NRC / Transnuclear Pre-Submittal Meeting for CoC 1004 Amendment 13

September 9, 2010

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Amendment 13 Pre Submittal Presentation Meeting Agenda

- Contents of Amendment 13
- Details of 69BTH and 37PTH DSCs
- Overview of Structural Analyses for 69BTH and 37PTH DSCs
- Overview of Structural Analyses for other changes
- Overview of Nuclear (Shielding and Criticality) Analyses for 69BTH and 37PTH DSCs
- Overview of Nuclear (Shielding and Criticality) Analyses for other changes
- Overview of Thermal Analyses for 69BTH and 37PTH DSCs
- Overview of Thermal Analyses for other changes
- Questions

Contents of Amendment 13

- **Incorporation of 37PTH and 69BTH DSCs already in P71 CoC 9302 application**
- **Enhancements to the authorized contents of existing 24PHB DSC**
- **Enhancements to the authorized contents of existing 32PT DSC**
- **Enhancements to the authorized contents of existing 24PTH DSC**
- **Enhancements to the authorized contents of existing 61BTH DSC**

Incorporation of NUHOMS® 69BTH and 37PTH Systems

- **69BTH System Components**
  - **69BTH DSC-Same as P71 Submittal**
  - **Existing OS200 Transfer Cask**
  - **Existing HSM-H/HSM-HS Storage Modules**
- **37PTH System Components**
  - **37PTH DSC- Same as P71 Submittal**
  - **Existing OS200 Transfer Cask**
  - **Existing HSM-H/HSM-HS Storage Modules**

69BTH and 37PTH DSC Shell Assemblies

- No changes to 69BTH and 37PTH DSCs relative to those submitted in P71 application to CoC 9302
- DSC Shell Assemblies are Similar to Other Existing Shell Assembly Designs in Previous CoC 1004 Amendments
- Basket Assemblies
  - 69BTH DSC is Similar to Existing 61BTH DSC
  - 37PTH DSC is Similar to Existing 32PT DSC

69BTH and 37PTH DSC Basket Assemblies

- No changes to 69BTH and 37PTH baskets relative to those submitted in P71 application to CoC 9302
- 69BTH basket design similar as 61BTH with solid aluminum rails for enhanced thermal performance
  - Max heat load: 35kW
- 37PTH basket design similar to 32PT with solid aluminum rails for enhanced thermal performance
  - Max heat load: 30kW
- Both 69BTH and 37PTH Baskets Use the Same Three Types of Neutron Absorber Material with Various Boron Content

69BTH and 37PTH DSCs Use Existing OS200/OS200FC Transfer Casks

- **No Changes to OS200/OS200FC Transfer Casks**

69BTH and 37PTH DSCs Use Existing HSM/HSM-H/HSM-HS Storage Modules

- **No Changes to Existing HSM-H/HSM-HS Storage Modules from Amendment 10**
- **Added Dose Reduction Hardware Details**

Enhancements to Existing 24PHB and 32PT DSCs

- **Changes to 24PHB System**
  - **Allow missing rods and control components other than BPRAs. Fuel assemblies Mark B11 and B11A with M5 cladding**
- **Changes to 32PT System**
  - **Incorporate high burn up fuel assemblies for certain fuel types**

Enhancements to Existing 61BTH and 24PTH DSCs

- **Changes to 61BTH System**
  - **Extend application of MMC for higher heat loads**
  - **Incorporate BWR failed fuel can (FFC) –same as in P71 CoC 9302 MP197HB application**
- **Changes to 24PTH System**
  - **Incorporate PWR failed fuel can (FFC) –same as in P71 CoC 9302 MP197HB application**

Enhancements to Existing HSM-H/HSM-HS

- **Shielding Enhancements to HSM-H/HSM-HS**
  - **Based on feedback from current users**

Enhancements to Existing OS200 TC/HSM-HS

- **Extend Use of OS200 TC for Transfer and HSM-HS for Storage of 61BT, 32PT, 24PTH, and 61BTH DSCs**
  - **Added Aluminum Sleeve to OS200 TC –Same as in P71 CoC 9302 for Transport of these DSCs in MP197HB**

Other Contents

- MOX contents added to 69BTH and 37PTH
- Allow Blended Low Enriched Uranium (BLEU) Fuel Assemblies in all DSCs
- Miscellaneous SAR Changes
  - Clarification to flood loads
  - Enhancements to HSM concrete mix to allow use of Type III cements for HSM fabrication

CoC 1004
Amendment 13
Structural Evaluation

Miguel Manrique

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Overview of Structural Analyses 69BTH and 37PTH

Component	Method of Analysis	Design Criteria
Canister Shell Assembly	3D ANSYS Models	ASME Subsection NB
	Hand Calculation	
Basket Assembly	3D ANSYS Model 3D LS-DYNA Model	ASME Subsection NG
	Hand Calculation	
Transfer Cask	No Changes to OS200/OS200FC	
HSM-H/HSM-HS	No Changes to HSM-H/HSM-HS	

Structural Analyses
Canister Shell Analysis Methods

Analysis Type	Implementation in 69BTH and 37PTH Analysis	Previously Submitted to or Being Reviewed by the Staff

