 15 psig in the DSC. <u>OR</u>	30 days
	A.2 Flood the DSC with spent fuel pool water or water meeting the requirements of LCO 3.2.1, if applicable, submerging all fuel assemblies.	30 days

(continued)

3.1 DSC Fuel Integrity (continued)

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.1	Verify that the DSC vacuum drying pressure is less than or equal to 3 Torr (3 mm Hg) absolute for at least 30 minutes following evacuation.	Once per DSC, after an acceptable NDE of the inner top cover plate to DSC shell weld.

(continued)

3.1 DSC Fuel Integrity (continued)

3.1.2 DSC Helium Backfill Pressure

LCO 3.1.2 DSC helium backfill pressure shall be 2.5 ± 1 psig (stable for 30 minutes after filling) after completion of vacuum drying.

APPLICABILITY: During LOADING OPERATIONS but before TRANSFER OPERATIONS.

ACTIONS:

CONDITION	REQUIRED ACTION	COMPLETION TIME
---------------- NOTE ----------------- Not applicable until SR 3.1.2 is performed. --- A. The required backfill pressure cannot be obtained or stabilized.	A.1 A.1.1 Maintain helium atmosphere in the DSC cavity. AND A.1.2 Confirm, check and repair or replace as necessary the vacuum drying system, helium source and pressure gauge. AND A.1.3 Check and repair, as necessary, the seal weld between the inner top cover plate and the DSC shell. OR A.2 Establish the DSC helium backfill pressure to within the limit. If pressure exceeds the criterion, release a sufficient quantity of helium to lower the DSC cavity pressure within the limit. OR	30 days 30 days

(continued)

3.1 DSC Fuel Integrity (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
	A.3	Flood the DSC with spent fuel pool water or water meeting the requirements of LCO 3.2.1, if applicable, submerging all fuel assemblies.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.2	Verify that the DSC helium backfill pressure is 2.5 ± 1 psig stable for 30 minutes after filling.	Once per DSC, after the completion of SR 3.1.1 requirement.

(continued)

3.1 DSC Fuel Integrity (continued)

3.1.3 Time Limit for Completion of DSC Transfer

LCO 3.1.3 The time to transfer the DSC to the HSM shall be within the limits.

Additionally, if the DSC and HLZC combination result in a time limit for completion of transfer from the table below, the air circulation system shall be assembled and be verified to be operable within 7 days before commencing the TRANSFER OPERATIONS of the loaded DSC.

DSC MODEL	APPLICABLE HLZC	TIME LIMITS (HOURS)
EOS-37PTH	HLZC 1 or 2	*8*$^{(1)}$
EOS-37PTH	HLZC 3	No Limit
EOS-37PTH	HLZC 4-11	8$^{(1)}$
EOS-89BTH	*HLZCs qualified per Figure 11*	*8*$^{(1)}$
EOS-89BTH	*HLZC 2*	*10*$^{(1)(2)}$
EOS-89BTH	*HLZC 3*	*No Limit*$^{(2)}$
61BTH Type 2	HLZC 1, 2, 3, 4, or 9	No limit
61BTH Type 2	5, 6, or 8	23
61BTH Type 2	7 or 10	10

---NOTE---

1. The time limit for completion of a DSC transfer is defined as the time elapsed in hours after the initiation of draining of TC/DSC annulus water until the completion of insertion of the DSC into the HSM. For transfer of an EOS-DSC, 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 *or EOS-89BTH DSC in EOS-TC125 with the maximum allowable heat load of 48.2 kW*. If the maximum heat load of a DSC is less than 50 kW *for EOS-37PTH DSC or 48.2 kW for the EOS-89BTH DSC*, a new time limit can be determined to provide additional time for transfer operations. The calculated time limit shall not be less than the time limit specified in LCO 3.1.3. The calculation should be performed using the same methodology documented in the UFSAR.
2. *HLZC 2 and 3 (shown in Figure 2) time limits apply for the EOS-89BTH transferred in the EOS-TC108 only. If transferring the EOS-89BTH with HLZC 2 or 3 in the EOS-TC125, the limits for Figure 11 apply.*

(continued)

3.1 DSC Fuel Integrity (continued)

APPLICABILITY: During LOADING OPERATIONS AND TRANSFER OPERATIONS.

ACTIONS:

CONDITION	REQUIRED ACTION	COMPLETION TIME
---------------------NOTE ------------------- Not applicable until SR 3.1.3 is performed. ---		
A. The required time limit for completion of a DSC transfer not met.	A.1 If the TC is in the cask handling area in a vertical orientation, remove the TC top cover plate and fill the TC/DSC annulus with clean water. <u>OR</u>	2 hours
	A.2 If the TC is in a horizontal orientation on the transfer skid, initiate air circulation in the TC/DSC annulus by starting one of the redundant blowers. <u>OR</u>	1 hour (1) (2)
	A.3 Return the TC to the cask handling area and follow required action A.1 above.	5 hours (1) (2)

1. For EOS-37PTH and EOS-89BTH DSCs: If Required Action A.2 is initiated, run the blower for a minimum of 8 hours. After the blower is turned off, the time limit for completion of DSC transfer is 4 hours. If Required Action A.2 fails to complete within one hour, follow Required Action A.3 for the time remaining in the original Required Action A.3 completion time of 5 hours. The minimum duration of 8 hours to run the blower and the time limit of 4 hours after the blower is turned off for completion of the transfer operations are determined based on the EOS-37PTH DSC in EOS-TC125 with the maximum allowable heat load of 50 kW *or EOS-89BTH DSC in EOS-TC125 with the maximum allowable heat load of 48.2 kW*. If the maximum heat load of a DSC is less than 50 kW *for EOS-37PTH DSC or 48.2 kW for the EOS-89BTH DSC*, new time limits can be determined to provide additional time for these transfer operations. The calculated time limits shall not be less than 4 hours for completion of transfer operation after the blower is turned off. The calculation should be performed using the same methodology documented in the UFSAR.
2. For 61BTH Type 2 DSC: If Required Action A.2 is initiated, run the blower for a minimum of 8 hours. After the blower is turned off, the time limit for completion of DSC transfer is 4 hours. If Required Action A.2 fails to complete within one hour, follow Required Action A.3 for the time remaining in the original Required Action A.3 completion time of 5 hours. The minimum duration of 8 hours to run the blower and the time limit of 4 hours after the blower is turned off for completion of the transfer operations are determined based on the 61BTH Type 2 DSC in OS197FC-B TC with the maximum allowable heat load of 31.2 kW. If the maximum heat load of a DSC is less than 31.2 kW, new time limits can be determined to provide additional time for these transfer operations. The calculated time limits shall not be less than 4 hours for completion of transfer operation after the blower is turned off. The calculation should be performed using the same methodology documented in the UFSAR.

(continued)

3.1 DSC Fuel Integrity (continued)

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.3	Verify that the time limit for completion of DSC transfer is met.	Once per DSC, after the initiation of draining of TC/DSC annulus water.

3.2 Cask Criticality Control

3.2.1 Soluble Boron Concentration

LCO 3.2.1 The boron concentration of the spent fuel pool water and the water added to the cavity of a loaded EOS-37PTH DSC shall be at least the boron concentration shown in Table 4 for the basket type and fuel enrichment selected.

APPLICABILITY: During LOADING and UNLOADING OPERATIONS with fuel and liquid water in the EOS-37PTH DSC cavity.

ACTIONS:

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Soluble boron concentration limit not met.	A.1 Suspend loading of fuel assemblies into DSC. AND A.2	Immediately
	A.2.1 Add boron and re-sample, and test the concentration until the boron concentration is shown to be at least that required. OR	Immediately
	A.2.2 Remove all fuel assemblies from DSC.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.2.1.1	Verify soluble boron concentration limit in spent fuel pool water and water to be added to the DSC cavity is met using two independent measurements (two samples analyzed by different individuals) for LOADING OPERATIONS.	Within 4 hours before insertion of the first fuel assembly into the DSC. AND Every 48 hours thereafter while the DSC is in the spent fuel pool or until the fuel has been removed from the DSC.
SR 3.2.1.2	Verify soluble boron concentration limit in spent fuel pool water and water to be added to the DSC cavity is met using two independent measurements (two samples analyzed by different individuals) for UNLOADING OPERATIONS.	Once within 4 hours prior to flooding DSC during UNLOADING OPERATIONS. AND Every 48 hours thereafter while the DSC is in the spent fuel pool or until the fuel has been removed from the DSC.

3.3 Radiation Protection

3.3.1 DSC and TRANSFER CASK (TC) Surface Contamination

LCO 3.3.1 — Removable surface contamination on the outer top 1 foot surface of the DSC AND the exterior surfaces of the TC shall not exceed:

a. 2,200 dpm/100 cm^2 from beta and gamma sources; and

b. 220 dpm/100 cm^2 from alpha sources.

APPLICABILITY: During LOADING OPERATIONS

ACTIONS:

-- NOTE --
Separate condition entry is allowed for each DSC and TC.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Top 1 foot exterior surface of the DSC removable surface contamination limits not met.	A.1 Decontaminate the DSC to bring the removable contamination to within limits.	Prior to TRANSFER OPERATIONS
B. TC removable surface contamination limits not met.	B.1 Decontaminate the TC to bring the removable contamination to within limits	Prior to TRANSFER OPERATIONS

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.1.1	Verify that the removable contamination on the top 1 foot exterior surface of the DSC is within limits.	Once, prior to TRANSFER OPERATIONS.
SR 3.3.1.2	Verify by either direct or indirect methods that the removable contamination on the exterior surfaces of the TC is within limits.	Once, prior to TRANSFER OPERATIONS.

4.0 DESIGN FEATURES

The specifications in this section include the design characteristics of special importance to each of the physical barriers and to the maintenance of safety margins in the NUHOMS® EOS System design.

4.1 Site

4.1.1 Site Location

Because this UFSAR is prepared for a general license, a discussion of a site-specific ISFSI location is not applicable.

4.2 Storage System Features

4.2.1 Storage Capacity

The total storage capacity of the ISFSI is governed by the plant-specific license conditions.

4.2.2 Storage Pad

For sites for which soil-structure interaction is considered important, the licensee is to perform site-specific analysis considering the effects of soil-structure interaction. Amplified seismic spectra at the location of the HSM center of gravity (CG) is to be developed based on the soil-structure interaction (SSI) responses. EOS-HSM seismic analysis information is provided in UFSAR Appendix 3.9.4, Section 3.9.4.9.2. HSM-MX seismic analysis information is provided in UFSAR Appendix A.3.9.4, Section A.3.9.4.9.2.

The storage pad location shall have no potential for liquefaction at the site-specific safe shutdown earthquake (SSE) level.

Additional requirements for the pad configuration are provided in Technical Specification 4.5.2.

4.3 Canister Criticality Control

The NUHOMS® EOS-37PTH DSC is designed for the storage of PWR fuel assemblies with a maximum planar average initial enrichment of less than or equal to 5.0 wt. % U-235 taking credit for soluble boron during LOADING OPERATIONS and the boron content in the poison plates of the DSC basket. The EOS-37PTH DSC uses a boron carbide/aluminum metal matrix composite (MMC) poison plate material. The EOS-37PTH DSC has two different neutron poison loading options, A and B, based on the boron content in the poison plates as listed in Table 5. Table 4 also defines the requirements for boron concentration in the DSC cavity water as a function of the DSC basket type for the various FUEL CLASSES authorized for storage in the EOS-37PTH DSC.

The NUHOMS® EOS-89BTH DSC is designed for the storage of BWR fuel assemblies with a maximum lattice average initial enrichment of less than or equal to *5.00* wt. % U-235 taking credit for the boron content in the poison plates of the DSC basket. There are three neutron poison loading options specified for the EOS-89BTH DSC depending on the type of poison material and the B-10 areal density in the plates, as specified in Table 8.

(continued)

4.0 Design Features (continued)

The 61BTH Type 2 DSC is designed for the storage of BWR fuel assemblies with a maximum lattice average initial enrichment of less than or equal to 5.0 wt. % U-235 taking credit for the boron content in the poison plates of the DSC basket. The 61BTH Type 2 DSC has multiple basket configurations based on the absorber material type (borated aluminum alloy, metal matrix composite (MMC), or Boral®) and boron content in the absorber plates as listed in Table 9 through Table 12.

4.3.1 Neutron Absorber Tests

The neutron absorber used for criticality control in the DSC baskets may be one of the following materials:

- Boron carbide/MMC
- BORAL® (EOS-89BTH or 61BTH Type 2 DSCs only)
- Borated aluminum (61BTH Type 2 DSC only)

Acceptance Testing (MMC, BORAL®, and borated aluminum)

B-10 areal density is verified by neutron attenuation testing or by chemical analysis of coupons taken adjacent to finished panels, and isotopic analysis of the boron carbide powder. The minimum B-10 areal density requirements are specified in Table 5 for EOS-37PTH, Table 8 for EOS-89BTH, and Table 9 through Table 12 for 61BTH Type 2 DSCs.

Finished panels are subject to visual and dimensional inspection.

Qualification Testing (MMC only)

MMCs are qualified for use in the NUHOMS® EOS System by verification of the following characteristics.

- The chemical composition is boron carbide particles in an aluminum alloy matrix.
- The form is with or without an aluminum skin.
- The median boron carbide particle size by volume is ≤ 80 microns with no more than 10% over 100 microns.
- The boron carbide content is ≤ 50% by volume.
- The porosity is ≤ 3%.

4.3.2 High Strength Low Alloy Steel for Basket Structure for EOS-37PTH and EOS-89BTH DSCs.

The basket structural material shall be a high strength low alloy (HSLA) steel meeting one of the following requirements A, B, or C:

A. ASTM A829 Gr 4130 or AMS 6345 SAE 4130, quenched and tempered at not less than 1050°F, 103.6 ksi minimum yield strength and 123.1 ksi minimum ultimate strength at room temperature.

B. ASME SA-517 Gr A, B, E, F, or P.

(continued)

4.0 Design Features (continued)

C. Other HSLA steel, with the specified heat treatment, meeting these qualification and acceptance criteria:

i. If quenched and tempered, the tempering temperature shall be at no less than 1000 °F,

ii. Qualified prior to first use by testing at least two lots and demonstrating that the fracture toughness value K_{JIc} ≥ 150 ksi √in at ≤ -40 °F with 95% confidence.

iii. Qualified prior to first use by testing at least two lots and demonstrating that the 95% lower tolerance limit of yield strength and ultimate strength ≥ the values in UFSAR Table 8-10.

iv. Meet production acceptance criteria based on the 95% lower tolerance limit of yield strength and ultimate strength at room temperature as determined by qualification testing described in Section 4.3.2.C.iii.

The basket structural material shall also meet one of the following production acceptance criteria for impact testing at ≤ -40 °F:

a. Charpy testing per ASTM A370, minimum absorbed energy 25 ft-lb average, 20 ft-lb lowest of three (for sub-size specimens, reduce these criteria per ASTM A370-17 Table 9), or

b. Dynamic tear testing per ASTM E604 with acceptance criterion minimum 80% shear fracture appearance.

4.4 Codes and Standards

4.4.1 HORIZONTAL STORAGE MODULE (HSM)

The reinforced concrete HSM is designed in accordance with the provisions of ACI 349-06. Code alternatives are discussed in Technical Specification 4.4.4. Load combinations specified in ANSI 57.9-1984, Section 6.17.3.1 are used for combining normal operating, off-normal, and accident loads for the HSM.

4.4.2 DRY SHIELDED CANISTER (DSC) (EOS-37PTH, EOS-89BTH, and 61BTH Type 2)

The DSC confinement boundary is designed, fabricated and inspected to the maximum practical extent in accordance with ASME Boiler and Pressure Vessel Code Section III, Division 1, Subsection NB, NF, and NG, for Class 1 components. The ASME code edition years and any addenda for the various DSC types and relevant subsections are provided in the table below. Code alternatives are discussed in Technical Specification 4.4.4.

DSC Type	Applicable Code	Edition/Year
EOS-37PTH, EOS-89BTH	ASME B&PV Code, Section III, Division 1, Subsection NB	2010 Edition with Addenda through 2011
61BTH Type 2	ASME B&PV Code, Section III, Division 1, Subsections NB, NG and NF	1998 Edition with Addenda through 2000

(continued)

4.0 Design Features (continued)

4.4.3 TRANSFER CASK

The EOS-TC design stress analysis and OS197 design stress analysis and fabrication, exclusive of the trunnions and the neutron shield enclosures, is performed in accordance with applicable codes as provided in the table below. The stress allowables for the upper trunnions for the EOS-TCs and the upper and lower trunnions for the OS197 conform to ANSI N14.6-1993 for single-failure-proof lifting.

TC	**Applicable Code**	**Edition/Year**
EOS-TC	ASME B&PV Code, Section III, Division 1, Subsection NF for Class 1 supports	2010 Edition with Addenda through 2011
OS197	ASME B&PV Code, Section III, Division 1, Subsection NC for Class 2 vessels	1983 Edition with Winter 1985 Addenda

4.4.4 Alternatives to Codes and Standards

ASME Code alternatives for the EOS-37PTH, EOS-89BTH DSC, and 61BTH Type 2 DSC are listed below:

(continued)

4.0 Design Features (continued)

EOS-37PTH and EOS-89BTH DSC ASME Code Alternatives, Subsection NB

REFERENCE ASME CODE SECTION/ARTICLE	CODE REQUIREMENT	JUSTIFICATION AND COMPENSATORY MEASURES
NCA	All	Not compliant with NCA
NB-1100	Requirements for Code Stamping of Components	The canister shell, the inner top cover, the inner bottom cover or bottom forging assembly, the outer top cover, and the drain port cover and vent port plug are designed and fabricated in accordance with the ASME Code, Section III, Subsection NB to the maximum extent practical. However, Code Stamping is not required. As Code Stamping is not required, the fabricator is not required to hold an ASME "N" or "NPT" stamp, or to be ASME Certified.
NB-2121	Permitted Material Specifications	Type 2205 and UNS S31803 are duplex stainless steels that provide enhance resistance to chloride-induced stress corrosion cracking. They are not included in Section II, Part D, Subpart 1, Tables 2A and 2B. UNS S31803 has been accepted for Class 1 components by ASME Code Case N-635-1, endorsed by NRC Regulatory Guide 1.84. Type 2205 falls within the chemical and mechanical requirements of UNS S31803. Normal and off-normal temperatures remain below the 600 °F operating limit. Accident conditions may exceed this limit, but only for durations too short to cause embrittlement.
NB-2130 NB-4121	Material must be supplied by ASME approved material suppliers Material Certification by Certificate Holder	Material is certified to meet all ASME Code criteria but is not eligible for certification or Code Stamping if a non-ASME fabricator is used. As the fabricator is not required to be ASME certified, material certification to NB-2130 is not possible. Material traceability and certification are maintained in accordance with the NRC approved QA program associated with CoC 1042.
NB-2300	Fracture toughness requirements for material	Type 2205 and UNS S31803 duplex stainless steels are tested by Charpy V-notch only per NB-2300. Drop weight tests are not required. Impact testing is not required for the vent port plug.
NB-2531	Drain port cover; straight beam ultrasonic testing (UT) per SA-578 for all plates for vessel	SA-578 applies to 3/8" and thicker plate only; allow alternate UT techniques to achieve meaningful UT results.
NB- 2531 and NB-2541	Vent port plug UT and liquid penetrant testing (PT)	This plug may be made from plate or bar. Due to its small area, it has no structural function. It is leak tested along with the inner top cover plate after welding. Therefore, neither UT nor PT are required.

(continued)

4.0 Design Features (continued)

EOS-37PTH and EOS-89BTH DSC ASME Code Alternatives, Subsection NB

(continued)

REFERENCE ASME CODE SECTION/ARTICLE	CODE REQUIREMENT	JUSTIFICATION AND COMPENSATORY MEASURES
NB-4243 and NB-5230	*Category C weld joints in vessels and similar weld joints in other components shall be full penetration joints. These welds shall be examined by UT or radiographic testing (RT) and either PT or magnetic particle testing (MT).*	*The shell to the outer top cover plate (OTCP) weld, the shell to the inner top cover weld, and the drain port cover and vent port plug welds are all partial penetration welds. The cover-to-shell welds are designed to meet the guidance provided in NUREG-1536, Revision 1 for the stress reduction factor. Nondestructive examination (NDE) is done by qualified personnel, in accordance with Section V and the acceptance standards of Section III, Subsection NB-5000, except as noted for OTCP weld option 2 ultrasonic examination.* *As an alternative to the NDE requirements of NB-5230 for Category C welds, all of these closure welds will be multi-layer welds and receive a root and final PT examination, except for the shell to the OTCP weld.* *<u>OTCP weld option 1</u>* *The shell to OTCP weld will be a multi-layer weld and receive multi-level PT examination in accordance with the guidance provided in NUREG 1536 Revision 1 for NDE. The multi-level PT examination provides reasonable assurance that flaws of interest will be identified.* *<u>OTCP weld option 2</u>* *The shell to the outer top cover plate weld will be examined by UT.*
NB-5330	*Ultrasonic Acceptance Standards*	*The UT acceptance criteria for OTCP weld option 2 are:* *1. Rounded flaws are evaluated by the acceptance criteria of NB-5331(a).* *2. Planar flaws are allowable up to the limit $(W - \Sigma hi) \geq D$ at any location, where Σhi is the sum of the depth of aligned planar defects, W is the measured weld thickness, and D is the minimum weld depth required by NB-3000.* *3. Planar flaws that penetrate the surface of the weld are not allowable.*
NB-5520	NDE Personnel must be qualified to the *2006* edition of SNT-TC-1A	Permit use of the Recommended Practice SNT-TC-1A up to the edition as *cited in Table NCA-7000-1 of the latest ASME Code edition listed in 10 CFR 50.55a at the time of construction.*

(continued)

All Indicated Changes are in response to RSI 10-1

4.0 Design Features (continued)

EOS-37PTH and EOS-89BTH DSC ASME Code Alternatives, Subsection NB

(continued)

REFERENCE ASME CODE SECTION/ARTICLE	CODE REQUIREMENT	JUSTIFICATION AND COMPENSATORY MEASURES
NB-6000	All completed pressure retaining systems shall be pressure tested	The DSC is not a complete or "installed" pressure vessel until the top closure is welded following placement of fuel assemblies within the DSC. Due to the inaccessibility of the shell and lower end closure welds following fuel loading and top closure welding, as an alternative, the pressure testing of the DSC is performed in two parts. The DSC shell, shell bottom, including all longitudinal and circumferential welds, is pneumatically tested and examined at the fabrication facility *when using the three plate bottom assembly. If using a single piece bottom forging, the fabrication leak test may be waived. The low test pressure test does not stress a single piece bottom and bottom-to-shell weld sufficiently to cause pre-existing defects to propagate into leaks. For the purpose of finding leaks, the helium leak test is far more sensitive than the pressure test.* The shell to the inner top cover closure weld is pressure tested and examined for leakage in accordance with NB-6300 in the field. The drain port cover and vent port plug welds will not be pressure tested; these welds and the shell to the inner top cover closure weld are helium leak tested after the pressure test. Per NB-6324 the examination for leakage shall be done at a pressure equal to the greater of the design pressure or three-fourths of the test pressure. As an alternative, if the examination for leakage of these field welds, following the pressure test, is performed using helium leak detection techniques, the examination pressure may be reduced to 1.5 psig. This is acceptable given the significantly greater sensitivity of the helium leak detection method.
NB-7000	Overpressure Protection	No overpressure protection is provided for the EOS-37PTH or EOS-89BTH DSC. The function of the DSC is to contain radioactive materials under normal, off-normal, and hypothetical accident conditions postulated to occur during transportation. The DSC is designed to withstand the maximum internal pressure considering 100% fuel rod failure at maximum accident temperature.

(continued)

4.0 Design Features (continued)

EOS-37PTH and EOS-89BTH DSC ASME Code Alternatives, Subsection NB

(continued)

NB-8000	Requirements for nameplates, stamping and reports per NCA-8000	The EOS-37PTH and EOS-89BTH DSC are stamped or engraved with the information required by 10 CFR Part 72. Code stamping is not required for these DSCs. QA Data packages are prepared in accordance with requirements of the NRC approved QA program associated with CoC 1042.

