framatome

NRC Pre-Application Meeting
MAP Package Amendment
Docket No. 9319

December 10, 2024

Agenda

1. **Framatome Team**
2. Project Description
3. Contents up to 8 wt.% ^{235}U Enrichment
4. Criticality Evaluation
   a) Methods of Analysis
   b) Benchmarking
   c) Results
5. Drawing Changes
6. Proposed Schedule
7. Opportunity for Public Comment

Framatome Team

Framatome

- Steve Cole, AFM Project Manager
- Tim Tate, Manager, Environmental, Health, Safety, and Licensing
- Calvin Manning, Manager, Licensing and Compliance
- Brandon Hanson, Acting Manager, Licensing and Compliance
- Bryan Flanagan, Packaging Engineer, Licensing and Compliance
- Dan Talmadge, PWR Product Engineer
- Michelle Guzzardo, Nuclear Criticality Safety Engineer

ORANO Federal Services

- Chris Backus, Licensing Manager
- Slade Klein, Engineering Manager
- Erik Gonsiorowski, Nuclear Criticality Safety Engineer
- Max Morrow, Nuclear Criticality Safety Engineer

Agenda

1. Framatome Team
2. **Project Description**
3. Contents up to 8 wt.% ^{235}U Enrichment
4. Criticality Evaluation
   a) Methods of Analysis
   b) Benchmarking
   c) Results
5. Drawing Changes
6. Proposed Schedule
7. Opportunity for Public Comment

Project Description

Advanced Fuel Management (AFM) Project

- Significantly reduce the utility customer's operating costs in the near term by bringing to market technologies which increase cycle lengths and capacity factors
- Reducing the number of refueling outages
- Improving fuel cycle economics
- Framatome is working in conjunction with a US reactor site to realize these benefits

NRC License Amendment Request

- Increase allowable enrichment up to 8 wt.% ^{235}U for all fuel assembly designs
- Miscellaneous drawing changes to facilitate package manufacturing
- Applicable for both the MAP-12 and MAP-13 packages

Agenda

1. Framatome Team
2. Project Description
3. **Contents up to 8 wt.% ^{235}U Enrichment**
4. Criticality Evaluation
   a) Methods of Analysis
   b) Benchmarking
   c) Results
5. Drawing Changes
6. Proposed Schedule
7. Opportunity for Public Comment

Contents ≤8 wt.% ^{235}U Enrichment

- **Type A and Type B Contents**
  - Both Type A and Type B contents shall remain the same material, fuel pellets loaded in rods are uranium oxides primarily as ceramic UO_2 and U_3O_8. The maximum enrichment is being increased to ≤8.0 wt.% ^{235}U for all fuel assembly arrays and remains within high assay low enriched limits.
- **Contents Tables for <5 and ≤8.0 wt.% ^{235}U Material**
  - No changes to content tables
- **Allowable Quantities of Radioactive Material**
  - No changes to allowable quantities
- **Gadolina Requirements**
  - Gadolina requirements expanded to all array types for enrichment above 5.0 wt.%

Agenda

1. Framatome Team
2. Project Description
3. Contents up to 8 wt.% ^{235}U Enrichment
4. **Criticality Evaluation**
   a) Methods of Analysis
   b) Benchmarking
   c) Results
5. Drawing Changes
6. Proposed Schedule
7. Opportunity for Public Comment

