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

June 15, 2018

Mr. Victor McCree
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: SAFETY EVALUATION FOR TOPICAL REPORT APR1400-F-A-TR-12004-P, REVISION 1, "REALISTIC EVALUATION METHODOLOGY FOR LARGE-BREAK LOSS OF COOLANT ACCIDENT OF THE APR1400"

Dear Mr. McCree:

During the 653rd and 654th meetings of the Advisory Committee on Reactor Safeguards, May 3-4 and June 6-7, 2018, we met with representatives of the NRC staff, the applicant, including Korea Electric Power Corporation (KEPCO), and Korea Hydro & Nuclear Power Company, Ltd., (KHNP) to review the safety evaluation for topical report APR1400-F-A-TR-12004-P, Revision 1, "Realistic Evaluation Methodology for Large-Break Loss of Coolant Accident of the APR1400." Our APR1400 Subcommittee reviewed the staff safety evaluation and the other referenced documents during a meeting on April 17, 2018. This topical report was submitted by KHNP in conjunction with its affiliate company, KEPCO, in support of the APR1400 design certification.

CONCLUSION AND RECOMMENDATION

1. The code-accuracy-based realistic evaluation methodology (CAREM) is acceptable for APR1400 LBLOCA evaluations, subject to conditions and limitations identified by the staff.

2. The staff should issue their safety evaluation report.

BACKGROUND

The KHNP topical report describes an evaluation method, CAREM, for the analysis of large break loss-of-coolant accidents (LBLOCAs). CAREM relies on modified versions of the RELAP5/MOD3.3 code for calculating reactor coolant system thermal-hydraulics and the CONTEMPT4/MOD5 code for calculating containment back pressure. LBLOCA evaluations must meet regulatory criteria in 10 CFR 50.46. CAREM follows the code scaling applicability and uncertainty methodology as described in NUREG/CR-5249 and Regulatory Guide 1.203, but takes minor departures by using a mix of non-parametric statistics and conservative assumptions for some input parameters.

The staff review of the topical report focused on the following areas: 1) the overall methodology, including coupling between RELAP and CONTEMPT codes, 2) the associated phenomena importance and ranking table, 3) code adequacy and applicability, 4) uncertainty parameters, ranges, and propagation in the model, and 5) compliance with relevant regulations and consistency with regulatory guidance.

DISCUSSION

The APR1400 LBLOCA analyses must consider several unique aspects of its emergency core cooling system's component operation. The APR1400 safety injection system consists of four mechanically and electrically independent trains. A safety injection pump and a safety injection tank are installed in each train. Emergency core cooling water is injected into the downcomer of the reactor pressure vessel through direct vessel injection nozzles that are fed by the safety injection tank and safety injection pump. Each safety injection tank is equipped with a fluidic device that passively adjusts the safety injection flow rate to provide the required water inventory throughout the injection period.

KHNP has evaluated CAREM by using a significant number of experimental data, including tests from FLECHT/SEASET, UPTF, MIDAS, DOBO, ATLAS, and VAPER. As part of their safety evaluation, the staff identified several limitations and conditions, which address the range of applicability and configuration control for CAREM evaluations.

A key phenomenon in LBLOCA analysis is fuel thermal conductivity degradation (TCD). The applicant has chosen to address TCD effects with burnup by using penalties or correction factors applied to the analyses modeling reactor performance or accident consequences. This approach has been used by licensees previously to justify continued operation of reactors and has been accepted by the staff.

The staff verified the approaches used to develop TCD-related penalties and conservatisms for LOCA modeling using several approaches, including audits and confirmatory calculations using the NRC computer code FRAPCON. Each affected analysis was reviewed to assure the rationale proposed and the computational approach were justified, and that the results and margins to limits were satisfactory. The LBLOCA review was comprehensive to assure that the methods, analyses, and results satisfied all regulatory requirements. The staff also performed best-estimate analyses using the TRACE computer code to confirm the magnitudes and trends predicted by the KHNP methodology. Additional assessments examined the sensitivities of the LOCA results to TCD modeling assumptions.

SUMMARY

The staff concluded that CAREM is acceptable for APR1400 LBLOCA evaluations, subject to the identified conditions and limitations. The staff should issue their safety evaluation.

Sincerely,

/RA/

Michael Corradini
Chairman

REFERENCES

1. U.S. Nuclear Regulatory Commission, “Final Safety Evaluation by the Office of New Reactors (Revised) Topical Report APR1400-F-A-TR-12004-P ‘Realistic Evaluation Methodology for Large-Break Loss of Coolant Accident of the APR1400’ Korea Hydro & Nuclear Power Co. LTD,” June 5, 2018 (ML18156A043).

2. Korea Electric Power Corporation and Korea Hydro & Nuclear Power Company, Ltd., Topical Report APR1400-F-A-TR-12004-P, “Realistic Evaluation Methodology for Large-Break LOCA of the APR1400,” Revision 1, August 2017 (ML17240A223).

3. U.S. Nuclear Regulatory Commission, NUREG/CR-5249, “Quantifying Reactor Safety Margins: Application of Code Scaling, Applicability and Uncertainty Evaluation Methodology to a Large-Break, Loss-of-Coolant Accident,” Revision 4, December 1989 (ML070310119).

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

5. Korea Electric Power Corporation and Korea Hydro & Nuclear Power Company, Ltd., “APR1400 Design Control Document,” Revision 2, February 2018 (ML18079A487).

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1. U.S. Nuclear Regulatory Commission, “Final Safety Evaluation by the Office of New Reactors (Revised) Topical Report APR1400-F-A-TR-12004-P ‘Realistic Evaluation Methodology for Large-Break Loss of Coolant Accident of the APR1400’ Korea Hydro & Nuclear Power Co. LTD,” June 5, 2018 (ML18156A043).

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

5. Korea Electric Power Corporation and Korea Hydro & Nuclear Power Company, Ltd., “APR1400 Design Control Document,” Revision 2, February 2018 (ML18079A487).

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