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

March 26, 2018

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

SUBJECT: SAFETY EVALUATION FOR ANP-10333P, REVISION 0, "AURORA-B: AN EVALUATION MODEL FOR BOILING WATER REACTORS; APPLICATION TO CONTROL ROD DROP ACCIDENT (CRDA)"

Dear Mr. McCree:

During the 651st meeting of the Advisory Committee on Reactor Safeguards, March 8-9, 2018, we completed our review of topical report ANP-10333P, Revision 0, "AURORA-B: An Evaluation Model For Boiling Water Reactors; Application To Control Rod Drop Accident (CRDA)" and the associated NRC staff's safety evaluation. Our Subcommittee on Thermal-Hydraulic Phenomena also reviewed this matter on January 23, 2018. During these reviews, we benefitted from discussions with representatives of the staff and Framatome. We also benefitted from the referenced documents.

CONCLUSION AND RECOMMENDATION

1. AURORA-B provides an acceptable methodology to evaluate boiling water reactor CRDAs.
2. The staff's safety evaluation, with its associated limitations and conditions, should be issued.

BACKGROUND

AURORA-B is a multi-physics, multi-code package developed for predicting the dynamic response of boiling water reactors during a variety of transient and accident scenarios, including control rod drops. We previously reviewed a separate application (ANP-10300P) of the Framatome methodology for AURORA-B application to most of the transient and accident events described in Chapter 15 of the Standard Review Plan (NUREG-0800). The current application extends AURORA-B use to CRDAs for current operating fuels and reactors (BWR-2 through 6 with velocity limiters), as described in topical report ANP-10333P and the associated safety evaluation.

DISCUSSION

Codes and Methods

AURORA-B is based on three independent computer codes: RODEX4 (fuel thermal-mechanical code), S-RELAP5 (thermal-hydraulic system code), and MB2-K (neutron kinetics code). These codes have individually received prior review and approval by the NRC for different applications and are approved for use in AURORA-B application to transients. The staff reviewed in detail all code and methodology modifications and found them acceptable for CRDA calculations.

Draft Regulatory Guide DG-1327

The staff is finalizing a new draft regulatory guide, DG-1327, on the CRDA topic. The primary changes are to acceptance criteria, which become a function of rod operating parameters such as internal pressure and clad hydrogen content. The staff's review concludes that the AURORA-B CRDA methodology is compatible with both the current and the proposed guidelines. When DG-1327 is finalized, the new criteria will be used.

AURORA-B CRDA Methodology

The AURORA-B CRDA topical report provides the phenomena identification ranking table (PIRT) that identifies the important parameters and phenomena for a CRDA. The topical report also discusses how the most limiting initial conditions important to the CRDA are selected. In their review of AURORA-B methodology for a CRDA, the staff focused on the model changes to the AURORA-B code suite designed to predict the important parameters that are relevant and affect the CRDA plant response. These models include:

- Pin power reconstruction at cold conditions
- Inclusion of moderator temperature and additional cross section branches for depressurized cold conditions to provide accurate feedback calculations
- Development of a peak pin power model using results from MB2-K and S-RELAP5
- Transfer of moderator temperature from S-RELAP5 to MB2-K
- Support for a peak pin heat structure

In addition, the AURORA-B CRDA methodology specifies procedures for selecting the limiting set of control rods that will be analyzed and the channel grouping that will be required for accurate analyses.

The staff reviewed these procedures, the code suite modifications, the PIRT, and the validation data provided. The staff concludes that the modifications are acceptable, contingent upon the associated limitations and conditions. We concur with the staff's evaluation of the AURORA-B methodology for CRDA.

Limitations and Conditions

The safety evaluation specifies 17 limitations and conditions to the range of applicability of the AURORA-B methodology. Most of them deal with specific details of the treatment of uncertainties, and they also enforce limitations to use the methodology within the validated range of applicability. We concur with these limitations and conditions.

SUMMARY

AURORA-B provides an acceptable methodology to evaluate boiling water reactor CRDAs. The staff's safety evaluation, with its associated limitations and conditions, should be issued.

Sincerely,

/RA/

Michael Corradini
Chairman

REFERENCES

1. AREVA, Inc., ANP-10333P, "AURORA-B: An Evaluation Model for Boiling Water Reactors; Application to Control Rod Drop Accident (CRDA)," Revision 0, March 2014 (ML14098A354).
2. AREVA, Inc., ANP-10333Q1P, "AURORA-B: An Evaluation Model for Boiling Water Reactors; Application to Control Rod Drop Accident (CRDA): Responses to NRC Request for Additional Information," Revision 0, April 2017 (ML17100A155).
3. U.S. Nuclear Regulatory Commission, Draft Regulatory Guide DG-1327, "Pressurized Water Reactor Control Rod Ejection and Boiling Water Reactor Control Rod Drop Accidents," November 2016 (ML16124A200).
4. AREVA NP Inc., ANP-10300P, "AURORA-B: An Evaluation Model for Boiling Water Reactors; Application to Transient and Accident Scenarios," Revision 0, December 2009 (ML100040163).
5. U.S. Nuclear Regulatory Commission, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR Edition."

SUMMARY

AURORA-B provides an acceptable methodology to evaluate boiling water reactor CRDAs. The staff's safety evaluation, with its associated limitations and conditions, should be issued.

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