Normal Loads	• 69BTH and 37PTH Canister shell thickness and top and bottom end assemblies are identical
	• Use single set of analysis with bounding 69BTH and 37PTH analysis parameters
	• DW, normal pressure, normal handling load combinations
	• Analysis models include 2D axisymmetric and 3D ANSYS models
	• Elastic Analyses
	• Equivalent Static Method
		• Models and analysis approaches are the same as for P71 analyses described in the MP197HB P71 SAR
		  • Appendix A.2.13.8.5 for 69BTH
		  • Appendix A.2.13.8.10 for 37PTH

Off-Normal Loads	• Off-Normal pressures and handling load combinations
	  • Hand calculations
	  • Same ANSYS Models and methods as for Normal Loads
		• Same as for Normal Loads
		  • Appendix A.2.13.8.5 for 69BTH
		  • Appendix A.2.13.8.10 for 37PTH

Structural Analyses
Canister Shell Analysis Methods

Analysis Type	Implementation in 69BTH and 37PTH Analysis	Previously Submitted or Being Reviewed
Accident Loads	• Seismic and Accident Drop Loads • Level C Seismic loads • Level D seismic loads • Accident Side and End Drops • Elastic Analysis • Elastic Plastic Analysis • Equivalent Static Method	• Same models described in MP197HB P71 SAR • Appendix A.2.13.8.5 for 69BTH • Appendix A.2.13.8.10 for 37PTH

Structural Analyses
Basket Assembly Analysis Methods

Analysis Type	Implementation in 69BTH and 37PTH Analysis	Previously Submitted or Being Reviewed
Normal Loads	• 69BTH • Tube basket with solid aluminum basket-to-shell transition "rails" • 3D ANSYS Model • Full (360°), 1-inch long basket segment • Same model used for thermal stress analyses • Equivalent Static Analysis • Model includes segment of canister shell • Interface between canister shell and cask modeled with gap/contact elements • Hand calculations ▪ 37PTH • Basket made up of welded plates to form grid cells; solid aluminum rails • 3D ANSYS Model; similar to 32PT • 360°, 1-inch long basket segment • Same model for thermal stress analysis • Equivalent Static Analysis • Gap/contact elements to model shell/cask interfaces	• Models and analysis approaches are the same as for P71 analyses described in the MP197HB P71 SAR • Appendix A.2.13.8.5 for 69BTH • Appendix A.2.13.8.10 for 37PTH

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Structural Analyses
Basket Assembly Analysis Methods

Analysis Type	Implementation in 69BTH and 37PTH Analysis	Previously Submitted or Being Reviewed

Off-Normal Loads	• Off Normal temperatures and handling load combinations
	  • Hand calculations
	  • Same ANSYS Models and methods as for Normal Loads
		• Same as for Normal Loads
		  • Appendix A.2.13.8.5 for 69BTH
		  • Appendix A.2.13.8.10 for 37PTH

Structural Analyses
Basket Assembly Analysis Methods

Analysis Type	Basket Assembly Analysis Methodology	
	Implementation in 69BTH and 37PTH Analysis	Previously Submitted or Being Reviewed
Accident Loads	• 69BTH • 3D ANSYS Models for Normal Loads is used for accident loads • Equivalent static non-linear elastic-plastic analysis • Hand calculations for end drops	• Models and analysis approaches are the same as for P71 analyses described in the MP197HB P71 SAR, Appendix A.2.13.8 for 69BTH
	• 37PTH • 3D LS DYNA model used for side drop stress analysis • 360°, 1-inch long basket segment • Model is for 80" drop onto concrete surface with corresponding initial velocity • Dynamic time history elastic-plastic analysis	• Dynamic analysis in accordance with NUREG-1536 R1

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Structural Analyses
Fuel Drop Analysis Methods

Analysis Type	Implementation in BWR and PWR Fuel Rod Analyses	Previously Submitted or Being Reviewed

Accident Loads (intact fuel)	**BWR Fuel Assembly**
	• Side Drop
	  • 3D ANSYS (one row of fuel assemblies)
	  • Elastic analysis
	• Corner Drop
	  • 3D LS-DYNA (single fuel rod is modeled)
	  • Unfiltered OS187H cask corner drop acceleration time history
		• Same methodology as used in Amendment 10 and 32P+ DSC for Calvert Cliffs site-specific license amendment
		• Same methodology as used in 32P+ DSC for Calvert Cliffs site-specific license amendment

	PWR Fuel Assembly
	• Side Drop
	  • 3D ANSYS (single fuel rod is modeled)
	  • Elastic analysis
	• Corner Drop
	  • 3D LS-DYNA (single fuel rod is modeled)
	  • Unfiltered OS187H cask corner drop acceleration time history
		• Same methodology as used in Amendment 10 and 32P+ DSC for Calvert Cliffs site-specific license amendment
		• Same methodology as used in 32P+ DSC for Calvert Cliffs site-specific license amendment

Structural Analyses
Damaged Fuel Analysis Methods

Analysis Type	Implementation in BWR and PWR Fuel Rod Analysis	Basis
Normal/Off-Normal Loads (damaged fuel)	• No change from Amendment 10 as large margins are maintained	

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Structural Evaluations
Changes Other Than 69BTH & 37PTH

