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FRAMATOME ANP

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U.S. Nuclear Regulatory Commission
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BWR CHF Correlation Bounds Checking

Ref.: 1. EMF-1997(P)(A) Revision 0, *ANFB-10 Critical Power Correlation*, Siemens Power Corporation - Nuclear Division, July 1998.

Ref.: 2. EMF-2209(P)(A) Revision 1, *SPCB Critical Power Correlation,* Siemens Power Corporation, July 2000.

Framatome ANP requests NRC concurrence with the clarifications provided below that concern the implementation of the NRC approved methodology described in References 1 and 2. These clarifications are related to the CHF correlation bounds checking described in the two references. We request a written response to these clarifications by September 7, 2001.

Clarification 1

In Section 2 of References 1 and 2 the following statement is made with respect to the actions taken if the calculated enthalpy falls below the correlation low enthalpy limit.

> *If the 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 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.

Under certain conditions a value more conservative than that specified by the methodology is used. These conditions and the determination of the more conservative value are described below.

The implementation of the methodology involves an artificial increase in the enthalpy and quality distributions. This increase is achieved by holding the inlet enthalpy fixed and incrementing each of the downstream enthalpies. This can be described by the following equation:

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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

Due to the thermodynamic relationship between enthalpy and quality, the quality distribution is also increased. The power distribution from the rod is not changed nor are the flow or pressure.

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. Each of these cases is further discussed below:

1. Artificially increased enthalpy and quality distributions yield a lower CHFR.

For this circumstance, the artificial increase in distribution brings the calculation within the range of the correlation with respect to the low and high enthalpy limits. The calculated CHFR is lower than the initial CHFR. Thus the new lower CHFR is used.

2. Artificially increased enthalpy and quality distributions yield a higher value of CHFR.

The CHFR is expected to decrease when the enthalpy and quality distributions are artificially increased. However, for some conditions an increased enthalpy and quality distribution shows an increase in CHFR. This occurs for particularly high positive values of axial offset (up-skew profiles). For an up-skewed axial, as the enthalpy and quality increases, the TONG factor decreases. The improvement in CHFR due to the decreased TONG factor may outweigh the penalty associated with the artificially increased enthalpy and quality on the uniform CHF value for some axial power shapes. Therefore, in order to determine a conservative CHFR, the minimum value is selected between the value that occurs prior to an increase in enthalpy and quality and the value following the increase in enthalpy and quality.

3. Artificially increased enthalpy and quality distributions result in exceeding the high enthalpy limit.

A circumstance could exist where the combination of the change in TONG factor and the increase in enthalpy and quality distribution results in conditions that exceed the high enthalpy limit. In this case, the CHFR based on the altered enthalpy distribution is compared with the initial CHFR and the lower value is selected. The apparent condition of exceeding the high enthalpy limit is not considered as a dryout condition since the high enthalpy limit is not violated by the initial set of conditions.

In items 2 and 3 above the final CHFR is based on a calculation that uses an enthalpy outside the correlation bounds and thus represents an extrapolation of the correlation. It is considered acceptable to use the results of the extrapolation for those conditions when the results from the extrapolation are conservative relative to the approach described in the topical report. Framatome ANP requests NRC concurrence with this approach.

Clarification 2

In Section 2.6.4 of Reference 1 (the ANFB-10 correlation) 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 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 2 (SPCB correlation) 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.

In current and future calculations using the ANFB-10 correlation, Framatome ANP intends to apply the restrictions specified in Reference 2 for calculating inlet subcooling. This is an acceptable approach because it provides a conservative adjustment for the conditions when the inlet subcooling exceeds the test range maximum. Also, the adjustment was approved by the NRC for use with the SPCB correlation. Framatome ANP requests NRC concurrence with this approach.

Very truly yours,

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Project No. 702