(continued)

4.0 Design Features (continued)

61BTH Type 2 DSC ASME Code Alternatives for the Confinement Boundary

REFERENCE ASME CODE SECTION/ ARTICLE	CODE REQUIREMENT	ALTERNATIVES, JUSTIFICATION & COMPENSATORY MEASURES
NCA	All	Not compliant with NCA. Quality Assurance is provided according to 10 CFR Part 72 Subpart G in lieu of NCA-4000.
NCA-1140	Use of Code editions and addenda	Code edition and addenda other than those specified in Section 4.4.2 may be used for construction, but in no case earlier than 3 years before that specified in the Section 4.4.2 table. Materials produced and certified in accordance with ASME Section II material specification from Code Editions and Addenda other than those specified in Section 4.4.2 may be used, so long as the materials meet all the requirements of Article 2000 of the applicable Subsection of the Section III Edition and Addenda used for construction.
NB-1100	Requirements for Code Stamping of Components, Code reports and certificates, etc.	Code Stamping is not required. As Code Stamping is not required, the fabricator is not required to hold an ASME "N" or "NPT" stamp, or to be ASME Certified.
NB-1132	Attachments with a pressure retaining function, including stiffeners, shall be considered part of the component.	Bottom shield plug and outer bottom cover plate are outside code jurisdiction; these components together are much larger than required to provide stiffening for the inner bottom cover plate; the weld that retains the outer bottom cover plate and with it the bottom shield plug is subject to root and final PT examination.
NB-2130	Material must be supplied by ASME approved material suppliers.	Material is certified to meet all ASME Code criteria but is not eligible for certification or Code Stamping if a non-ASME fabricator is used. As the fabricator is not required to be ASME certified, material certification to NB-2130 is not possible. Material traceability and certification are maintained in accordance with TN's NRC approved QA program.
NB-4121	Material Certification by Certificate Holder	
NB-4243 and NB-5230	Category C weld joints in vessels and similar weld joints in other components shall be full penetration joints. These welds shall be examined by UT or RT and either PT or MT.	The shell to the outer top cover weld, the shell to the inner top cover weld, the siphon and vent cover plate welds, and the vent and siphon block welds to the shell are all partial penetration welds. As an alternative to the NDE requirements of NB-5230 for Category C welds, all of these closure welds will be multi-layer welds and receive a root and final PT examination, except for the shell to the outer top cover weld. The shell to the outer top cover weld will be a multi-layer weld and receive multi-level PT examination in accordance with the guidance provided in NUREG-1536 Revision 1 for NDE. The multi-level PT Examination provides reasonable assurance that flaws of interest will be identified. The PT examination is done by qualified personnel, in accordance with Section V and the acceptance standards of Section III, Subsection NB-5000. All of these welds will be designed to meet the guidance provided in NUREG-1536 Revision 1 for stress reduction factor.

(continued)

4.0 Design Features (continued)

61BTH Type 2 DSC ASME Code Alternatives for the Confinement Boundary

REFERENCE ASME CODE SECTION/ ARTICLE	CODE REQUIREMENT	ALTERNATIVES, JUSTIFICATION & COMPENSATORY MEASURES
NB-6100 and 6200	All completed pressure retaining systems shall be pressure tested.	The 61BTH Type 2 DSC is not a complete or “installed” pressure vessel until the top closure is welded following placement of Fuel Assemblies with the DSC. Due to the inaccessibility of the shell and lower end closure welds following fuel loading and top closure welding, as an alternative, the pressure testing of the DSC is performed in two parts. The DSC shell and shell bottom (including all longitudinal and circumferential welds) is pressure tested and examined at the fabrication facility. The shell to the inner top cover closure weld are pressure tested and examined for leakage in accordance with NB-6300 in the field. The siphon/vent cover welds are not pressure tested; these welds and the shell to the inner top cover closure weld are helium leak tested after the pressure test. Per NB-6324, the examination for leakage shall be done at a pressure equal to the greater of the design pressure or three-fourths of the test pressure. As an alternative, if the examination for leakage of these field welds, following the pressure test, is performed using helium leak detection techniques, the examination pressure may be reduced to ≥ 1.5 psig. This is acceptable given the significantly greater sensitivity of the helium leak detection method.
NB-7000	Overpressure Protection	No overpressure protection is provided for the NUHOMS® DSCs. The function of the DSC is to contain radioactive materials under normal, off-normal and hypothetical accident conditions postulated to occur during transportation and storage. The DSC is designed to withstand the maximum possible internal pressure considering 100% fuel rod failure at maximum accident temperature.
NB-8000	Requirements for nameplates, stamping & reports per NCA-8000.	The NUHOMS® DSC nameplate provides the information required by 10 CFR Part 71, 49 CFR Part 173 and 10 CFR Part 72 as appropriate. Code stamping is not required for the DSC. QA data packages are prepared in accordance with the requirements of TN’s approved QA program.
NB-5520	NDE personnel must be qualified to a specific edition of SNT-TC-1A.	Permit use of the Recommended Practice SNT-TC-1A to include up to the most recent 2011 edition.

(continued)

4.0 Design Features (continued)

61BTH Type 2 DSC ASME Code Alternatives for the Basket

REFERENCE ASME CODE SECTION/ ARTICLE	CODE REQUIREMENT	ALTERNATIVES, JUSTIFICATION & COMPENSATORY MEASURES
NCA	All	Not compliant with NCA. Quality Assurance is provided according to 10 CFR Part 72 Subpart G in lieu of NCA-4000.
NCA-1140	Use of Code editions and addenda	Code edition and addenda other than those specified in Section 4.4.2 may be used for construction, but in no case earlier than 3 years before that specified in the Section 4.4.2 table. Materials produced and certified in accordance with ASME Section II material specification from Code Editions and Addenda other than those specified in Section 4.4.2 may be used, so long as the materials meet all the requirements of Article 2000 of the applicable Subsection of the Section III Edition and Addenda used for construction.
NG/NF-1100	Requirements for Code Stamping of Components, Code reports and certificates, etc.	Code Stamping is not required. As Code Stamping is not required, the fabricator is not required to hold an ASME “N” or “NPT” stamp, or to be ASME Certified.
NG/NF-2000	Use of ASME Material	Some baskets include neutron absorber and aluminum plates that are not ASME Code Class 1 material. They are used for criticality safety and heat transfer, and are only credited in the structural analysis with supporting their own weight and transmitting bearing loads through their thickness. Material properties in the ASME Code for Type 6061 aluminum are limited to 400 °F to preclude the potential for annealing out the hardening properties. Annealed properties (as published by the Aluminum Association and the American Society of Metals) are conservatively assumed for the aluminum transition rails for use above the Code temperature limits.
NG/NF-2130	Material must be supplied by ASME approved material suppliers.	Material is certified to meet all ASME Code criteria but is not eligible for certification or Code Stamping if a non-ASME fabricator is used. As the fabricator is not required to be ASME certified, material certification to NG/NF-2130 is not possible. Material traceability and certification are maintained in accordance with TN’s NRC approved QA program.
NG/NF-4121	Material Certification by Certificate Holder	
NG-3352	Table NG-3352-1 lists the permissible welded joints and quality factors.	The fuel compartment tubes may be fabricated from sheet with full penetration seam weldments. Per Table NG-3352-1, a joint efficiency (quality) factor of 0.5 is to be used for full penetration weldments examined in accordance with ASME Section V visual examination (VT). A joint efficiency (quality) factor of 1.0 is utilized for the fuel compartment longitudinal seam welds (if present) with VT examination. This is justified because the compartment seam weld is thin and the weldment is made in one pass; and both surfaces of the weldment (inside and outside) receive 100% VT examination. The 0.5 quality factor, applicable to each surface of the weldment, results is a quality factor of 1.0 since both surfaces are 100% examined. In addition, the fuel compartments have no pressure retaining function and the stainless steel material that comprises the fuel compartment tubes is very ductile.
NG/NF-8000	Requirements for nameplates, stamping & reports per NCA-8000.	The NUHOMS® DSC nameplate provides the information required by 10 CFR Part 71, 49 CFR Part 173 and 10 CFR Part 72 as appropriate. Code stamping is not required for the DSC. QA data packages are prepared in accordance with the requirements of TN’s approved QA program.
NG/NF-5520	NDE personnel must be qualified to a specific edition of SNT-TC-1A.	Permit use of the Recommended Practice SNT-TC-1A to include up to the most recent 2011 edition.

(continued)

4.0 Design Features (continued)

Code alternatives for the HSM concrete specifications are listed below:

REFERENCE ACI349-06 SECTION/ARTICLE	CODE REQUIREMENT	ALTERNATIVES, JUSTIFICATION AND COMPENSATORY MEASURES
Appendix E, Section E.4-Concrete Temperatures, Paragraph E.4.3	Paragraph E.4.3 requires testing of concrete for temperatures higher than those given in Paragraph E.4.1.	The concrete temperature limit criteria in NUREG-1536, Section 8.4.14.2 is used for normal and off-normal conditions. Alternatively, per ACI 349-13, Code Requirements for Nuclear Safety-Related Concrete Structures and Commentary, Section RE.4, the specified compressive strength, which may be tested up to 56 days, is increased to 7,000 psi for HSM fabrication so that any losses in properties (e.g., compressive strength) resulting from long-term thermal exposure will not affect the safety margins based on the specified 5,000 psi compressive strength used in the design calculations. Additionally, also as indicated in Section RE.4, short, randomly oriented steel fibers may be used to provide increased ductility, dynamic strength, toughness, tensile strength, and improved resistance to spalling. The safety margin on compressive strength is 40% for a concrete temperature limit of 300 °F normal and off-normal conditions.

Proposed alternatives to the above-specified ASME and ACI codes, other than the aforementioned alternatives, may be used when authorized by the Director of the Office of Nuclear Material Safety and Safeguards, or designee. The applicant should demonstrate that:

1. The proposed alternatives would provide an acceptable level of quality and safety, or
2. Compliance with the specified requirements of above-specified ASME and ACI codes would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The applicant should also submit information regarding the environmental impact of such a request to support the NRC's NEPA regulations in 10 CFR Part 51. Any proposed alternatives must be submitted and approved prior to implementation.

Requests for exceptions in accordance with this section should be submitted in accordance with 10 CFR 72.4.

(continued)

4.0 Design Features (continued)

4.5 Storage Location Design Features

The following storage location design features and parameters shall be verified by the system user to assure technical agreement with the UFSAR.

4.5.1 Storage Configuration

EOS-HSMs and HSM-MXs are placed together in single rows or back to back arrays. A rear shield wall is placed on the rear of any single row loaded EOS-HSM.

4.5.2 Concrete Storage Pad Properties to Limit DSC Gravitational Loadings Due to Postulated Drops

The EOS-37PTH DSC and EOS-89BTH DSC have been evaluated for drops of up to 65 inches onto a reinforced concrete storage pad. The 61BTH Type 2 DSC has been evaluated for drops of up to 80 inches onto a reinforced concrete storage pad.

4.5.3 Site Specific Parameters and Analyses

The following parameters and analyses are applicable to all HSMs unless specifically noted and shall be verified by the system user for applicability at their specific site. Other natural phenomena events, such as lightning, tsunamis, hurricanes, and seiches, are site specific and their effects are generally bounded by other events, but they should be evaluated by the user.

1. Flood levels up to 50 ft and water velocity of 15 fps.
2. One-hundred year roof snow load of 110 psf.
3. Normal ambient temperature is based on the heat load of the DSC as follows:

   For the EOS-HSM:

   a. For the EOS-37PTH DSCs with a heat load less than or equal to 41.8 kW or for the EOS-89BTH DSCs with a heat load less than or equal to 41.6 kW, the minimum temperature is -20 °F. The maximum calculated normal average ambient temperature corresponding to a 24-hour period is 90 °F.
   b. For the EOS-37PTH DSCs with a heat load greater than 41.8 kW or for the EOS-89BTH DSCs with a heat load greater than 41.6 kW, the minimum temperature is -20 °F. The maximum calculated average yearly temperature is 70 °F.

   For the HSM-MX:

   c. The minimum temperature is -20 °F. The maximum calculated normal average ambient temperature corresponding to a 24-hour period is 90 °F.
4. Off-normal ambient temperature range of -40 °F without solar insolation to 117 °F with full solar insolation. The 117 °F off-normal ambient temperature corresponds to a 24-hour calculated average temperature of 103 °F.

(continued)

4.0 Design Features (continued)

5. The response spectra at the base of the HSMs shall be compared against the response spectra defined in UFSAR Section 2.3.4 for the EOS-HSM, and Section A.2.3.4 for the HSM-MX and shown to be enveloped by the UFSAR response spectra. If it is not enveloped, stability can be demonstrated by either static or dynamic analysis.
6. The potential for fires and explosions shall be addressed, based on site-specific considerations.
7. Supplemental Shielding: In cases where engineered features (i.e., berms, shield walls) are used to ensure that the requirements of 10 CFR 72.104(a) are met, such features are to be considered important to safety and must be evaluated to determine the applicable Quality Assurance Category.
8. If an INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI) site is located in a coastal salt water marine atmosphere, then any load-bearing carbon steel DSC support structure rail components for the EOS-HSM, or front and rear DSC supports for the HSM-MX shall be procured with a minimum 0.20% copper content or stainless steel shall be used for corrosion resistance. For weld filler material used with carbon steel, 1% or more nickel bearing weld material would also be acceptable in lieu of 0.20% copper content.
9. If an ISFSI site is required to evaluate blockage of air vents for durations longer than evaluated in the UFSAR, a new duration can be determined based on site-specific parameters. The evaluation should be performed using the same methodology documented in the UFSAR.

5.0 ADMINISTRATIVE CONTROLS

5.1 Programs

Each user of the NUHOMS® EOS System will implement the following programs to ensure the safe operation and maintenance of the ISFSI:

- Radiological Environmental Monitoring Program (see 5.1.1 below)
- Radiation Protection Program (see 5.1.2 below)
- HSM Thermal Monitoring Program (see 5.1.3 below)

5.1.1 Radiological Environmental Monitoring Program

a. A radiological environmental monitoring program will be implemented to ensure that the annual dose equivalent to an individual located outside the ISFSI controlled area does not exceed the annual dose limits specified in 10 CFR 72.104(a).

b. Operation of the ISFSI will not create any radioactive materials or result in any credible liquid or gaseous effluent release.

5.1.2 Radiation Protection Program

The Radiation Protection Program will establish administrative controls to limit personnel exposure to As Low As Reasonably Achievable (ALARA) levels in accordance with 10 CFR Part 20 and Part 72.

a. As part of its evaluation pursuant to 10 CFR 72.212, the licensee shall perform an analysis to confirm that the limits of 10 CFR Part 20 and 10 CFR 72.104 will be satisfied under the actual site conditions and configurations considering the planned number of DSCs to be used and the planned fuel loading conditions. This analysis is also used to qualify fuel considered for loading, as outlined below:

   1. For the DSCs considered for loading, select HLZC(s) appropriate to store the spent fuel.
   2. Compute the decay heat of the fuel assemblies considered for loading. Methods include, but are not limited to, NRC Regulatory Guide 3.54, or the methodology described in the UFSAR (i.e., ORIGEN-ARP).
   3. Compute the source term for the fuel assemblies considered for loading. The design basis source terms provided in the UFSAR may be used for site-specific shielding analysis if they are shown to bound the site-specific source terms.
   4. Demonstrate computationally that the EOS-HSM or HSM-MX to be loaded meets the dose rate requirements of TS 5.1.2(c). This evaluation may be used as the basis for the dose rate limits established in TS 5.1.2(b).
   5. Demonstrate computationally that direct radiation from the ISFSI meets the requirements of 72.104.

(continued)

5.0 ADMINISTRATIVE CONTROLS (continued)

b. On the basis of the analysis in TS 5.1.2(a), the licensee shall establish a set of HSM dose rate limits which are to be applied to DSCs used at the site. Limits shall establish dose rates for:

i. HSM front face,

ii. HSM door centerline, and

iii. End shield wall exterior for the EOS-HSM or exterior side wall of the HSM-MX monolith.

c. Notwithstanding the limits established in TS 5.1.2(b), the dose rate limits may not exceed the following values as calculated for a content of design basis fuel as follows:

For EOS-HSM:

i. *65* mrem/hr average over the front face,

ii. *15* mrem/hr at the door centerline, and

iii. 5 mrem/hr average at the end shield wall exterior.

For HSM-MX:

i. *165* mrem/hr average over the front face,

ii. *15* mrem/hr at the door centerline, and

iii. 5 mrem/hr average at the exterior side wall of the HSM-MX monolith.

If the measured dose rates do not meet the limits of TS 5.1.2(b) or TS 5.1.2(c), whichever are lower, the licensee shall take the following actions:

- Notify the U.S. Nuclear Regulatory Commission (Director of the Office of Nuclear Material Safety and Safeguards) within 30 days,
- Administratively verify that the correct fuel was loaded,
- Ensure proper installation of the HSM door,
- Ensure that the DSC is properly positioned on the DSC supports, and
- Perform an analysis to determine that placement of the as-loaded DSC at the ISFSI will not cause the ISFSI to exceed the radiation exposure limits of 10 CFR Part 20 and 10 CFR Part 72 and/or provide additional shielding to assure exposure limits are not exceeded.

d. A monitoring program to ensure the annual dose equivalent to any real individual located outside the ISFSI controlled area does not exceed regulatory limits is incorporated as part of the environmental monitoring program in the Radiological Environmental Monitoring Program of TS 5.1.1.

(continued)

5.0 ADMINISTRATIVE CONTROLS (continued)

e. When using the EOS-TC108 with a liquid neutron shield (NS), the NS shall be verified to be filled when DSC cavity draining or TC/DSC annulus draining operations are initiated and continually monitored during the first five minutes of the draining evolution to ensure the NS remains filled. The NS shall also be verified to be filled prior to the movement of the loaded TC from the decontamination area. Observation of water level in the expansion tank or some other means can be used to verify compliance with this requirement.

f. Following completion of the DSC shell assembly at the fabricator facility, the inner bottom cover plate, canister shell and all associated welds are leak-tested to demonstrate that these welds and components meet the “leak-tight” criterion ($\leq 1.0 \times 10^{-7}$ reference cm^3/sec) as defined in “American National Standard for Radioactive Materials – Leakage Tests on Packages for Shipment”, ANSI N14.5-1997. If the leakage rate exceeds 1.0×10^{-7} reference cm^3/sec, check and repair these welds or components.

Following completion of the welding of the DSC shell to the inner top cover and drain port cover and vent plug after fuel loading, these welds and components are leak-tested to demonstrate that they meet the “leak-tight” criterion ($\leq 1.0 \times 10^{-7}$ reference cm^3/sec) as defined in “American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment”, ANSI N14.5-1997. If the leakage rate exceeds 1.0×10^{-7} reference cm^3/sec, check and repair these welds or components.

5.1.3 HSM Thermal Monitoring Program

Two separate programs for the EOS-HSM and MATRIX HSM are described in Technical Specifications 5.1.3.1 and 5.1.3.2, respectively.

(continued)

5.0 ADMINISTRATIVE CONTROLS (continued)

5.1.3.1 EOS-HSM Thermal Monitoring Program

This program provides guidance for temperature measurements that are used to monitor the thermal performance of each EOS-HSM. The intent of the program is to prevent conditions that could lead to exceeding the concrete and fuel clad temperature criteria. Each user must implement either TS 5.1.3.1(a) OR 5.1.3.1(b).

a. Daily Visual Inspection of EOS-HSM Inlets and Outlets (Front Wall and Roof Birdscreens) and Wind Deflectors

   i. The user shall develop and implement procedures to perform visual inspection of EOS-HSM inlets and outlets on a daily basis.

   Perform a daily visual inspection of the air vents to ensure that EOS-HSM air vents are not blocked for more than 40 hours. If visual inspection indicates blockage, clear air vents and replace or repair birdscreens if damaged. If the air vents are blocked or could have been blocked for more than 40 hours, evaluate existing conditions in accordance with the site corrective action program to confirm that conditions adversely affecting the concrete or fuel cladding do not exist.

   ii. Daily Visual Inspection of Wind Deflectors

   If wind deflectors are required per TS 5.5, the user shall develop and implement procedures to perform visual inspection of the wind deflectors on a daily basis.

   There is a possibility that the wind deflectors could become damaged or lost by extreme winds, tornados, or other accidents. The condition caused by a damaged or lost wind deflector is bounded by the air vent blockage postulated and analyzed in the UFSAR accident analyses. The procedures shall ensure that the duration of a damaged or lost wind deflector will not exceed periods longer than 40 hours as assumed in the UFSAR analyses for vent blockage. If visual inspection indicates a damaged or lost wind deflector, replace or repair the wind deflector. If the wind deflectors are damaged or could have been damaged for more than 40 hours, evaluate existing conditions in accordance with the site corrective action program to confirm that conditions adversely affecting the concrete or fuel cladding do not exist.

b. Daily EOS-HSM Temperature Measurement Program

   i. The user shall develop a daily temperature measurement program to verify the thermal performance of each NUHOMS® EOS System. The user shall establish administrative temperature limits to (1) detect off-normal and accident blockage conditions before the EOS- HSM components and fuel cladding temperatures would exceed temperature design limits and (2) ensure the EOS-HSM air vents are not blocked for more than 40 hours. The daily temperature measurements shall include one of the following options:

      1. direct measurement of the EOS-HSM concrete temperature

      2. direct measurement of inlet and outlet air temperatures

(continued)

5.0 ADMINISTRATIVE CONTROLS (continued)

If the direct measurement of the inlet and outlet air temperatures (option 2) is performed, the measured temperature differences of the inlet and outlet vents of each individual EOS-HSM must be compared to the predicted temperature differences for each individual EOS-HSM during normal operations. The measured temperature difference between the inlet and outlet vents shall not exceed 138 °F.

ii. The user shall establish in the program, measurement locations in the EOS-HSM that are representative of the EOS-HSM thermal performance and directly correlated to the predicted fuel cladding temperatures, air mass flow rates, and NUHOMS® EOS System temperature distributions that would occur with the off-normal and accident blockage conditions, as analyzed in the UFSAR. The administrative temperature limits shall employ appropriate safety margins that ensure temperatures would not exceed design basis temperature limits in the UFSAR, and be based on the UFSAR methodologies used to predict thermal performance of the NUHOMS® EOS System. If the direct measurement of the inlet and outlet air temperatures (option 2) is performed, the user must develop procedures to measure air temperatures that are representative of inlet and outlet air temperatures, as analyzed in the UFSAR. The user must also consider site-specific environmental conditions, loaded decay heat patterns, and the proximity of adjacent EOS-HSM modules in the daily air temperature measurement program. The user must ensure that measured air temperatures reflect only the thermal performance of each individual module, and not the combined performance of adjacent modules.

iii. The user shall establish in the program the appropriate actions to be taken if administrative temperature criteria are exceeded. If an administrative temperature limit is exceeded during a daily measurement, the user shall inspect the vents, wind deflectors if installed, and implement TS 5.1.3.1(a) for the affected system, until the cause of the excursion is determined and necessary corrective actions are completed under the site corrective action program.

iv. If measurements or other evidence indicate that the EOS-HSM concrete temperatures have exceeded the concrete accident temperature limit of 500 °F for more than 40 hours, the user shall perform an analysis and/or tests of the concrete in accordance with TS 5.3. The user shall demonstrate that the structural strength of the EOS-HSM has an adequate margin of safety and take appropriate actions to return the EOS-HSM to normal operating conditions.

v. If measurements or other evidence indicate that off-normal or accident temperature limits for fuel cladding have been exceeded, verify that canister confinement is maintained and assess analytically the condition of the fuel. Additionally, within 30 days, take appropriate actions to restore the spent fuel to a safe configuration.

(continued)

5.0 ADMINISTRATIVE CONTROLS (continued)

5.1.3.2 HSM-MX Thermal Monitoring Program

This program provides guidance for temperature measurements that are used to monitor the thermal performance of each HSM-MX. There are no credible scenarios that could block both the inlet and outlet vents. Therefore, only blockage of inlet vent is considered in the UFSAR. The intent of the program is to prevent conditions that could lead to exceeding the concrete and fuel clad temperature criteria. Each user must implement either TS 5.1.3.2(a) OR 5.1.3.2(b).

a. Daily Visual Inspection of HSM-MX Inlets and Outlets (Front Wall and Roof Birdscreens)

The user shall develop and implement procedures to perform visual inspection of HSM-MX inlets and outlets on a daily basis.

