PROPOSED RENEWED AMENDMENT NUMBER 19 TO COC 1004

APPENDIX A

INSPECTIONS, TESTS, AND EVALUATIONS FOR THE STANDARDIZED NUHOMS® HORIZONTAL MODULAR STORAGE SYSTEM

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1.0 Use and Application

1.1 Definitions

Certain terms of this section appear in capitalized type and are applicable throughout these Inspections, Tests, and Evaluations. The definitions for those terms can be found in CoC 1004 Appendix B, Section 1.1.

2.0 Inspections, Tests, and Evaluations for Canister Criticality Control

The neutron absorber used for criticality control in the DRY SHIELDED CANISTER (DSC) basket may consist of any of the following types of material:

- Borated aluminum
- Boron carbide / aluminum metal matrix composite (MMC)
- BORAL® (except for the 32PT DSC)

The minimum B-10 areal density requirements are specified in in the CoC 1004 Appendix B Technical Specifications (TS) tables referred to in the table below:

DSC Model	Basket Type	Minimum B-10 Areal Density for Absorber Plates or Poison Rod Assemblies
24P and 24PHB	N/A	These DSC models do not contain borated absorber plates. Poison rod assemblies are not credited.
52B	N/A	The 52B utilizes borated stainless steel basket plates rather than separate absorber plates. The minimum natural boron content is 16 mg/cm^2.
61BT	A, B or C	Per TS Table 1-1k
32PT	A, A1, A2, B, C or D	Per TS Table 1-1h
24PTH	1A, 1B, or 1C 2A, 2B or 2C 3D	Per TS Table 1-1 r
61BTH	A, B, C, D, E or F or Type 3	Per TS Table 1-1v or Table 1-1w or Table 1-1w1 or Table 1-1x
32PTH1	1A, 1B, 1C, 1D, or 1E 2A, 2B, 2C, 2D, or 2E	Per TS Table 1-1ff
69BTH	A, B, C, D, E, or F	Per TS Table 1-1jj or Table 1-1kk
37PTH	There is just one basket.	Per TS Table 1-1rr or Table 1-1ss

2.1 Acceptance of Borated Aluminum

In no case shall the boron content in the aluminum or aluminum alloy exceed 5% by weight.

Neutron Transmission acceptance testing procedures shall be subject to approval by the Certificate Holder.

2.2 Acceptance of Boron carbide / aluminum metal matrix composite (MMC)

The boron carbide content shall not exceed 40% by volume. The boron carbide content for MMCs with an integral aluminum cladding or produced by molten metal infiltration shall not exceed 50% by volume.

The final MMC product shall have density greater than 98% of theoretical density demonstrated by qualification testing. For MMC with an integral cladding, the final density of the core shall be greater than 97% of theoretical density demonstrated by qualification testing.

At least 50% by weight of the B_4C particles in MMCs shall be smaller than 40 microns. No more than 10% of the particles shall be over 60 microns.

MMC for use in 61BTH DSCs is alternatively acceptable with 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%.

2.3 Acceptance of BORAL®

Before rolling, at least 80% by weight of the B_4C particles in BORAL® shall be smaller than 200 microns. The nominal boron carbide content shall be limited to 65% (+ 2% tolerance limit) of the core by weight.

2.4 High Strength Low Alloy Steel for Type 3 Basket Structure for the 24PTH and 61BTH DSC.

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.

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 $K_{Jic} \geq 150$ ksi $\sqrt{in}$ 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 P.3.3-10.

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 2.4.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.

