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CoC 1042 Amendment 4 Application Meeting

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Purpose of the Meeting/Agenda

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- To discuss plans for Amendment 4 to CoC 1042
- Obtain NRC feedback and facilitate NRC planning

Agenda

- General Overview/Amendment scope
- Impacts for each technical discipline
- Licensing approach
- Submittal schedule
- Discussion/Questions

EOS Amendment 4 Scope

1) Add damaged and failed fuel storage capability to the EOS-89BTH

- Existing staggered basket concept from EOS-37PTH
- Two new basket types

2) Introduce a steel-plate composite option for the EOS-HSM (EOS-HSM-SC)

- Steel-plate composite components instead of reinforced concrete
- Steel shells pre-fabricated and shipped to site for concrete placement at the ISFSI

3) Demonstrate MAVRIC software capability for use in dose rate analyses

- Comparison of MCNP runs with MAVRIC software runs to demonstrate similar results

Add damaged and failed fuel storage capability to the EOS-89BTH

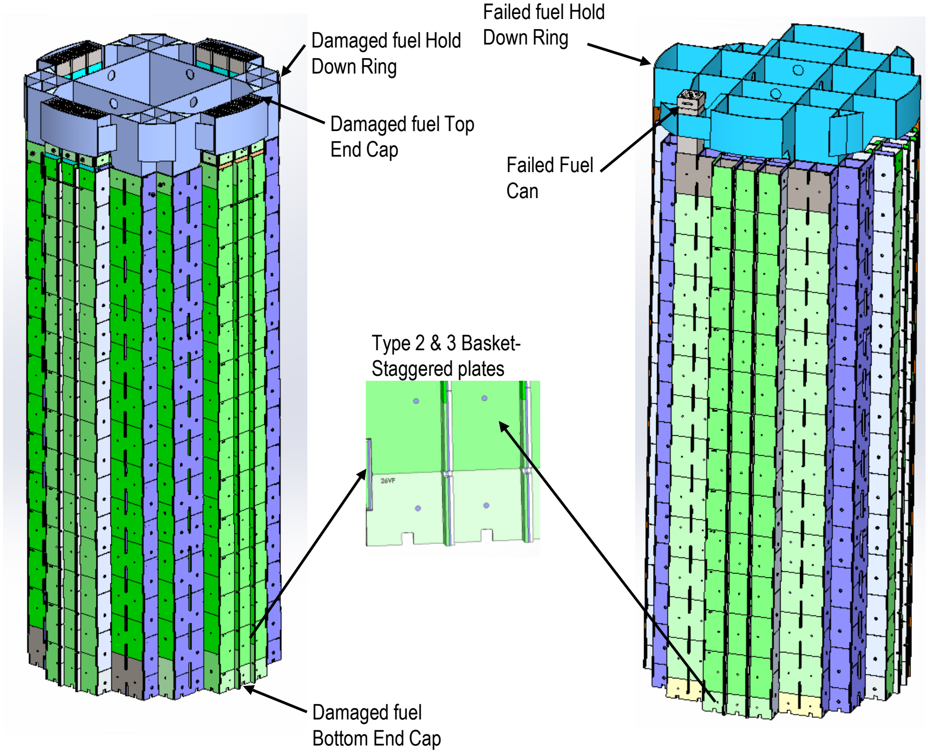
Staggered basket similar to EOS-37PTH

- **Approved contents for storage include intact, damaged, and failed fuel**
  - Definition of intact, damaged, and failed fuel initially included in CoC 1042 Amendment 1
  - Store all existing BWR fuel assembly designs
  - Fuel radiological parameters consistent with current CoC 1042 Technical Specifications
- **Affected components**
  - EOS-HSM and HSM-MX, EOS-TC125
  - Maximum Heat Load Configuration (MHLC)

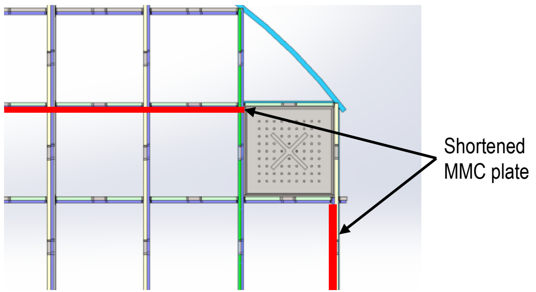
Basket Types

EOS-89BTH Basket	Intact Fuel	Damaged Fuel	Failed Fuel	Basket Geometry
Type 1	Yes	No	No	Non-staggered[1]
Type 2[2]	Yes	Yes	Yes with modified FFC	Staggered
Type 3	Yes	No	Yes with no limitations	Staggered & Short MMC