Perform a daily visual inspection of the air vents to ensure that HSM-MX air vents are not blocked for more than 32 hours. If visual inspection indicates blockage, clear air vents and replace or repair birdscreens if damaged. If the air vents are blocked or could have been blocked for more than 32 hours, evaluate existing conditions in accordance with the site corrective action program to confirm that conditions adversely affecting the concrete or fuel cladding do not exist.

b. Daily HSM-MX Temperature Measurement Program

i. The user shall develop a daily temperature measurement program to verify the thermal performance of each HSM-MX System through direct measure of the HSM-MX concrete temperature. The user shall establish administrative temperature limits to (1) detect off-normal and accident blockage conditions before the HSM components and fuel cladding temperatures would exceed temperature design limits and (2) ensure the HSM-MX air vents are not blocked for more than 32 hours.

ii. The user shall establish in the program measurement locations in the HSM-MX that are representative of the HSM-MX thermal performance and directly correlated to the predicted fuel cladding temperatures, air mass flow rates, and NUHOMS® MATRIX System temperature distributions that would occur with the off-normal and accident blockage conditions, as analyzed in the UFSAR. The administrative temperature limits shall employ appropriate safety margins that ensure temperatures would not exceed design basis temperature limits in the UFSAR, and be based on the UFSAR methodologies used to predict thermal performance of the NUHOMS® MATRIX System.

iii. The user shall establish in the program the appropriate actions to be taken if administrative temperature criteria are exceeded. If an administrative temperature limit is exceeded during a daily measurement, the user shall inspect the vents and implement TS 5.1.3.2(a) for the affected system, until the cause of the excursion is determined and necessary corrective actions are completed under the site corrective action program.

(continued)

5.0 ADMINISTRATIVE CONTROLS (continued)

iv. If measurements or other evidence indicate that the HSM-MX concrete temperatures have exceeded the concrete accident temperature limit of 500 °F for more than 32 hours, the user shall perform an analysis and/or tests of the concrete in accordance with TS 5.3. The user shall demonstrate that the structural strength of the HSM-MX has an adequate margin of safety and take appropriate actions to return the HSM-MX to normal operating conditions.

v. If measurements or other evidence indicate that off-normal or accident temperature limits for fuel cladding have been exceeded, verify that canister confinement is maintained and assess analytically the condition of the fuel. Additionally, within 30 days, take appropriate actions to restore the spent fuel to a safe configuration.

5.2 Lifting Controls

5.2.1 TC/DSC Lifting Height and Temperature Limits

The requirements of 10 CFR 72 apply to TC/DSC lifting/handling height limits outside the FUEL BUILDING. The requirements of 10 CFR Part 50 apply to TC/DSC lifting/handling height limits inside the FUEL BUILDING. Confirm the surface temperature of the TC before TRANSFER OPERATIONS of the loaded TC/DSC.

The lifting height of a loaded TC/ DSC is limited as a function of low temperature and the type of lifting/handling device, as follows:

- No lifts or handling of the TC/DSC at any height are permissible at TC surface temperatures below 0 °F
- The maximum lift height of the TC/DSC shall be 65 inches for the EOS-DSCs or 80 inches for the 61BTH Type 2 DSC if the surface temperature of the TC is above 0 °F and a non-single-failure-proof lifting/handling device is used.
- No lift height restriction is imposed on the TC/DSC if the TC surface temperature is higher than 0 °F and a single-failure-proof lifting/handling system is used.

The requirements of 10 CFR Part 72 apply when the TC/DSC is in a horizontal orientation on the transfer trailer. The requirements of 10 CFR Part 50 apply when the TC/DSC is being lifted/handled using the cask handling crane/hoist. (This distinction is valid only with respect to lifting/handling height limits.)

5.2.2 Cask Drop

<u>Inspection Requirement</u>

The TC will be inspected for damage and the DSC will be evaluated after any TC with a loaded DSC side drop of 15 inches or greater.

<u>Background</u>

TC/DSC handling and loading activities are controlled under the 10 CFR Part 50 license until a loaded TC/DSC is placed on the transporter, at which time fuel handling activities are controlled under the 10 CFR Part 72 license.

(continued)

5.0 ADMINISTRATIVE CONTROLS (continued)

Safety Analysis

The analysis of bounding drop scenarios shows that the TC will maintain the structural integrity of the DSC confinement boundary from an analyzed side drop height of 65 inches for the EOS-DSCs and 80 inches for the 61BTH Type 2 DSC. This 65-inch/80-inch drop height envelopes the maximum height from the bottom of the TC when secured to the transfer trailer while en route to the ISFSI.

Although analyses performed for cask drop accidents at various orientations indicate much greater resistance to damage, requiring the inspection of the DSC after a side drop of 15 inches or greater ensures that:

1. The DSC will continue to provide confinement.
2. The TC can continue to perform its design function regarding DSC transfer and shielding.

5.3 Concrete Testing

HSM concrete shall be tested during the fabrication process for elevated temperatures to verify that there are no significant signs of spalling or cracking and that the concrete compressive strength is greater than that assumed in the structural analysis. Tests shall be performed at or above the calculated peak temperature and for a period no less than the permissible duration as specified in Technical Specification 5.1.3.

HSM concrete temperature testing shall be performed whenever:

- There is a change in the supplier of the cement, or
- There is a change in the source of the aggregate, or
- The water-cement ratio changes by more than 0.04.

(continued)

5.0 ADMINISTRATIVE CONTROLS (continued)

5.4 Hydrogen Gas Monitoring

For DSCs, while welding the inner top cover during LOADING OPERATIONS, and while cutting the inner top cover to DSC shell weld when the DSC cavity is wet during UNLOADING OPERATIONS, hydrogen monitoring of the space under the top shield plug in the DSC cavity is required, to ensure that the combustible mixture concentration remains below the flammability limit of 4%. If this limit is exceeded, all welding operations shall be stopped and the DSC cavity purged with helium to reduce hydrogen concentration safely below the limit before welding or cutting operations can be resumed.

5.5 EOS-HSM Wind Deflectors

If the heat load of an EOS-37PTH DSC loaded per HLZC 1, 4, 6, 10, or 11 during STORAGE OPERATIONS is greater than 41.8 kW, wind deflectors shall be installed on the EOS-HSM.

If the heat load of a fuel assembly loaded per HLZC 5 in the EOS-37PTH DSC during STORAGE OPERATIONS is greater than 1.625 kW, wind deflectors shall be installed on the EOS-HSM.

If the heat load of an EOS-89BTH DSC during STORAGE OPERATIONS is greater than 41.6 kW, wind deflectors shall be installed on the EOS-HSM.

Table 1
Fuel Assembly Design Characteristics for the EOS-37PTH DSC

PWR FUEL CLASS	B&W 15X15	WE 17X17	CE 15X15	WE 15X15	CE 14X14	WE 14X14	CE 16X16
Fissile Material	UO_2	UO_2	UO_2	UO_2	UO_2	UO_2	UO_2
Maximum Number of Fuel Rods	208	264	216	204	176	179	236
Maximum Number of Guide/ Instrument Tubes	17	25	9	21	5	17	5

Table 2
Maximum Uranium Loading per FFC for Failed PWR Fuel

Fuel Assembly Class	Maximum Uranium Loading (MTU)
WE 17x17	0.550
CE 16x16	0.456
BW 15x15	0.492
WE 15x15	0.480
CE 15x15	0.450
CE 14x14	0.400
WE 14x14	0.410

Table 3
Co-60 Equivalent Activity for CCs Stored in the EOS-37PTH DSC

Fuel Region	Maximum Co-60 Equivalent Activity per DSC (Curies/DSC)(2)
Active Fuel	32,656
Plenum/Top Region	6,671

Notes:

1. Not Used.
2. NSAs and Neutron Sources shall only be stored in the inner zone of the basket. Figure 3 defines the compartments categorized as the Inner and Peripheral Zones.

Table 4
Maximum Planar Average Initial Enrichment for EOS-37PTH

(2 Pages)

PWR Fuel Class	Minimum Soluble Boron (ppm)	Maximum Planar Average Initial Enrichment (wt. % U-235) as a Function of Soluble Boron Concentration and Basket Type (Fixed Poison Loading) With and Without CCs							
		Basket Type							
		A1/A2/A3/A4H/A4L/A5				B1/B2/B3/B4H/B4L/B5			
		w/o CCs		w/ CCs		w/o CCs		w/ CCs	
		INTACT FUEL	DAMAGED/ FAILED FUEL(2)	INTACT FUEL	DAMAGED/ FAILED FUEL(2)	INTACT FUEL	DAMAGED/ FAILED FUEL(3)	INTACT FUEL	DAMAGED/ FAILED FUEL(3)
WE 17x17 Class	2000	4.35	4.20	4.35	4.15	4.50	4.15	4.45	4.25
	2100	4.50	4.20	4.45	4.20	4.65	4.25	4.60	4.40
	2200	4.60	4.40	4.55	4.35	4.75	4.45	4.70	4.55
	2300	4.70	4.45	4.65	4.50	4.85	4.65	4.85	4.60
	2400	4.85	4.45	4.80	4.60	5.00	4.65	4.95	4.75
	2500	4.95	4.65	4.90	4.70	5.00	5.00	5.00	4.95
CE 16x16 Class	2000	5.00	4.75	5.00	4.70	5.00	5.00	5.00	5.00
	2100	5.00	5.00	5.00	5.00	-	-	-	-
	2200	-	-	-	-	-	-	-	-
	2300	-	-	-	-	-	-	-	-
	2400	-	-	-	-	-	-	-	-
	2500	-	-	-	-	-	-	-	-
BW 15x15 Class	2000	4.25	4.05	4.20	4.00	4.40	4.10	4.35	4.15
	2100	4.40	4.10	4.30	4.15	4.55	4.20	4.45	4.25
	2200	4.50	4.25	4.45	4.15	4.65	4.35	4.60	4.30
	2300	4.60	4.35	4.55	4.30	4.80	4.40	4.70	4.50
	2400	4.75	4.40	4.65	4.45	4.90	4.55	4.85	4.50
	2500	4.85	4.55	4.75	4.65	5.00	4.75	4.90	4.75
	2600	(1)	(1)	(1)	(1)	5.00	5.00	(1)	(1)
WE 15x15	2000	4.45	4.10	4.40	4.10	4.55	4.30	4.55	4.25
	2100	4.60	4.15	4.55	4.15	4.65	4.50	4.65	4.35
	2200	4.70	4.25	4.65	4.35	4.80	4.55	4.80	4.45
	2300	4.85	4.35	4.75	4.45	5.00	4.50	4.95	4.50
	2400	4.95	4.50	4.90	4.50	5.00	4.90	5.00	4.80
	2500	5.00	4.75	5.00	4.65	5.00	5.00	5.00	5.00
CE 15x15 Assembly Class	2000	4.60	4.25	4.55	4.20	4.75	4.35	4.70	4.30
	2100	4.70	4.45	4.65	4.40	4.85	4.50	4.85	4.35
	2200	4.85	4.50	4.80	4.45	5.00	4.60	4.95	4.60
	2300	5.00	4.55	4.90	4.65	5.00	5.00	5.00	4.80
	2400	5.00	5.00	5.00	4.85	5.00	5.00	5.00	5.00
	2500	-	-	5.00	5.00	-	-	-	-
CE 14x14 Assembly Class	2000	5.00	5.00	5.00	4.50	5.00	5.00	5.00	4.95
	2100	-	-	5.00	4.95	-	-	5.00	5.00
	2200	-	-	5.00	5.00	-	-	-	-
	2300	-	-	-	-	-	-	-	-
	2400	-	-	-	-	-	-	-	-
	2500	-	-	-	-	-	-	-	-

Table 4
Maximum Planar Average Initial Enrichment for EOS-37PTH

(2 Pages)

PWR Fuel Class	Maximum Planar Average Initial Enrichment (wt. % U-235) as a Function of Soluble Boron Concentration and Basket Type (Fixed Poison Loading) With and Without CCs								
	Minimum Soluble Boron (ppm)	Basket Type							
		A1/A2/A3/A4H/A4L/A5				B1/B2/B3/B4H/B4L/B5			
		w/o CCs		w/ CCs		w/o CCs		w/ CCs	
		INTACT FUEL	DAMAGED/ FAILED FUEL(2)	INTACT FUEL	DAMAGED/ FAILED FUEL(2)	INTACT FUEL	DAMAGED/ FAILED FUEL(3)	INTACT FUEL	DAMAGED/ FAILED FUEL(3)
WE 14x14 Class	2000	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	2100	-	-	-	-	-	-	-	-
	2200	-	-	-	-	-	-	-	-
	2300	-	-	-	-	-	-	-	-
	2400	-	-	-	-	-	-	-	-
	2500	-	-	-	-	-	-	-	-

Notes:

1. Not analyzed.
2. May only be stored in basket types A4H and A4L
3. May only be stored in basket types B4H and B4L

Table 5
Minimum B-10 Content in the Neutron Poison Plates of the EOS-37PTH DSC

Basket Type	Minimum B-10 Content (areal density) for MMC (mg/cm^2)
A1/A2/A3/A4H/A4L/A5	28.0
B1/B2/B3/B4H/B4L/B5	35.0

Table 6
Fuel Assembly Design Characteristics for the EOS-89BTH DSC

BWR FUEL CLASS	*BWR Fuel ID*	*Example Fuel Designs* (1)(2)
7 x 7	*ENC-7-A*	*ENC-IIIA*
7 x 7	*ENC-7-B*	*ENC-III* *ENC-IIIE* *ENC-IIIF*
7 x 7	*GE-7-A*	*GE-1, GE-2, GE-3*
8 x 8	*ENC-8-A*	*ENC Va and Vb*
8 x 8	*ABB-8-A*	*SVEA-64*
8 x 8	*ABB-8-B*	*SVEA-64*
8 x 8	*FANP-8-A*	*FANP 8x8-2*
8 x 8	*GE-8-A*	*GE-4, XXX-RCN*
8 x 8	*GE-8-B*	*GE-5, GE-Pres* *GE-Barrier* *GE-8 Type 1*
8 x 8	*GE-8-C*	*GE-8 Type II*
8 x 8	*GE-8-D*	*GE-9, GE-10*
9 x 9	*FANP-9-A*	*FANP-9x9-79/2* *FANP-9x9-72* *FANP-9x9-80* *FANP-9x9-81*
9 x 9	*FANP-9-B*	*Siemens QFA* *ATRIUM 9*
9 x 9	*GE-9-A*	*GE-11, GE-13*
10 x 10	*ABB-10-A*	*SVEA-92* *SVEA-96Opt* *SVEA-100*
10 x 10	*ABB-10-B*	*SVEA-92* *SVEA-96* *SVEA-100*
10 x 10	*ABB-10-C*	*SVEA-96Opt2*
10 x 10	*FANP-10-A*	*ATRIUM 10* *ATRIUM 10XM*
10 x 10	*GE-10-A*	*GE-12, GE-14*
10 x 10	*GE-10-B*	*GNF2*
11 x 11	*FANP-11-A*	*ATRIUM 11*

Notes:

1. Any fuel channel average thickness up to 0.120 inch is acceptable on any of the fuel designs.
2. Example BWR fuel designs are listed herein and are not all-inclusive.

Table 7A
PWR Minimum Enrichments as a Function of Burnup

Burnup Range (GWd/MTU)	Minimum Enrichment (wt. % U-235)
1-6	0.7
7-16	1.3
17-30	1.8
31-62	Burnup/16[(1)]

Notes:

(1) Round enrichment down to the nearest 0.1%. Example: for 62 GWd/MTU, 62/16 = 3.875%, round down to 3.8%.

(2) Fuel below the minimum enrichment defined in this table is classified as LOW-ENRICHED OUTLIER FUEL. Number and location are specified in Section 2.1.

Table 7B
EOS-37PTH DSC Fuel Qualification Table, All Fuel

(Minimum required years of cooling time after reactor core discharge)

Burnup (GWd/FA)	Fuel Assembly Average Initial U-235 Enrichment (wt.%)												
	0.7	1.3	1.8	2.0	2.5	2.8	3.1	3.4	3.7	3.8	4.0	4.5	5.0
2.95	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
4.92		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
9.84			2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
14.76			2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
19.68					2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
22.14						2.16	2.12	2.09	2.05	2.04	2.02	2.00	2.00
24.60							2.35	2.31	2.28	2.26	2.24	2.18	2.14
27.06								2.55	2.51	2.49	2.47	2.41	2.35
29.52									2.76	2.75	2.71	2.64	2.58
30.50										2.85	2.82	2.74	2.67
34.10										3.22	3.20	3.11	3.03

Notes:

(1) The minimum cooling time is 2.0 years.

(2) The burnup in GWd/FA is the assembly average burnup in GWd/MTU multiplied by the MTU of the fuel assembly.

(3) Linear interpolation is allowed to obtain a cooling time within the specified range of burnup and enrichment values.

(4) Extrapolation is allowed to obtain a cooling time in the gray-shaded region.

Table 7C
Deleted

Table 8
Maximum Lattice Average Initial Enrichment and Minimum B-10 Areal Density for the EOS-89BTH DSC

Neutron Poison Loading Option	Loading Configuration - Number of Fuel Assemblies (1)	Maximum Lattice Average Initial Enrichment (wt. % U-235)			Minimum B-10 Areal Density (mg/cm^2)	
		All fuel Except ABB-10-C and ATRIUM 11	ABB-10-C Fuel	ATRIUM 11 Fuel	MMC	BORAL®
M1-A (2)	89	4.20	4.05	4.05	32.7	39.2
	88	4.45	4.25	4.25		
	87	4.60	4.40	4.35		
	84	5.00	4.90	4.80		
M1-B (2)	89	4.55	4.35	4.30	41.3	49.6
	88	4.80	4.60	4.50		
	87	4.95	4.70	4.65		
	84	5.00	5.00	5.00		
M2-A (2)	89	4.85	4.60	(3)	Not Allowed	60.0

Note:

1. *See Figure 10 for 88-FA, 87-FA and 84-FA loading configurations.*
2. *Mixing fuel types in the same DSC is permissible based on the calculated enrichments for each fuel type for a given basket type and loading configuration. For example, when mixing GNF2 and ATRIUM 11 fuels in an M1-A poison type DSC and 88-fuel-assembly loading configuration, the maximum enrichment for GNF2 fuels is 4.45wt% and the maximum enrichment for ATRIUM 11 fuels is 4.25wt%.*
3. *ATRIUM 11 fuel is not an allowed content for DSCs utilizing M2-A poison.*

Table 9
Maximum Lattice Average Initial Enrichment and Minimum B-10 Areal Density for the 61BTH Type 2 DSC (Intact Fuel)

Basket Type	Maximum Lattice Average Initial Enrichment (wt. % U-235)(1)	Minimum B-10 Areal Density, (mg/cm^2)	
		Borated Aluminum/MMC	Boral®
A	3.7	22	27
B	4.1	32	38
C	4.4	42	50
D	4.6	48	58
E	4.8	55	66
F	5.0(1)	62	75

Note:

1) For ATRIUM 11 fuel assemblies, the U-235 wt. % enrichment is reduced by 0.55%. The ATRIUM 11 fuel assemblies are authorized for storage in the Type F basket only.

Table 10
Maximum Lattice Average Initial Enrichment and Minimum B-10 Areal Density for the 61BTH Type 2 DSC (Damaged Fuel)

Basket Type	Maximum Lattice Average Initial Enrichment (wt. % U-235)		Minimum B-10 Areal Density, (mg/cm^2)	
	Up to 4 Damaged Assemblies(1)	Five or More Damaged Assemblies(1) (16 Maximum)	Borated Aluminum/MMC	Boral®
A	3.7	2.80	22	27
B	4.1	3.10	32	38
C	4.4	3.20	42	50
D	4.6	3.40	48	58
E	4.8	3.50	55	66
F	5.0(2, 3)	3.60	62	75

Notes:

1) See Figure 5 for the location of damaged fuel assemblies within the 61BTH Type 2 DSC.
2) ATRIUM 11 fuel assemblies are authorized for storage only in the Type F basket only with a maximum of 4 damaged fuel assemblies.
3) For ATRIUM 11 fuel assemblies, the U-235 wt. % enrichment is reduced by 0.55%.

Table 11
Maximum Lattice Average Initial Enrichment and Minimum B-10 Areal Density for the 61BTH Type 2 DSC (Failed and Damaged Fuel)

Basket Type	Maximum Lattice Average Initial Enrichment (wt. % U-235)		Minimum B-10 Areal Density (mg/cm^2)	
	Up to 4 Failed Assemblies (Corner Locations)(1, 2)	Up to 4 Failed Assemblies (Corner Locations) and up to 12 Damaged Assemblies (Interior Locations)(1, 2)	Borated Aluminum/MMC	Boral®
A	3.7	2.8	22	27
B	4.0	3.1	32	38
C	4.4	3.2	42	50
D	4.6	3.4	48	58
E	4.8	3.4	55	66
F	5.0	3.5	62	75

Notes:

1) See Figure 5 for the locations of the failed and damaged assemblies within the 61BTH Type 2 DSC.
2) Failed ATRIUM 11 fuel assemblies are not authorized for storage in the 61BTH Type 2 DSC.

Table 12
Maximum Lattice Average Initial Enrichments and Minimum B-10 Areal Density for the 61BTH Type 2 DSC for > 16 Damaged Fuel Assemblies

Basket Type	Up to 57 Damaged Fuel at 3.30 wt. % U-235		Minimum B-10 Areal Density (mg/cm^2)	
	Remaining Four Intact Assemblies (1)	Remaining Four Damaged Assemblies (1)	Borated Aluminum/MMC	Boral®
A	-	-	-	-
B	-	-	-	-
C	-	-	-	-
D	5.00	4.20	48	58
E	5.00	4.20	55	66
F	5.00	4.20	62	75

Note:
1) See Figure 5 for the locations of the damaged assemblies within the 61BTH Type 2 DSC

Table 13
BWR Fuel Assembly Design Characteristics for the 61BTH Type 2 DSC

BWR FUEL CLASS	Initial Design or Reload Fuel Designation(1) (3)
7x7-49/0	GE1 GE2 GE3
8x8-63/1	GE4
8x8-62/2	GE-5 GE-Pres GE-Barrier GE8 Type I
8x8-60/4	GE8 Type II
8x8-60/1	GE9 GE10
9x9-74/2	GE11 GE13
10x10-92/2	GE12 GE14 GNF2
7x7-49/0	ENC-IIIA
7x7-48/1Z	ENC-III(2)
8x8-60/4Z	ENC Va ENC Vb
8x8-62/2	FANP 8x8-2
9x9-79/2	FANP9 9x9-2
Siemens QFA	9x9
10x10-91/1	ATRIUM-10 ATRIUM-10XM
11x11	ATRIUM-11

Notes:

(1) Any fuel channel average thickness up to 0.120 inch is acceptable on any of the fuel designs.

(2) Includes ENC-IIIE and ENC-IIIF.

(3) Initial designs or reload fuel designations belonging to a listed fuel class, but not listed herein may be qualified for storage using the same methodology as documented in the UFSAR.

