UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

March 20, 2023

Mr. Daniel H. Dorman
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: SAFETY EVALUATION FOR FRAMATOME INC., TOPICAL REPORT ANP-10353P, REVISION 0, "INCREASED ENRICHMENT FOR PWRs"

Dear Mr. Dorman:

During the 703rd meeting of the Advisory Committee on Reactor Safeguards, March 2, 2023, we completed our review of the Framatome, Inc. (Framatome) licensing topical report (TR) ANP-10353P, Revision 0, "Increased Enrichment for PWRs [Pressurized Water Reactors]" and the associated staff safety evaluation (SE). Our Accident Analyses–Thermal Hydraulic Subcommittee also reviewed this topic on February 15, 2023. During these meetings, we had the benefit of discussions with the staff and representatives from Framatome. We also had the benefit of the referenced documents.

CONCLUSION AND RECOMMENDATION

1. The methodology documented in ANP-10353P, Revision 0, when applied within the staff-imposed limitations and conditions (L&Cs), is acceptable for the calculation of PWR fuel performance with enrichments higher than 5% uranium (U)-235.

2. The SE report should be issued.

BACKGROUND

The purpose of ANP-10353P is to support increasing the range of applicability for advanced Framatome codes and methods used to evaluate the performance of uranium dioxide fuel for enrichments greater than 5% U-235. Although increased fuel enrichment is expected to lead to increased fuel burnup levels, this TR and the associated SE are not intended to support the use of higher enriched fuel at a fuel rod average burnup beyond the current licensed limit of 62 GWd/MTU. Framatome is expected to submit a separate TR to support fuel burnup extensions.

DISCUSSION

The TR applies only to the following fuel designs:

- GAIA™ 17×17 for Westinghouse plants
- HTP™ 15×15 for Westinghouse plants
- HTP™ 14×14 for Combustion Engineering plants
- HTP™ 16×16 for Combustion Engineering plants

Framatome evaluated these fuels using the methodology in the GAIA™ generic fuel design TR, ANP-10342P-A, Revision 0, "GAIA™ Fuel Assembly Mechanical Design." Framatome intends for this methodology to be applied in fuel-transition license amendment requests (LARs) when an enrichment greater than 5% U-235 is initially loaded into a plant. The staff reviewed the L&Cs in the GAIA™ SE report and found the L&Cs remain applicable at the proposed enrichment increase.

The staff evaluation included detailed review of codes and methods used to evaluate the following: neutronics, thermal hydraulics, thermomechanical, external loads, fuel hold down, cladding collapse, fuel rod bow, loss of coolant accidents (LOCAs), non-LOCAs, and decay heat. The staff evaluation was thorough and found that, for most methods, the impact of the proposed enrichment increase is minimal because most components of the analysis codes and methodology are not dependent upon U-235 enrichment. In addition, some performance characteristics at higher enrichment are bounded by those observed at currently licensed enrichment levels.

The neutronics evaluations included criticality, depletion, accident tolerant fuel (ATF) designs, uncertainty on the local power peaking and power distribution, and changes in detector sensitivity. The thermal hydraulic evaluation concentrated on the applicability of the COBRA–FLX™ subchannel code and its critical heat flux correlations. The staff found that the approved code package for neutronic, fuel thermomechanical, and thermal hydraulic aspects of core design, ARCADIA™, can perform the necessary calculations with reasonable accuracy. The staff reviewed the L&Cs in the ARCADIA™ SE report and found the L&Cs remain applicable at the proposed enrichment increase.

The TR and the staff SE evaluated the impact of increased fuel enrichment on fuel thermomechanical performance and related analysis methodologies. Enrichment level affects some fuel thermal properties, such as fuel conductivity and centerline temperature, as well as performance features such as fission gas release and the in-pellet radial power profile. The staff found that the range of applicability for these correlations and models can be extended to the proposed increase in the fuel enrichment level. This is justified by both the existing and new experimental data provided by Framatome. The staff also found that mechanical properties are typically a function of fast fluence, which is reduced as enrichment increases; therefore, results of current models and analyses for these fuel designs remain bounding. The corrosion and hydriding models for Framatome cladding are independent of fuel enrichment and fast fluence; therefore, current methodologies for assessing corrosion and hydriding remain applicable. The staff concluded that the approved GALILEO™ thermal mechanical computer code is applicable and remains validated for use at the proposed higher enrichment values.

The Framatome TR provides a detailed study and evaluation of decay heat performance data over the proposed range of fuel enrichment. The staff performed a thorough review of the applicability of the ARTEMIS™ neutronics code and found that the Framatome decay heat models in the code remain conservative up to the proposed enrichment levels.

In their review, the staff considered rod ejection accidents and fuel fragmentation, relocation, and dispersal (FFRD). They concluded the ARCADIA™ Rod Ejection Accident (AREA™) rod ejection methodology remains applicable at the proposed enrichment levels. Because FFRD is a function of fuel burnup, the staff found FFRD is not within the scope of this TR.

Framatome has submitted detailed justification for the application of their analysis codes and methods to support the proposed increase in U-235 fuel enrichment. We concur with the staff evaluation results and conclusion in their SE. The SE report includes two L&Cs. The first one deals with uncertainties, which have not been approved generically and must be justified, for specific applications, with additional analysis or data. The second one limits the TR applicability to the fuel assembly types analyzed in this TR, but it notes that the methodology may be used to gain approval for future designs.

Operating reactor licensees intending to utilize benefits of increased enrichment will be required to submit a plant-specific LAR demonstrating continued compliance with regulations.

SUMMARY

The methodology documented in ANP-10353P, Revision 0, when applied within the staff-imposed L&Cs, is acceptable for the calculation of PWR fuel performance with enrichments higher than 5% U-235. The SE report should be issued. Applicability of this methodology to ATF fuel designs or with fuel discharge burnup higher than current limits will be the subject of separate staff reviews.

No response to this letter is required.

Sincerely,

Signed by Rempe, Joy
on 03/20/23

Joy Rempe
Chairman

REFERENCES

1. ANP-10353P, Revision 0, “Increased Enrichment for PWRs,” January 31, 2021 (Publicly Available ML21035A075/Non-publicly Available ML21035A076).

2. ANP-10353P, Revision 0, “Response to Request for Additional Information Regarding ANP-10353P, Revision 0, ‘Increased Enrichment for PWRs’,” January 26, 2022 (ML22034A539).

3. U.S. Nuclear Regulatory Commission, “Draft Safety Evaluation Report for Framatome Inc., Topical Report ANP-10353P, Revision 0, ‘Increased Enrichment for PWRs’,” December 2, 2022 (Non-publicly Available ML22298A270).

4. ANP-10342P–A, “GAIA Fuel Assembly Mechanical Design,” September 30, 2019 (ML19309D916).

5. ANP-10297P–A, Revision 0, “The ARCADIA Reactor Analysis System for PWRs Methodology Description and Benchmarking Results,” February 28, 2013 (ML14195A147).

6. ANP-10297NP–A, Revision 0, Supplement 1, “The ARCADIA Reactor Analysis System for PWRs Methodology Description and Benchmarking Results,” June 26, 2015 (Publicly Available ML15187A268/Non-publicly Available ML15187A269).

7. ANP-10323P–A, Revision 1, “GALILEO Fuel Rod Thermal-Mechanical Methodology for Pressurized Water Reactors,” November 30, 2020 (ML21005A030).

8. ANP-10338P–A, Revision 0, “AREA – ARCADIA Rod Ejection Accident,” December 31, 2017 (ML18059A782).

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