Criticality Evaluation

Methods of Analysis

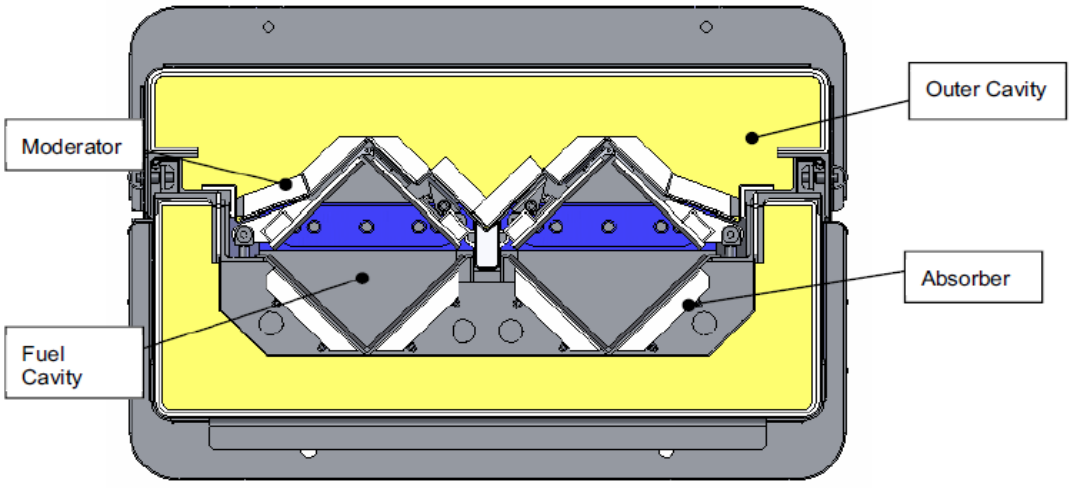
- Criticality evaluations performed using SCALE 6.3.1
  - CSAS6 (Keno-VI) with ENDF/B-VII.1 group library
  - Gd_2O_3 fuel rods used for criticality control (multiple configurations evaluated for different enrichments)
  - Modeling choices shown to be conservative in prior analyses are assumed still conservative for the new payload.
- Licensing basis consistent with current SAR methodology to identify the most reactive credible configuration consistent with the chemical and physical form of the material
  - Configuration based on fuel at T.D. and fully flooded fuel cavity, void in outer cavity for HAC array

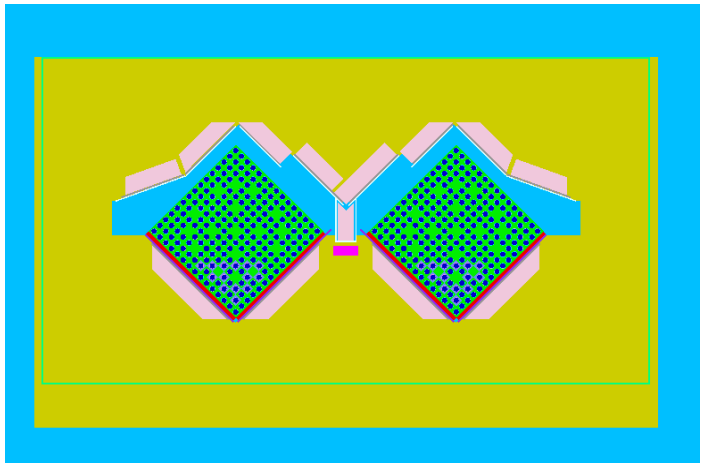
Benchmarking

- Benchmark experiments were selected from the International Handbook of Evaluated Criticality Safety Benchmark Experiments (IHECSBE).
- Methodology used to determine the Upper Safety Limit (USL) is consistent with NUREG-6698, *Guide for Validation of Nuclear Criticality Safety Calculational Methodology*.
- Sensitivity/Uncertainty Analysis are being used to mathematically identify applicable critical experiments to the application model
  - TSUNAMI-3D (Scale module) used to generate sensitivity data file (SDF) for licensing basis application model
  - TSUNAMI-IP (Scale module) used to evaluate the similarity of critical experiments to application model (SDFs for critical experiments are taken from IHECSBE)
  - the bias and uncertainties associated with the calculation method, including use of the administrative subcritical margin of 0.05 to set an upper subcritical limit (USL) of 0.94083

Criticality Evaluation

- Selection of critical experiments
  - The critical experiments and the safety basis model need to use the nuclear data in a similar energy-dependent manner; otherwise, an incorrect bias could be generated
  - 163 benchmarks used within the evaluation to calculate the USL
- Correlation coefficients (C_k) were determined for each application/experiment model pair
- All selected models have significantly more than 20 correlation coefficients above 0.90 showing that selected benchmarks are valid