Table 14
Maximum Uranium Loading per FFC for Failed 61BTH Type 2 Fuel

Fuel Assembly Class	Maximum MTU/Assembly
7x7	0.198
8x8	0.188
9x9	0.180
10x10	0.187

Table 15
System Configurations for EOS-37PTH HLZCs

HLZC	Storage Module	Transfer Cask
1	EOS-HSM	EOS-TC125 EOS-TC135
2	EOS-HSM	EOS-TC108 EOS-TC125 EOS-TC135
3	EOS-HSM	EOS-TC108 EOS-TC125 EOS-TC135
4	EOS-HSM	EOS-TC108 EOS-TC125 EOS-TC135
5	EOS-HSM	EOS-TC108 EOS-TC125 EOS-TC135
6	EOS-HSM	EOS-TC108 EOS-TC125 EOS-TC135
7	HSM-MX	EOS-TC108 EOS-TC125 EOS-TC135
8	HSM-MX	EOS-TC108 EOS-TC125 EOS-TC135
9	HSM-MX	EOS-TC108 EOS-TC125 EOS-TC135
10	EOS-HSM	EOS-TC125 EOS-TC135
11	EOS-HSM HSM-MX	EOS-TC125 EOS-TC135

Table 16
Deleted

Table 17
System Configurations for 61BTH Type 2 HLZCs

HLZC	Storage Module	Transfer Cask
1	HSM-MX	OS197/OS197H/ OS197FC-B/OS197HFC-B
2	HSM-MX	OS197/OS197H/ OS197FC-B/OS197HFC-B
3	HSM-MX	OS197/OS197H/ OS197FC-B/OS197HFC-B
4	HSM-MX	OS197/OS197H/ OS197FC-B/OS197HFC-B
5	HSM-MX	OS197FC-B/OS197HFC-B
6	HSM-MX	OS197FC-B/OS197HFC-B
7	HSM-MX	OS197FC-B/OS197HFC-B
8	HSM-MX	OS197FC-B/OS197HFC-B
9	HSM-MX	OS197/OS197H/ OS197FC-B/OS197HFC-B
10	HSM-MX	OS197FC-B/OS197HFC-B

Table 18
BWR Minimum Enrichments as a Function of Burnup (*EOS-89BTH DSC and* 61BTH Type 2 DSC)

Burnup Range (GWd/MTU)	Minimum Enrichment (wt. %)
1-6	0.7
7-19	0.9
20-35	Burnup/20[(1)]
36-62	Burnup/16[(1)]

Notes:

1) Round down to the nearest 0.1%. Example: for 62 GWd/MTU, 62/16 = 3.875%, round down to 3.8%.
2) Fuel below the minimum enrichment defined in this table is classified as LOW-ENRICHED OUTLIER FUEL. Number and location are specified in *Section 2.2 for the EOS-89BTH DSC and in* Section 2.3 *for the 61BTH Type 2 DSC*.

Table 19
61BTH Type 2 DSC Fuel Qualification Table, All Fuel

(Minimum required years of cooling time after reactor core discharge)

Burnup (GWd/FA)	Fuel Assembly Average Initial U-235 Enrichment (wt.%)														
	0.7	0.9	1.0	1.5	1.7	2.2	2.5	2.8	3.1	3.4	3.7	3.8	4.0	4.5	5.0
1.19	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
1.39		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
2.97		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
3.76		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
3.96			2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
5.94				2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
6.93					2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
7.13						2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
7.92							2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
8.91								2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
9.90									2.11	2.06	2.01	2.00	2.00	2.00	2.00
10.89										2.29	2.24	2.22	2.19	2.11	2.05
11.88											2.48	2.46	2.43	2.34	2.27
12.28												2.57	2.53	2.44	2.36

Notes:

1) The minimum cooling time is 2.0 years.
2) The burnup in GWd/FA is the assembly average burnup in GWd/MTU multiplied by the MTU of the fuel assembly.
3) Linear interpolation is allowed to obtain a cooling time within the specified range of burnup and enrichment values.
4) Extrapolation is allowed to obtain a cooling time in the gray-shaded region.

Table 20
61BTH Type 2 DSC Fuel Qualification Table, HLZC 2, 4, 5, 6, 7, and 8, Peripheral Locations

(Minimum required years of cooling time after reactor core discharge)

Burnup (GWd/FA)	Fuel Assembly Average Initial U-235 Enrichment (wt.%)														
	0.7	0.9	1.0	1.5	1.7	2.2	2.5	2.8	3.1	3.4	3.7	3.8	4.0	4.5	5.0
1.19	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
1.39		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
2.97		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
3.76		2.35	2.33	2.23	2.20	2.12	2.09	2.06	2.03	2.01	2.00	2.00	2.00	2.00	2.00
3.96			2.41	2.31	2.28	2.20	2.16	2.13	2.10	2.08	2.06	2.05	2.04	2.02	2.00
5.94				3.13	3.09	2.98	2.93	2.88	2.83	2.79	2.75	2.74	2.72	2.67	2.63
6.93					3.55	3.43	3.36	3.29	3.24	3.18	3.14	3.12	3.10	3.03	2.98
7.13						3.52	3.45	3.39	3.33	3.27	3.22	3.21	3.18	3.11	3.06
7.92							3.87	3.79	3.71	3.64	3.58	3.57	3.53	3.45	3.38
8.91								4.39	4.29	4.20	4.12	4.10	4.05	3.94	3.85
9.90									5.03	4.91	4.80	4.77	4.70	4.56	4.43
10.89										5.86	5.70	5.65	5.56	5.35	5.18
11.88											6.97	6.89	6.75	6.45	6.19
12.28												7.53	7.36	7.00	6.70

Notes:

1) The minimum cooling time is 2.0 years.
2) The burnup in GWd/FA is the assembly average burnup in GWd/MTU multiplied by the MTU of the fuel assembly.
3) Linear interpolation is allowed to obtain a cooling time within the specified range of burnup and enrichment values.
4) Extrapolation is allowed to obtain a cooling time in the gray-shaded region.
5) The peripheral locations are defined in Figure 6.

Table 21
EOS-89BTH DSC Fuel Qualification Table, All Fuel

(Minimum required years of cooling time after reactor core discharge)

Burnup (GWd/FA)	Fuel Assembly Average Initial U-235 Enrichment (wt.%)														
	0.7	0.9	1.0	1.5	1.7	2.2	2.5	2.8	3.1	3.4	3.7	3.8	4.0	4.5	5.0
1.19	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.39		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2.97		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.76		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.96			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.94				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.93					1.11	1.06	1.03	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.13						1.09	1.06	1.03	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.92							1.17	1.14	1.11	1.08	1.06	1.05	1.04	1.00	1.00
8.91								1.28	1.25	1.22	1.19	1.18	1.16	1.12	1.09
9.90									1.40	1.36	1.33	1.32	1.30	1.25	1.21
10.89										1.51	1.48	1.46	1.44	1.39	1.34
11.88											1.63	1.62	1.59	1.53	1.48
12.28												1.68	1.66	1.60	1.54

Notes:

1) *The minimum cooling time is 1.0 year.*
2) *The burnup in GWd/FA is the assembly average burnup in GWd/MTU multiplied by the MTU of the fuel assembly.*
3) *Linear interpolation is allowed to obtain a cooling time within the specified range of burnup and enrichment values.*
4) *Extrapolation is allowed to obtain a cooling time in the gray-shaded region.*
5) *For fuel transferred in the EOS-TC108, additional cooling time restrictions are specified in Figure 2.*

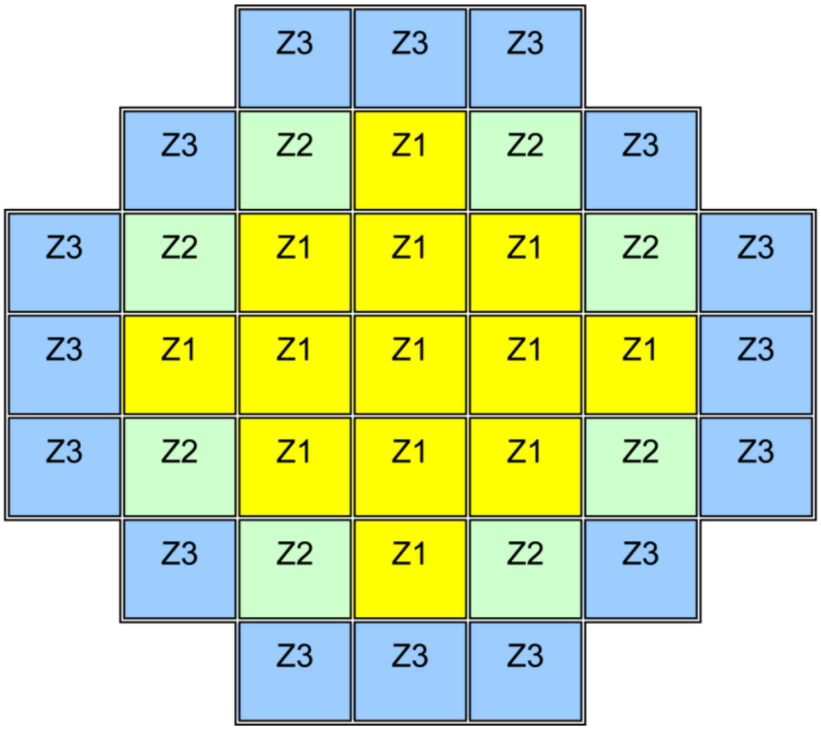
Table 22
EOS-89BTH DSC Reconstituted Fuel Limits for Transfer in the EOS-TC125

Parameter	*Limit*
Number of RECONSTITUTED FUEL ASSEMBLIES per DSC	*≤ 89*
Maximum number of irradiated stainless steel rods per RECONSTITUTED FUEL ASSEMBLY	*Per table below*
Minimum cooling time	*Per table below*

Number of Irradiated Stainless Steel Rods per Fuel Assembly										*Minimum Cooling Time (years)*
7x7 Class		*8x8 Class*		*9x9 Class*		*10x10 Class*		*11x11 Class*		
Min.	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	
0	*5*	*0*	*6*	*0*	*7*	*0*	*9*	*0*	*11*	*Per Table 21*
6	*15*	*7*	*18*	*8*	*22*	*10*	*26*	*12*	*34*	*2.00*
16	*20*	*19*	*24*	*23*	*29*	*27*	*34*	*35*	*46*	*2.25*
21	*25*	*25*	*30*	*30*	*37*	*35*	*43*	*47*	*57*	*2.50*
26	*30*	*31*	*36*	*38*	*44*	*44*	*51*	*58*	*69*	*2.75*
31	*35*	*37*	*42*	*45*	*51*	*52*	*60*	*70*	*80*	*3.00*
36	*49*	*43*	*64*	*52*	*81*	*61*	*100*	*81*	*112*	*3.25*

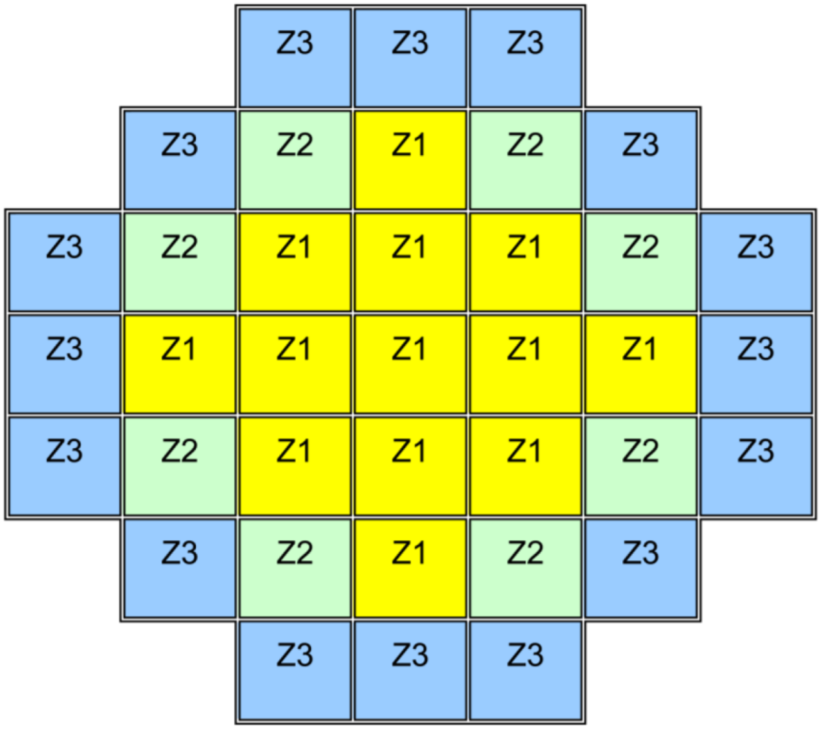
Table 23
EOS-89BTH DSC Reconstituted Fuel Limits for Transfer in the EOS-TC108

Parameter	*Limit*
Number of RECONSTITUTED FUEL ASSEMBLIES per DSC	• *≤ 89 (all types)* • *≤ 49 containing irradiated stainless steel rods*
Maximum number of irradiated stainless steel rods per DSC	• *100 for 7x7 Class* • *120 for 8x8 Class* • *140 for 9x9 Class* • *180 for 10x10 Class* • *220 for 11x11 Class*
Maximum number of irradiated stainless steel rods per RECONSTITUTED FUEL ASSEMBLY	• *5 for 7x7 Class* • *6 for 8x8 Class* • *7 for 9x9 Class* • *9 for 10x10 Class* • *11 for 11x11 Class*
Loading restrictions for locations within the basket	*Per Figure 9*
Minimum cooling time	*Per Table 21*



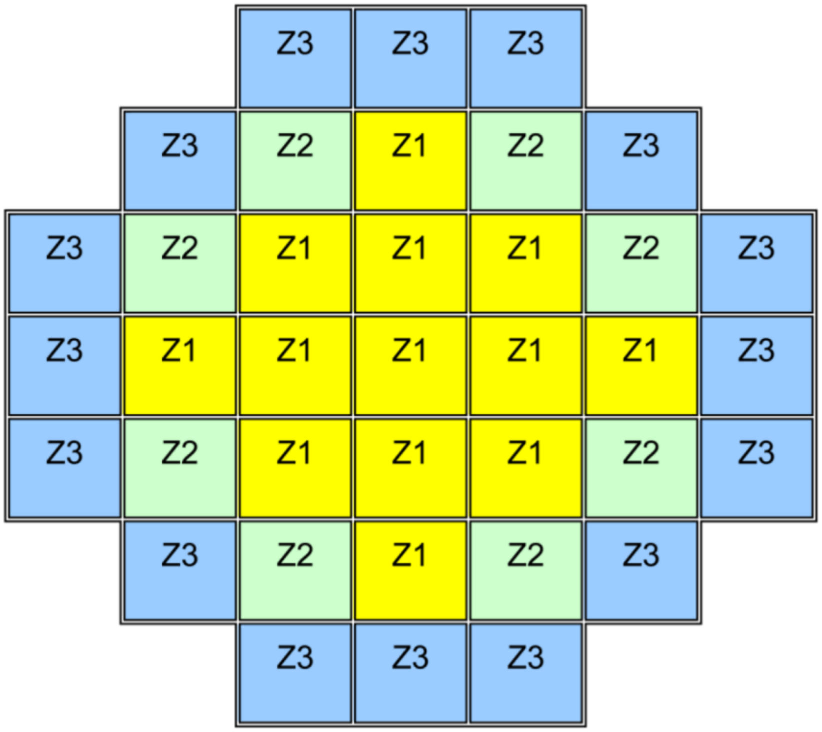
Zone Number	1	2	3
Maximum Decay Heat (kW/FA plus CCs, if included)	1.0	2.0	1.3125
Maximum Number of Fuel Assemblies	13	8	16
Maximum Decay Heat per DSC (kW)	50.0		

Figure 1A
Heat Load Zone Configuration 1 for the EOS-37PTH DSC



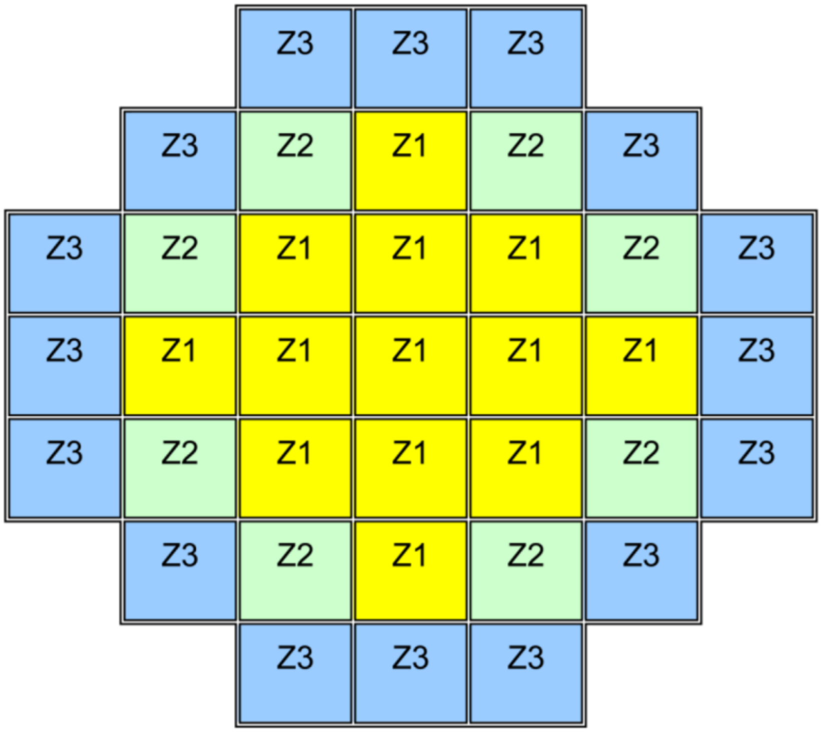
Zone Number	1	2	3
Maximum Decay Heat, (H), (kW/FA plus CCs, if included)	1.0	1.5	1.05
Maximum Number of Fuel Assemblies	13	8	16
Maximum Decay Heat per DSC (kW)	41.8		

Figure 1B
Heat Load Zone Configuration 2 for the EOS-37PTH DSC



Zone Number	1	2	3
Maximum Decay Heat (kW/FA plus CCs, if included)	0.95	1.0	1.0
Maximum Number of Fuel Assemblies	13	8	16
Maximum Decay Heat per DSC (kW)	36.35		

Figure 1C
Heat Load Zone Configuration 3 for the EOS-37PTH DSC

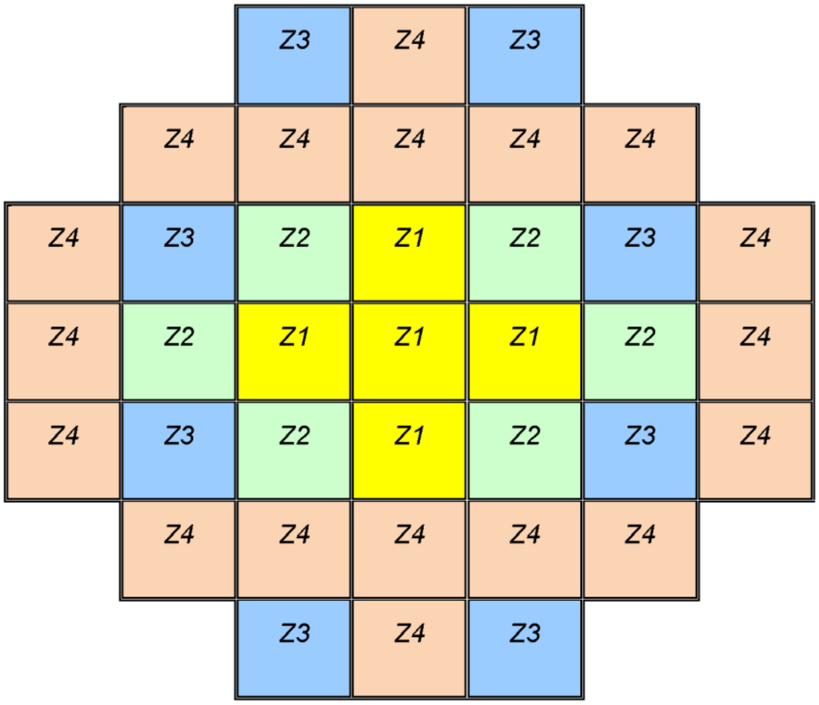


Zone Number	1	2	3
Maximum Decay Heat (kW/FA plus CCs, if included)	1.0	1.625	1.6
Maximum Number of Fuel Assemblies	13	8	16
Maximum Decay Heat per DSC (kW)	50.0[1]		

Notes:

1. Adjust payload to maintain total canister heat load within the specified limit.

Figure 1D
Heat Load Zone Configuration 4 for the EOS-37PTH DSC

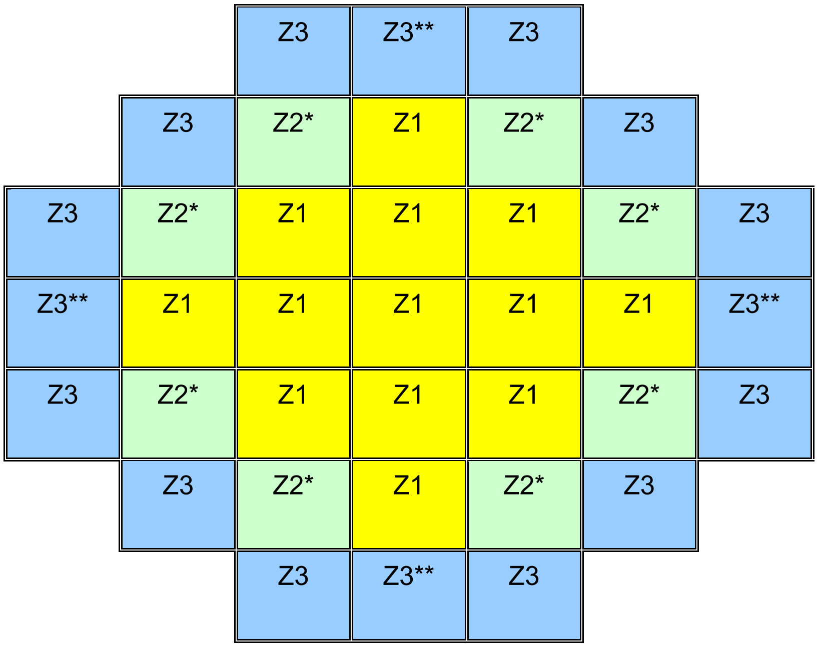


Zone Number	1	2	3	4
Maximum Decay Heat (kW/FA plus CCs, if included)	0.7	0.5	2.4	0.85
Maximum Number of Fuel Assemblies	5	6	8	18
Maximum Decay Heat per DSC (kW)	41.0			

Notes:

1. Adjust payload to maintain total canister heat load within the specified limit.

Figure 1E
Heat Load Zone Configuration 5 for the EOS-37PTH DSC

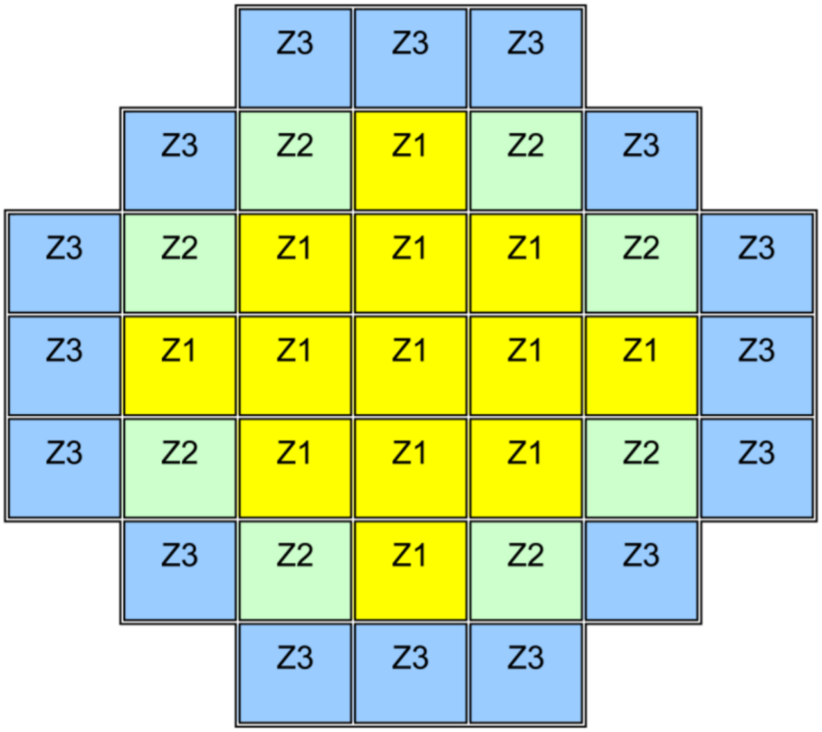


(*) denotes location where INTACT or DAMAGED FUEL can be stored.
(**) denotes location where INTACT or FAILED FUEL can be stored.

