November 4, 2003

Mr. James F. Mallay
Director, Regulatory Affairs
Framatome ANP
3815 Old Forest Road
Lynchburg, VA 24501

SUBJECT: DRAFT SAFETY EVALUATION FOR FRAMATOME ANP TOPICAL REPORT BAW-10242(NP), REVISION 0, "ZERO POWER PHYSICS TESTING FOR B&W REACTORS" (TAC NO. MB9977)

Dear Mr. Mallay:

Enclosed for Framatome ANP's review and comment is a copy of the staff's draft safety evaluation (SE) for Topical Report (TR) BAW-10242(NP), Revision 0, "Zero Power Physics Testing for B&W Reactors."

Please review the draft SE for factual errors or clarity concerns and identify any such errors or concerns within 10 working days of the date of this letter. In the event of any comments or questions, please contact Bo Pham at (301) 415-8450.

Sincerely,

/RA/

Stephen Dembek, Chief, Section 2
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 728

Enclosure: Draft Safety Evaluation

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cc w/encl: See next page

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ACCESSION NO.: ML033090620 **NRR-106**

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DRAFT SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

BAW-10242(NP), REVISION 0, "ZERO POWER PHYSICS TESTING FOR B&W REACTORS"

FRAMATOME ANP

PROJECT NO. 728

1.0 INTRODUCTION

By letter dated July 11, 2003, Framatome ANP (FANP) submitted Topical Report (TR) BAW-10242(NP), Revision 0, "Zero Power Physics Testing for B&W Reactors," and requested staff review of modified zero power physics testing at cycle startup (Reference 1). Supplemental information was also submitted on September 23, 2003 (Reference 2).

Zero power physics testing (ZPPT) is required for PWRs following completion of a refueling outage. The required testing involves a number of tests performed at zero (very low) power prior to power escalation. The purpose of the testing is to determine that the operating characteristics of the core are consistent with the design predictions and to assure that the core can operate as designed. Successful completion of the testing is demonstrated when measured key physics parameters are within predetermined uncertainties.

Part of the ZPPT requires the measurement of "control" rod reactivity worth. Babcock & Wilcox (B&W) reactors have three "control" rod groups (CRGs): 5, 6 and 7, which are used to maintain reactivity control and core flux shaping. Rod groups 1-4 are considered "shutdown" rod groups, as they are fully withdrawn during normal operation and are used for negative reactivity insertion.

Licensees are currently measuring the reactivity worth of CRGs (5-7) using the boron dilution method as described in Regulatory Guide (RG) 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants." In the TR, FANP proposes to modify the ZPPT program for B&W reactors by forgoing the testing (reactivity worth measurement) of CRG 5, so that testing is only required for CRGs 6 and 7. Other changes are also listed in the TR, but those are all variations of existing test programs, and therefore, do not require NRC approval. This safety evaluation (SE) is limited to only assessing the safety significance and justification of removing CRG 5 from the boron dilution test.

2.0 REGULATORY EVALUATION

There are no specific regulatory requirements for conducting startup physics tests. However, the staff adopted the scope and objectives of the ANS/ANSI-19.6.1 Standard, "Reload Startup Physics Tests for Pressurized Water Reactors," which defines the acceptance criteria for CRG worth measurement (Reference 3). This standard specifies the content of the minimum acceptable startup physics test program for commercial pressurized water reactors and describes acceptable methods for performing individual tests. (Note: RG 1.68 provides guidance for initial plant startup, but not during reload. Also, General Design Criterion 1 requires testing, but is not specific on the method).

3.0 TECHNICAL EVALUATION

In B&W reactors, the core distribution of the "control" rod groups (located mainly in the peripheral assemblies) suggests their low reactivity worth, which suits their role for reactivity control and core flux shaping. "Shutdown" rod groups on the other hand, are high in reactivity worth and their distribution is mainly towards the center part of the core. CRG 5 for the B&W reactors is located at the core’s outer periphery, and consists of 12 control rods (versus 8 for CRGs 6 and 7). Because of its high reactivity worth, however, FANP states that CRG 5 has rarely been used for "control" in B&W reactors, and in actual practice, has been used essentially as a "shutdown" rod group. For this reason, the applicant requests to discontinue the reactivity worth measurement of CRG 5, as doing so would reduce the ZPPT time and increase the efficiency of post-refueling activities.

