MARCH 4-5, 2026, REGULATORY AUDIT REPORT REGARDING FRAMATOME INC. TOPICAL REPORT EMF-93-177, REVISION 1, SUPPLEMENT 3P, REVISION 0, "MECHANICAL DESIGN FOR BWR FUEL CHANNELS: ATRIUM BWR ENHANCED ACCIDENT MODEL"

DOCKET NO. 99902041

PROJECT NO. 728

EPID L-2028-TOP-0018

1.0 BACKGROUND

On May 16, 2025 (Agencywide Documents Access and Management System (ADAMS) Package Accession No. ML25136A387), Framatome, Inc. (Framatome) submitted Topical Report (TR) EMF-93-177, Revision 1, Supplement 3P, Revision 0, "Mechanical Design for BWR [Boiling Water Reactor] Fuel Channels: ATRIUM BWR Enhanced Accident Model," for U.S. Nuclear Regulatory Commission (NRC) staff's review and approval. To support its review of the TR, the NRC and Pacific Northwest National Laboratory (PNNL) staff conducted an in-person regulatory audit at Framatome's Richland, Washington facility on March 4-5, 2026 (ML26015A112). The purpose of the audit was to get clarification on questions described in the audit plan. The audit was performed consistent with NRC Office of Nuclear Reactor Regulation Office Instruction LIC-111, Revision 2, "Regulatory Audits," (ML24309A281) and will assist the NRC staff in developing the TR safety evaluation (SE).

A summary of the audit discussions is provided in Section 4.0 below.

2.0 REGULATORY AUDIT OBJECTIVES

The in-person audit facilitated the discussion of questions regarding the TR through direct interaction with Framatome's technical experts, NRC staff, and PNNL staff. The audit participants are listed below.

Name	Affiliation
Alex Collier	NRC
Joseph Messina	NRC
Ngola Otto	NRC
James Fitzpatrick	PNNL
Kevin Kadooka	PNNL
Nicholas Klymyshyn	PNNL
Scott Adair	Framatome
Morris Byram	Framatome
Benoit Dulauroy	Framatome
Victor Hatman	Framatome
Szilard Kovacs	Framatome
Jeff Morris	Framatome

3.0 REGULATORY AUDIT BASES

Regulatory guidance for the review of fuel system designs and adherence to Title 10 of the *Code of Federal Regulations,* Appendix A to Part 50, General Design Criteria-10, "Reactor Design," is provided in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (SRP), Section 4.2, "Fuel System Design." In accordance with SRP Section 4.2, the objectives of the fuel design's safety review are to provide reasonable assurance that: (1) the fuel system is not damaged as a result of normal operation and anticipated operational occurrence, (2) fuel system damage is never so severe as to prevent control rod insertion when it is required, (3) the number of fuel rod failures is not underestimated for postulated accidents, and (4) coolability is always maintained. The design bases include (1) fuel system damage, (2) fuel rod failure, and (3) fuel coolability. Dimensional changes of the fuel channels must be included in the design analysis to establish operational tolerances, which are part of the requirements in the design bases.

4.0 DISCUSSION

The audit focused primarily on the TR, the audit information needs, all relevant supporting documentation (e.g., methodology, calculations), and questions. During the audit discussions, the NRC and PNNL staff gained a more detailed understanding of the information supporting Framatome's proposed TR methodology via in-person discussions. Non-docketed information reviewed during the audit that the NRC staff deems necessary to support the development of its SE will be requested to be submitted on the docket. A summary of each question is provided below.

- Regarding audit question 1, Framatome agreed during audit discussion to clarify the TR regarding fuel bundle deflection. Specifically, they will detail how the fuel channel ensures control blade insertion is not hindered. The NRC staff will follow up with a formal request for additional information (RAI) for these revisions to be docketed.

- Regarding audit question 2, PNNL verified that Framatome's ABEAM model utilizes a **[[ ]]** approaches, with **[[ ]]** The review confirmed that this approach yields conservative, higher-amplitude responses, with **[[ ]]** however, an RAI will be submitted to docket the methodology employed by Framatome to implement **[[ ]]** in the ABEAM.

- Regarding audit question 3, PNNL confirmed that the ABEAM model responds appropriately to varying damping levels. Framatome's sensitivity study identified **[[ ]]** consequently, they **[[ ]]** to ensure conservative SSE/LOCA predictions. While the documented **[[ ]]** Because the resulting model response **[[ ]]** the results are sufficiently conservative. An RAI will be submitted to docket the ABEAM sensitivity to damping.

- Regarding audit question 4, PNNL staff confirmed with Framatome representatives that the **[[**

  ]] is considered appropriate as it is integrated into the calibration process, where successful results demonstrate that the model accurately reflects intended physical behaviors. Furthermore, **[[** **]]** aligns with the specifications in the accepted base TR. This issue is now resolved.