24PHB DSC

- Evaluation of B&W 15x15 fuel rod using mechanical properties for M5 cladding
- Analysis model and methodology same as that used for fuel assemblies in 37PTH

32 PT DSC

- Evaluated effect of internal pressure increase due to higher burnup

Structural Evaluations Changes Other Than 69BTH & 37PTH

61BTH DSC

- No structural changes related to MMC use
- 61BTH DSC evaluated for FFC in P71 CoC 9302 MP197HB submittal

24PTH DSC

- 24PTH DSC evaluated for FFC in P71 CoC 9302 MP197HP submittal

Structural Evaluations for Changes Other Than 69BTH & 37PTH

- **HSM-H/HSM-HS Shielding Enhancement Changes**
  - Negligible impact on structural evaluation of HSM-H/HSM-HS
- **HSM-HS and OS200 TC with 61BT, 32PT, 24PTH, 61BTH authorized contentss**
  - No structural changes/impact on HSM-HS. Already designed for small diameter DSCs.
  - Added Sleeve to OS200TC. Same as for MP197HB TC in P71 CoC 9302 submittal.
  - Evaluated effect of higher seismic load

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TS 1.2.10 and 1.2.13 Govern Handling of the TC/DSC Inside (Part 50) and Outside (Part 72) the Spent Fuel Pool Building

- **TS 1.2.10: TC/DSC Handling Height Outside the Spent Fuel Pool Building**
  - When handling a loaded TC/DSC at a height greater than 80 inches outside the spent fuel pool building , a special lifting device that has at least twice the normal stress design factor for handling heavy loads, or a single failure proof handling system shall be used
- **TS 1.2.13 TC/DSC Lifting Heights as a Function of Low Temperature and Location**
  - No lifts or handling of the TC/DSC at any height are permissible at DSC basket temperatures below -20F <u>inside</u> the spent fuel pool building
  - The maximum lift height of the TC/DSC shall be 80 inches if the basket temperature is below 0F but higher than -20F <u>inside</u> the spent fuel pool building
  - No lift restriction is imposed on the TC/DSC if the basket temperature is higher than 0F <u>inside</u> the spent fuel building
  - When handling a loaded TC/DSC at a height greater than 80 inches <u>outside</u> the spent fuel pool building, a special lifting device that has at least twice the normal stress design factor for handling heavy loads, or a single failure proof handling system shall be used and the basket temperature may not be lower than 0F

Basis for Assertion That End Drops Are Not Credible

- **Inside Spent Fuel Pool Building—Part 50**
  - Only case where the TC/DSC is in vertical orientation
  - TC trunnions meet requirements of ANSI N14.6 for non-redundant lifting device
  - TC trunnions are designed with 6/10 factors—single failure proof trunnions
  - Single Failure Proof Crane is used
  - TC/DSC End Drops are not credible
- **Outside Spent Fuel Pool Building—Part 72**
  - Loaded TC is horizontally mounted to the transfer trailer
  - TC is moved horizontally to the ISFSI pad
  - At the ISFSI pad, the TC is backed up against the HSM front wall and restrained to it by the TC restraints
  - A hydraulic ram is used to push the DSC out of the cask and inserted into the HSM
  - At no time during the transfer operation is there a need for vertical lifts of the loaded TC
  - TC/DSC end drops are not credible

Basis for TC Drop Height of 80 Inches

- While mounted horizontally on the transfer trailer skid and in route to the ISFSI pad, the distance from the bottom of the TC to the ground is approximately 64” to 68” (depending upon type of cask used (OS197, OS200) and the allowed trailer suspension height adjustments)
- At the ISFSI, with the transfer trailer resting on the approach slabs, the vertical distance from the concrete pad to the centerline of the TC is adjusted so that the TC is aligned with the centerline of the HSM-H door opening. The maximum distance from the bottom of the TC to the approach slab is approximately 65” to 68”
- For conservatism 80” is used for the side drop analysis
- A corner drop from a height of 80” is also postulated

Thermal Evaluation for Amendment 13

Kamran Tavassoli

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Overview of Thermal Evaluations

- Thermal Evaluations for New DSC Types
  - 69BTH DSC and
  - 37PTH DSC
- Thermal Evaluations for OS200 with Inner Sleeve
  - Evaluations for 24PTH and 61BTH with time limit for transfer operation
  - Evaluations for 61BT and 32PT with no time limit for transfer operation
- Thermal Evaluations for Failed Fuel Assemblies
  - Failed FA in 24PTH DSC
  - Failed FA in 61BTH DSC
- Thermal Evaluations for 24PHB DSC with Damaged Fuel Assemblies
- Other Enhancements
  - 61BTH - Extend of MMC plates to High Heat Load
  - 32PT DSC – Inclusion of High Burnup Fuel Assemblies
  - HSM-H/HSM-HS - Dose Reduction Hardware

Thermal Evaluation for 69BTH and 37PTH Systems

- **DSC Types and Heat Loads**
- **Analyzed Cases**
- **Methodology and Computational Tools**
- **Summary**

NOTE:

69BTH and 37PTH are under review as a payload in the Transport Application for MP197HB Transport Package

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69BTH and 37PTH –DSC Types and Heat Loads