Criticality Evaluation

- **Results - K_{eff} example**

			Single HAC Unrestricted		Single HAC Design Basis		2x2 Package Array HAC Design Basis		3x4 Package Array HAC Design Basis	
Enrichment [wt.% U235]	Size	Type	Minimum Gd Count	k_{safe}	Minimum Gd Count	k_{safe}	Minimum Gd Count	k_{safe}	Minimum Gd Count	k_{safe}
5.0	14x14	1	0	0.85194	0	0.85194	0	0.86945	0	0.88595
		2	0	0.83701	0	0.83701	0	0.85277	0	0.86712
	15x15	1a	0	0.88761	0	0.88761	0	0.90800	0	0.92622
		1b	0	0.87699	0	0.87699	0	0.89570	0	0.91425
		1c	0	0.87717	0	0.87717	0	0.89768	0	0.91541
		2	0	0.84435	0	0.84435	0	0.86165	0	0.87850
		3	0	0.87871	0	0.87871	0	0.89789	0	0.91502
	16x16	1	0	0.85218	0	0.85218	0	0.86985	0	0.88541
	17x17	1	0	0.87988	0	0.87988	0	0.90008	0	0.91730
		2	0	0.87678	0	0.87678	0	0.89504	0	0.91409
		3	0	0.87790	0	0.87790	0	0.89614	0	0.91504
5.5	14x14	1	0	0.86499	0	0.86499	0	0.88267	0	0.89929
		2	0	0.84849	0	0.84849	0	0.86496	0	0.87980
	15x15	1a	0	0.90098	0	0.90098	0	0.92104	0	0.93886
		1b	0	0.88840	0	0.88840	0	0.90902	0	0.92763
		1c	0	0.89103	0	0.89103	0	0.91073	0	0.92895
		2	0	0.85600	0	0.85600	0	0.87334	0	0.89048
		3	0	0.89187	0	0.89187	0	0.91083	0	0.92934
	16x16	1	0	0.86537	0	0.86537	0	0.88211	0	0.89842
	17x17	1	0	0.89193	0	0.89193	0	0.91292	0	0.93085
		2	0	0.88916	0	0.88916	0	0.90874	0	0.92681
		3	0	0.89034	0	0.89034	0	0.90867	0	0.92762

$$k_{safe} = k_{eff} + 2\sigma \leq USL$$

Criticality Evaluation

Results - Gadolinia Requirements for >5 wt.% ^{235}U Remaining Arrays

- Includes CSI 8.3, 25, and 50 (not shown)
- Clarification to be added: Required gadolinia rods may be placed asymmetrically. (Not required to be distributed symmetrically along the major diagonal as currently stated in license)

Table 6-9: Minimum Gd-Rod Requirements for 2x2 Package Array (CSI = 25)

Array	14x14		15x15					16x16	17x17		
Type	1	2	1a	1b	1c	2	3	1	1	2	3
Enr.	Minimum 2.0 wt.% Gadolinia Rods Required for k_{safe} < USL										
5.0	0	0	0	0	0	0	0	0	0	0	0
5.5	0	0	0	0	0	0	0	0	0	0	0
6.0	0	0	0	0	0	0	0	0	0	0	0
6.5	0	0	1	0	0	0	0	0	0	0	0
7.0	0	0	6	0	0	0	0	0	1	0	0
7.5	0	0	9	4	5	0	4	0	7	5	5
8.0	0	0	11	7	8	0	7	0	10	9	8

Table 6-10: Minimum Gd-Rod Requirements for 3x4 Package Array (CSI = 8.3)

Array	14x14		15x15					16x16	17x17		
Type	1	2	1a	1b	1c	2	3	1	1	2	3
Enr.	Minimum 2.0 wt.% Gadolinia Rods Required for k_{safe} < USL										
5.0	0	0	0	0	0	0	0	0	0	0	0
5.5	0	0	0	0	0	0	0	0	0	0	0
6.0	0	0	5	0	0	0	0	0	2	0	0
6.5	0	0	9	5	5	0	4	0	7	5	5
7.0	0	0	11	8	8	0	8	0	11	9	9
7.5	0	0	15	11	11	0	11	0	16	13	14
8.0	2	0	17	13	14	0	13	2	18	17	16