Notes:
1. Approved in Amendment 0 to CoC 1042
2. Damaged and failed fuel may not be stored in the same DSC



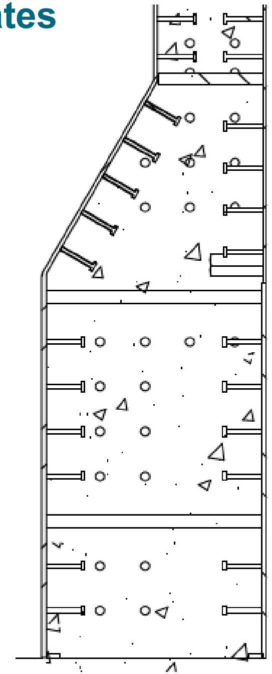
Basket Type 2 Basket Type 3

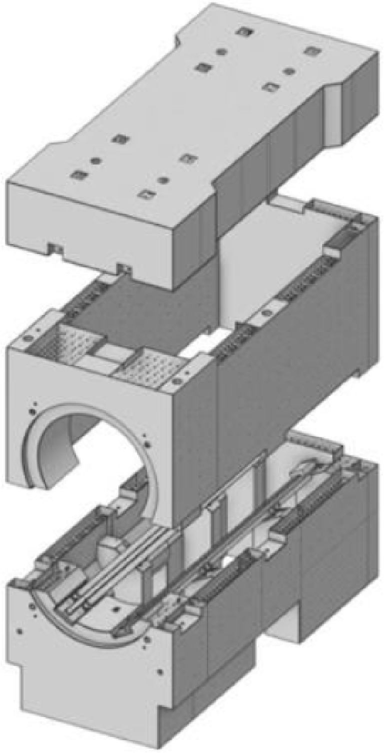


EOS-HSM-SC

Steel-Plate Composite Wall (SC) construction

- **Concrete walls reinforced with two steel faceplates**
- **Steel headed stud anchors**
  - Attach concrete
  - Composite behavior of faceplates and concrete
- **Steel tie bars**
  - Connect faceplates
  - Provide structural integrity
  - Prevent delamination of concrete core
  - Shear reinforcement
- **Increasing use in nuclear facilities**
  - GE Hitachi, Toshiba, TEPCO-ABWR reactors
  - Westinghouse- AP 1000
  - Korea Hydro & Nuclear Power (APR+)
  - SMRs





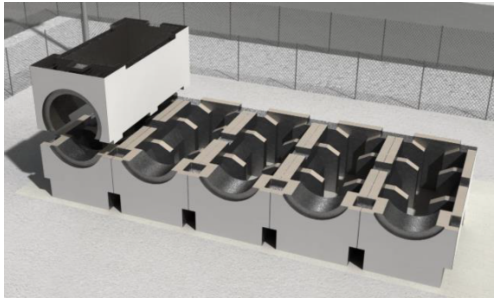
EOS-HSM-SC

Steel-plate composite (SC) construction

- Steel casing manufactured and transported to site
- Concrete placement in place on site

Option for all existing EOS-HSMs and HLZCs

- EOS-HSMS Segmented design
- EOS-HSM-FPS: Flat Plate Support rail used as DSC support structure



EOS-HSM-SC

EOS-HSM-SC Structural Design Criteria

- Same load cases as for reinforced concrete EOS-HSM
- Same load combinations as for reinforced concrete EOS-HSM (based on ANSI/ANS 57.9)
- Design per ANSI/AISC N690-18 code
  - **Regulatory Guide 1.243 considered**
  - **Exceptions to N690-18 based on testing and analytical studies**

EOS Amendment 4 Structural Impacts

1) Damaged and failed fuel storage in EOS-89BTH

- **Reconciliation of basket Types 2 and 3 temperature with basket Type 1**
- **Structural evaluation based on same methods used for EOS-37PTH/NUH-61BTH:**
  - Failed Fuel Can (FFC)
  - Damaged fuel assembly
  - Damaged fuel extension tube
  - Hold Down Ring (HDR) for intact/damaged/failed fuel
- **Structural SAR sections affected: 3.9.2 and 3.9.6**

2) EOS-HSM-SC

- **A new section in CoC 1042 UFSAR (Appendix 3.9.8): Similar to Appendix 3.9.4 (EOS-HSM structural analysis) and Appendix 3.9.7 (stability analysis)**