- **69BTH**
  - **Allows for borated aluminum, MMC, and Boral™ as neutron absorber**
  - **Allows for six Heat Load Zone Configurations (including HLZCs used for Transport Application)**
  - **Maximum total heat load 35.0 kW**
  - **Maximum decay heat per fuel assembly 0.70 kW**

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69BTH System Configuration/Interfaces

Basket Type		Max. Heat Load (kW) per DSC	Transfer Cask	Storage Module
Basket w/ Aluminum Rails	Borated Aluminum or MMC or Boral as neutron absorber material	Up to 24 kW	OS200	HSM-H/HSM-HS
		Up to 35 kW	OS200FC	

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69BTH and 37PTH – DSC Types and Heat Loads

- **37PTH**
  - **Allows for two length options, 37PTH-S and 37PTH-M**
  - **Allows for borated aluminum, MMC, and Boral as neutron absorber**
  - **Three Heat Load Zone Configurations (including HLZCs used for Transport Application)**
  - **Maximum total heat load 30.0 kW**
  - **Maximum decay heat per fuel assembly 1.20 kW**
  - **The short DSC length is considered for all analyses to maximize the heat flux and resulting temperatures**
  - **The lowest conductivity for neutron absorber plates is used in all models**

37PTH DSC System Configuration/Interfaces

37PTH DSC Type	Basket Type	Max. Heat Load (kW) per DSC	Transfer Cask	Storage Module
37PTH-S or 37PTH-M Basket w/ Aluminum Rails	Borated Aluminum MMC Boral as neutron absorber material	Up to 24 kW	OS200	HSM-H/HSM-HS
		Up to 30 kW	OS200FC	

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69BTH and 37PTH – Analyzed Cases

- **Storage in HSM-H/ HSM-HS**
  - **Normal, off-normal, and accident conditions are the same as those considered in UFSAR Appendix T, Section T.4.4 and Appendix U, Section U.4.4 for 61BTH and 32PTH1 systems**
- **Transfer in OS200 / OS200FC**
  - **Steady state evaluation for heat loads ≤ 24 kW**
  - **Time limit for transfer operations (transient evaluation) for heat loads >24 kW**
- **Loading and Unloading Conditions including Vacuum Drying**
  - **Thermal Design Criteria and methodology for 69BTH and 37PTH systems are identical to 61BTH and 32PTH1 systems described in UFSAR Appendix T, Section T.4.7 and Appendix U, Section U.4.7**

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69BTH and 37PTH – Boundary Conditions

- **The DSC Shell Temperatures are taken from 32PTH1 DSC with 32.1 kW heat load in HSM-H or OS200 to analyze storage and transfer conditions for 37PTH with 30 kW heat load**
- **The DSC Shell Temperatures are taken from 32PTH1 DSC with 40.8 kW heat load in OS200 to analyze transfer conditions for 69BTH with 35 kW heat load**
- **The HSM-H is reevaluated for 35 kW to analyze storage conditions for 69BTH**

Thermal Design Criteria for 69BTH and 37PTH systems are the same as those for 61BTH and 32PTH1 in Amendment 10

69BTH and 37PTH – Methodology & Tools

Analysis	Methodology	Previously Reviewed and Accepted by NRC
Exit / Bulk Air Temperature	Loss Coefficient Calculation Verified by Thermal Test	Standardized NUHOMS® UFSAR Appendix P, Section P.4.4.3 Reviewed also in Amendment 10 for 61BTH and 32PTH1
Storage Module HSM-H	ANSYS 3-D Models of HSM-H Verified by Thermal Test	Standardized NUHOMS® UFSAR Appendix P, Section P.4.4.4 for 24PTH Reviewed also in Amendment 10 Appendix T, Section T.4.4.4 for 61BTH and Appendix U, Section U.4.4.4 for 32PTH1
Transfer Cask OS200 and OS200FC	SINDA/FLUINT™ and Thermal Desktop® 3-D Models	Standardized NUHOMS® UFSAR Appendix U, Section U.4.5.2

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69BTH and 37PTH – Summary

- **The methodologies to evaluate the thermal performance of 69BTH and 37PTH systems were reviewed by NRC in previous applications for Amendment 8 (24PTH system), and Amendment 10 (61BTH and 32PTH1 systems)**

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Transfer in OS200 with Inner Sleeve

- **Proposed DSCs for transfer in OS200 with inner sleeve are:**
  - **61BT**
  - **32PT**
  - **24PTH**
  - **61BTH**
- **An inner sleeve similar to MP197HB Transport Cask is designed to provide the same gaps between the DSC shell and the inner sleeve as it was the case for transfer of small diameter DSCs (61BT, 32PT, 61BTH, and 24PTH) in OS197 Transfer Cask**

Transfer in OS200 with Inner Sleeve

- An ANSYS 3-D model is used for analysis
- The ANSYS model is benchmarked against the SINDA/FLUINT model reviewed in Amendment 10 (UFSAR, Appendix U, Section U.4.5)
- No time limit for transfer operation is needed for 61BT DSC and 32PT DSC
- The bounding cases from the existing UFSAR analyses are reevaluated considering transfer in OS200 with inner sleeve
- Heat Loads, DSC Types, and Analyzed Cases are unchanged from the existing UFSAR analyses