3.0 Storage Location Inspections, Tests, and Evaluations

3.1 Site-Specific Parameters and Analyses

The potential Standardized NUHOMS® System user (general licensee) shall perform the verifications and evaluations in accordance with 10 CFR 72.212 before the use of the system under the general license. The following parameters and analyses shall be verified by the system user for applicability at their specific site. Other natural phenomena events, such as lightning (damage to electrical system, e.g., thermal performance monitoring), 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. The analyzed flood conditions of 50 ft. height of water (full submergence of the loaded HORIZONTAL STORAGE MODULE (HSM) with DSC) and water velocity of 15 fps.
2. One-hundred year roof snow load of 110 psf.
3. The maximum yearly average temperature shall be 70 °F for the 24P, 52B and 61BT DSCs only. The average daily ambient temperature shall be 100 °F or less for the 52B, 61BT, 32PT, 24PHB, 24PTH, 61BTH Type 1 and Type 2, 69BTH, and 37PTH DSCs. For the 32PTH1 DSC, the average daily ambient temperature shall be 106 °F or less. For 61BTH Type 3 DSC, the average daily ambient temperature shall be 90 °F or less.
4. The temperature extremes either of 125 °F (for the 24P, 52B and 61BT DSCs) or 117 °F (for the 32PT, 24PHB, 24PTH, 61BTH Type 1 and Type 2, 32PTH1, 69BTH, and 37PTH DSCs). The 117 °F extreme ambient temperature corresponds to a 24-hour calculated average temperature of 102 °F for the 32PT DSC and 103 °F for the 61BTH Type 3 DSC only. The extreme minimum ambient temperature is –40 °F for storage of the DSC inside HSM.
5. The potential for fires and explosions shall be addressed, based on site-specific considerations.
6. Supplemental shielding: In cases where supplemental shielding and engineered features (i.e., earthen 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.
7. Seismic restraints shall be provided to prevent overturning of a loaded TRANSFER CASK (TC) in a vertical orientation in the plant's FUEL BUILDING during a seismic event if a certificate holder determines that the horizontal acceleration is 0.4g or greater. The determination of the horizontal acceleration acting at the center of gravity (CG) of the loaded TC must be based on a peak horizontal ground acceleration at the site.
8. Site design spectra seismic zero period acceleration (ZPA) levels of 0.25g horizontal and 0.17g vertical for the systems using the Standardized HSMs. Site design spectra seismic ZPA for systems using the HSM-H modules are payload specific as follows:
   - 0.3g horizontal and 0.2g vertical for the 24PTH and 61BTH DSCs
   - 0.3g horizontal and 0.25g vertical for the 32PTH1, 69BTH, and 37PTH DSCs

- Site design spectra seismic ZPA levels for the 32PT, 61BT, 24PTH with Basket Types 1 and 2, 61BTH Type 1 and Type 2, 32PTH1, 69BTH, and 37PTH DSC systems when stored within the “high seismic option” HSM-H modules are 1.0g horizontal and 1.0g vertical.

9. The storage pad location shall have no potential for liquefaction at the site-specific safe shutdown earthquake (SSE) level.
10. Any other site parameters or considerations that could decrease the effectiveness of cask systems important to safety.
11. The storage pad location shall be evaluated for the effects of soil-structure interaction which may affect the response of the loaded HSMs. Seismic responses at the location of the HSM CG may be obtained from the soil-structure interaction analyses.

3.2 Transfer Cask Dose Rate Evaluation

The TC total dose rate shall be less than or equal to the value specified below for the various DSCs. The dose rates should be measured as soon as possible after the TC is removed from the spent fuel pool when in the configuration defined below but before the TC is down ended on the transfer trailer to be transferred to the ISFSI.

Dose Rate Limits for the TC (except OS197L TC)

DSC Model	TC, Axial Surface Dose Rate Limit (mrem/hour)	TC, Radial Surface Dose Rate Limit (mrem/hour)
24P	600	600
52B	600	600
61BT	800	1200
32PT	900	1100
24PHB	1200	1200
24PTH	1200	1500(1)
61BTH	2910	2860
32PTH1	1300	700
69BTH	2050	700
37PTH	1300	700

(1) For the 24PTH-S-LC, the limit is 600 mrem/hour

Dose Rate Limits for the OS197L TC

DSC Model	Axial Surface Dose Rate Limit (mrem/hour)	TC, Radial Decontamination Area Surface Dose Rate Limit (mrem/hour)
61BT	800	70
32PT	900	70

The following configuration shall be employed for all TC axial dose rate measurements:

- Neutron shielding material present in the TC NS cavity
- TC/DSC annulus filled with water and water level in the annulus is at least up to the top of the fuel assembly level
- Bulk water removed from the DSC cavity. For the 24PHB DSC only, the DSC cavity is filled with water such that the fuel assemblies are submerged.
- DSC shield plug installed
- DSC inner top cover plate installed
- Temporary shielding consisting of a minimum of 3″ NS-3 and a minimum of 1″ steel or effective equivalent above the inner top cover plate, which is the analyzed configuration; however, if the dose rate limits above can be met without employing temporary shielding, temporary shielding is not required.