Zone Number	1	2(1)	3(1)
Maximum Decay Heat (kW/FA plus CCs, if included)	1.0	1.5	1.3125(2)
Maximum Number of Fuel Assemblies	13	8	16
Maximum Decay Heat per DSC (kW)	46.00		

1. DAMAGED FUEL and FAILED FUEL shall not be loaded in the same DSC.
2. The maximum allowable heat load per FAILED FUEL compartment is 0.8 kW.

Figure 1F
Heat Load Zone Configuration 6 for the EOS-37PTH DSC



Zone Number	1	2	3
Maximum Number of Fuel Assemblies	13	8	16
Upper Compartment			
Maximum Decay Heat (kW/FA plus CCs, if included)	1.0	1.60	1.3125
Maximum Decay Heat per DSC (kW)	41.8[(1)]		
Lower Compartment			
Maximum Decay Heat (kW/FA plus CCs, if included)	0.9	1.60	1.60
Maximum Decay Heat per DSC (kW)	50.0[(1)]		

Notes:

1. Adjust payload to maintain total canister heat load within the specified limit.

Figure 1G
Heat Load Zone Configuration 7 for the EOS-37PTH DSC

		Z3	Z3**	Z3		
	Z3	Z2*	Z1	Z2*	Z3	
Z3	Z2*	Z1	Z1	Z1	Z2*	Z3
Z3**	Z1	Z1	Z1	Z1	Z1	Z3**
Z3	Z2*	Z1	Z1	Z1	Z2*	Z3
	Z3	Z2*	Z1	Z2*	Z3	
		Z3	Z3**	Z3		

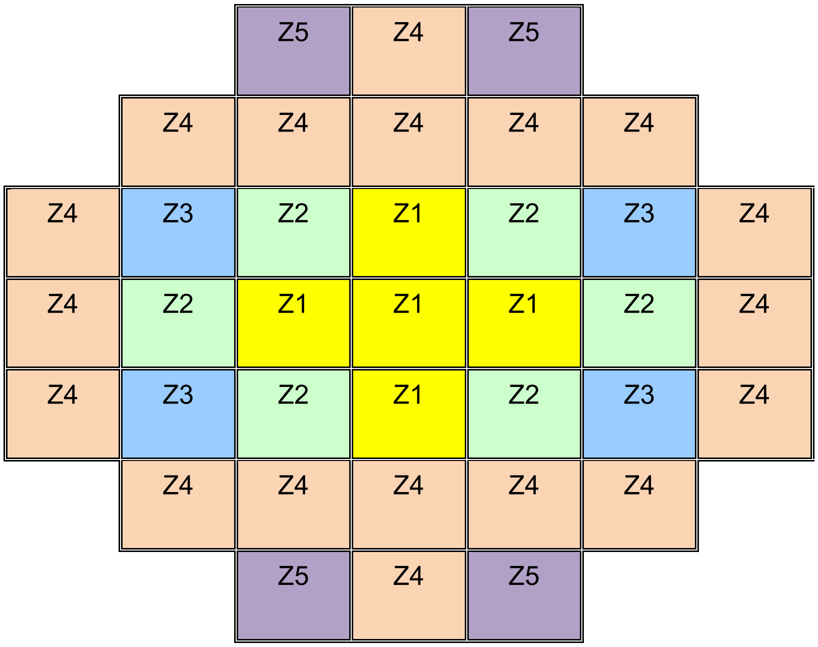
(*) denotes location where INTACT or DAMAGED FUEL can be stored.
(**) denotes location where INTACT or FAILED FUEL can be stored.

Zone Number	1	2[2]	3[2][3]
Maximum Number of Fuel Assemblies	13	8	16
Upper Compartment			
Maximum Decay Heat (kW/FA plus CCs, if included)	0.8	1.50	1.50
Maximum Decay Heat per DSC (kW)	41.8[1][4]		
Lower Compartment			
Maximum Decay Heat (kW/FA plus CCs, if included)	0.8	1.50	1.50
Maximum Decay Heat per DSC (kW)	46.4[1]		

Notes:

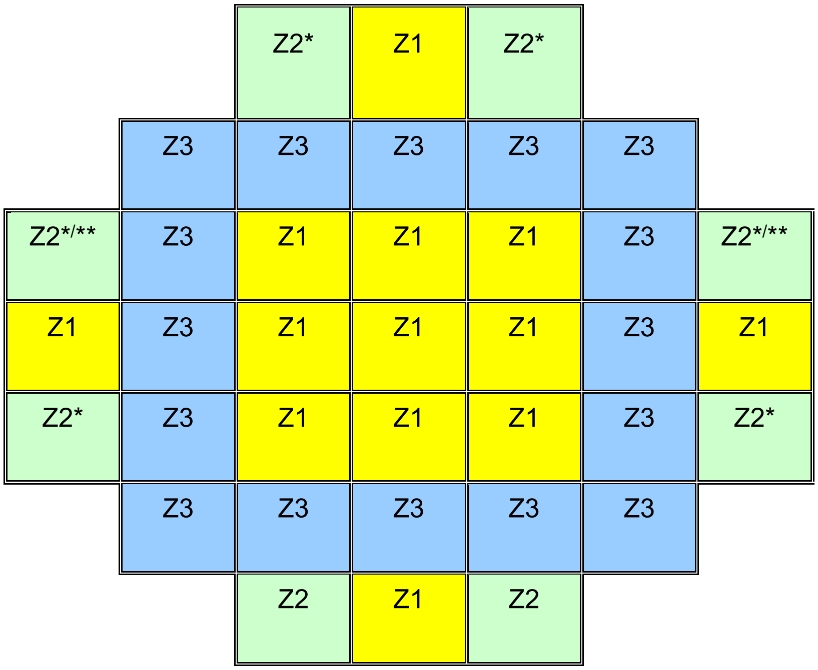
1. The maximum decay heat per DSC is limited to 41.8 kW when DAMAGED or FAILED FUEL is loaded.
2. DAMAGED FUEL and FAILED FUEL shall not be loaded in the same DSC.
3. The maximum allowable heat load per FAILED FUEL is 0.8 kW.
4. Adjust payload to maintain total canister heat load within the specified limit.

Figure 1H
Heat Load Zone Configuration 8 for the EOS-37PTH DSC



Zone Number	1	2	3	4	5
Maximum Decay Heat (kW/FA plus CCs, if included)	0.50	0.70	2.0	0.75	2.4
Maximum Number of Fuel Assemblies	5	6	4	18	4
Maximum Decay Heat per DSC (kW)	37.80				

Figure 1I
Heat Load Zone Configuration 9 for the EOS-37PTH DSC



(*) denotes location where INTACT or DAMAGED FUEL ASSEMBLY can be stored.
(**) denotes location where INTACT or FAILED FUEL can be stored.

Zone Number	1	2[1]	3
Max Decay Heat (kW/ plus CCs, if included)	0.5	3.5[2]	0.7
Maximum Number of Fuel Assemblies	13	8	16
Maximum Decay Heat per DSC (kW)	45.7		

Notes:

1. DAMAGED FUEL and FAILED FUEL shall not be loaded in the same DSC.
2. The maximum allowable heat load per FAILED FUEL is 0.8 kW.

Figure 1J
Heat Load Zone Configuration 10 for the EOS-37PTH DSC

		Z4*	Z1	Z4*		
	Z3	Z3	Z3	Z3	Z3	
Z4*/**	Z3	Z1	Z1	Z1	Z3	Z4*/**
Z1	Z3	Z1	Z1	Z1	Z3	Z1
Z2*	Z3	Z1	Z1	Z1	Z3	Z2*
	Z3	Z3	Z3	Z3	Z3	
		Z2	Z1	Z2		

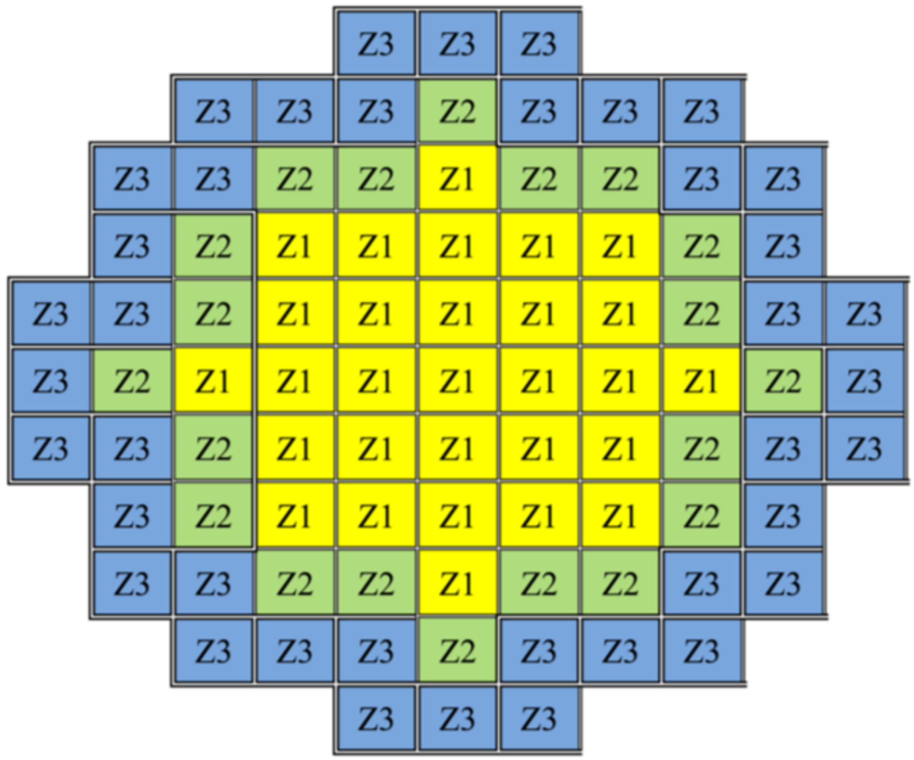
(*) denotes location where INTACT or DAMAGED FUEL ASSEMBLY can be stored.
(**) denotes location where INTACT or FAILED FUEL can be stored.

Zone Number	1	2(1)	3	4(1)
Maximum Number of Fuel Assemblies	13	4	16	4
Upper Compartment				
Maximum Decay Heat (kW/FA plus CCs, if included)	0.5	3.0	0.7	3.0(2)
Maximum Decay Heat per DSC (kW)	41.8			
Lower Compartment				
Maximum Decay Heat (kW/FA plus CCs, if included)	0.5	3.5	0.7	3.2(2)
Maximum Decay Heat per DSC (kW)	44.5			

Notes:

1. DAMAGED FUEL and FAILED FUEL shall not be loaded in the same DSC.
2. The maximum allowable heat load per FAILED FUEL is 0.8 kW.

Figure 1K
Heat Load Zone Configuration 11 for the EOS-37PTH DSC



Heat Load Zone Configuration 2

Zone Number	1	2	3[(1)]
Maximum Decay Heat (kW/FA plus channel, if included)	0.4	0.5	0.5
Maximum Number of Fuel Assemblies	29	20	40
Maximum Decay Heat per DSC (kW)	41.6		

Heat Load Zone Configuration 3

Zone Number	1	2	3[(2)]
Maximum Decay Heat (kW/FA plus channel, if included)	0.36	0.4	0.4
Maximum Number of Fuel Assemblies	29	20	40
Maximum Decay Heat per DSC (kW)	34.44		

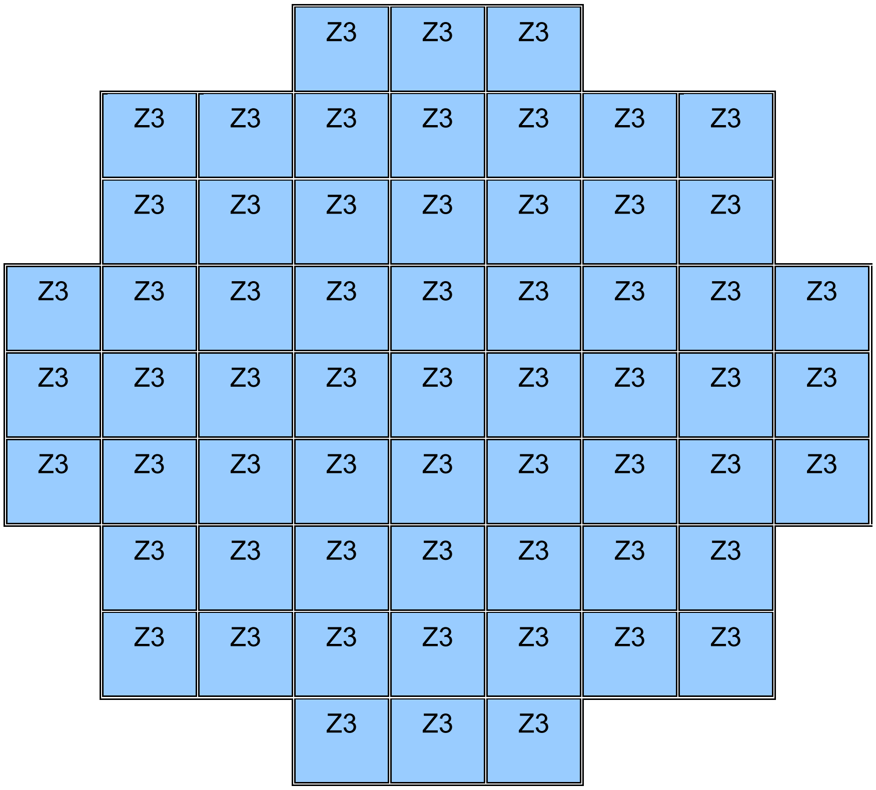
Notes:

1. The minimum cooling time for HLZC 2 Zone 3 in the EOS-TC108 is 9.7 years.
2. The minimum cooling time for HLZC 3 Zone 3 in the EOS-TC108 is 9.0 years.

Figure 2
EOS-89BTH DSC Heat Load Zone Configurations for transfer in the EOS-TC108

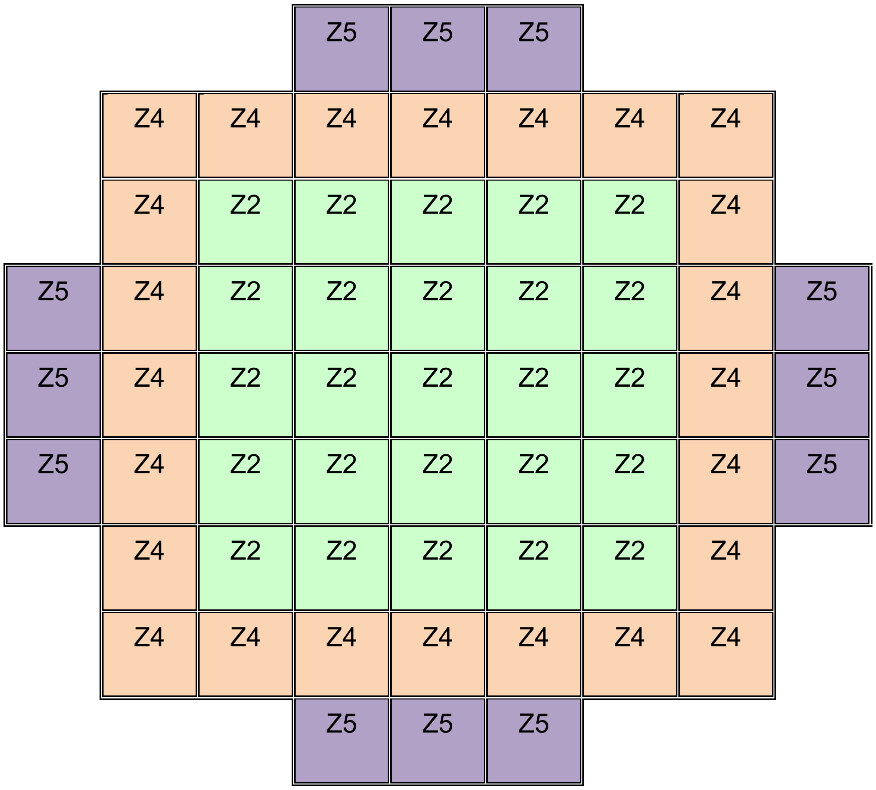
		P	P	P		
	P	I	I	I	P	
P	I	I	I	I	I	P
P	I	I	I	I	I	P
P	I	I	I	I	I	P
	P	I	I	I	P	
		P	P	P		

Figure 3
Peripheral (P) and Inner (I) Fuel Locations for the EOS-37PTH DSC



	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Maximum Decay Heat (kW/FA)	NA	NA	0.393	NA	NA	NA
Maximum Decay Heat per Zone (kW)	NA	NA	22.0	NA	NA	NA
Maximum Decay Heat per DSC (kW)	22.0					

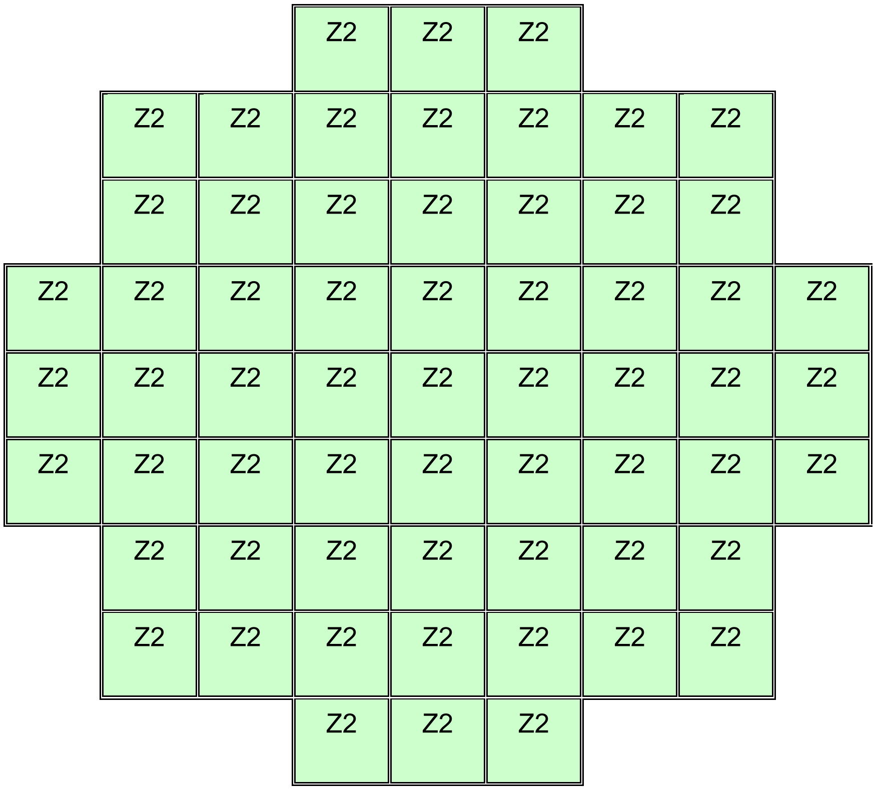
Figure 4A
Heat Load Zone Configuration 1 for the 61BTH Type 2 DSC



	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Maximum Decay Heat (kW/FA)	NA	0.35	NA	0.48	0.54	NA
Maximum Decay Heat per Zone (kW)	NA	8.75	NA	11.52	6.48	NA
Maximum Decay Heat per DSC (kW)	22.0[(1)]					

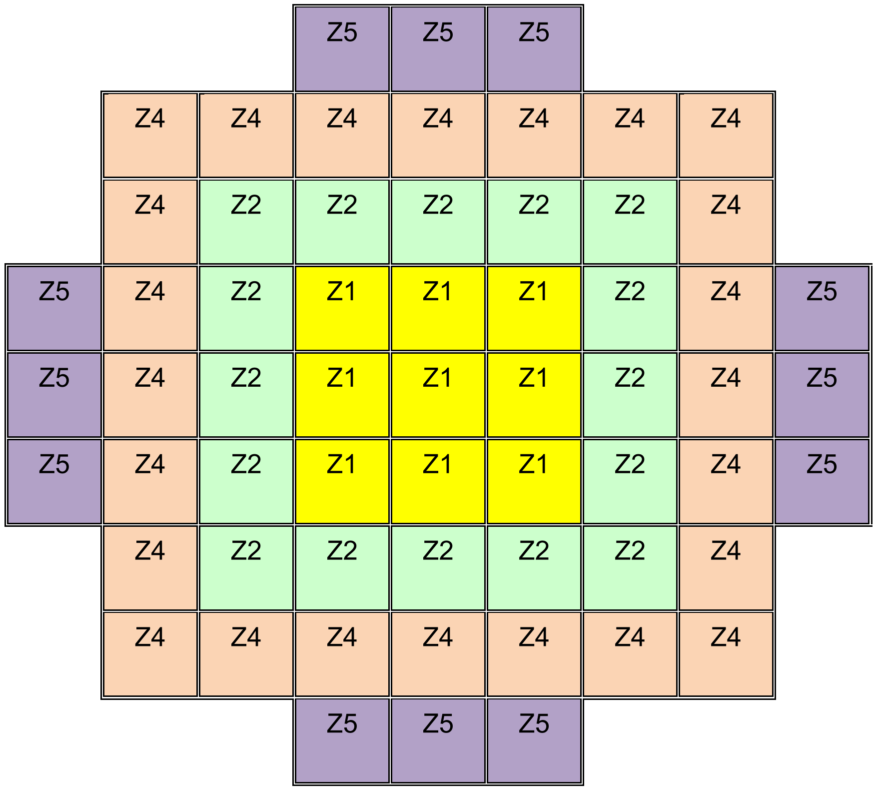
(1) Adjust payload to maintain total DSC heat load within the specified limit

Figure 4B
Heat Load Zone Configuration 2 for the 61BTH Type 2 DSC



	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Maximum Decay Heat (kW/FA)	NA	0.35	NA	NA	NA	NA
Maximum Decay Heat per Zone (kW)	NA	19.4	NA	NA	NA	NA
Maximum Decay Heat per DSC (kW)	19.4					

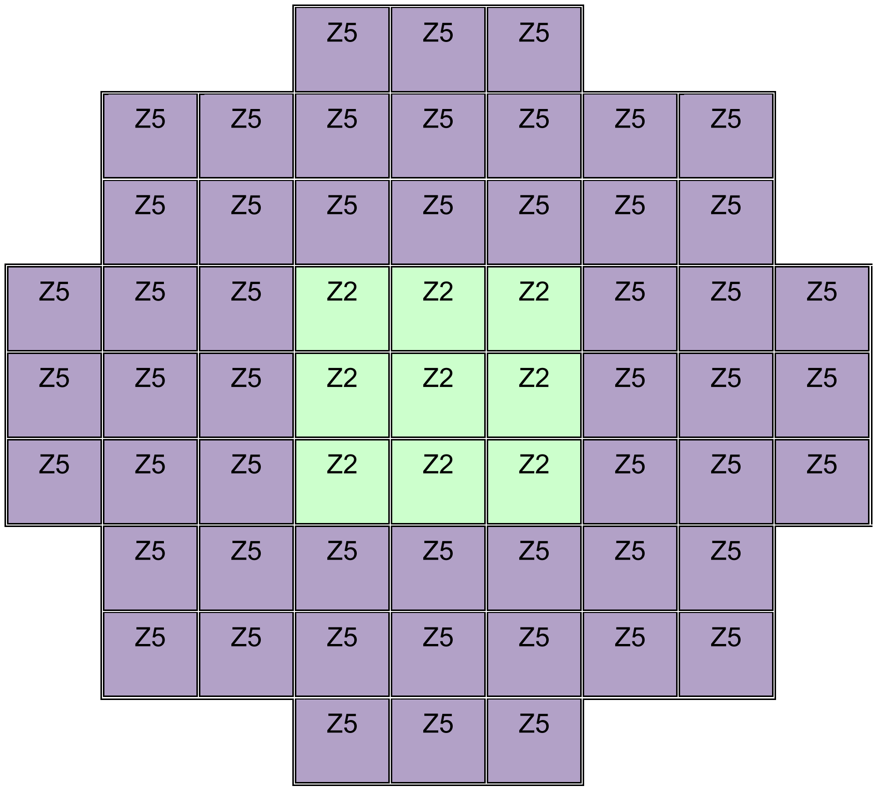
Figure 4C
Heat Load Zone Configuration 3 for the 61BTH Type 2 DSC



	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Maximum Decay Heat (kW/FA)	0.22	0.35	NA	0.48	0.54	NA
Maximum Decay Heat per Zone (kW)	1.98	5.60	NA	11.52	6.48	NA
Maximum Decay Heat per DSC (kW)	19.4(1)					

(1) Adjust payload to maintain total DSC heat load within the specified limit.