Proprietary Information on Pages 10 and 11
Withheld Pursuant to 10 CFR 2.390

EOS Amendment 4 Thermal Impacts

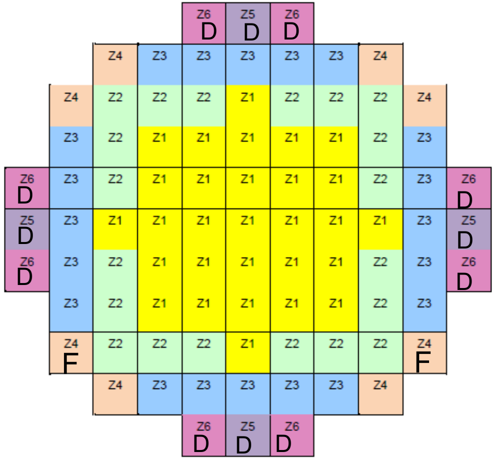
2) Failed fuel storage in EOS-89BTH

- **Up to 2 failed fuels can be stored in both Basket Types 2 and 3 of EOS-89BTH DSC (0.8 kW max)**
- **The maximum heat loads per DSC for failed fuels are reduced to ensure previous thermal evaluations for intact fuels are still bounding:**
  - 45 kW in EOS-HSM and the lower compartment of HSM-MX
  - 39 kW in the upper compartment of HSM-MX
- **Thermal evaluations are based on previously approved methodology in UFSAR for EOS-37PTH Failed Assemblies in Amendment 1 to CoC 1042.**
  - No change to the specified time limits in the current UFSAR
  - Maximum fuel cladding temperatures are bounded by the values in the current UFSAR
  - Internal pressure is bounded by the value in the current UFSAR
- **Thermal implications are addressed in new Appendix 4.9.9 and Chapter A.4**

EOS Amendment 4 Thermal Impacts

3) MHLC

- MHLC within the Technical Specifications is revised to specify the maximum heat load for each basket type.



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 MHLC head load limit in table below					

MHLC Heat Load Limits for Storage

	Basket Type			
HSM Type	Type 1	Type 2		Type 3
		Intact/Damaged FAs[1]	FFC[1]	
EOS-HSM	48.2 kW	48.2 kW	45.0 kW	45.0 kW
HSM-MX Upper	48.2 kW	48.2 kW	45.0 kW	45.0 kW
HSM-MX Lower	41.8 kW	41.8 kW	39.0 kW	39.0 kW

Notes: (1) 12 damaged or 2 failed FAs are located according to the figure
(2) FFC decay heat is limited to 0.8 kW

- Chapter 2 of the UFSAR is updated to clarify the use of MHLC for use with new basket types and damaged/failed fuel assemblies.

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EOS Amendment 4 Thermal Impacts

4) EOS-HSM-SC

All the thermal evaluations for the reinforced concrete EOS-HSM will remain bounding for the steel-plate composite variant EOS-HSM-SC.

- In this steel-plate composite variant, the vent sizes along with the HSM cavity remain unchanged, therefore, the heat dissipation from natural convection will remain the same.
- The addition of steel composite to the EOS-HSM will enhance the thermal performance since the concrete is replaced with steel.
- Eliminates the optional Dose Reduction Hardware. This will increase the air flow through the inlets and outlets, and therefore will enhance the heat removal capability.
- **Thermal implications of EOS-HSM-SC are addressed in the new Section 4.4.12**

EOS Amendment 4 Shielding Impacts

1) Damaged and failed fuel storage in EOS-89BTH DSC

- The MHLC is unchanged from Amendment 3. No new source terms.
- Due to changes in the hold-down ring (HDR) design for the Type 2 and 3 baskets compared to the Type 1 design, EOS-TC125 dose rates increase near the HDR. This dose rate increase is not significant and has negligible effect on peak EOS-TC125 side dose rates. No effect on storage dose rates. EOS-TC125 dose rates are updated.
- The EOS-37PTH DSC has proportionally more damaged and failed fuel relative to intact fuel compared to the EOS-89BTH DSC. Extensive damaged/failed fuel dose rate calculations performed for the EOS-37PTH DSC demonstrate negligible effect on dose rates. Damaged fuel maintains geometry for normal and off-normal conditions. Failed fuel limited to 0.8 kW/FA, much less than the as-modeled 1.7 kW/FA for intact fuel. Therefore, EOS-89BTH DSC dose rates are presented only for intact fuel, and reference is made to the EOS-37PTH DSC analysis to justify damaged/failed fuel has negligible effect on dose rates.