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Thermal Evaluation for Failed Fuel

- **No change to the failed fuel locations from the MP197HB transport application in 24PTH and 61BTH DSCs**
- **Failed FA is modeled as rubble with minimum height**
  - **Decay heat load of Failed FA in 24PTH is reduced from 1.7 kW to 1.2 kW to maintain the maximum temperatures below the existing component temperatures**
  - **Decay heat load of Failed FA in 61BTH remains unchanged at 0.54 kW**
- **The bounding cases from the existing UFSAR analyses are reevaluated considering Failed FAs**
- **DSC Types, Analyzed Cases, Methodology and Computational Tools are unchanged from UFSAR analyses for 24PTH and 61BTH (Appendices P.4 and T.4)**

24PHB with Damaged Fuel Assemblies

- **Four Damaged FAs stored in corner guide sleeves equipped with end caps**
  - **61BT DSC with damaged fuel described in UFSAR, Appendix K, Section K.4.8 has similar configuration to 24PHB DSC**
  - **The conclusions from the 61BT evaluation are applicable to 24PHB DSC**

Other Enhancements

- **61BTH DSC – Use of MMC plates for High Heat Load Baskets**
  - **The conductivity requirement for borated aluminum plates are considered for qualification of MMC plates**
  - **Heat Loads and DSC Types, Analyzed Cases, Methodology, and Computational Tools are unchanged from UFSAR, Appendix T.4**

Other Enhancements

- **32PT with High Burnup Fuel**
  - **The single MMC chevron replaces the paired aluminum and borated aluminum chevrons**
  - **The conductivity requirement for poison plate remain unchanged**
  - **The effect of higher internal pressure due to higher burnup is reevaluated**
  - **Heat Loads, DSC Types, Methodology, and Computational Tools are unchanged from UFSAR, Appendix M.4**

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Other Enhancements

- **HSM-H/HSM-HS – Dose Reduction Hardware**
  - **Three staggered pipes are added to the back of the front inlet vent**
  - **A single row of pipes are added to the entrance channel to the HSM-H cavity**
- **The flow resistances of the pipes are calculated using the same methodologies described in Amendment 8 (Appendix P, Section P.4.4.3) and Amendment 10 (Sections T.4.4.3 and U.4.4.3) for HSM-H airflow calculation**

Amendment 13 – Summary

- **The methodologies to evaluate the thermal performance of changes proposed in Amendment 13 were reviewed by NRC in previous applications:**
  - **in Amendment 5 (UFSAR, App. M.4 for 32PT system),**
  - **in Amendment 6 (UFSAR, App. N.4 for 24PHB system),**
  - **in Amendment 7 & 9 (UFSAR, App. K.4 for 61BT system),**
  - **in Amendment 8 (UFSAR, App. P.4 for 24PTH system), and**
  - **in Amendment 10 (UFSAR, App. T.4 for 61BTH system and UFSAR, App. U.4 for 32PTH1 system)**

Nuclear Evaluations for Amendment 13

Enhancements to NUHOMS® 32PT, 24PHB, 24PTH and 61BTH
&
Addition of NUHOMS® 37PTH and 69BTH

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Enhancements to NUHOMS® 32PT

- ***Increase the Fixed Poison Loading in the 24 poison plate Basket Design for all Fuel Assembly Classes***

Implementation in 32PT Analysis	References Reviewed and Accepted by the NRC
Criticality Evaluation for the 24 poison plate design with fixed poison loading of 15 mg and 20 mg B-10/cm^2 and no PRAs	Identical to existing analyses for the 24 poison plate design with no PRAs in UFSAR Appendix M, Section M.6.4.2 for 32PT for fixed poison loading of 7 mg B-10/cm^2

- ***All source term and shielding calculations remain unchanged***

Enhancements to NUHOMS® 32PT

- *Increase the maximum allowable burnup from 45 GWD/MTU to 55 GWD/MTU*

Implementation in 32PT Shielding Analysis	References Reviewed and Accepted by the NRC
Fuel Qualification was updated to include additional burnup / enrichment / cooling time combinations for burnups up to 55 GWD/MTU. The neutron and gamma source terms and decay heat per assembly per DSC are not changed. Only cooling times are changed.	Identical to existing fuel qualification methodology documented in UFSAR Appendix M, Section M.5.2.4

- *Criticality Analysis remains unchanged because it is based on fresh fuel assumption*

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Enhancements to NUHOMS® 24PHB

- ***Include the B&W 15x15 Mark B11 fuel assembly design***

Implementation in 24PHB Criticality Analysis	References Reviewed and Accepted by the NRC
Include the B&W Mark B11 fuel assembly design and evaluate this design in the most reactive fuel assembly criticality calculations	Identical Approach as described in UFSAR Appendix P, Section P.6.4.2.A for 24PTH since the B&W Mark B11 fuel assembly design is authorized in the 24PTH DSC

- ***All source term and shielding calculations remain unchanged since the design basis spent fuel parameters remain unchanged***