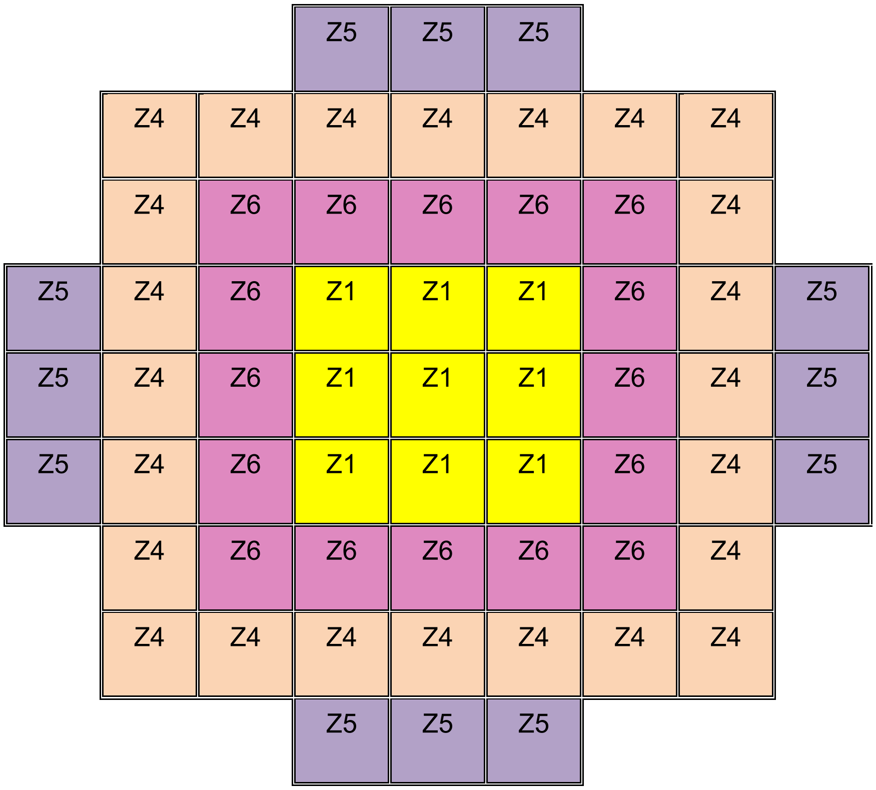
Figure 4D
Heat Load Zone Configuration 4 for the 61BTH Type 2 DSC



	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Maximum Decay Heat (kW/FA)	NA	0.35	NA	NA	0.54	NA
Maximum Decay Heat per Zone (kW)	NA	3.15	NA	NA	28.08	NA
Maximum Decay Heat per DSC (kW)	31.2[(1)]					

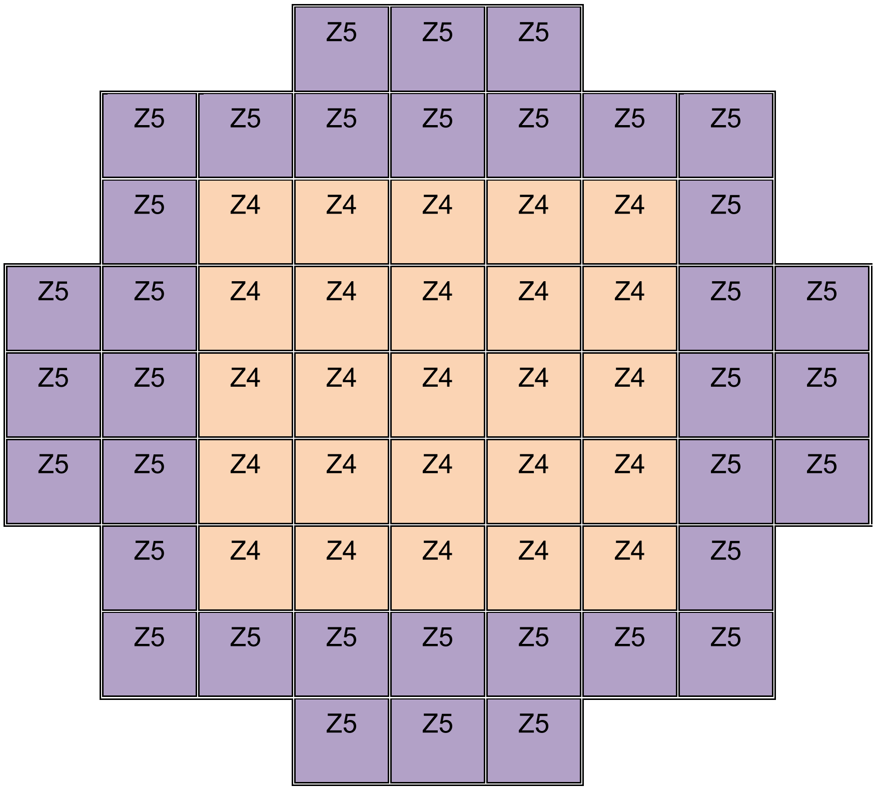
[(1)] Adjust payload to maintain total DSC heat load within the specified limit.

Figure 4E
Heat Load Zone Configuration 5 for the 61BTH Type 2 DSC



	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Maximum Decay Heat (kW/FA)	0.22	NA	NA	0.48	0.54	0.70
Maximum Decay Heat per Zone (kW)	1.98	NA	NA	11.52	6.48	11.20
Maximum Decay Heat per DSC (kW)	31.2					

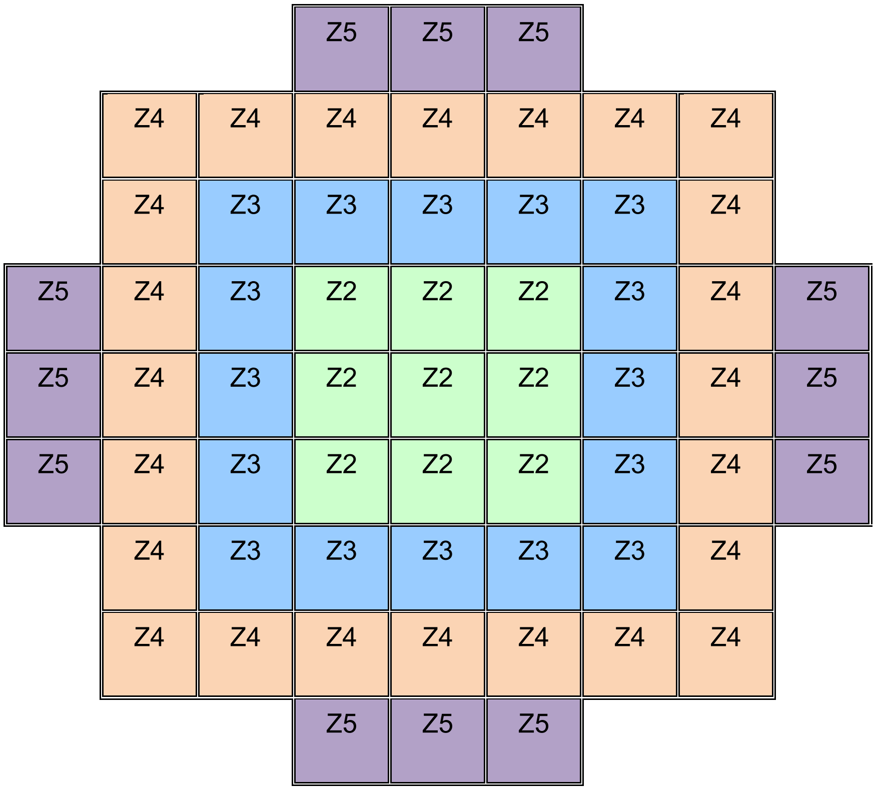
Figure 4F
Heat Load Zone Configuration 6 for the 61BTH Type 2 DSC



	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Maximum Decay Heat (kW/FA)	NA	NA	NA	0.48	0.54	NA
Maximum Decay Heat per Zone (kW)	NA	NA	NA	12.00	19.44	NA
Maximum Decay Heat per DSC (kW)	31.2(1)					

(1) Adjust payload to maintain total DSC heat load within the specified limit.

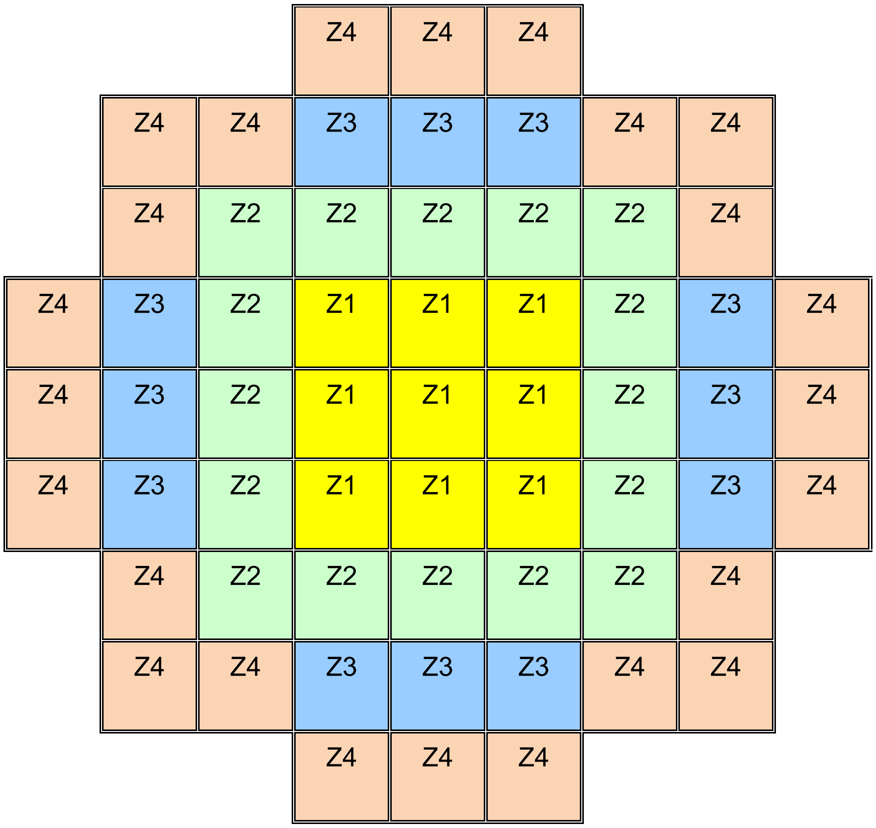
Figure 4G
Heat Load Zone Configuration 7 for the 61BTH Type 2 DSC



	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Maximum Decay Heat (kW/FA)	NA	0.35	0.393	0.48	0.54	NA
Maximum Decay Heat per Zone (kW)	NA	3.15	6.288	11.52	6.48	NA
Maximum Decay Heat per DSC (kW)	27.4[1]					

[1] Adjust payload to maintain total DSC heat load within the specified limit.

Figure 4H
Heat Load Zone Configuration 8 for the 61BTH Type 2 DSC



	Zone 1	Zone 2	Zone 3	Zone 4
Maximum Decay Heat (kW/FA)	0.393	0.48	0.35	0.35
Maximum Decay Heat per Zone (kW)	3.54	7.68	4.2	8.4
Maximum Decay Heat per DSC (kW)	22.0(1)			

Note 1: Adjust payload to maintain total canister heat load within the specified limit.

Figure 4I
Heat Load Zone Configuration 9 for the 61BTH Type 2 DSC

			Z4	Z4	Z4			
	Z4	Z4	Z3	Z3	Z3	Z4	Z4	
	Z4	Z2	Z2	Z2	Z2	Z2	Z4	
Z4	Z3	Z2	Z1	Z1	Z1	Z2	Z3	Z4
Z4	Z3	Z2	Z1	Z1	Z1	Z2	Z3	Z4
Z4	Z3	Z2	Z1	Z1	Z1	Z2	Z3	Z4
	Z4	Z2	Z2	Z2	Z2	Z2	Z4	
	Z4	Z4	Z3	Z3	Z3	Z4	Z4	
			Z4	Z4	Z4			

	Zone 1	Zone 2	Zone 3	Zone 4
Maximum Decay Heat (kW/FA)	0.393	0.48[(2)]	1.20[(2)]	0.48[(2)]
Maximum Decay Heat per Zone (kW)	3.54	7.68	14.4	11.52
Maximum Decay Heat per DSC (kW)	31.2[(1)]			

Note 1: Adjust payload to maintain total canister heat load within the specified limit.

Note 2: If the maximum decay heat per FA in Zone 3 is greater than 0.9 kW, the maximum decay heat per FA in Zone 2 and Zone 4 shall be less than or equal to 0.393 kW.

Figure 4J
Heat Load Zone Configuration 10 for the 61BTH Type 2 DSC

			C	C	C			
	A	B	C	C	C	B	A	
	B	B	C	C	C	B	B	
C	C	C	C	C	C	C	C	C
C	C	C	C	C	C	C	C	C
C	C	C	C	C	C	C	C	C
	B	B	C	C	C	B	B	
	A	B	C	C	C	B	A	
			C	C	C			

A	Corner Locations See Note 1		B	Interior Locations See Note 2
C	Interior/Edge Locations See Note 3			

Note 1: When loading up to 4 damaged or 4 failed assemblies, these must be placed in corner “A” locations, and the remaining locations “B” and “C” shall be loaded with intact fuel. If fewer than 4 damaged or 4 failed assemblies are to be stored, the remaining “A” locations may be loaded with intact fuel provided they meet the respective damaged or failed enrichment limits of Table 10 or Table 11. Damaged and failed fuel shall not be mixed, i.e., up to four damaged assemblies may be stored, or up to four failed assemblies may be stored in “A” locations.

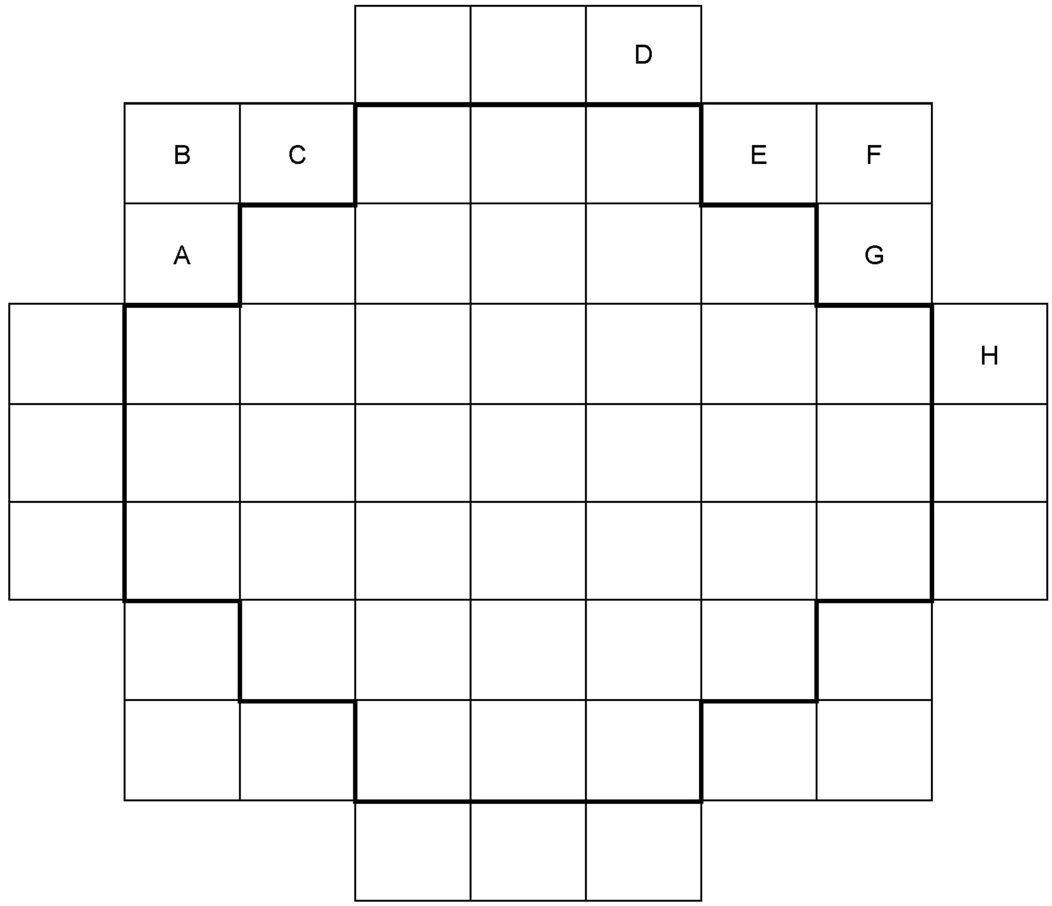
Note 2: If loading more than four damaged assemblies, place first four damaged assemblies in the corner “A” locations per Note 1, and up to 12 additional damaged assemblies in these interior “B” locations, with the remaining intact in a 61BTH Type 2 Basket. The maximum lattice average initial enrichment of assemblies (damaged or intact stored in the 2x2 cells) is limited to the “Five or More Damaged Assemblies” column of Table 10. For the 61BTH Type 2 DSC containing both damaged and failed fuel assemblies, this enrichment is limited to the “and up to 12 Damaged Assemblies” column of Table 11.

Note 3: If loading more than 16 damaged assemblies, place the first 57 damaged assemblies in the interior/edge "C" and the interior “B” locations. Place the remaining four intact or damaged assemblies in the corner "A" locations. The maximum lattice average initial enrichments of assemblies is limited to the “Remaining Four Intact Assemblies” or “Remaining Four Damaged Assemblies” column of Table 12.

Figure 5
Location of Damaged and Failed Fuel Assemblies inside the 61BTH Type 2 DSC

			P	P	P			
	P	P	I	I	I	P	P	
	P	I	I	I	I	I	P	
P	I	I	I	I	I	I	I	P
P	I	I	I	I	I	I	I	P
P	I	I	I	I	I	I	I	P
	P	I	I	I	I	I	P	
	P	P	I	I	I	P	P	
			P	P	P			

Figure 6
Peripheral (P) and Inner (I) Fuel Locations for the 61BTH Type 2 DSC



RECONSTITUTED FUEL ASSEMBLIES with ≤ 5 irradiated stainless steel rods may be loaded into all peripheral locations (i.e., not restricted). See Figure 6 for peripheral locations.

A RECONSTITUTED FUEL ASSEMBLY with > 5 and ≤ 10 irradiated stainless steel rods may be loaded in any peripheral location, with additional restrictions in accordance with Section 2.3. Examples:

- If Location B contains a RECONSTITUTED FUEL ASSEMBLY with > 5 irradiated stainless steel rods, peripherally adjacent Locations A and C shall contain fuel assemblies that do not contain irradiated stainless steel rods.
- If Locations E and G contain RECONSTITUTED FUEL ASSEMBLIES with > 5 irradiated stainless steel rods, peripherally adjacent Locations D, F, and H shall contain fuel assemblies that do not contain irradiated stainless steel rods.

Figure 7
Peripheral Location Restrictions for Reconstituted Fuel with Irradiated Stainless Steel Rods for the 61BTH Type 2 DSC

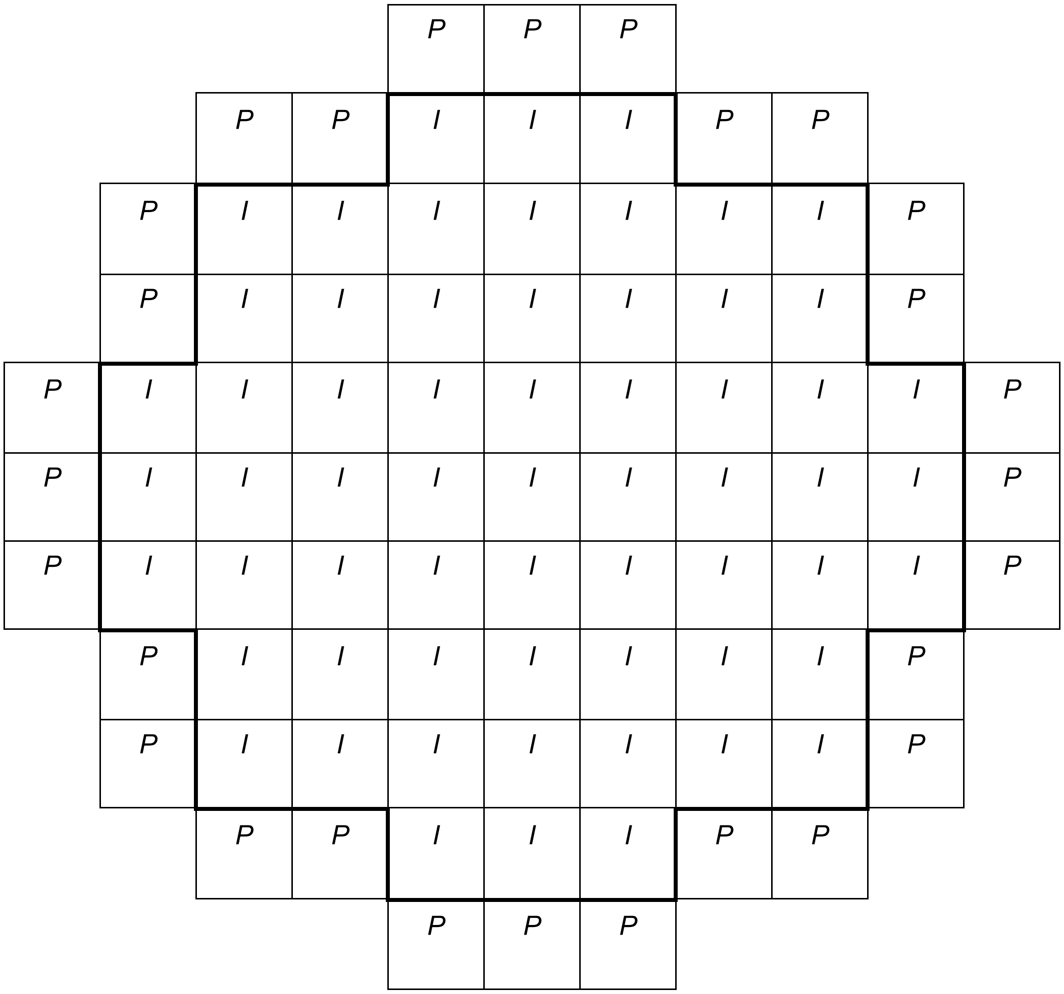


Figure 8
Peripheral (P) and Inner (I) Fuel Locations for the EOS-89BTH DSC

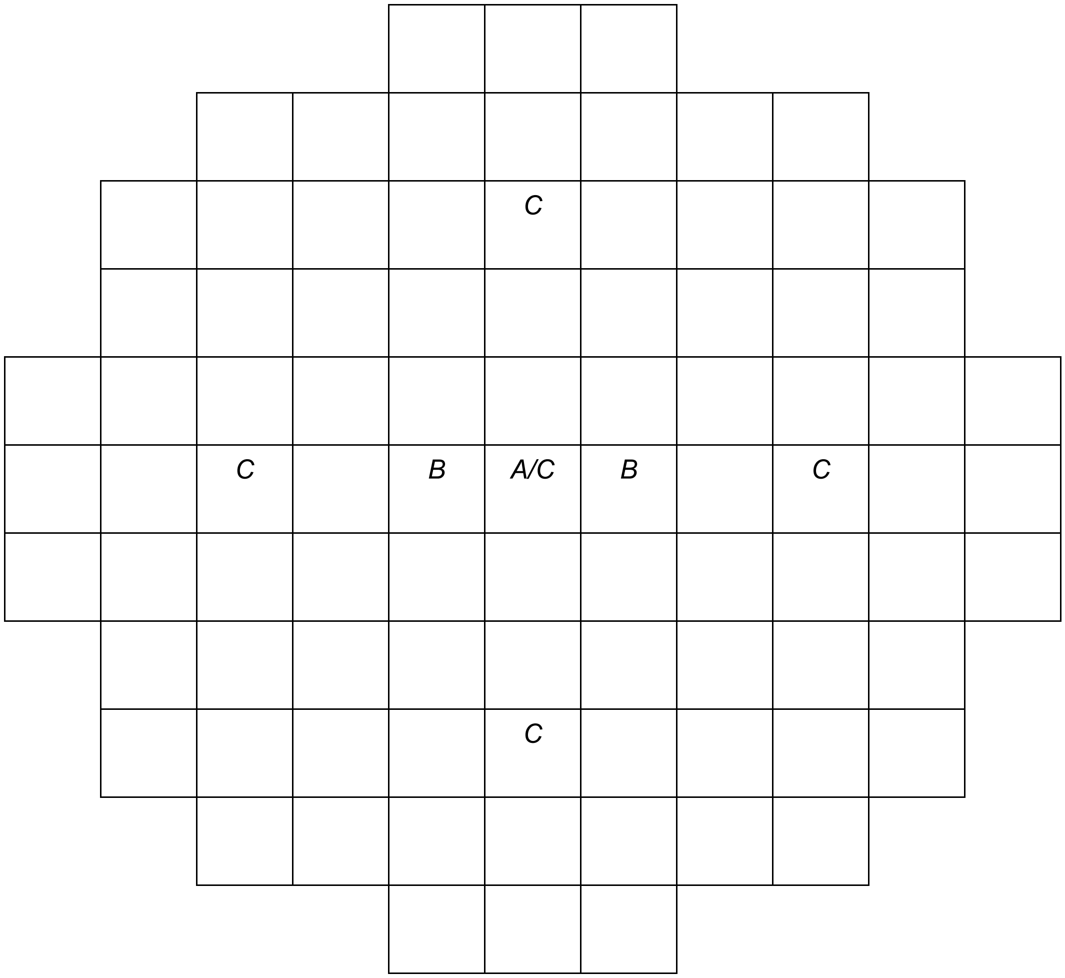
				X	*X*	*X*				
		X	*X*	*X*	*R*	*X*	*X*	*X*		
	X	*X*	*R*	*R*	*R*	*R*	*R*	*X*	*X*	
	X	*R*	*R*	*R*	*R*	*R*	*R*	*R*	*X*	
X	*X*	*R*	*R*	*R*	*R*	*R*	*R*	*R*	*X*	*X*
X	*R*	*R*	*R*	*R*	*R*	*R*	*R*	*R*	*R*	*X*
X	*X*	*R*	*R*	*R*	*R*	*R*	*R*	*R*	*X*	*X*
	X	*R*	*R*	*R*	*R*	*R*	*R*	*R*	*X*	
	X	*X*	*R*	*R*	*R*	*R*	*R*	*X*	*X*	
		X	*X*	*X*	*R*	*X*	*X*	*X*		
				X	*X*	*X*				

R = RECONSTITUTED FUEL ASSEMBLIES with irradiated stainless steel rods allowed at these locations.