EOS Amendment 4 Shielding Impacts

2) EOS-HSM-SC Dose Rates

- The “steel lined” EOS-HSM results in a significant reduction in dose rates.
- Vent dose rates are gamma-dominated, and replacing concrete with steel significantly reduces dose rates.
- A sensitivity MCNP analysis is performed for this design. Front and roof average dose rates decrease by approximately 50% and 75%, respectively.
- Therefore, the original EOS-HSM dose rates remain bounding and are not updated.

EOS Amendment 4 Shielding Impacts

3) MAVRIC analysis

- A MAVRIC analysis for the HSM-MX is provided to demonstrate reasonable comparison to MCNP.
- Conclusions are applicable to the EOS-HSM, which is similar in design (i.e., vented concrete structure).
- Source terms are consistent with the EOS-37PTH DSC with HLZC 10 sources.
- The MCNP model is a segment of a larger structure with reflective boundaries on 3 sides (left side, right side, and rear). Because MAVRIC does not allow reflective boundary conditions, the MAVRIC model is a full back-to-back array of modules.
- MCNP dose rates are compared with MAVRIC dose rates at the center of the array.

Proprietary Information on Pages 18 and 19
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EOS Amendment 4 Shielding Impacts

3) MAVRIC analysis conclusions

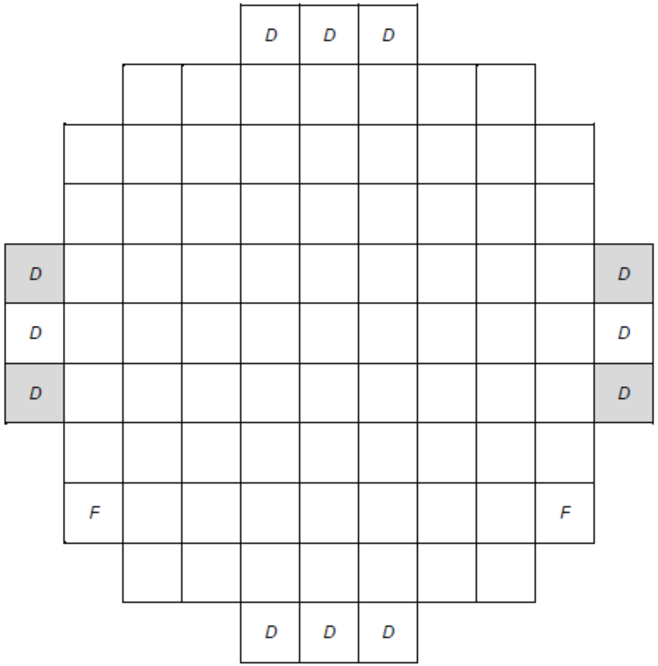
- Agreement is excellent between MCNP and MAVRIC
- MAVRIC may be used for dose rate licensing actions for the HSM-MX and EOS-HSM, including site-specific site dose analyses

EOS Amendment 4 Criticality Impacts

Damaged and failed fuel storage in the EOS-89BTH DSC

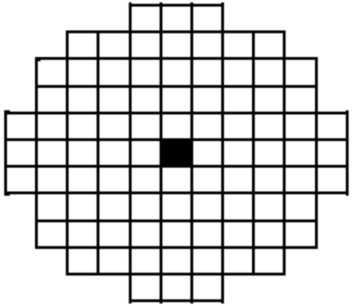
- Planar average enrichment limits are developed for up to 12 damaged and up to 2 failed BWR fuel assemblies per DSC.
- Enrichment limits developed for several short-loading configurations
- Damaged and failed fuel shall not be placed in the same DSC.
- The limiting damaged fuel geometry is pitch expansion with missing fuel rods.
- For poison loading B, enrichment limits are developed both with and without credit for the BWR fuel channel to constrain the damaged fuel rod pitch.
- The failed fuel geometry is based on a limiting combination of pellet diameter and the number of fuel rods (without fuel cladding) to provide a bounding failed fuel representation, similar to the EOS-37PTH DSC analysis.