Enhancements to NUHOMS® 24PHB

- *Include damaged B&W 15x15 class fuel assemblies (maximum 4 per basket)*

Implementation in 24PHB Criticality Analysis	References Reviewed and Accepted by the NRC
Evaluate the various damaged assembly configurations and determine most reactive damaged configuration	Identical Approach as described in UFSAR Appendix P, Sections P.6.4.2.D and P.6.4.2.E for 24PTH for the analyzed damaged configurations
Initial Enrichment as a function of soluble boron loading	Identical Approach as described in UFSAR Appendix P, Section P.6.4.2.F for 24PTH

- *All source term and shielding calculations remain unchanged since the design basis spent fuel parameters remain unchanged*

Enhancements to NUHOMS® 24PHB

- *Control Components (CCs) included in all Fuel Assembly (FA) Classes*

Implementation in 24PHB Analysis	References Reviewed and Accepted by the NRC
CC definition expanded to other hardware – previously only BPRAs were included. No additional shielding analysis is required	Identical to CC definition in UFSAR Appendix P, Section P.5.2 (24PTH) and UFSAR Appendix U, Section U.5.2 (32PTH1) with identical design basis CC source terms

- *Criticality Analysis remains unchanged because BPRAs were previously included and bound all CCs*

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Enhancements to NUHOMS® 24PTH

- ***Allow for the loading of Failed Fuel Assemblies in the Failed Fuel Canister***

Implementation in 24PTH Criticality Analysis	References Reviewed and Accepted by the NRC
Perform most reactive configuration criticality analysis with failed fuel assemblies	Identical Approach as damaged fuel assemblies as described in UFSAR Appendix P, Sections P.6.4.2.D and P.6.4.2.E for 24PTH except that additional configurations with radial and axial variations in fuel rod spacing are evaluated
Initial Enrichment as a function of soluble boron loading	Identical Approach as described in UFSAR Appendix P, Section P.6.4.2.F for 24PTH

Enhancements to NUHOMS® 24PTH

- ***Allow for the loading of Failed Fuel Assemblies in the Failed Fuel Canister***
- ***Fuel Qualification remains unchanged since so changes are made to the decay heat or the heat loading zones***
- ***The design basis neutron and gamma source terms remain unchanged***
- ***Shielding Analyses remain unchanged***

Enhancements to NUHOMS® 61BTH

- ***Allow for the loading of Failed Fuel Assemblies in the Failed Fuel Canister***

Implementation in 61BTH Criticality Analysis	References Reviewed and Accepted by the NRC
Perform most reactive configuration criticality analysis with failed fuel assemblies	Identical Approach as described in Appendix A, Section A.6.5.1.4.3.D for 61BTH in the MP197HB Transport SAR
Initial Enrichment as a function of fixed poison loading	Identical Approach as described in UFSAR Appendix T, Section T.6.4.2.C for 61BTH for damaged fuel assemblies and Appendix A, Section A.6.5.1.4.3.D in the MP197HB Transport SAR

Enhancements to NUHOMS® 61BTH

- *Allow for the loading of Failed Fuel Assemblies in the Failed Fuel Canister*
- *Fuel Qualification remains unchanged since so changes are made to the decay heat or the heat loading zones*
- *The design basis neutron and gamma source terms remain unchanged*
- *Shielding Analyses remain unchanged*

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NUHOMS® 37PTH and 69BTH Criticality

- *Spent Fuel Loading*
- *Materials Description*
- *Computer Codes*
- *Basic Computational Models*
- *Criticality Analysis - Intact Fuel*
- *Criticality Analysis - Damaged Fuel*
- *Criticality Benchmarks and USL*
- *MOX Contents*

NUHOMS® 37PTH and 69BTH Criticality Spent Fuel Loading

Parameter / Methodology Description	Implementation in 37PTH and 69BTH Analysis	References Reviewed and Accepted by the NRC
Spent Fuel Authorized Contents 37PTH	PWR Assembly Classes with Control Components	Identical to UFSAR Appendix U, Table U.6-5 for 32PTH1 except that B&W 15x15 class is not authorized
Spent Fuel Authorized Contents 69BTH	BWR Assembly Classes with or without channels	Identical to UFSAR Appendix T, Table T.6-2 for 61BTH except for additional fuel designs

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NUHOMS® 37PTH and 69BTH Criticality Materials Description

Parameter / Methodology Description	Implementation in 37PTH and 69BTH Analysis	References Reviewed and Accepted by the NRC
Material Densities	Fuel, DSC and Cask Materials from SCALE Standard Composition for PWR and BWR Fuel	Identical to UFSAR Appendix U, Table U.6-8 for 32PTH1 for PWR Fuel Identical to UFSAR Appendix T, Section T.6.3.2 for 61BTH for BWR Fuel

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NUHOMS® 37PTH and 69BTH Criticality Computer Codes

Parameter / Methodology Description	Implementation in 37PTH and 69BTH Analysis	References Reviewed and Accepted by the NRC
Computer Code / Cross Section Library	KENO V.a code with CSAS5 module of SCALE6 with the 44 Group ENDF/B-V Library for 37PTH KENO V.a code with CSAS25 module of SCALE 4.4 with the 44 Group ENDF/B-V Library for 69BTH	Criticality code and Cross Section Library are identical as described in UFSAR Appendix U, Section U.6.4.1.1 for 32PTH1 except that the SCALE6 software is employed Identical as described in UFSAR Appendix T, Section T.6.4.1.1 for 61BTH for BWR Fuel