The following locations shall be employed for all TC axial dose rate measurements:

- Five locations are chosen within a radius of 10 to 25 inches (diameter of 20 to 50 inches) around the DSC centerline on the top surface of the temporary shielding (as described earlier) or the inner top cover plate if temporary shielding is not employed.
- None of these measurements shall exceed the specified dose rate limits.

The following configuration shall be employed for all TC radial dose rate measurements:

- Neutron shielding material present in the TC NS cavity
- TC/DSC annulus water drained
- DSC cavity vacuum drying is complete
- DSC outer top cover plate welding completed
- TC top lid installed
- TC is in a vertical position

In addition to the configuration above, decontamination area shielding is installed in the radial direction with a nominal thickness of 6 inches of steel only for the OS197L TC.

The following locations shall be employed for all TC radial dose rate measurements:

- Eight approximately equally spaced locations around the radial surface of the cask at an axial location corresponding to within approximately 24″ of the center of the TC.
- For the OS197L TC only, dose rate measurements are taken on the surface of the decontamination area shielding.
- None of these measurements shall exceed the specified dose rate limits.

The TC dose rate limits are specified to maintain dose rates as-low-as-reasonably-achievable during DSC TRANSFER OPERATIONS. Additional temporary shielding can be employed before and/or after dose rate measurements to further reduce dose rates. These dose rate limits are based on the shielding analysis for the various DSCs included in the UFSAR Chapter 7 and Appendix J, Appendix K, Appendix M, Appendix N, Appendix P, Appendix T, Appendix U, Appendix W, Appendix Y and Appendix Z with some added margin for uncertainty.

If the measured dose rates exceed above values, place temporary shielding around the affected areas of the TC and review plant records of the fuel assemblies which have been placed in the DSC to ensure that they conform to the fuel specification of Technical Specification 2.1 for the applicable DSCs. Submit a letter report to the NRC within 30 days summarizing actions taken and the results of the surveillance, investigation and findings. The report must be submitted using instructions in 10 CFR 72.4 with a copy sent to the administrator of the appropriate NRC regional office.

3.3 HSM or HSM-H Dose Rate Evaluation Program

3.3.1 The licensee shall establish a set of HSM dose rate limits which are to be applied to DSCs used at the site to ensure the limits of 10 CFR Part 20 and 10 CFR 72.104 are met. Limits shall establish peak dose rates at the following three locations:

1. HSM front bird screen,
2. Outside HSM door, and
3. End shield wall exterior.

3.3.2 Notwithstanding the limits established in 3.3.1, the dose rate limits listed below for the Standardized HSM and HSM-H shall be met when a specific DSC model loaded with fuel is stored within a module:

Dose Rate Limits for the Standardized HSM and HSM-H

DSC Model	HSM Model	Dose Rate Limit HSM Front Bird Screen (mrem/hour)	Dose Rate Limit Outside HSM Door (mrem/hour)	Dose Rate Limit End Shield Wall Exterior (mrem/hour)
24P	Standardized HSM	350	70	55
52B	Standardized HSM	350	70	55
61BT	Standardized HSM	1300	200	15
32PT	Standardized HSM	1000	250	10
24PHB	Standardized HSM	525	20	275
24PTH-S-LC	Standardized HSM	600	105	400
61BTH	Standardized HSM	200	100	15
24PTH	HSM-H	1400	5	20
61BTH	HSM-H	2330	5	20
32PTH1	HSM-H	600	5	20
69BTH	HSM-H	250	5	20
37PTH	HSM-H	600	5	20

The number and locations of the dose rate measurements on the surface of front bird screen of the HSM are indicated below:

- Two dose rate measurements are taken for each front bird screen for the HSM-H. These dose rate measurements are approximately within 24 inches measured from the surface of the ISFSI pad and are approximately 6 inches from the centerline of each front bird screen.

