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

April 21, 2022

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

SUBJECT: SAFETY EVALUATION FOR TOPICAL REPORT NEDC-33922P, "BWRX-300 CONTAINMENT EVALUATION METHOD," REVISION 2

Dear Mr. Dorman:

During the 694th meeting of the Advisory Committee on Reactor Safeguards (ACRS), April 6-8, 2022, we completed our review of topical report NEDC-33922P, "BWRX-300 Containment Evaluation Method," Revision 2, and the associated safety evaluation (SE). Our BWRX-300 Design Centered Subcommittee reviewed this matter on March 18, 2022. During these meetings, we had the benefit of discussions with representatives of the U. S. Nuclear Regulatory Commission (NRC) staff and GE-Hitachi Nuclear Energy Americas, LLC (GEH or the applicant). We also benefited from the referenced documents.

CONCLUSIONS AND RECOMMENDATION

1. The proposed analysis methodology documented in NEDC-33922P, Revision 2, subject to the staff-imposed limitations and conditions, is appropriate to evaluate BWRX-300 containment performance.

2. A key BWRX-300 performance issue is the potential accumulation of non-condensable gases that may limit heat transfer capability or increase the potential for deflagration during accidents. When the design is finalized, the methodology report limitations and conditions require that these performance issues are addressed.

3. The SE report should be issued.

BACKGROUND

BWRX-300 is an evolutionary light-water reactor based on the certified Economically Simplified Boiling Water Reactor (ESBWR) design and operating experience of the boiling water reactor fleet. Rated at 300 MW-electric, it is a natural-circulation small modular reactor being developed by GEH. The applicant has employed risk-informed design principles with the goal of reducing overall plant size and minimizing the highest risk contributors from the ESBWR design.

Topical Report NEDC-33922P presents the analysis methodology that will be used to demonstrate that the BWRX-300 containment design satisfies the acceptance criteria listed in topical report NEDC-33911P, "BWRX-300 Containment Performance." In our letter of March 1, 2021, documenting our review of NEDC-33911P, we concluded that these criteria are appropriate to evaluate the BWRX-300 containment performance.

The NRC and the Canadian Nuclear Safety Commission (CNSC) are conducting joint reviews of GEH topical reports related to BWRX-300. For this joint review on containment evaluation, the scope was focused on the methodology and not necessarily the design inputs or simulation outputs. The report from the joint review does not affect the jurisdiction and/or the discretion of CNSC or NRC.

DISCUSSION

The containment analysis methodology is applied to the events that are evaluated to establish the suitability of the containment performance with respect to the acceptance criteria, including: anticipated operational occurrences; station blackout, as required by 10 CFR 50.63; anticipated transients without scram, as required by 10 CFR 50.62; large-break loss-of-coolant accident (LOCA) inside containment; and small-break LOCA inside containment.

GEH performed a detailed phenomena identification and ranking table (PIRT) evaluation. The staff reviewed the qualitative details of the containment PIRT survey methodology and found it to be rigorous and consistent with industry best practices. The methodology uses the TRACG code to calculate the mass and energy release from the reactor coolant system and the GOTHIC code to evaluate the containment response, including its passive cooling system. The staff concluded that the proposed methodology is consistent with Regulatory Guide 1.203 because it is based on a conservative analysis using mature computer codes with a sufficient qualification basis, and is therefore, acceptable. We concur.

The staff has performed a series of confirmatory calculations using the TRACE and MELCOR computer codes. These independent analyses provided significant value, not just by confirming the accuracy of GEH's calculations, but also by providing technical insights about the proposed design. Based on these calculations, the staff focused their efforts on identifying the possibility and consequences of ingress of non-condensable gases in the isolation condenser (IC), which would degrade its performance. It is encouraging that, rather than analyzing the problem away with increasingly sophisticated analyses, GEH has committed to improve the BWRX-300 design to make gas accumulation in the IC highly unlikely. We concur with the staff conclusion that the proposed design improvements should address potential degradation concerns.

The staff imposes four limitations and conditions for future applications of this methodology. Three of them are related to non-condensable gases, and one is related to passive containment cooling. Specifically, the limitations are:

1. Limit the radiolytic gas accumulation to a safe concentration in the IC.

2. Provide design improvements to prevent reverse flow through the IC.

3. Size the containment passive cooling capabilities to prevent reverse flow from containment to the reactor cooling system during small-break LOCAs to prevent ingress of containment gasses.

4. If the passive containment cooling system design changes, the applicability of the methodology will need to be reviewed.

The staff's limitations and conditions are adequate to ensure that important containment-design improvements are implemented and that design-specific applications of the proposed methodology are likely to satisfy regulatory requirements.

The joint CNSC/NRC review has been mutually beneficial. We encourage such interactions, when warranted, and look forward to following the staff progress on future interactions. The results of this effort, however, do not provide any regulatory bases for the implementation of future licensing submittals; those bases are provided in the staff SE. We recommend that the SE report be issued.

SUMMARY

The proposed analysis methodology documented in NEDC-33922P, Revision 2, subject to the staff-imposed limitations and conditions, is appropriate to evaluate BWRX-300 containment performance. A key BWRX-300 performance issue is the potential accumulation of non-condensable gases that may limit heat transfer capability or increase the potential for deflagration during accidents. When the design is finalized, the methodology report limitations and conditions require that these performance issues are addressed. The SE report should be issued.

We are not requesting a formal response from the staff to this letter.

Sincerely,

Signed by Rempe, Joy
on 04/21/22

Joy L. Rempe
Chairman

REFERENCES

1. U. S. Nuclear Regulatory Commission, "Safety Evaluation by the Office of Nuclear Reactor Regulation Licensing Topical Report NEDC-33922P, Revision 2, 'BWRX-300 Containment Evaluation Method'," March 9, 2022 (ML22040A004).

2. GE-Hitachi Nuclear Energy Americas, LLC, Licensing Topical Report NEDC-33922P, "BWRX-300 Containment Evaluation Method," Revision 2, December 31, 2021 (ML21351A173).

3. U. S. Nuclear Regulatory Commission, "Regulatory Audit Report of the GE-Hitachi Nuclear Energy Americas, LLC Topical Report NEDC-33922, 'BWRX-300 Containment Evaluation Method'," March 2, 2022 (ML21343A195).

4. Advisory Committee on Reactor Safeguards, "Safety Evaluation for Topical Report NEDC-33911P, 'BWRX-300 Containment Performance'," March 1, 2021 (ML21049A340).

5. Advisory Committee on Reactor Safeguards, “Applicability of TRACE Thermal-Hydraulic System Analysis Code to Evaluate the ESBWR Design and Related Matters,” July 29, 2009 (ML091940352).

6. Advisory Committee on Reactor Safeguards, “Interim Letter 3: Chapters 4, 6, 15, 18, and 21 of the NRC Staff’s Safety Evaluation Report with Open Items Related to the Certification of the ESBWR Design,” May 23, 2008 (ML081330447).

7. U.S. Nuclear Regulatory Commission and Canadian Nuclear Safety Commission, “Joint Report on GE Hitachi’s Containment Evaluation Method,” April 2022 (ML22091A201).

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

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