ANSI-19.6.1 Standard states: "Prior to return to normal operation, successful execution of a physics test program is required to determine . . . that the core can be operated as designed." The measurement of "control" rod worth is an important verification of shutdown margin and overall power distribution; it is also a check of the computer code results for predicted rod worth. In recent reload history, reload errors for B&W reactors have decreased overall. Reload errors basically distort flux (and power) distribution, and in turn affect the CRG worth. The ANSI Standard lists 15 percent ({Calculated-Measured}/Measured)x100 as the test acceptance criterion for the allowable percent deviation of an individual CRG’s worth measurement. In the TR, FANP provided 3-5 cycles of data for each B&W plant and their CRG deviations, demonstrating that the predicted worth is within a few percent of the calculated value. The largest deviations were listed for CRG 5, but individual CRG deviations and the mean values are within the ANSI Standard test criterion of 15 percent. In addition, FANP demonstrated in this data analysis that total CRG worth percent deviations would be nearly identical if only CRGs 6 and 7 are measured versus the current practice of measuring CRGs 5, 6, and 7. FANP also stated that the current practice at B&W plants is to keep CRG 5 fully withdrawn during operation, essentially making it a "shutdown" rod group by use. The staff concludes from the results above that CRG 5 can be used as either a "control" or "shutdown" rod group in B&W reactors.

In addition, FANP suggests that flux distribution anomalies and reload errors can be better monitored and accounted for at power using core power distribution testing rather than during the ZPPT. This point was illustrated by FANP in Reference 2 for the case of an uncoupled (unlatched) rod in CRG 5, where the ZPPT program did not reveal an uncoupled rod through measuring CRG 5 worth. Instead of having to rely on reactivity measurements during the ZPPT, B&W reactors are equipped with fixed incore detectors and associated on-line computing software to measure and record core power distribution (and perform flux symmetry evaluations) at five power levels during power ascent. In the case highlighted by FANP, an unlatched assembly in CRG 5 was not detected during zero power measurement because the differential worth was within uncertainty limits; the anomaly was eventually revealed during the power escalation sequence through power distribution monitoring instead. From the analysis above, the staff concludes that the verification of shutdown margin and overall power distribution can be accomplished in B&W reactors through core power distribution testing at power just as reliably as through boron dilution reactivity measurements.

Finally, although FANP requested to eliminate CRG 5 from startup testing, it is seeking to retain measurements following the introduction of new control rod assemblies and during reload startup tests where any rod worth acceptance criteria has failed. This is a conservative and prudent provision and is acceptable.

The discussion presented by FANP indicates that the scope and objectives of the ZPPT program’s CRG reactivity worth measurements (as presented in the ANSI 19.6.1 Standard) will be fulfilled for B&W reactors through FANP's proposal. The reactivity measurement of CRGs 6 and 7, using boron dilution, will suffice instead of measuring all CRGs 5, 6 and 7, as FANP has demonstrated that the elimination of CRG 5 from the boron reactivity measurements does not diminish the effectiveness of the ZPPTs.

4.0 CONCLUSION

The staff has reviewed BAW-10242(NP), Revision 0, "Zero Power Physics Testing for B&W Reactors," and the supplemental information provided in Reference 2. The objective of the review was to establish that the scope and objectives of the ANSI 19.6.1 Standard for the ZPPT are not compromised with the proposed change to eliminate CRG 5 from the required reactivity worth measurement. The staff’s conclusion, based on the reasoning above, is that CRG 5 is effectively a "shutdown" rod group in B&W reactors, and is not required to be measured for reactivity worth during ZPPT.

5.0 REFERENCES

1 Letter from J. F. Mallay, Framatome ANP to US Nuclear Regulatory Commission, "Request for Approval of BAW-10242(NP) Revision 0, 'Zero Power Physics Testing for B&W Reactors'," July 11, 2003.

2 Letter from J. F. Mallay, Framatome ANP to US Nuclear Regulatory Commission, "Response to Request for Additional Information - BAW-10242(NP), 'Zero Power Physics Testing for B&W Reactors'," September 23, 2003.

3 ANSI/ANS-19.6.1, American National Standard, "Reload Startup Physics Tests for Pressurized Water Reactors," 2002.

Principle Contributor: L. Lois

Date: November 4, 2003