X = RECONSTITUTED FUEL ASSEMBLIES with irradiated stainless steel rods not allowed at these locations.

Note: No restrictions on location for RECONSTITUTED FUEL ASSEMBLIES that do not contain irradiated stainless steel rods.

Figure 9
EOS-89BTH DSC Allowed Reconstituted Fuel Locations for Transfer in the EOS-TC108

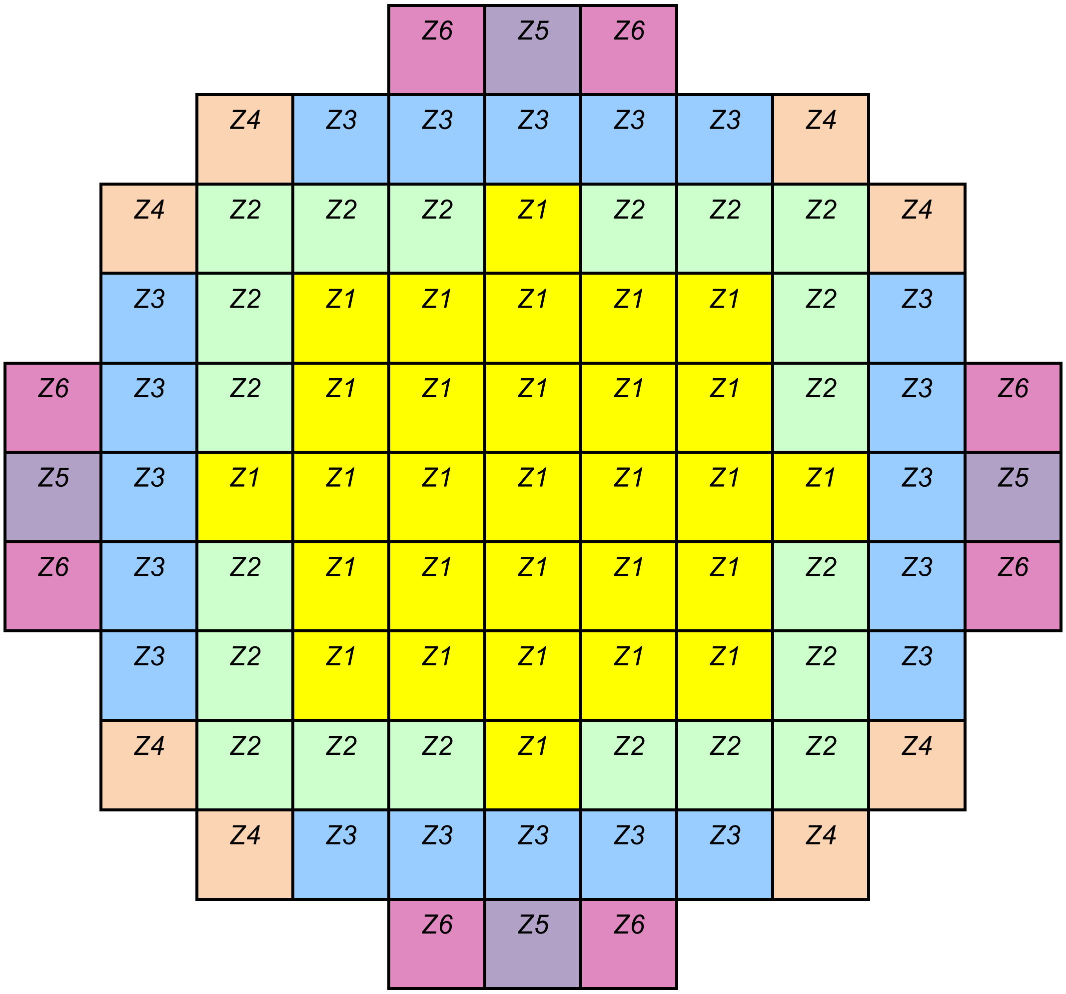


Note:

1. *Location identified as "A" is for empty placement in 88-FA Loading*
2. *Locations identified as "B" are for empty placements in 87-FA Loading*
3. *Locations identified as "C" are for empty placements in 84-FA Loading*

Figure 10
Empty Locations in Short-Loading Configurations for the EOS-89BTH DSC

All Indicated Changes are in response to Observation RSI 6-1



Zone No.	*Z1*	*Z2*	*Z3*	*Z4*	*Z5*	*Z6*
Max. Decay Heat per SFA (kW)	*0.40*	*0.60*	*1.30*	*1.70*	*1.30*	*1.70*
No. of Fuel Assemblies	*29*	*20*	*20*	*8*	*4*	*8*
Heat Load Per Zone	*11.6*	*12.0*	*26.0*	*13.6*	*5.2*	*13.6*
Max. Decay Heat per DSC (kW)	*See Note 1 for EOS-HSM and Note 2 for HSM-MX*					

Notes:

1. *Maximum heat load for EOS-89BTH DSC during Storage is 48.2 kW in EOS-HSM.*
2. *Maximum heat load for EOS-89BTH DSC during Storage is 48.2 kW in lower compartment of HSM-MX and 41.8 kW in upper compartment of HSM-MX.*

Figure 11
Maximum Heat Load Configuration 1 for EOS-89BTH DSC (MHLC-89-1) Transferred in the EOS-TC125

Enclosure 7 to E-58840

CoC 1042 Amendment 3, Revision 1 UFSAR Changed Pages

Withheld Pursuant to 10 CFR 2.390

Enclosure 8 to E-58840

CoC 1042 Amendment 3, Revision 1 UFSAR Changed Pages

(Public)

2.4.3.1 Methodology for Evaluating Additional HLZCs in EOS-89BTH DSC

OBS 4-4

This section provides the detailed methodology to qualify a new HLZC for EOS-89BTH DSC. HLZCs evaluated for use with the EOS-89BTH should follow the same methodology as described in Chapter 4, Section 4.9.8.2 for EOS-HSM and/or Appendix A.4, Section A.4.5.6 for HSM-MX depending on the storage module. Similarly, the methodology laid out in Chapter 4, Section 4.9.8.3 should be followed to ensure that the various design criteria for transfer operations are satisfied. The following steps present the methodology to qualify new HLZCs for EOS-89BTH DSC:

[ ]

4.2 Material and Design Limits

To establish the heat removal capability, several thermal design criteria are established for the NUHOMS® EOS System. These are:

- Maximum temperatures of the containment structural components must not adversely affect the containment function.
- A maximum fuel cladding temperature limit of 400 °C (752 °F) has been established for normal conditions of storage and for short-term storage operations such as transfer and vacuum drying [4-1]. During off-normal storage and accident conditions, the fuel cladding temperature limit is 570 °C (1058 °F) [4-1].
- A maximum temperature limit of 327 °C (620 °F) is considered for the lead in the TC, corresponding to the melting point [4-2].
- A maximum temperature limit of 128 °C (262 °F) is considered for the bottom neutron shield (Borotron® HD050) in the TC, corresponding to the melting point [4-3]. *For accident conditions, it is assumed that all neutron shielding materials including the bottom neutron shield are lost as discussed in Section 6.3.2. Since no credit is taken for the bottom neutron shielding material within the shielding evaluation during accident conditions, there is no temperature criteria for the neutron shield during accident conditions.*
- The temperature of the water in the neutron shield is limited by the rating of the pressure relief valves (20 psig) on the neutron shield. The temperature of the water cannot rise above the equivalent steam saturation temperature at this pressure (i.e., approximately 259 ºF) without risk of activating the relief valves and losing some of the water in the neutron shield.
- The ambient temperature ranges are -20 to 100 °F (-28.9 to 37.8 °C) for normal storage operations with heat load less than or equal to 41.8 kW for the EOS-37PTH DSC and 41.6 kW for the EOS-89BTH DSC. For normal storage operations with heat load greater than 41.8 kW for the EOS-37PTH DSC and 41.6 kW for the EOS-89BTH DSC, the minimum ambient temperature is -20 °F (-28.9 °C) and the maximum yearly average ambient temperature is 70 °F (21.1 °C). For off-normal storage operations, the ambient temperature range is -40 to 117 °F (-40 to 47.2 °C). The ambient temperature ranges are 0 to 100 °F (-17.8 to 37.8 °C) for normal transfer and 0 to 117 °F (-17.8 to 47.2 °C) for off-normal transfer operations. In general, all the thermal criteria are associated with maximum temperature limits and not minimum temperatures. All materials can be subjected to a minimum environment temperature of -40 °F (-40 °C) without adverse effects.
- The maximum DSC internal pressure during normal and off-normal conditions must be below the pressure of 20 psig used for structural evaluations. For hypothetical accident cases, the maximum DSC internal pressure must be lower than 130 psig. The evaluations of the maximum DSC internal pressure during normal, off-normal, and hypothetical accident conditions assume the rupture of 1%, 10 %, and 100% of the fuel rods, respectively.

All Indicated Changes are in response to Observation 4-10

Table 4-28
Maximum Temperatures of EOS-TC125 with EOS-37PTH DSC at 50 kW, Accident Loss of Neutron Shield with Loss of Air Circulation Accident Conditions

	Accident, Hot, Horizontal, Steady State Air filled Neutron Shield, (Load Case 5)	Maximum Allowable Temperature
Heat Load	50 kW	
Time Limit	-	
Components Name	Temperature (°F)	
Fuel Cladding	935	1058
DSC Shell	674	-
Inner Shell	583	-
Gamma Shield	579	620
Structural Shell (TC Outer Shell)	478	-
Neutron Shield Outer Skin	296	-
Solid Neutron Shield Avg.	257	*(N/A)*[1]
Closure Lid	255	-
Top Ring	316	-
Bottom Ring	304	-

Notes:

(1) For accident conditions, it is assumed that all neutron shielding materials including the bottom neutron shield are lost as discussed in Section 6.3.2. Therefore, the temperature limit of 262°F is not applicable to the bottom neutron shield for the accident case (LC5).

All Indicated Changes are in response to Observation 4-10

Table 4-29
Maximum Temperatures of Key Components in EOS-TC125 loaded with EOS-37PTH DSC

Component	Fuel Cladding	Basket Plate	Transition Rail	DSC Shell	Lead	Neutron Shield	Bottom Neutron Shield
	Temperature (°F)						
Temperature Limit	752(3)/1058(3)	--	--	--	620	259	262
Load Case							
1(1)	736	680	553	484	315	212	223
2	<734	<670	<552	<483	<344	<203	<172
3(1)	734	670	552	483	344	203	172
4	<734	<670	<552	<483	<344	<203	<172
5	935	902	750	674	579	N/A(4)	257*(6)*
6a(5)	732	673	532	452	364	194	121
6b	698	626	501	427	347	170	111
7(2)	737	679	548	474	371	201	148
8	732	687	557	495	342	236	228
9	<714	<669	<549	<487	<366	<227	<194
10	714	669	549	487	366	227	194

Notes:

(1) Temperature reported in transient case at 14 hours.

(2) Temperature reported in transient case at 6 hours.

(3) Temperature limit of 752 °F is applicable for all load cases except load case 5. For Load Case 5 a temperature limit of 1058 °F is considered. See Section 4.2 for additional details.

(4) It is assumed that the water in the neutron shield is lost during the accident condition.

(5) Temperature reported in transient case at 8 hours.

(6) For accident conditions, it is assumed that all neutron shielding materials including the bottom neutron shield are lost as discussed in Section 6.3.2. Therefore, the temperature limit of 262°F is not applicable to the bottom neutron shield for the accident case (LC5).

All Indicated Changes are in response to Observation 4-10

Table 4-34
Maximum Temperatures of Key Components in EOS-TC125 Loaded with EOS-89BTH DSC

Component	Fuel Cladding	Basket Plate	Transition Rail	DSC Shell	Lead	Neutron Shield	Bottom Neutron Shield
	Temperature (°F)						
Temperature Limit	752(4)/1058(4)	--	--	--	620	259	262
Load Case (3)							
1(1)	<736	<680	<553	<484	<315	<212	<223
2	<734	<670	<552	<483	<344	<203	<172
3(1)	<734	<670	<552	<483	<344	<203	<172
4	<734	<670	<552	<483	<344	<203	<172
5	<935	<902	<750	<674	<579	N/A(5)	<257*(7)*
6a(6)	<732	<673	<532	<452	<364	<194	<121
6b	<698	<626	<501	<427	<347	<170	<111
7(2)	<737	<679	<548	<474	<371	<201	<148
8	728	710	531	479	332	230	238
9	<728	<710	<531	<479	<332	<230	<238
10	<728	<710	<531	<479	<332	<230	<238

Notes:

(1) Temperature reported in transient case at 14 hours.

(2) Temperature reported in transient case at 6 hours.

(3) See Table 4-23 for the description of the load cases.

(4) Temperature limit of 752 °F is applicable for all load cases except load case 5. For Load Case 5 a temperature limit of 1058 °F is considered. See Section 4.2 for additional details.

(5) It is assumed that the water in the neutron shield is lost during the accident condition.

(6) Temperature reported in transient case at 8 hours.

(7) For accident conditions, it is assumed that all neutron shielding materials including the bottom neutron shield are lost as discussed in Section 6.3.2. Therefore, the temperature limit of 262°F is not applicable to the bottom neutron shield for the accident case (LC5).

All Indicated Changes are in response to Observation 4-10

Table 4-40
Maximum Temperatures of Key Components in EOS-TC108 Loaded with EOS-37PTH DSC

Component	Fuel Cladding	Basket Plate	Transition Rail	DSC Shell	Lead	Neutron Shield	Bottom Neutron Shield
	Temperature (°F)						
Temperature Limit	752[4]/1058[4]	--	--	--	620	259	262
Load Case [3]							
1[1]	<736	<680	<553	<484	<315	<212	<223
2	<734	<670	<552	<483	<344	<203	<172
3[1]	<734	<670	<552	<483	<344	<203	<172
4	<734	<670	<552	<483	<344	<203	<172
5	<935	<902	<750	<674	<579	N/A[5]	<257[7]
6a[6]	<732	<673	<532	<452	<364	<194	<121
6b	<698	<626	<501	<427	<347	<170	<111
7[2]	<737	<679	<548	<474	<371	<201	<148
8	737	692	563	498	347	243	228
9	<737	<692	<563	<498	<347	<243	<228
10	<737	<692	<563	<498	<347	<243	<228

Notes:

(1) Temperature reported in transient case at 14 hours.

(2) Temperature reported in transient case at 6 hours.

(3) See Table 4-36 for the description of the load cases.

(4) Temperature limit of 752 °F is applicable for all load cases except load case 5. For Load Case 5 a temperature limit of 1058 °F is considered. See Section 4.2 for additional details.

(5) It is assumed that the water in the neutron shield is lost during the accident condition.

(6) Temperature reported in transient case at 8 hours.

(7) For accident conditions, it is assumed that all neutron shielding materials including the bottom neutron shield are lost as discussed in Section 6.3.2. Therefore, the temperature limit of 262°F is not applicable to the bottom neutron shield for the accident case (LC5).

All Indicated Changes are in response to Observation 4-10

Table 4-43
Maximum Temperatures of Key Components in EOS-TC108 Loaded with EOS-89BTH DSC

Component	Fuel Cladding	Basket Plate	Transition Rail	DSC Shell	Lead	Neutron Shield	Bottom Neutron Shield
	Temperature (°F)						
Temperature Limit	752(4)/1058(4)	--	--	--	620	259	262
Load Case (3)							
1(1)	<736	<680	<553	<484	<315	<212	<223
2	<734	<670	<552	<483	<344	<203	<172
3(1)	<734	<670	<552	<483	<344	<203	<172
4	<734	<670	<552	<483	<344	<203	<172
5	<935	<902	<750	<674	<579	N/A(5)	<257*(7)*
6a(6)	<732	<673	<532	<452	<364	<194	<121
6b	<698	<626	<501	<427	<347	<170	<111
7(2)	<737	<679	<548	<474	<371	<201	<148
8	733	715	538	483	339	237	239
9	<733	<715	<538	<482	<339	<237	<239
10	<733	<715	<538	<482	<339	<237	<239

Notes:

(1) Temperature reported in transient case at 14 hours.

(2) Temperature reported in transient case at 6 hours.

(3) See Table 4-36 for the description of the load cases.

(4) Temperature limit of 752 °F is applicable for all load cases except load case 5. For Load Case 5 a temperature limit of 1058 °F is considered. See Section 4.2 for additional details.

(5) It is assumed that the water in the neutron shield is lost during the accident condition.

(6) Temperature reported in transient case at 8 hours.

(7) For accident conditions, it is assumed that all neutron shielding materials including the bottom neutron shield are lost as discussed in Section 6.3.2. Therefore, the temperature limit of 262°F is not applicable to the bottom neutron shield for the accident case (LC5).

All Indicated Changes are in response to Observation 4-10

A condition is also postulated where the air circulation is lost during transfer operation. To minimize the occurrence of this condition, the EOS-TC125 skid is equipped with redundant industrial grade blowers and each one of these blowers is capable of supplying the required minimum airflow rate. These blowers are also powered with a redundant power supply.

Both of the above scenarios (i.e., turning off air circulation to offload the EOS-89BTH DSC to the storage module or failure of the air circulation) will decrease the heat dissipation and result in a gradual increase of the maximum temperatures of the EOS-TC125 and EOS-89BTH DSC components. Therefore, for these conditions, an additional time limit is calculated to complete the transfer of the EOS-89BTH DSC from the EOS-TC125 to the storage module or to restart the air circulation or initiate other recovery operations to ensure that the peak fuel cladding temperature remains below the temperature limit of 752 °F established in [4.9.8-5].

Observation 4-9

Section 4.5.11 presents the thermal evaluation for the EOS-89BTH DSC during loading operations, including vacuum drying.

For all the normal, off-normal hot conditions, and accident design LCs considered in Table 4.9.8-8, insolation is considered per 10 CFR 71.71 [4.9.8-6].

4.9.8.3.2 EOS-89BTH DSC - Thermal Model for Transfer in EOS-TC125

4.9.8.3.3 EOS-89BTH DSC - Normal and Off-Normal Conditions of Transfer

Due to the high decay heat loads considered for the EOS-89BTH DSC, certain time limits are applicable to the transfer operations under normal and off-normal conditions. The time limits are established to maintain the fuel cladding and the EOS-TC125 components temperatures below the allowable limits based on various LCs discussed in Section 4.9.8.3.1. An overview of these time limits is provided in Section 4.9.8.3.4 and Table 4.9.8-13.

As described in Section 4.9.8.3.1, the maximum temperatures and time limits determined for the EOS-89BTH DSC with HLZC 4 during transfer in EOS-TC125 bound the maximum temperatures and time limits determined for the EOS-89BTH DSC with HLZCs 5 and 6.

All Indicated Changes are in response to Observation 4-1

Proprietary Information on Pages 4.9.8-16 through 4.9.8-18
Withheld Pursuant to 10 CFR 2.390

Table 4.9.8-3
Maximum Fuel Cladding and Concrete Temperatures of EOS-HSM loaded with EOS-89BTH DSC

LC (1)	Description	Fuel Cladding Temperature (°F)		Concrete Temperature (°F)	
		Maximum	Limit(1)	Maximum	Limit(1)
1	[	729	752	220	300
1b		723		259	
2		752	1058	253	
3	]	858		*438*	500

Notes:

(1) See Table 4.9.8-1 for the description of the LCs.

(2) The temperature limits are from NUREG-1536 [4.9.8-5].

All Indicated Changes are in response to RSI 4-1

Table 4.9.8-4
Maximum Temperatures of Key Components of EOS-HSM Loaded with EOS-89BTH DSC

LC [(1)]	Temperature (°F)				
	Basket Plate	Transition Rails	DSC Shell	Heat Shield	Support Structure
1	709	487	413	207	323
1b	704	492	422	265	334
2	733	515	428	240	344
3	844	652	584	*460*	*498*

Notes:

(1) See Table 4.9.8-1 for the description of the LCs.

Table 4.9.8-5
Average Temperatures of Key Components of EOS-HSM Loaded with EOS-89BTH DSC

LC (1)	Temperature (°F)					
	Fuel Assembly	Cavity Gas	DSC Shell	Basket Plates	Transition Rails	HSM
1	574	360	244	521	408	124
1b	572	379	275	525	418	155
2	596	384	272	544	432	161
3	715	519	413	669	571	*219*

Notes:

(1) See Table 4.9.8-1 for the description of the LCs.

Table 4.9.8-6
Summary of Air Temperatures and Mass Flow Rates at Inlet and Outlet of EOS-HSM Loaded with EOS-89BTH DSC

LC (1)	T_{inlet} (°F)	T_{exit} (°F)	T_{exit}-T_{inlet} (°F)	Mass Flow Rate at Inlet (kg/s)		
				Inlet	Outlet	Imbalance
1	70	139	69	8.61E-01	8.48E-01	1.31E-02
1b	90	111	*21*	5.10E-01	5.03E-01	7.10E-03
2	103	197	94	8.48E-01	8.48E-01	6.72E-05

Notes:

(1) See Table 4.9.8-1 for the description of the LCs.