Agenda

1. Framatome Team
2. Project Description
3. Contents up to 8 wt.% ^{235}U Enrichment
4. Criticality Evaluation
   a) Methods of Analysis
   b) Benchmarking
   c) Results
5. **Drawing Changes**
6. Proposed Schedule
7. Opportunity for Public Comment

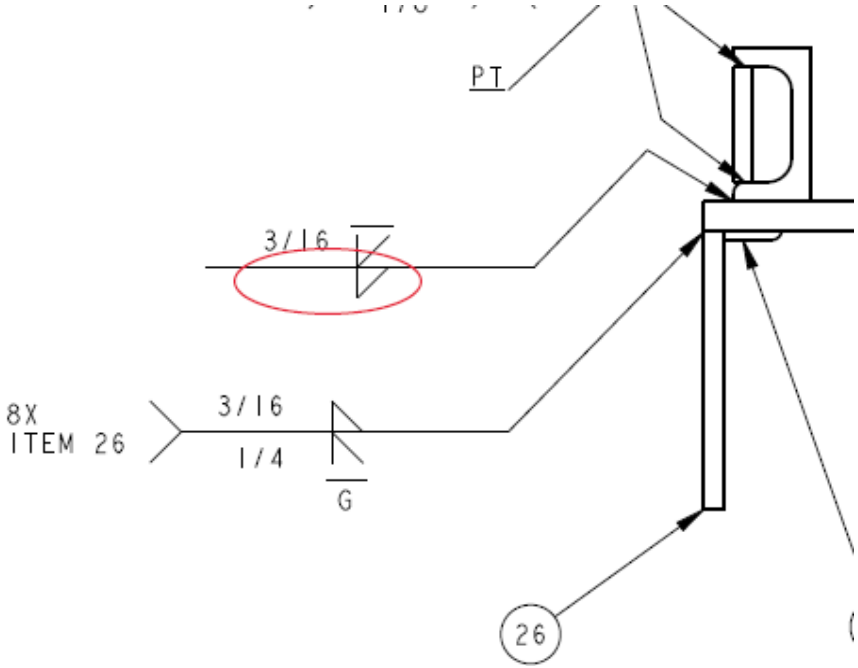
Drawing Changes

- **All changes implemented to facilitate fabrication of new packaging**
- **Drawing 9045393 - BOM**
  - Revised part number of items 53, 54, and 58 to reflect current Cherry Aerospace rivet nomenclature
  - Revised items 44, 45, 55, and 68 to include “OR EQUIV” to facilitate procurement of equivalent parts
  - Revised part number of item 55 to include next size rivet to allow appropriate grip length (with flag note)

	2	68		525 OR 625 EXTREN FIBERGLASS OR EQUIV.	ANGLE 2.0 X 1/4"
		67		NOT USED	
		66		NOT USED	
		65		NOT USED	
	160	64		HEXNUT, 1/4-20 UNC	ASTM A194, GRADE 2H, Zn PLATED
	160	63		FLAT WASHER, HARDENED 1/4	ASTM F436, Zn PLATED
		62		NOT USED	
	3	61		SOC HD CAP SCR, 1/2-13 X 3.0 LG	ASTM A574, Zn PLATED
	320	60		FL HD SOC 5/16-18 UNC X .75 LG	ASTM F835, Zn PLATED
	160	59		FL HD SOC 1/4-20 UNC X 1.0 LG	ASTM F835, Zn PLATED
	A/R	58	CR2562-8-09	RIVET, 1/4"	WIREDRAW CHERRYLOCK RIVET OR EQUIV.
	176	57		FASTENER, THREAD CUTTING, #8 X 1.5 LG	STAINLESS STEEL
	30	56	P-68V	PLASTIC THREADED PLUG	CAP PLUG OR EQUIV.
XX	A/R	55	SD814BS OR SD816BS	1/4" POP BLIND RIVET	HANSON OR EQUIV.
	A/R	54	CR2162-6-08	FLAT HEAD RIVET, 3/16	WIREDRAW CHERRYLOCK RIVET OR EQUIV.
	A/R	53	CR2563-8-06	1/4 RIVET	WIREDRAW CHERRYLOCK RIVET OR EQUIV.
	10	52	MS20001-16	HINGE	
	4	51		ANGLE, 1.5 X .125	ASTM A276 TYPE 304
		50		NOT USED	
19	A/R	49		PAD, 1/8 THK MIN.	NEOPRENE AND/OR DELRIN
	30	48	4464K225	HALF COUPLING, 3/4 NPT	MCMASTER-CARR OR EQUIV.
	A/R	47		POLYURETHANE, FOAM, LOWER	6 LB/CUFT
	A/R	46		POLYURETHANE, FOAM, UPPER	6 LB/CUFT
	A/R	45	1535-L	CERAMIC FIBER PAPER, LYTHERM	LYDALL, 68.0 X .25 THK OR EQUIV.
	2	44		525 OR 625 EXTREN FIBERGLASS OR EQUIV.	4.0 X .25 THK

