FRAMATOME ANP

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FRAMATOME ANP, Inc.

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Response to Request for Additional Information – Appendix A to EMF-92-153(P)(A), "HTP: Departure From Nucleate Boiling Correlation for High Thermal Performance Fuel"

Ref.: 1. Letter, James F. Mallay (Framatome ANP) to Document Control Desk (NRC), "Request for Review and Approval of Appendix A to EMF-92-153(P)(A), 'HTP: Departure From Nucleate Boiling Correlation for High Thermal Performance Fuel'," NRC:04:025, May 19, 2004.

The NRC requested additional information to facilitate the completion of its review of the Framatome ANP topical report, Appendix A to EMF-92-153(P)(A) (Reference 1), in an e-mail on August 10, 2004. The questions along with the responses are presented in the attachments to this letter. Attachment A is the proprietary version of the responses. Attachment B is the non-proprietary version.

Framatome ANP considers some of the material contained in Attachment A to be proprietary. The affidavit provided with the original submittal of the topical report 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
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Enclosures

cc: M. C. Honcharik
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Attachment B

RESPONSES

REQUEST FOR ADDITIONAL INFORMATION
EMF 92-153, APPENDIX A
HTP: Departure From Nucleate Boiling Correlation for High Thermal Performance Fuel

Question 1: *The submitted Appendix A of EMF-92-153(P)(A) gives justifications for encroaching upon regions outside the established limits of the HTP-CHF correlation. However, in order to make the quantitative statement that there is a 95% probability at the 95% confidence level that the core does not experience DNB, the HTP-CHF correlation's high degree of uncertainty in the proposed regions of lower quality and higher pressure must be quantified. Please provide technical and quantitative justification for arriving at these uncertainties, and demonstrate the incorporation of the uncertainties in the DNBR Design Limit.*

Response 1:

BWU-I Data – Columbia University Heat Transfer Research Facility – Westinghouse Grids

Quality at CHF	Number of Data	Mean M/P CHF	Standard Deviation
Below 5%	459	1.000	0.084
5% to 10%	384	1.018	0.093
10% to 15%	391	0.985	0.103
Above 15%	264	0.993	0.127

BWU-N Data – Alliance Research Center – Babcock and Wilcox Grids

Quality at CHF	Number of Data	Mean M/P CHF	Standard Deviation
Below 5%	225	1.006	0.068
5% to 10%	181	0.998	0.071
10% to 15%	218	1.001	0.078
15% to 20%	158	1.006	0.097
20% to 25%	104	0.975	0.135
Above 25%	167	1.008	0.151

BWU-I Data – Columbia University Heat Transfer Research Facility – Westinghouse Grids

Pressure, psia	Number of Data	Mean M/P CHF	Standard Deviation
1250 - 1649	228	1.013	0.109
1650 - 1949	334	0.990	0.105
1950 - 2249	398	0.998	0.098
Above 2250	538	1.000	0.094

BWU-N Data – Alliance Research Center – Babcock and Wilcox Grids

Pressure, psia	Number of Data	Mean M/P CHF	Standard Deviation
1250 - 1649	193	1.011	0.113
1650 - 1949	198	0.989	0.093
1950 - 2249	447	1.000	0.096
Above 2250	215	1.004	0.102

Question 2: *The design limit MDNBR for the BWU-Z correlation with Mark-BW17 grids is specified in BAW-10199(P)(A) as 1.20 for pressures between 700 and 1000 psia, and 1.59 for pressures between 400 and 700 psia. The increase in the design limit was established because the corresponding data set did not quite span the full range of intended application for the correlation. Why wasn't a similar methodology proposed for extending the design limit of the HTP correlation in regions of lower quality and higher pressure?*

Response 2: The BWU-Z data base was basically a high pressure data set. The pressure range 1400 to 1500 psia is considered the lower grouping of high pressure PWR CHF data (i.e., Westinghouse, Combustion, B&W, etc.). A small group of data was taken and grouped at lower pressures. When BAW-10199P-A (Reference 2) was reviewed by the NRC, the reviewer noticed that the data sets for the low pressure groupings contained very few data points – 6 at 400 psia nominal, 20 at 700 psia nominal and 40 at 1000 to 1200 nominal. The reviewer asked for one sided tolerance limits at the lower pressures. The following table develops these limits. These limits are also shown in the NRC SER (Table 1, page v) and in the body of the main report (Table 4-1, page 4-5).

Nominal Pressure, psia	Number of Data	Mean M/P CHF Ratio	M/P Standard Deviation	95/95 Owens One Sided K (Ref. 3)	Derived Design Limit
400	6	0.8739	0.0661	3.708	1.590
700	20	1.0413	0.0866	2.396	1.199
1000 – 1200	40	1.0556	0.0787	2.125	1.126
1500 and above	464	0.9976	0.0902	1.768	1.193
All Data – See page 4-3 of BAW-10199P-A	530	1.0022	0.09268	1.762	1.193

In the report EMF-92-153(P)(A) 1800 psia was chosen as the nominal lower pressure group (actual measured lower limit value of 1775 psia). The data base in this report has a significantly large number of data points in each nominal pressure grouping (each with a mean P/M ratio close to 1.0). Thus, a separate statistical limit was not required for various pressure groupings.

Question 3: *Explain why none of the "new" 159 data was used, as was done in sec. A.4.3.2 of Appendix A, in the extrapolation justifications given in sections A.4.4.1 and A.4.4.2 ?*

Response 3: The 159 "new" data were of lower pressure than that of the original HTP data base and thus the thermodynamic qualities at CHF tended to be higher. No new low quality data was obtained from these 159 data points (A.4.4.1). Similarly, the "new" data was at the other end of the spectrum from an extension to high pressure.

References

1. Dan Lurie and Roger H. Moore, Applying Statistics, United States Nuclear Regulatory Commission, 1994 (page 14-41).

2. BAW-10199P-A, "The BWU CHF Correlations," Babcock and Wilcox, August 1996.

3. D. B. Owens, "Factors for One-Sided Tolerance Limits and for Variables Sampling Plans," Sandia Corporation Monograph, SCR-607, March 1963.