All Indicated Changes are in response to Observation 4-10

Table 4.9.8-11
Maximum Temperatures of EOS-TC125 with EOS-89BTH DSC at 48.2 kW, Accident Loss of Neutron Shield with Loss of Air Circulation Accident Conditions

	Accident, Hot, Horizontal, Steady State Air filled Neutron Shield, (LC 5)	Max. Allowable Temperature
Heat Load	48.2 kW	
Time Limit	-	
Components Name	Temperature (°F)	
Fuel Cladding	935	1058
DSC Shell	651	-
Inner Shell	561	-
Gamma Shield	556	620
Structural Shell (TC Outer Shell)	445	-
Neutron Shield Outer Skin	345	-
Solid Neutron Shield (Max/Avg)	354/292	*(N/A)*(1)
Closure Lid	206	-
Top Ring	262	-
Bottom Ring	341	-

Notes:

(1) For accident conditions, it is assumed that all neutron shielding materials including the bottom neutron shield are lost as discussed in Section 6.3.2. Therefore, the temperature limit of 262°F is not applicable to the bottom neutron shield for the accident case (LC5).

All Indicated Changes are in response to Observation 4-10

Table 4.9.8-14
Maximum Temperatures of Key Components in EOS-TC125 loaded with EOS-89BTH DSC

LC	Fuel Cladding	Basket Plate	Transition Rail	DSC Shell	Lead (Gamma Shield)	Neutron Shield	Bottom Neutron Shield
Temperature Limit (°F)	752(4)/ 1058(4)	--	--	--	620	259	262
	Temperature (°F)						
1(1)	682	664	500	450	293	196	231
1(2)	718	701	530	477	318	209	235
2	<709	<694	<536	<478	<348	<201	<207
3(1)	674	658	506	451	322	189	199
3(2)	709	694	536	478	348	201	207
4	<709	<694	<536	<478	<348	<201	<207
5	935	921	715	651	556	NA(5)	292*(7)*
6a(6)	707	687	496	429	355	187	138
6b	683	666	487	427	357	171	123
7(3)	710	691	514	448	364	191	161

Notes:

(1) Temperature reported in transient case at 8 hours.

(2) Temperature reported in transient case at 13 hours.

(3) Temperature reported in transient case at 4 hours.

(4) Temperature limits for normal and off-normal conditions are 752 °F and 1058 °F, respectively.

(5) It is assumed that the water in the neutron shield is lost during the accident condition.

(6) Temperature reported in transient case at 8 hours.

(7) For accident conditions, it is assumed that all neutron shielding materials including the bottom neutron shield are lost as discussed in Section 6.3.2. Therefore, the temperature limit of 262°F is not applicable to the bottom neutron shield for the accident case (LC5).

All Indicated Changes are in response to Observation 4-10

Proprietary Information on Pages 4.9.8-35 through 4.9.8-38
Withheld Pursuant to 10 CFR 2.390

Proprietary Information on Pages 4.9.8-45 and 4.9.8-46
Withheld Pursuant to 10 CFR 2.390

C. Determination of the Maximum Initial Enrichment for *89* BWR Fuel Assemblies

The design basis KENO model with the *GNF2* fuel assembly design is employed to determine the maximum allowable initial enrichment for the three allowable fixed poison loadings. The KENO model employed herein incorporates the bounding modeling features evaluated in the previous evaluations and also is consistent with the actual design dimensions as discussed in the Section 7.3.1. The results of the criticality analyses are shown in Table 7-43. These results demonstrate that the maximum k_{eff} of the system remains below *the* USL.

[ ]

All Indicated Changes are in response to RSI 6-1

[ ]

D. Determination of Maximum Allowable Enrichment for Short-Loading Scenarios

Higher enrichments may be achieved when considering less than 89 BWR fuels loaded in the 89BTH DSC (i.e., short-loading). For M1-A and M1-B basket types, higher enrichment limits are developed for three short loading scenarios of 88, 87, and 84 fuel assemblies. Because ABB-10-C and ATRIUM 11 fuel classes are more reactive than the GNF2 fuel used to bound all other fuel assembly classes, separate enrichment limits are developed for each fuel assembly class. The KENO models employed herein incorporate the bounding modelling features evaluated in the 89 fuel assembly analysis.

The short-loading scenarios are illustrated in Figure 7-28 through Figure 7-30. The empty locations indicated in these figures must remain empty when taking credit for a reduced number of fuel assemblies (i.e., dummy fuel assemblies are not allowed in these locations). The results for the GNF2, ABB-10-C, and ATRIUM 11 fuel assembly classes are presented in Table 7-43a.

E. Summary of Enrichment Limits

The enrichment limits from Table 7-43 (for 89 fuel assemblies) and from Table 7-43a (for short-loading) are consolidated in Table 7-4.

7.4.4 Criticality Results

In Table 7-44, a summary of the bounding scenarios that exist for both the EOS-37PTH and EOS-89BTH are presented. These are: dry storage condition, applicable to the DSC and placed in the EOS-HSM, normal loading or unloading operation where the DSC is in the fuel pool with 100% internal moderator density, and condition where the internal moderator density is at the optimum calculated for maximum reactivity.

For the EOS-37PTH, loading of intact fuels only, the most reactive case for the normal loading or unloading condition is calculated for the CE 15x15 class FA with 4.75 wt. % U-235, Type B basket, without CCs and 2000 ppm of soluble boron 100% internal moderator density, which is also the most optimum density. For the dry storage condition, this CE 15x15 case is modified by changing the internal and external moderator density to air, because this results in a bounding dry condition scenario.

All Indicated Changes are in response to RSI 6-1

For the EOS-37PTH, loading of damaged or failed fuels balanced with intact fuels, the most reactive case for the normal loading or unloading condition is calculated for the WE 17x17 class FA with 4.85 wt. % U-235 for intact fuels and 4.85 wt. % U-235 for failed fuels, (Basket Type B, without CCs and 2300 ppm of soluble boron 90% internal moderator density).

For the EOS-89BTH the most reactive case for the normal loading or unloading condition is calculated for the *ATRIUM 11 with 84 FAs at 4.80 wt.% U-235*, Type *M1*-A basket and 100% internal moderator density, which is also the optimum density. *The dry storage condition is based on 89 GNF2 FAs at 4.85 wt. % U-235. The dry model is developed from the equivalent moderated model* by changing the internal and external moderator density to *void (i.e., water with density of 1E-07 g/cm^3),* as this results in a bounding dry condition scenario. 72.48

The criterion for subcriticality is that:

$$k_{keno} + 2\sigma_{keno} < USL$$

where USL is the upper subcriticality limit established by an analysis of benchmark criticality experiments. From Section 7.5 the USL for the EOS-37PTH DSC is 0.9404 while the USL for the EOS-89BTH DSC is 0.9418.

From Table 7-44, the most reactive case determined for PWR intact fuel storage only is:

$$k_{keno} + 2\sigma_{keno} = 0.9371+2*0.0007=0.9385 < 0.9404,$$

From Table 7-44, the most reactive case determined for the storage of a maximum of up to eight damaged PWR FAs or up to four FFCs containing failed PWR fuel balanced with intact PWR FAs:

$$k_{keno} + 2\sigma_{keno} = 0.9370+2*0.0007=0.9384 < 0.9404,$$

From Table 7-44, the most reactive case determined for BWR fuel storage is:

$$k_{keno} + 2\sigma_{keno} = 0.9399+2*0.0005= 0.9409 < 0.9418.$$

All Indicated Changes are in response to RSI 6-1

7.5.3 Results of the Benchmark Calculations

The k_{eff} values of the 92 experiments are examined to determine correlation against the independent parameters listed in Section 7.5.2. The results in Table 7-47 indicate that there is no close correlation. The k_{eff} values are normally distributed and therefore, a single-sided lower tolerance limit USL is computed according to the methodology described in NUREG/CR-6698. The USL for the EOS-37PTH DSC is 0.9404. The results are summarized in Table 7-48.

The highest k_{eff} obtained for fuels loaded in the EOS-37PTH DSC is 0.9371+2*0.0007=0.9385, which is less than the USL of 0.9404.

The k_{eff} values of the 51 experiments are examined to determine correlation against the independent parameters listed in Section 7.5.2. The results in Table 7-47 indicate that there is no close correlation. The k_{eff} values are normally distributed and, therefore, a single-sided lower tolerance limit USL is computed according to the methodology described in NUREG/CR 7109. The USL for the EOS-89BTH DSC is 0.9418. The results are summarized in Table 7-48.

The highest k_{eff} obtained for fuels loaded in the EOS-89BTH DSC is *0.9399*+2**0.0005*= *0.9409*, which is less than the USL of 0.9418.

All Indicated Changes are in response to RSI 6-1

Table 7-4
EOS-89BTH Maximum Lattice Average Initial Enrichment

Basket Type	***Number of Assemblies[(1)]***	***Maximum Lattice Average Initial Enrichment (wt.% U-235)***		
		All fuel Except ABB-10-C and ATRIUM 11	***ABB-10-C Fuel***	***ATRIUM 11 Fuel***
M1-A (A1/A2/A3)	*89*	*4.20*	*4.05*	*4.05*
	88	*4.45*	*4.25*	*4.25*
	87	*4.60*	*4.40*	*4.35*
	84	*5.00*	*4.90*	*4.80*
M1-B (B1/B2/B3)	*89*	*4.55*	*4.35*	*4.30*
	88	*4.80*	*4.60*	*4.50*
	87	*4.95*	*4.70*	*4.65*
	84	*5.00*	*5.00*	*5.00*
M2-A (C1/C2/C3)	*89*	*4.85*	*4.60*	*(3)*

Note:

1. *When short-loading the basket, allowable loading patterns are defined in Figure 7-28, Figure 7-29, and Figure 7-30. Locations marked as empty in these figures shall not contain fuel or dummy fuel.*
2. *Mixing fuel types in the same DSC is permissible based on the calculated enrichments for each fuel type for a given basket type and loading configuration. For example, when mixing GNF2 and ATRIUM 11 fuels in an M1-A poison type DSC and 88-fuel-assembly loading configuration, the maximum enrichment for GNF2 fuels is 4.45wt% and the maximum enrichment for ATRIUM 11 fuels is 4.25wt%.*
3. *ATRIUM 11 fuel is not an allowed content for DSCs utilizing M2-A poison.*

All Indicated Changes are in response to RSI 6-1

Table 7-43
Determination of Minimum Poison Loading Requirement, *89 Fuel Assemblies*

Basket Type	***Enrichment (wt% of U-235)***	***As-Modeled B-10 Content (mg/cm^2)***	k_{keno}	σ_{keno}	k_{eff}
All Fuel Except ABB-10-C and ATRIUM 11					
MMC	*4.20*	*29.4*	*0.9375*	*0.0005*	*0.9385*
	4.55	*37.2*	*0.9383*	*0.0005*	*0.9393*
BORAL®	*4.85*	*45.0*	*0.9380*	*0.0005*	*0.9390*
ABB-10-C Fuel					
MMC	***4.05***	***29.4***	***0.9386***	***0.0005***	***0.9396***
	4.35	*37.2*	*0.9380*	*0.0005*	*0.9390*
BORAL®	*4.60*	*45.0*	*0.9375*	*0.0005*	*0.9385*
ATRIUM 11 Fuel					
MMC	*4.05*	*29.4*	*0.9389*	*0.0005*	*0.9399*
	4.30	*37.2*	*0.9382*	*0.0005*	*0.9392*

All Indicated Changes are in response to RSI 6-1

Table 7-43a
Maximum Allowable Enrichment Values, EOS-89BTH DSC Short-Loading

As-Modeled B-10 Content (mg/cm²)	*Number of Assemblies*	*Enrichment (wt.% U-235)*	k_{keno}	σ_{keno}	k_{eff}
All Fuel Except ABB-10-C and ATRIUM 11					
29.4	*88*	*4.45*	*0.9385*	*0.0005*	*0.9395*
	87	*4.60*	*0.9392*	*0.0005*	*0.9402*
	84	*5.00*	*0.9330*	*0.0005*	*0.9340*
37.2	*88*	*4.80*	*0.9384*	*0.0005*	*0.9394*
	87	*4.95*	*0.9387*	*0.0005*	*0.9397*
	84	*5.00*	*0.9181*	*0.0005*	*0.9191*
ABB-10-C Fuel					
29.4	*88*	*4.25*	*0.9388*	*0.0005*	*0.9398*
	87	*4.40*	*0.9393*	*0.0005*	*0.9403*
	84	*4.90*	*0.9392*	*0.0005*	*0.9402*
37.2	*88*	*4.60*	*0.9394*	*0.0005*	*0.9404*
	87	*4.70*	*0.9381*	*0.0005*	*0.9391*
	84	*5.00*	*0.9285*	*0.0005*	*0.9295*
ATRIUM 11 Fuel					
29.4	*88*	*4.25*	*0.9393*	*0.0005*	*0.9403*
	87	*4.35*	*0.9398*	*0.0005*	*0.9408*
	84	***4.80***	***0.9399***	***0.0005***	***0.9409***
37.2	*88*	*4.50*	*0.9389*	*0.0004*	*0.9397*
	87	*4.65*	*0.9391*	*0.0005*	*0.9401*
	84	*5.00*	*0.9340*	*0.0005*	*0.9350*

All Indicated Changes are in response to RSI 6-1

Table 7-44
Criticality Results

EOS-37PTH: Regulatory Requirements for Storage			
Configuration	k_{keno}	σ_{keno}	k_{eff}
Dry Storage (Bounded by infinite array of undamaged storage casks) for intact fuel assemblies	0.6203	0.0003	0.6209
Normal Loading and Unloading Conditions (Optimum Moderator Density) for intact fuel assemblies	0.9371	0.0007	0.9385
Normal Loading and Unloading Conditions (Optimum Moderator Density) for damaged and failed fuels balanced with intact fuels	0.9370	0.0007	0.9384
USL = 0.9404			
EOS-89BTH: Regulatory Requirements for Storage			
Configuration	k_{keno}	σ_{keno}	k_{eff}
Dry Storage (Bounded by infinite array of undamaged storage casks)	*0.4909*	*0.0004*	*0.4917*
Normal Loading and Unloading Conditions (Optimum Moderator Density)	*0.9399*	*0.0005*	*0.9409*
USL = 0.9418			

All Indicated Changes are in response to RSI 6-1

Table 7-81
EOS-37PTH - Maximum Uranium Mass per FFC, Failed Fuel Debris Analysis

Fissile Rods Diameter	Maximum Uranium Mass
10x10 array size	
0.8 inch	1104 kg
0.6 inch	621 kg
9x9 array size	
0.9 inch	1132 kg
0.6 inch	503kg
8x8 array size	
1 inch	1104 kg
0.6 inch	397 kg

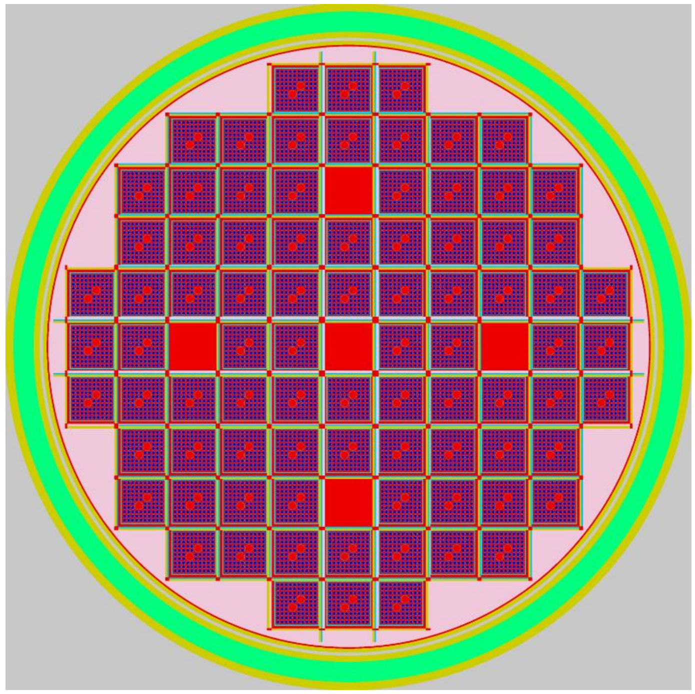
Note: This table presents the as-modeled uranium masses in the failed fuel debris models. The MTU limits for an FFC containing failed fuel are defined in Chapter 2, Table 2-4b.

Table 7-82
Sensitivity Analysis on ATRIUM 11 Lattices

[ ]

All Indicated Changes are in response to RSI 6-1

Proprietary Information on Pages 7-179 and 7-180
Withheld Pursuant to 10 CFR 2.390



(GNF2 Fuel Depicted)

Figure 7-30
Cross-Sectional View of NUHOMS® EOS-89BTH DSC Loaded with 84 Fuel Assemblies

All Indicated Changes are in response to RSI 6-1

Proprietary Information on This Page
Withheld Pursuant to 10 CFR 2.390

1. Disconnect the VDS from the DSC. Seal weld the prefabricated cover plate over the drain port, inject helium into blind space just prior to completing welding, and perform root and final dye penetrant weld examinations in accordance with Section 4.4.4 of the Technical Specification [9-5] requirements.

2. Temporary shielding may be installed as necessary to minimize personnel exposure. *Place the outer top cover plate (OTCP)* onto the DSC. Verify proper fit up of the OTCP with the DSC shell. *Install the welding machine onto the OTCP.* 72.48

3. Tack weld the OTCP to the DSC shell. Place the OTCP weld. *If the weld will be inspected by multi-layer PT, place only the* root pass.

4. Helium leak test the inner top cover plate and vent/drain port plug/plate welds using the leak test port in the OTCP in accordance with Section*s* 4.4.4 *and 5.1.2.f* of the Technical Specification [9-5] limits. Verify that the personnel performing the leak test are qualified in accordance with SNT-TC-1A [9-3]. Alternatively, this can be done with a test head prior to installing and welding the OTCP. *The use of a test head is recommended when the outer top cover will be welded by single pass HA-GTAW.* 72.48

5. If a leak is found, remove the OTCP *weld*, the *drain port cover and vent port plug welds,* and repair the ITCP welds. Repeat procedure steps from Section 9.1.3 Step *14*. 72.48

6. Perform dye penetrant examination of the *OTCP* root pass weld. Weld out the OTCP to the DSC shell. Perform root and multilayer dye penetrant examination in accordance with Section 4.4.4 of the Technical Specifications [9-5]. *The OTCP-to-shell weld may instead be examined by UT per Section 4.4.4 of the Technical Specifications [9-5].* 72.48

7. Seal weld the prefabricated plug over the *OTCP* test port and perform root and final dye penetrant weld examinations. 72.48

8. Remove the welding machine from the DSC.

All Indicated Changes are in response to RSI 9-1

Table A.4-45
Maximum Fuel Cladding and Concrete Temperatures for Storage Conditions of EOS-89BTH DSC in Updated HSM-MX with HLZCs 3 through 6

Load Case (1)	Description	Max Fuel Cladding Temperature (°F)			Concrete Temperature (°F)	
		Upper Compartment	Lower Compartment	Limit (2)	Maximum(4)	Limit (2)
1a (3)		<731	<711	752	<281	300
1b (3)		<678	<718	752	<240	300
1c (3)		<751	<790	1058	<342	500(6)
2a		731	711	752	281	300
2b		678	718	752	240	300
2c		751	790	1058	342	500(6)
3a		677	677	752	281	300
3b (4)		<678	<718	752	<240	300
3c (5)		<751	<790	1058	<342	500(6)
4a		686	685	752	278	300
4b (4)		<678	<718	752	<240	300
4c (5)		<751	<790	1058	<342	500(6)

Notes:

(1) See Table A.4-43 for the description of the LCs.

(2) The temperature limits are from NUREG-1536 [A.4-1].

(3) Load Cases 1a, 1b and 1c are bounded by Load Cases 2a, 2b and 2c, respectively, due to lower heat load.

(4) Load Cases 3b and 4b are bounded by Load Case 2b.

(5) Load Cases 3c and 4c are bounded by Load Case 2c.

(6) The temperature limit for concrete at accident condition is 500 °F. The maximum concrete temperature for accident conditions is above the 350 °F limit given in ACI 349-06 [A.4-4]. Testing will be performed, as described in Chapter A.8, Section A.8.2.1.3.

All Indicated Changes are in response to RSI 4-1

Proprietary Information on Pages A.4-96 and A.4-97
Withheld Pursuant to 10 CFR 2.390

All Indicated Changes are in response to RSI 4-1

Proprietary Information on Pages A.4-163 through A.4-165
Withheld Pursuant to 10 CFR 2.390

All Indicated Changes are in response to RSI 4-1

Listing of Computer Files Contained in Enclosure 10

Disk ID No. (size)	Discipline	System/Component	File Series (topics)	Number of Files
Enclosure 10 One Computer Hard Drive Total (86.20 GB) Thermal (85.90 GB) Criticality (0.020 GB)	**Thermal**	**EOS-89BTH DSC in HSM-MX**	**Section_ A.4.5.6-LC2c (LC 2c in Table A.4-43)** Input and output files for the bounding accident storage evaluation of EOS-89BTH DSC in HSM-MX with HLZC 4 (ANSYS FLUENT Evaluation)	5
		EOS-89BTH DSC in EOS-HSM	**Section_4.9.8.2-LC3 (LC 3 in Table 4.9.8-1)** Input and output files for the bounding accident storage condition of EOS-89BTH DSC in EOS-HSM with HLZC 4. (ANSYS FLUENT Evaluation)	5
		EOS-89BTH DSC in EOS-TC125	**Section_4.9.8.3.6-LC3s (LC 3S in Table 4.9.8-17)** Input and output files for the sensitivity study of the variable lead gamma shielding thickness for EOS-89BTH DSC in EOS-TC125 with HLZC 4 during transfer operations. (ANSYS FLUENT Evaluation)	11
	Criticality	**EOS-89BTH DSC**	**Section 7.4.3 EOS-89BTH DSC Folder:\Criticality** - subfolders for 89 fuel assembly loading for ATRIUM 11 and short-loading scenarios for each main fuel class (i.e., GNF2, ABB-10-C, and ATRIUM 11)	52

Background and Technical Discussion

For the NUHOMS® systems, Heat Load Zoning Configurations (HLZCs) are typically provided in the Technical Specifications (TS). This ensures that the maximum temperatures evaluated within the system remain within the allowable limits as approved by the U.S. NRC (NRC). Due to the large number of HLZCs proposed for each system and the repetitive nature of adding HLZCs, TN is proposing a graded approach to consolidate the key safety parameters with respect to the heat load of the dry shielded canister (DSC) into one Figure within the TS. This maximum heat load configuration (MHLC) is presented as Figure 11 in the TS, and individual HLZCs are relocated to Chapter 2 of the Updated Safety Analysis Report (UFSAR) for the EOS-89BTH when transferred in the EOS-TC125.

In developing this, TN utilized the graded approach from the Application for Amendment 16 to Certificate of Compliance (CoC) No. 1004. The graded approach in Amendment 16 to CoC 1004 considered various criteria to determine whether an item remains within the CoC, Inspections, Tests, and Examinations (ITE), or TS. However, no technical changes or methodology improvements were to be considered in that pilot application. This application proposes a combination of both, i.e., it utilizes the Graded Approach (based on criteria for Section 2, Approved Contents and the three risk insight questions), along with a new methodology to simplify the amount of information within the TS while ensuring the same level of safety assurance. Based on this approach,

1. Figure 11 replaces the individual EOS-89BTH HLZCs within the TS while retaining three key limitations, as discussed below, to define the thermal performance of the system.

2. Individual HLZCs are described in Chapter 2 of the UFSAR based on Figure 11 of the TS.

The following three conditions serve as guidelines to achieve the same intended objective (i.e., ensure the maximum component temperatures remain within the allowable limits as approved by NRC while also providing flexibility to TN and it users to customize HLZCs based on customer needs). The three conditions retained within Figure 11 of the TS include:

1. A limit on the maximum allowable heat load within the DSC as required per 10 CFR 72.236(a).

[ ]

2. A limit on the maximum allowable heat load within each fuel compartment/zone.

[ ]

3. Limitations on the methodology to evaluate new HLZCs:

Proprietary Information on Pages 3 and 4
Withheld Pursuant to 10 CFR 2.390