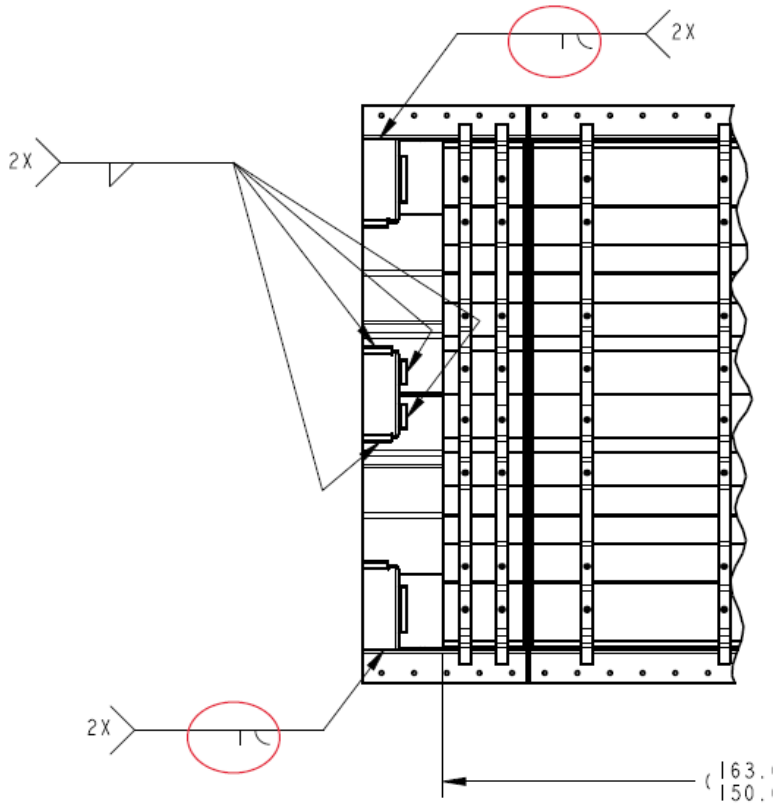
Drawing Changes

- **Drawing 9045402**
  - Removed ¼” bevel weld callout. The U-channel used for the rail is tapered to 3/16” at the ends where the fillet weld is prescribed.



Drawing Changes

- **Drawing 9045403**
  - Removed 1/8” weld size callout on flare bevel weld due to thickness of base material of 0.09”



Agenda

1. Framatome Team
2. Project Description
3. Contents up to 8 wt.% ^{235}U Enrichment
4. Criticality Evaluation
   a) Methods of Analysis
   b) Benchmarking
   c) Results
5. Drawing Changes
6. **Proposed Schedule**
7. Opportunity for Public Comment

Proposed Schedule

- **Schedule:**
  - **NRC Submittal – January 31, 2024**
  - **Amendment Request – 1 year, approximately January 2025**

Agenda

1. Framatome Team
2. Project Description
3. Contents up to 8 wt.% ^{235}U Enrichment
4. Criticality Evaluation
   a) Methods of Analysis
   b) Benchmarking
   c) Results
5. Drawing Changes
6. Proposed Schedule
7. **Opportunity for Public Comment**

framatome

Opportunity for Public Comment

framatome

Thank You