- Regarding audit question 5, Framatome provided sufficient justification for all mass assignments within the ABEAM model. Based on this technical review, the issue is now considered resolved.

- Regarding audit question 6, Framatome developed a **[[** **]]** ATRIUM 11 fuel assembly model to evaluate **[[** **]]** characteristics under applied loads. This model was validated against experimental data, demonstrating that the **[[**

  ]] Consequently, Framatome confirmed that these **[[**

  ]] This item is considered closed.

- Regarding audit question 7, PNNL confirmed that **[[**

  ]]

  While the documented **[[**

  ]] Because the ABEAM model's **[[** **]]** the predictions are considered sufficiently conservative. This item is resolved.

- Regarding audit question 8, PNNL confirmed with Framatome representatives **[[**

  ]] Because this approach ensures the **[[** **]]** throughout the entire duration, the methodology is acceptable. This item is considered closed.

- Regarding audit question 9, PNNL staff were able to confirm with Framatome representatives a typographical error in the TR associated with this question, and agreed to update Table 5-1, "Fuel Channel **[[** **]]** Results," to include SSE in the description of the Case 2 load scenario. Therefore, the NRC staff plans to request the proposed changes to the TR be submitted on the docket via an RAI.

- Regarding audit question 10, Framatome justified the **[[**

  ]] This question is considered resolved.

- Regarding audit question 11, PNNL confirmed that the **[[**

  ]] This item is considered closed.

- Regarding audit question 12, PNNL confirmed that **[[**

]] An RAI will be issued for Framatome to docket the methodology used in calculating the **[[ ]]**

- Regarding audit question 13, PNNL confirmed that the **[[**

]] The NRC staff intends to request that this clarification be formally submitted on the docket via an RAI.

- Regarding audit question 14, PNNL confirmed that this treatment is consistent with the methodology presented in the NRC-approved base TR. Consequently, this question is considered resolved.

- Regarding audit question 15, Framatome **[[**

]] This technical justification resolves the concern, and the question is closed.

- Regarding audit question 16, PNNL verified the ABEAM model's bottom geometry and connectivity. Framatome confirmed that the lower tie plate (LTP) **[[**

]] Additionally, the audit identified that **[[**

]] ensuring no impact on current results. **[[**

]] The NRC staff intends to request that the clarifications on the **[[**

]] be formally submitted on the docket via an RAI.

- Regarding audit question 17, PNNL confirmed that the identified discrepancy stems from the **[[**

]] which aligns with the model input values. The NRC staff intends to request that this clarification be formally submitted on the docket via RAI .

- Regarding audit question 18, Framatome justified the **[[**

]] Further justification regarding the **[[**

]] can be found in the response to Audit Question 17. Consequently, this question is considered closed.

5.0 CONCLUSION

The audit objectives were accomplished through discussions with the Framatome technical experts and engineers, document review, and verification of results regarding the 18 audit questions. More specifically, the NRC and PNNL staff confirmed information by reviewing reference documents and conducting technical discussions with Framatome representatives. No regulatory decisions were made during the audit.

6.0 LIST OF AUDIT DOCUMENTS

[1] FS1-0061860, Revision 1.0, "ABEAM Sample Problem: **[[ ]]** (tape 1) and Sample Runs at BOL and EOL"

[2] FS1-0061861, Revision 2.0, "ABEAM Sample Problem: tape4 Development"

[3] FS1-0061862, Revision 1.0, "ABEAM Sample Problem: Sensitivity Studies"

[4] FS1-0082871, Revision 1.0, "ABEAM Sample Problem: **[[ ]]**

[5] FS1-0046315, Revision 1.0, "Determination of the Dynamic Behavior of the ATRIUM 11 Fuel Assembly with **[[ ]]**

[6] FS1-0052184, Revision 1.0, "Determination of the Dynamic Behavior of the ATRIUM 11 Fuel Assembly with **[[ ]]** Using ABEAM"

[7] FS1-0042817, Revision 3.0, "Accident Analysis in Support of **[[ ]]** ATRIUM 11"

[8] FS1-0049331, Revision 1.0, "Derivation of the Beam Properties for the **[[ ]]**

[9] FS1-0009179, Revision 1.0, **[[ ]]**

[10] FS1-0048722, Revision 1.0, **[[ ]]**

[11] FS1-0069562, Revision 1.0, **[[ ]]**

[12] FS1-0017411, Revision 1.0, "Best Practices for **[[ ]]**

[13] FSI-0077129, Revision 1.0, “Overall Damping Ratio of **[[ ]]** ATRIUM 11 Fuel Assembly with **[[ ]]** in BWR Accident Analysis”

Date: May 11, 2026