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

November 04, 2019

Ms. Margaret M. Doane
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: SAFETY EVALUATION OF TOPICAL REPORT ANP-10346P, REVISION 0, "ATWS-I ANALYSIS METHODOLOGY FOR BWRs USING RAMONA5-FA"

Dear Ms. Doane:

During the 667th meeting of the Advisory Committee on Reactor Safeguards, October 2-4, 2019, we reviewed the staff's safety evaluation report of Framatome topical report ANP-10346P, Revision 0, "ATWS-I Analysis Methodology for BWRs using RAMONA5-FA." Our Thermal Hydraulic Subcommittee also reviewed this topical report on August 21, 2019. 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 RAMONA5-FA methodology to analyze anticipated transients without scram with instability (ATWS-I), when used in compliance with the seven limitations and conditions imposed by the staff, is acceptable for use in boiling water reactor (BWR) licensing applications.

2. The safety evaluation should be issued.

Background

RAMONA is a family of codes. In the U.S., RAMONA-III was first acquired by the U.S. NRC from Scandpower, Norway, in 1979. Based on this code, Brookhaven National Laboratory (BNL) developed RAMONA-3B/MOD0. BNL later incorporated three-dimensional (3D) neutron kinetics and other model improvements to develop RAMONA-4B. RAMONA5-FA is a Framatome proprietary version, which has been approved for use in some licensing applications, including calculation of setpoints for stability solution implementations. The AISHA and SINANO codes described in ANP-3274P-A were approved for use to analyze ATWS-I events for extended flow window (EFW) applications at Monticello Nuclear Generating Plant, Unit 1.

The AISHA and SINANO models and other improvements have been incorporated in the RAMONA5-FA ATWS-I methodology on a generic (i.e., non-plant specific) basis. The current topical report, ANP-10346P, documents this update and provides an ATWS-I phenomena identification and ranking table (PIRT), a summary of the validation for the methodology, and a description of the analysis procedure.

Discussion

The staff has previously approved multiple components of the RAMONA5-FA ATWS-I methodology as part of their review of the Monticello EFW license amendment request; therefore, the primary focus of the staff review was the aspects of this methodology that are novel to ensure applicability on a generic basis, as well as the integration of multiple methodologies developed at different times into a single approach for generic ATWS-I analyses. The staff also reviewed the ATWS-I PIRT, experiment benchmarking, and an example plant application. The staff review followed key elements of the evaluation model development and assessment process outlined in Regulatory Guide 1.203, including: accident scenario description and phenomena identification and ranking; evaluation methodology; code assessment; uncertainty analysis; and documentation.

Main features of the RAMONA5-FA ATWS-I methodology include: adaptive 3D nodal diffusion with two-energy groups tightly coupled to the thermal hydraulics solution; automated coupling to MICROBURN-B2 cross sections; random noise models that excite all neutronic modes; nonequilibrium thermal hydraulic models to allow vapor superheat; and a numerical solution that allows for reverse flow and prevents singularities. The control systems and vessel models have been improved to track water level and feedwater temperature to simulate operator mitigation actions more accurately. The fuel thermal-mechanical models have been updated based on the RODEX4 and XEDOR methodologies to include thermal conductivity degradation, gap conductance, and chromium-doped pellet properties. As with all versions of RAMONA, it has the same basic limitation that sacrifices pressure-wave tracking in favor of a more robust solution for momentum conservation.

One of the most significant modifications is the use of the new CPROM critical power ratio correlation to integrate transient dryout and rewet phenomena into a single methodology, without a minimum stable film boiling temperature correlation. CPROM has been developed based on proprietary data from the Karlstein Thermal Hydraulic (KATHY) test facility. The post-dryout heat transfer models are based on KATHY ATRIUM-fuel-specific measurements. The staff has reviewed in detail the models in the RAMONA5-FA ATWS-I methodology and found them acceptable for their intended use.

Framatome has performed code assessment and validation against an extensive set of experimental data, most of them ATRIUM-specific. The data include: void fraction, pressure drop, flow stability tests, and transient dryout-rewet. Benchmarks were also performed against integral tests for a number of plant linear instabilities, and nonlinear plant instability events. Framatome has addressed uncertainties via sensitivity analyses, including sensitivity to nodalization and integration time step. The staff has reviewed the RAMONA5-FA ATWS-I validation and found it acceptable.

The staff has found the RAMONA5-FA methodology acceptable for ATWS-I calculations with seven limitations and conditions: the gap conductance sensitivity shall be reevaluated for new fuels; justification must be provided to demonstrate adequate margin in operator action timing; the assumptions employed in the analysis of record must be verified for core specific applications; transition cores must have additional verification; both turbine trip and recirculation pump trip must be analyzed to determine the limiting ATWS-I event; plant-specific steam line and valve models must be verified; and plant-specific applications must justify the selected settings for RAMONA5-FA. We concur with these limitations and conditions.

Summary

The RAMONA5-FA methodology to analyze anticipated transients without scram with instability, when used in compliance with the seven limitations and conditions imposed by the staff, is acceptable for use in BWR licensing applications. The safety evaluation should be issued.

Sincerely,

/RA/

Peter Riccardella
Chairman

REFERENCES

1. U.S. Nuclear Regulatory Commission, Safety Evaluation, "Final Safety Evaluation for Licensing Topical Report ANP-10346P, "ATWS-I Analysis Methodology for BWRs using RAMONA5-FA," Revision 0, October 3, 2019 (ML19276E475 (Non-Proprietary/Publicly Available) and ML19276E152 (Proprietary/Non-Publicly Available)).

2. AREVA NP Inc. Report ANP-10346P, "ATWS-I Analysis Methodology for BWRs Using RAMONA5-FA," Revision 0, December 15, 2017, (ML17355A235 (Non-Proprietary/Publicly Available) and ML17355A233 (Proprietary/ Non-Publicly Available)).

3. AREVA NP Inc. Licensing Topical Report EMF 3028P-A, "RAMONA5-FA: A Computer Program for BWR Transient Analysis in the Time Domain: Theory Manual," Volume 2, Revision 4, June 4, 2013 (ML131550602 (Proprietary/Non-Publicly Available)).

4. AREVA NP Inc. Report ANP-3274P-A, "Analytical Methods for Monticello ATWS-I," Revision 2, July 2016 (ML16221A275 (Non-Proprietary/Publicly Available) and ML16221A278 (Proprietary/Non-Publicly Available)).

5. U.S. Nuclear Regulatory Commission, "Monticello Nuclear Generating Plant Renewed Facility Operating License No. DPR-22," February 23, 2017 (ML17054C394).

6. AREVA NP Inc. Licensing Topical Report BAW-10247PA, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors," April 30, 2008 (ML081340208 (Non-Proprietary/Publicly Available) and ML081340383 and ML081340385 (Proprietary/ Non-Publicly Available)).

7. Letter from Gary Peters, Director, Licensing & Regulatory Affairs, Framatome, Inc., to USNRC Document Control Desk, "Response to Request for Additional Information Regarding ANP-10346P, Revision 0, "ATWS-I Analysis Methodology for BWRs Using RAMONA5-FA," March 8, 2019 (ML19071A271 (Proprietary/Non-Publicly Available))

8. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.203, "Transient and Accident Analysis Methods," December 30, 2005 (ML053500170).

November 4, 2019

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