July 2, 2002

Mr. James F. Mallay
Director, Regulatory Affairs
Framatome ANP, Richland, Inc.
2101 Horn Rapids Road
Richland, WA 99352

SUBJECT: SAFETY EVALUATION FOR BWR CHF CORRELATION BOUNDS CHECKING CLARIFICATIONS RELATING TO TOPICAL REPORTS EMF-1997(P)(A), REVISION 0 AND EMF-2209(P)(A), REVISION 1 (TAC NO. MB3107)

Dear Mr. Mallay:

By letter dated June 12, 2001, as supplemented by letter dated January 11, 2002, Framatome ANP submitted a request for the NRC staff to review two clarifications. The review of the two clarifications is related to Topical Reports EMF-1997(P)(A), Revision 0, "ANFB-10 Critical Power Correlation," July 1998, and EMF-2209(P)(A), Revision 1, "SPCB Critical Power Correlation," July 2000. Specifically, the first clarification deals with what actions are to be taken if the calculated enthalpy falls below the correlation low enthalpy limit as referred to in EMF-1997(P)(A) and EMF-2209(P)(A). The second clarification deals with bounds checking for inlet subcooling in both of the referenced topical reports.

The staff has completed its review of the clarifications and finds them acceptable for referencing in licensing applications to the extent specified in the clarification letter and in the SE which is enclosed. The SE defines the basis for acceptance of the clarifications.
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Pursuant to 10 CFR 2.790, we have determined that the enclosed SE does not contain proprietary information. However, we will delay placing the SE in the public document room for a period of 10 working days from the date of this letter to provide you with the opportunity to comment on the proprietary aspects only. If you believe that any information in the enclosure is proprietary, please identify such information line by line and define the basis pursuant to the criteria of 10 CFR 2.790.

We do not intend to repeat our review of the matters described in the clarification letter, and found acceptable, when the clarifications appear as a reference in license applications, except to ensure that the material presented applies to the specific plant involved.

Should our criteria or regulations change so that our conclusions as to the acceptability of the clarification letter are invalidated, Framatome and/or the applicants referencing the clarification letter will be expected to revise and resubmit their respective documentation, or submit justification for the continued applicability of the clarification letter without revision of their respective documentation.

Sincerely,

/RA/
William H. Ruland, Director
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 693

Enclosure: Safety Evaluation

Should our criteria or regulations change so that our conclusions as to the acceptability of the clarification letter are invalidated, Framatome and/or the applicants referencing the clarification letter will be expected to revise and resubmit their respective documentation, or submit justification for the continued applicability of the clarification letter without revision of their respective documentation.

Sincerely,

/RA/
William H. Ruland, Director
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 693

Enclosure: Safety Evaluation

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO BOILING WATER REACTOR CRITICAL HEAT FLUX

CORRELATION BOUNDS CHECKING

EMF-1997(P)(A), REVISION 0, "ANFB-10 CRITICAL POWER CORRELATION"

AND EMF-2209(P)(A), REVISION 1, "SPCB CRITICAL POWER CORRELATION"

FRAMATOME ANP

PROJECT NO. 693

1.0 INTRODUCTION

By letter dated June 12, 2001 (Reference 1), and supplemental letter dated January 11, 2002 (Reference 2), Framatome ANP submitted a request for NRC concurrence pertaining to two clarifications in Topical Reports EMF-1997(P)(A), Revision 0, "ANFB-10 Critical Power Correlation" (Reference 3), and EMF-2209(P)(A), Revision 1, "SPCB Critical Power Correlation" (Reference 4). One of the clarifications is related to the boiling water reactor (BWR) critical heat flux (CHF) correlation bounds checking in Section 2.6.2.3 of the topical reports with respect to the actions taken if the calculated enthalpy falls below the correlation low enthalpy limit. The other clarification is related to the BWR correlation range of application in Section 2.6.4 of the topical reports with respect to the bounds checking for inlet subcooling.

2.0 BACKGROUND

The staff's safety evaluation for Topical Report EMF-2209(P)(A) Revision 1, "SPCB Critical Power Correlation" was approved on July 3, 2000. The SPCB correlation uses empirical fits to the data that use planar average conditions to predict CHF.

The staff's safety evaluation for Topical Report EMF-1997(P)(A), Revision 0, "ANFB-10 Critical Power Correlation" was approved on July 17, 1998. The ANFB-10 correlation uses planar average values of coolant mass velocity, enthalpy and pressure to predict planar average CHF for assemblies with all full length rods.

3.0 EVALUATION

3.1 Clarification 1 - Low Enthalpy Limit

In Section 2.6.2.3 of References 3 and 4, the following statement is made with respect to the actions taken if the calculated enthalpy is below the correlation low enthalpy limit (specified in Table 1.3 of Reference 3 and Table 1.2 of Reference 4).

> If the minimum critical heat flux ratio (MCHFR) nodal enthalpy is below the low enthalpy limit, the enthalpy and quality distributions are artificially increased, as in the steady state core monitoring calculation to determine a conservative critical heat flux ratio (CHFR). This CHFR is then used to compute the number of rods in boiling transition.