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NUHOMS® 37PTH and 69BTH Criticality Basic Computational Models

Parameter / Methodology Description	Implementation in 37PTH and 69BTH Analysis	References Reviewed and Accepted by the NRC
Computational and Calculational Models	37PTH - 3D model of the DSC with fuel in Cask 69BTH - 3D model of the DSC with fuel in Cask	Identical to modeling approach described in UFSAR Appendix M, Section M.6.3.1 for 32PT. Basket reactivity is comparable to Type C of 32PTH1. Identical to modeling approach described in UFSAR Appendix T, Section T.6.3.1 for 61BTH and SAR Appendix A, Section A.6.5.2.3.1 for 69BTH is the MP197HB.

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NUHOMS® 37PTH and 69BTH Criticality
Criticality Analysis – Intact Fuel

Parameter / Methodology Description	References Reviewed and Accepted by the NRC - for 37PTH	References Reviewed and Accepted by the NRC - for 69BTH
Most reactive fuel design	Identical Approach as described in UFSAR Appendix U, Section U.6.4.2.A for 32PTH1	Identical to UFSAR Appendix T, Section T.6.4.2.A for 61BTH. GE 10x10 is the design basis fuel for 61BTH and 69BTH
Most reactive geometry / material configuration	Identical Approach as described in UFSAR Appendix U, Section U.6.4.2.B for 32PTH1	Identical Approach as described in UFSAR Appendix T, Section T.6.4.2.B for 61BTH
Initial Enrichment as a function of poison loading	Identical Approach as described in UFSAR Appendix U, Section U.6.4.2.C for 32PTH1	Identical Approach as described in UFSAR Appendix T, Section T.6.4.2.B for 61BTH

NUHOMS® 37PTH and 69BTH Criticality Criticality Analysis – Damaged Fuel

Parameter / Methodology Description	References Reviewed and Accepted by the NRC - for 37PTH	References Reviewed and Accepted by the NRC - for 69BTH
Evaluate the various damaged assembly configurations and determine most reactive damaged configuration	Identical Approach as described in UFSAR Appendix U, Sections U.6.4.2.D and U.6.4.2.E for 32PTH1 including the analyzed damaged configurations	Identical Approach as described in UFSAR Appendix T, Sections T.6.4.2.C for 61BTH and SAR Appendix A, Sections A.6.5.2.4.2.D for 69BTH in MP197HB
Initial Enrichment as a function of poison loading	Identical Approach as described in UFSAR Appendix U, Section U.6.4.2.F for 32PTH1	Identical Approach as described in UFSAR Appendix T, Section T.6.4.2.C for 61BTH and Appendix A, Section A.6.5.2.4.2.E for 69BTH in MP197HB

NUHOMS® 37PTH and 69BTH Criticality Criticality Benchmarks and USL

Parameter / Methodology Description	References Reviewed and Accepted by the NRC - for 37PTH	References Reviewed and Accepted by the NRC - for 69BTH
Criticality Benchmarks	Identical Experiments (121) and Benchmark Parameters utilized in UFSAR Appendix U, Section U.6.5 for 32PTH1	Identical Experiments (125) and Benchmark Parameters utilized in UFSAR Appendix T, Section T.6.5 for 61BTH and SAR Appendix A, Section A.6.5.4 in MP197HB
Upper Subcritical Limit (USL-1) with USLSTATS Code 37PTH = 0.9408 69BTH = 0.9416	USLSTATS to determine minimum USL-1, Value = 0.9417	USLSTATS code to determine minimum USL-1, Value = 0.9415

NUHOMS® 37PTH and 69BTH Criticality MOX Contents

Parameter / Methodology Description	Implementation in 37PTH and 69BTH Analysis	References Reviewed and Accepted by the NRC
Include MOX as authorized content – Intact Fuel Only	Determine maximum allowable MOX loading as a function of Fuel Class	No Change when compared to UO_2 analysis
Determine USL functions for MOX fuel	Evaluate additional MOX critical experiments and determine changes to USL	No Change when compared to UO_2 analysis

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NUHOMS® 37PTH and 69BTH Shielding

- ***Source Terms***
- ***Fuel Qualification and Computer Codes***
- ***Materials and Shielding Configurations***
- ***Computer Codes and Models***
- ***Shielding Analysis for HSM Arrays***
- ***MOX Contents***

NUHOMS® 37PTH and 69BTH Shielding Source Terms

Parameter / Methodology Description	Implementation in 37PTH and 69BTH Analysis	References Reviewed and Accepted by the NRC
Design Basis Fuel Assembly	B&W 15x15 (490 KgU) is conservatively employed as the design basis fuel Assembly and BPRAs with a decay heat of 8 watts are the design basis CCs for 37PTH DSC	Identical Fuel Assembly and CC for 32PTH1 as described in UFSAR Appendix U, Section U.5.2
Design Basis Fuel Assembly	GE 7x7 is the design basis fuel Assembly with Channel for 69BTH DSC	Identical Fuel Assembly as described in UFSAR Appendix T, Section T.5.2 for 61BTH

