FRAMATOME ANP

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FRAMATOME ANP, Inc.

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Document Control Desk
ATTN: Chief, Planning, Program and Management Support Branch
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Request for Additional Information - BAW-10244(P) Revision 0, "Mark-BW CHF Correlations Applied with XCOBRA-IIIC"

Ref.: 1. Email, Michelle Honcharik (NRC) to Jerry Holm (Framatome ANP), "Request for Additional Information - BAW-10244(P) Revision 0, 'Mark-BW CHF Correlations Applied with XCOBRA-IIIC'," March 9, 2004.

Ref.: 2. Letter, James F. Mallay (Framatome ANP) to Document Control Desk (NRC), "Request for Review of BAW-10244(P), "Mark-BW CHF Correlation Applied with XCOBRA-IIIC'," NRC 03:055, September 3, 2003.

In Reference 1, the NRC requested additional information to facilitate the completion of its review of the Framatome ANP topical report BAW-10244(P). Responses to this request are provided in two attachments--one proprietary and one non-proprietary.

Framatome ANP considers some of the information contained in the attachments to this letter to be proprietary. The affidavit provided with the original submittal of the reference report (Reference 2) satisfies the requirements of 10 CFR 2.390(b) to support the withholding of this information from public disclosure.

Very truly yours,

James F. Mallay, Director
Regulatory Affairs

Enclosures

cc: M. C. Honcharik
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Attachment B

RESPONSES TO REQUEST FOR ADDITIONAL INFORMATION

BAW-10244P, "MARK-BW CHF CORRELATIONS APPLIED WITH XCOBRA-IIIC"

Question 1: *Provide rationale for the need to use XCOBRA-IIIC code for the proposed licensing topical report (TR), BAW-10244P,"Mark-BW CHF [Critical Heat Flux] Correlations Applied with XCOBRA-IIIC" relative to LYNXT code.*

Response 1: The accurate prediction of CHF in operating reactors requires analysis with a subchannel thermal-hydraulic analysis code to predict the local coolant conditions at any point in the core. Several industry and vendor codes are available and in use: XCOBRA-IIIC, LYNXT, VIPRE and FLICA. Each is a derivative of the original COBRA code developed in the 1960's. The main parts of these codes are a mathematical implementation of the momentum equations, modeling of the coolant physical properties and empirical models of the derived coolant properties (void fraction, etc.). The models differ slightly between the codes. Consequently, the NRC has required that CHF correlations must be separately qualified for use with each different thermal-hydraulic analysis code for which they will be used. This requirement assures the application of the BWU CHF correlations with the XCOBRA-IIIC code provides the same level of protection (95/95) as the application of the BWU CHF correlations with the LYNXT code.

Framatome ANP is a joint venture of the companies Framatome and Siemens. This new company has created opportunities for the fuel designs previously developed within one former company to be analyzed with the thermal-hydraulic code previously developed by the other former company. The need for NRC approval of BAW-10244, "Mark-BW Critical Heat Flux Correlations" is to support the use of CHF correlations for a fuel product design (the Mark-BW) developed by the former Framatome company to be combined with the reload analysis methodology developed by the former Siemens company. The XCOBRA-IIIC code is integral to the reload analysis methodology developed by Siemens and is currently used for CE and Westinghouse-type plants.

An analogous situation led to the 2002 submittal of BAW-10241P ("BHTP DNB Correlation Applied with LYNXT") in which the CHF correlation for the HTP spacer grid design (originally developed by the former Siemens using XCOBRA-IIIC) was qualified for use with the LYNXT code. The LYNXT code is integral to the reload analysis methodology developed by Framatome and is currently used for B&W and Westinghouse-type plants.

Question 2: *Provide evaluation for satisfying the limitations imposed on the application of the approved BWU CHF correlation to the proposed TR with a different thermal hydraulic safety analysis code.*

Response 2: To assist the analyst and reviewer, both LYNXT and XCOBRA identify any of the local variables that violate the ranges of the specific correlation being used. The range violation reports are contained both in the body of the code output and in a separate error file for both codes.

Assuring that the imposed limits of any CHF correlation are respected is a dual responsibility of the analyst and the quality assurance reviewer. All safety related calculations, and quality assurance of such calculations, are governed by established Framatome ANP quality assurance procedures.

Question 3: *Please identify any differences in relation to the data bases to support the code development and verification, assumptions, ranges of the application, and expected results of the analysis under same conditions between the proposed licensing TRs using XCOBRA-IIIC code and the BWU CHF correlation using LYNXT.*

Response 3: The codes LYNXT and XCOBRA-IIIC have almost identical subchannel modeling capability and produce virtually the same results when identical modeling is employed. The sole significant difference in modeling is in the treatment of subchannel form loss coefficients. This difference and its impact on the safety limits are discussed in detail in the response to Question 4 below.

Subchannel thermal-hydraulic analysis codes are not qualified using CHF data bases since there is no "CHF" figure of merit that can be calculated using the models present in these codes. Instead, they have been qualified using data from benchmark tests such as cross flow velocity tests and pressure drop tests. The qualification of these codes for thermal-hydraulic analysis of reactor cores is included in their respective qualification topicals (Reference 3 for XCOBRA-IIIC and Reference 4 for LYNXT in section 5.0 of the topical report, BAW-10244P).