Damaged and Failed Fuel Locations

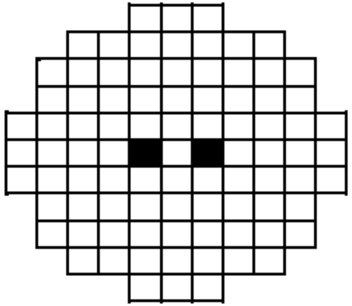


D= Damaged
F= Failed

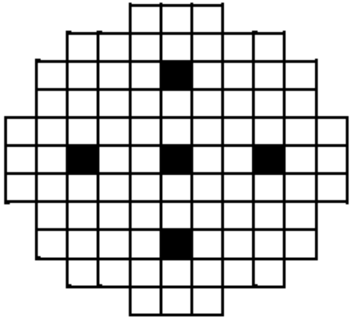
Short-Loading Options



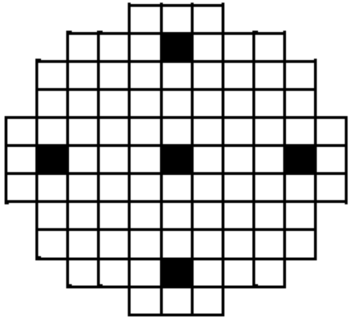
88 FAs



87 FAs



84 FAs Configuration 1 (84 con. 1)



84 FAs Configuration 2 (84 con. 2)

Criticality Limit Table Example (Type B2, damaged fuel)

- Separate enrichment limits for up to 4 and 12 damaged fuel assemblies.
- Values are enrichment limits. Each DSC may have a different set of enrichment limits.
- As the intact fuel enrichment limit increases, the damaged fuel enrichment limit decreases.

Type B2 Basket (41.3 mg/cm² minimum B-10 areal density) All Fuel (Including ABB-10-C and ATRIUM 11)											
Configuration	Max. Intact Enrich. (wt.% U-235)	Number of Assemblies [4a][4b]									
		89		88		87		84 con. 1		84 con. 2	
		No. Chan.	With Chan.	No. Chan.	With Chan.	No. Chan.	With Chan.	No. Chan.	With Chan.	No. Chan.	With Chan.
		Max. Damaged Enrichment (wt.% U-235)									
Up to 4 damaged fuel assemblies	4.30	4.30	4.30	-	-	-	-	-	-	-	-
	4.45	-	-	4.45	4.45	-	-	-	-	-	-
	4.55	-	-	-	-	4.55	4.55	-	-	-	-
	4.85	-	-	-	-	-	-	-	-	4.85	4.85
	5.00	-	-	-	-	-	-	5.00	5.00	-	-
Up to 12 damaged fuel assemblies [4c]	4.15	4.15	4.15	-	-	-	-	-	-	-	-
	4.20	4.10	4.20	-	-	-	-	-	-	-	-
	4.25	3.80	4.25	4.25	4.25	-	-	-	-	-	-
	4.30	3.45	3.85	4.15	4.30	4.30	4.30	-	-	-	-
	4.35	-	-	4.05	4.35	4.30	4.35	-	-	-	-
	4.40	-	-	3.85	4.35	4.20	4.40	-	-	-	-
	4.45	-	-	3.70	4.10	4.05	4.45	-	-	-	-
	4.50	-	-	3.35	3.90	3.85	4.40	-	-	-	-
	4.55	-	-	-	-	3.70	4.20	-	-	-	-
	4.60	-	-	-	-	3.50	4.00	-	-	-	-
	4.65	-	-	-	-	3.30	3.80	4.65	4.65	-	-
	4.70	-	-	-	-	-	-	4.65	4.70	-	-
	4.75	-	-	-	-	-	-	4.60	4.75	4.75	4.75
	4.80	-	-	-	-	-	-	4.50	4.80	4.65	4.80
	4.85	-	-	-	-	-	-	4.40	4.85	4.10	4.85
	4.90	-	-	-	-	-	-	4.30	4.90	3.45	4.15
	4.95	-	-	-	-	-	-	4.20	4.80	-	-
	5.00	-	-	-	-	-	-	4.00	4.65	-	-

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Criticality Limit Table Example (Type A2/A3/B2/B3, failed fuel)

- Intact and failed fuel enrichments are the same for simplicity.

Basket Type	Loading Configuration – Number of Fuel Assemblies and FFCs	Maximum Lattice Average Initial Enrichment, Intact and Failed Fuel (wt. % U-235)		Minimum B-10 Areal Density (mg/cm^2)
		All Fuel Types (Excluding ATRIUM11 and ABB-10-C)	All Fuel Types	
A2/A3	89	4.20	4.00	32.7
	88	4.35	4.15	
	87	4.50	4.30	
	84 con. 1	4.90	4.65	
B2/B3	89	4.50	4.30	41.3
	88	4.70	4.45	
	87	4.85	4.55	
	84 con. 1	5.00	4.95	

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Submittal Schedule

Application Submittal- 1st Quarter 2022

Requested Approval- December 2023

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Giving nuclear energy its full value