NUHOMS® 37PTH and 69BTH Shielding Fuel Qualification and Computer Codes

Parameter / Methodology Description	Implementation in 37PTH and 69BTH Analysis	References Reviewed and Accepted by the NRC
Fuel Qualification Tables (FQT)	FQTs for the various allowable Decay Heat determined using SAS2H MCNP response function methodology for both 37PTH and 69BTH	FQT Methodology is identical to the 32PTH1 methodology described in UFSAR Appendix U, Section U.5.2 and UFSAR Appendix T, Section T.5.2 although MCNP is employed instead of ANISN
Computer Codes for Source Terms Calculation	SAS2H module of the SCALE 4.4 Code for both 37PTH and 69BTH	Source term codes / calculations are identical to those in 32PTH1 from UFSAR Appendix U, Section Appendix U.5.2 and 61BTH from UFSAR Appendix T, Section T.5.2

NUHOMS® 37PTH and 69BTH Shielding Materials and Shielding Configurations

Parameter / Methodology Description	Implementation in 37PTH and 69BTH Analysis	References Reviewed and Accepted by the NRC
Material Densities	Determine material densities for all materials used in evaluation	Identical to the densities described in UFSAR Appendix U, Section U.5.3 for 32PTH1 for PWR fuel and UFSAR Appendix T, Section T.5.3 for BWR fuel
Shielding Configurations	DSC in HSM (Storage) DSC in TC (Loading and Transfer) HSM Array in ISFSI (Site Dose)	Identical configurations utilized in UFSAR Appendix U, Chapters U.5 and U.10 for 32PTH1 and UFSAR Appendix T, Chapters T.5 and T.10 for 61BTH

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NUHOMS® 37PTH and 69BTH Shielding Computer Codes and Models

Parameter / Methodology Description	Implementation in 37PTH and 69BTH Analysis	References Reviewed and Accepted by the NRC
Computer Codes	MCNP5	MCNP5 utilized in 32PTH1 (UFSAR Appendix U, Section U.5.4.1) and 61BTH (UFSAR Appendix T, Section T.5.4.1)
Shielding Models for Storage - DSC in HSM-H	3D MCNP model with design basis fuel and source terms	MCNP model of HSM-H similar to model in UFSAR Appendix U, Section U.5.4.7.1 in 32PTH1
Shielding Models for Loading and Transfer - DSC in TC	3D MCNP model with design basis fuel and source terms	MCNP model of TC similar to model in UFSAR Appendix U, Sections U.5.4.7.2, U.5.4.8 and U.5.4.9 in 32PTH1 For 37PTH, TC results are directly (conservatively) obtained from 32PTH1

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NUHOMS® 37PTH and 69BTH Shielding Shielding Analysis for HSM Arrays

Parameter / Methodology Description	Implementation in 37PTH and 69BTH Analysis	References Reviewed and Accepted by the NRC
Shielding Methods for Site Dose Calculations (Array of HSM-Hs)	Bootstrap MCNP model 2x10 back-to-back and 2-1x10 front-to-front array of HSM-Hs	MCNP results of arrays for 32PTH1 are directly (conservatively) utilized for 37PTH MCNP results of arrays for 61BTH are directly (conservatively) utilized for 69BTH

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NUHOMS® 37PTH and 69BTH Shielding MOX Contents

Parameter / Methodology Description	Implementation in 37PTH and 69BTH Analysis	References Reviewed and Accepted by the NRC
Include MOX as authorized content – Intact Fuel Only	Develop SAS2H models for use in response functions to determine effect on dose rates and heat loads. Determine additional cooling time as a function of burnup required to ensure existing analyses are conservative	No Change when compared to UO_2 analysis

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Inclusion of BLEU Fuel

- ***Include Blended Low Enriched Uranium (BLEU) as allowable fuel material***

Definition of BLEU	Implementation in Fuel Qualification
BLEU fuel is identical to UO_2 fuel except that it contains additional impurities (higher co-59 impurity) that affect fuel qualification from a shielding standpoint	Performed a Sensitivity evaluation in 69BTH to show that the effect is limited to outermost zone locations with an additional cooling time requirement of 5 years This approach is identical to that employed for qualification of CCs for 32PTH1 in UFSAR Appendix U, Section U.5.2

- ***Criticality Analysis calculations remain unchanged because the impurities in BLEU do not affect criticality***

Improve NUHOMS® HSM-H and HSM-HS

- *Improve the shielding performance of the HSM-H and HSM-HS storage modules*
- *Array of pipes near the inlet vents*
- *Array of pipes under the inlet channel*
- *Vent liner under the roof vent cap*
- *MCNP sensitivity calculations are documented for the HSM-H / 69BTH configuration*
- *Results indicate a significant reduction in the dose rates – approximately 50%*
- *No change in the SAR design basis dose rates since these enhancements are optional features*

Use of Sleeve with NUHOMS® OS200 TC

- ***Include an aluminum sleeve with OS200 TC in order to transfer small diameter DSCs – 32PT, 61BT, 24PTH, 61BTH***
- ***All criticality calculations remain unchanged***
- ***All fuel qualification calculations remain unchanged since decay heats remain unchanged***
- ***All shielding calculations remain unchanged since the inclusion of the aluminum sleeve will lead to slightly lower dose rates***