- For the standardized HSM models, three dose rates are taken on the surface of each front bird screen. The central dose location shall be at the approximate centerline of the front bird screen. The other two dose locations are spaced at approximately equal distance on either side of the central dose location. All dose locations shall be at least 24 inches above the pad surface.
- None of these measurements shall exceed the specified dose rate limits.

The number and locations of the dose rate measurements on the outside surface of the HSM door are indicated below:

- Five locations within a radius of approximately 25 inches (diameter of approximately 50 inches) around the door centerline.
- None of these measurements shall exceed the specified dose rate limits.

The number and locations of the dose rate measurements on the exterior surface of the HSM end shield wall are indicated below:

- Five dose rate measurements are taken for every end shield wall. The central dose location shall be approximately 10 feet from the HSM front surface and at an elevation corresponding to the approximate door centerline. The remaining four dose locations shall be within a radius of approximately 25 inches (diameter of approximately 50 inches) around the central dose location.
- None of these measurements shall exceed the specified dose rate limits.

3.3.3 If the measured dose rates do not meet the limits of 3.3.1 or 3.3.2, whichever are lower, the licensee shall take the following actions until compliance is achieved:

a. Ensure proper installation of the HSM door and check for any streaming around the door, AND
b. Administratively verify that the spent fuel assemblies loaded in the DSC meet Technical Specification 2.0 limits, AND
c. Ensure that the DSC is properly positioned on the support rails. If compliance is not achieved then proceed to d and e.
d. 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 72.104(a) and ALARA and/or provide additional temporary or permanent shielding to assure exposure limits are not exceeded, and
e. Notify the U.S. Nuclear Regulatory Commission (Director of the Office of Nuclear Material Safety and Safeguards) within 30 days, summarizing the actions taken and the results of the surveillance, investigation and findings. This report must be submitted using instructions in 10 CFR 72.4 with a copy sent to the administrator of the appropriate NRC regional office.

4.0 Fabrication-Related Inspections, Tests, and Evaluations

4.1 Leakage Testing of the Confinement Boundary

The DSC shell (including the inner bottom cover plate) base metal and associated confinement boundary welds are tested during fabrication to $1x10^{-7}$ ref cm^3/s.

Following completion of the seal weld of the DSC inner top cover plate/top shield plug assembly, (including vent and siphon port cover), this weld shall be leak tested with a helium leak detection device. The leak testing is performed to the criteria as listed below:

DSC Model	Leak Test Criterion
24P, 52B	$\leq 1x10^{-4}$ atm.cm^3/sec
61BT, 32PT, 24PHB, 24PTH, 61BTH, 32PTH1, 69BTH, or 37PTH	$\leq 1x10^{-7}$ Ref.cm^3/sec

If the leakage rate of the inner seal weld exceeds the specified criterion, check and repair (a) the inner seal welds (b) the inner top cover and port covers for any surface indications resulting in leakage.

4.2 Concrete Testing for HSM-H

HSM-H 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 40-hour duration of HSM-H blocked vent transient for components exceeding 350 °F.

HSM concrete temperature testing shall be performed whenever there is a change in the cement specification type, or aggregates, or the cement supplier, or the water-cement ratio changes by more than 0.04.

4.3 DSC Closure Weld Non-Destructive Examination

All DSC closure welds except those subjected to full volumetric inspection shall be liquid penetrant tested in accordance with the requirements of the ASME Boiler and Pressure Vessel Code Section III, Division 1, Article NB-5000. The liquid penetrant test acceptance standards shall be those described in Subsection NB-5350 of the Code.

These criteria are applicable to all DSCs. The welds include inner and outer top and bottom covers, and vent and siphon port covers.

If the liquid penetrant test indicates that the weld is unacceptable:

1. The weld shall be repaired in accordance with approved ASME procedures, and
2. The new weld shall be re-examined in accordance with this specification.