These actions are taken in both the core monitoring code and the safety limit code. However, the topical reports do not present the details of how the artificial increase occurs and is implemented. This artificial increase is achieved by holding the inlet enthalpy fixed and incrementing each of the downstream enthalpies (Reference 1). The details can be described by the following equation for HNEW:

HNEW = HIN + HRATIO*(HOLD-HIN)

Where: HNEW = new value of enthalpy
HIN= inlet enthalpy
HOLD = prior value of enthalpy

and

HRATIO = (HLIM + 0.01 - HIN)/(H(limiting node) - HIN)

Where: HLIM = correlation lower bound enthalpy
H (limiting node) = enthalpy of dryout node

The equation for HNEW (the new value of enthalpy) ensures that the enthalpy of the limiting node is always above the correlation lower bound enthalpy limit. This can be illustrated by substituting H(limiting node) for HOLD in the equation for HNEW. HNEW is then equal to HLIM+0.01 and thus the limiting node enthalpy is 0.01 larger than the correlation lower bound enthalpy limit. Adding 0.01 to the correlation lower bound enthalpy limit in the equation for HNEW ensures that the revised enthalpy for the limiting node will be slightly above the correlation lower bound enthalpy limit rather than equal to the correlation lower bound enthalpy.

Three circumstances are considered in the implementation of these criteria. These include: (1) the most expected case for which the new conditions yield a lower CHFR; (2) the new conditions yield an increased CHFR; and (3) the new conditions exceed the high enthalpy bound. The CHFR is normally expected to decrease when the enthalpy and quality distributions are artificially increased like circumstance (1) where the new lower CHFR is used. However, in circumstances (2) and (3), which are due to a combination of the decrease in Tong factor (relating to non-uniform flux shape) and increase in enthalpy and quality distribution, the final lower value of CHFR is selected by comparing the CHFR based on the altered enthalpy distribution with the initial CHFR.

The staff has reviewed the proposed clarification for the implementation of the approved critical power correlation methodologies (References 3 and 4) and has found it acceptable because the results are conservative relative to that specified by the approved topical report.

3.2 Clarification 2 - Inlet Subcooling

In Section 2.6.4 of Reference 3, the following statement is made with respect to the bounds checking for inlet subcooling: The test range for inlet subcooling is presented in Table 1.2. The Siemens Power Corporation (SPC) methodology checks the inlet subcooling against this range; if the subcooling falls outside of the test range, the calculation is stopped.

In Section 2.6.4 of Reference 4, the following statement is made with respect to the bounds checking for inlet subcooling:

> The test range for inlet subcooling is presented in Table 1.1. The SPC methodology checks the inlet subcooling against this range; if the subcooling falls below the test range minimum, the calculation is stopped. If the subcooling exceeds the test range maximum, the inlet subcooling is set to the maximum subcooling limit.

Framatome ANP intends to apply the restrictions on specified in Reference 4 for calculating inlet subcooling to the ANFB-10 correlation in Reference 3.

The staff has reviewed the proposed clarifications with regard to bounds checking and has found them acceptable since the same approach was approved in Reference 4 for use with the Siemens Power Corporation correlation given in that reference.

4.0 CONCLUSION

Based on our review of Framatome ANP's request for NRC concurrence with the clarifications on BWR CHF correlation bounds checking, the staff has found the request is acceptable because a relatively conservative result is used for the circumstance of "if the MCHF [minimum critical heat flux] nodal enthalpy is below the low enthalpy limit" and an approved approach is used for the circumstance of "if the subcooling exceeds the test range maximum, the inlet subcooling is set to the maximum subcooling limit." The subject clarifications were reviewed against the requirements of General Design Criteria 10, "Reactor Design" of 10 CFR Part 50, Appendix A. The clarifications were found acceptable in that the clarifications ensure that the reactor core is designed with sufficient margin to assure that specified design limits are not exceeded. The Standard Review Plan (SRP) is utilized by the staff in assuring that the criteria of 10 CFR Part 50, Appendix A are met . Specifically the SRP states on page 4.4-3:

> For DNBR, CHFR, or CPR correlations, the limiting (minimum) value of DNBR, CHFR, [or] CPR is to be established such that at least 99.9% of the fuel rods in the core would not be expected to experience departure from nucleate boiling or boiling transition during normal operation or anticipated operational occurrences.

5.0 REFERENCES

1. Letter (NRC:01:023) from James F. Mallay to USNRC, "Request for NRC Concurrence with Clarification for 'BWR CHF Correlation Bounds Checking'," June 12, 2001.

2. Letter (NRC:02:003) from James F. Mallay to USNRC, "Response to NRC Request for Additional Information Regarding Clarification for 'BWR CHF Correlation Bounds Checking'," January 11, 2002.

3. EMF-1997(P)(A), Revision 0, "ANFB-10 Critical Power Correlation," Siemens Power Corporation - Nuclear Division, July 1998.

4. EMF-2209(P)(A), Revision 1, "SPCB Critical Power Correlation," Siemens Power Corporation, July 2000.

Principal Contributor: T. Huang

Date: July 2, 2002