Question 4: *Provide in details the reasons causing the different results of the departure from nucleate boiling ratio (DNBR) design limits and quantify their impact on the plant-specific applications with respect to the safety margin for the plant operation.*

Response 4: The BWU correlations were originally developed using the LYNXT thermal-hydraulic analysis code. The present analysis uses the XCOBRA-IIIC code. Both are derived from the original COBRA code written in the 1960's. The codes have nearly identical water properties. The mathematical modeling options (void fraction models, etc.) produce quite similar results for the evaluation of CHF test results.

The difference in the modeling of the spacer grid form losses by the respective analysis codes is the primary reason for the difference in the design limits. The LYXNT and XCOBRA-IIIC codes both model the geometry on a subchannel basis (flow area, wetted perimeter, etc.). LYNXT incorporates the capability to model discrete subchannel form loss coefficients for each subchannel type (unit subchannel, guide tube subchannel, etc.) whereas XCOBRA-IIIC uses a single average value of the form loss (a grid form loss) for each subchannel type. The BWU CHF correlation was developed (optimized) using the LYNXT code and thus the predictions will be slightly different when the BWU CHF correlation is used in another code which uses slightly different modeling.

The difference in modeling of the form loss coefficients results in an increase of about two percent on the design limit when using the XCOBRA-IIIC code as compared to using the LYNXT code. Thus the XCOBRA-IIIC design limit for the Mark-BW MSM and Non-MSM grids is 1.22 compared to the corresponding LYNXT 1.19 design limit. The XCOBRA-IIIC design limit for the Non-Mixing vane grids is 1.23 compared to the corresponding LYNXT 1.21 design limit.

During plant-specific applications of the BWU correlations using the XCOBRA-IIIC code, the predicted minimum DNBRs will be approximately two percent higher than the minimum DNBR predictions using the BWU CHF correlations with the LYNXT code. This difference in minimum DNBR predictions is consistent with the difference observed in the respective design limits established for the correlations with XCOBRA-IIIC and LYNXT. As a result, the safety margin for plant operation will essentially be the same whether the XCOBRA-IIIC or LYNXT code is used in the DNB analysis.

Question 5: *It appears that the DNBR design limit of 1.22 for BWU-N with non-mixing vane when the pressure is above 1500 psia stated in Table 4.3 is inconsistent with the DNBR design limit of 1.23 stated on Page 1-1. Please clarify the difference.*

Response 5: You are correct, a value of 1.23 was developed on page 4-3 for BWU-N with non-mixing vane grids. The value of 1.22 in Table 4.3 is a typographical error and will be changed to 1.23 in the release of the approved topical.

Question 6: *Please clarify that the performance factor as shown in the equation Q_{chf} and Table 3.1 indicates that the proposed TR is only applied to the Mark-BW17 fuel design.*

Response 6: The performance factor (PF) in Table 3.1 applies to each type of spacer grid listed in that table. Specifically it applies to grid spans containing that specific type of grid. In other words, if a grid span contains only Mark-BW Non-MSM grids or only Non-Mixing Vane grids, the PF is unity in both cases. Only for spans containing a Mark-BW MSM grid is the PF greater than unity [ ]. Framatome ANP proposes to change the headings to Mark BW Fuel Assembly Grid Spans with Mark-BW Non-MSM Grids only, Mark BW Fuel Assembly Grid Spans containing a Mark-BW MSM Grid, and Fuel Assembly Grid Spans with Non-Mixing Vane grids respectively in the approved topical report.

Question 7: *Provide uncertainties, confidence level, and ranges of application in a table for BWU CHF correlation in the code LYNXT versus COBRA-IIIC code, and identify the impact on the DNBR design limit due to the different uncertainties.*

Response 7:

Parameter	BWU with XCOBRA-III (BAW-10244P)	BWU with LYNXT (BAW-10199P-A)
Pressure, psia	400-2465 (BW Grid) 594-2425 (BW-MSM Grid) 788-2616 (Non-Mixing Grid)	400-2465 (BW Grid) 594-2425 (BW-MSM Grid) 788-2616 (Non-Mixing Grid)
Mass Velocity, mlb/hr-ft^2	0.352-3.577 (BW Grid) 0.492-3.517 (BW-MSM Grid) 0.272-3.775 (Non-Mixing Grid)	0.360-3.550 (BW Grid) 0.477-3.385 (BW-MSM Grid) 0.250-3.830 (Non-Mixing Grid)
Quality at CHF	below 0.731 (BW Grid) below 0.674 (BW-MSM Grid) below 0.690 (Non-Mixing Grid)	below 0.740 (BW Grid) below 0.677 (BW-MSM Grid) below 0.700 (Non-Mixing Grid)
Mean M/P CHF Ratio	0.981 (BW Data) 0.980 (BW-MSM Data) 0.993 (Non-Mixing Data)	1.002 (BW Data) 1.000 (BW-MSM Data) 1.001 (Non-Mixing Data)
Standard Deviation (of M/P Ratio)	0.0886 (BW Data) 0.0847 (BW-MSM Data) 0.1031 (Non-Mixing Data)	0.0914 (BW Data) 0.0918 (BW-MSM Data) 0.1002 (Non-Mixing Data)
Design Limit DNBR (95% Conf / 95% Prot)	1.220 (BW Grid) 1.220 (BW-MSM Grid) 1.230 (Non-Mixing Grid)	1.190 (BW Grid) 1.190 (BW-MSM Grid) 1.210 (Non-Mixing Grid)