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September 14, 1990

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Subject: McGuire Nuclear Station
Docket Numbers 50-369 and -370
Catawba Nuclear Station
Docket Numbers 50-413 and -414
Topical Report DPC-NE-2004

By letter dated January 9, 1989, Duke submitted the subject Topical Report for review. By letter dated August 2, 1990, the NRC staff requested additional information. Attached are responses to the 18 questions transmitted by that letter.

Please note that this submittal contains proprietary information, pursuant to 10 CFR 2.790 which should be withheld from public disclosure. An affidavit which supports the proprietary designation is included in the January 9, 1989 submittal.

If there are any questions, please call Scott Gewehr at (704) 373-7581.

Very truly yours,

H. B. Tucker MJS

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1. For McGuire and Catawba application, specify the user-determined input used in the VIPRE-01 models for: (a) heat transfer correlations, (b) UPFLOW versus RECIRC options, and (c) damping factor (D_R). Also provide bases or justifications for these selections.

a) As stated in Section 5.2, only the steady-state core thermal-hydraulic analyses that ensure that the DNB design basis is met are discussed in this report. Heat transfer correlations are used in VIPRE-01 to obtain the heat tranufer solution only when the conduction model is used and the conduction model is not used for steady-state analyses. The following heat transfer correlations are input since some of the flow correlations make use of the heat transfer correlations:

EPRI single-phase forced convection correlation
Thom subcooled nucleate boiling correlation
Thom saturated nucleate boiling correlation
BWCMV CHF correlation defining the peak of the boiling curve

b) The RECIRC solution option will be used for all of the steady-state core thermal-hydraulic analyses discussed in DPC-NE-2004. The VIPRE-01 SER, ref. 1, concluded that "the UPFLOW and RECIRC options are properly implemented and these solution techniques are acceptable for licensing calculations".

c) The default value (0.9) is used for the damping factor applied to the tentative axial flow and crossflow. As stated in the VIPRE-01 SER, ref. 1, if a convergence problem occurs, the calculation would stop and sufficent information would be printed to allow the user to determine the state of convergence. Therefore, the use of damping factors and their effect on numerical stability is not a concern.

Reference

1. Letter from C. E. Rossi (NRC) to J. A. Blaisdell (UGRA), "Acceptance for Referencing of Licensing Topical Report, VIPRE-01: A Thermal-Hydraulic Analysis Code for Reactor Cores", EPRI-NP-2511-CCM, Vol. 1-5, May 1, 1986.

2. Justify that the generic 1/8 core VIPRE model with the smallest number of channels and the assumed core center hot assembly location is conservative and representative of the future McGuire/Catawba reload core designs, including the mixed fuel designs.

The generic 8 channel 1/8 core VIPRE-01 model described in DPC-NE-2004 is used to determine the regions of safe operation in terms of power level, reactor coolant temperature and pressure, and power distribution. The allowable space is first determined in terms of power level and reactor coolant pressure and temperature based on a reference power distribution which is discussed in Section 5.5.1 and shown in Figures 5 and 6. The reference hot assembly pin power distribution, Fig. 5, is relatively flat to conservatively minimize the benefits of crossflow (refer to the response for Question 6). The lumped channel power shown in Fig. 6 is based on the relatively flat assembly power distribution shown in Fig. 2 to eliminate any DNBR impact due to assembly power.

After calculating the allowed operating space using the reference peaking, the combinations of radial and axial peaking are determined which provide equivalent DNB protection. These limits are known as Maximum Allowable Peaking (MAP) limits and they are compared with cycle-specific predicted peaking in a maneuvering analysis, ref. 1. The peak pin powers calculated in a maneuvering analysis may be predicted in any core location (1/4 core symmetry is assumed). The peak pin powers are compared with the MAP limits conservatively based on the power distributions discussed above. If any negative peaking margins are determined (predicted peaking greater than the MAP limit) during a maneuvering analysis, the MDNBR will be calculated using the limiting predicted power distribution. The predicted radial power distribution and axial power profile is input directly into VIPRE-01.

Mixed core analyses are addressed in the response to question 5.

Reference

1. Nuclear Design Methodology for Core Operating Limits of Westinghouse Reactors, DPC-NE-2011P, April 1988.

3. Provide either (a) comparison to experimental data on pressure drop, or (b) the results of sensitivity studies to demonstrate that the use of the Blasius friction pressure factor expression and the EPRI two-phase friction multiplier yield conservative results for both single and two-phase flow.

A sensitivity study was performed to select the axial friction factor. The default smooth tube friction factor was compared with the following correlations:

$f = 0.32Re^{-0.25}$	default
$f = 0.184Re^{-0.2}$	
$f = 0.092Re^{-0.2}$	
$f = 0.368Re^{-0.2}$	

The sensitivity study results are given in Table 3-1. The MDNBR and local hot channel conditions for the first two correlations are nearly identical. Halving or doubling the leading coefficient of the correlation yields the expected decrease and increase in pressure drop and a fairly significant change in the local conditions and MDNBR. Doubling the leading coefficient, although yielding a conservative MDNBR, unrealistically increases the pressure drop across an assembly. Based on the sensitivity study results given in Table 1 and the recommendation in Vol. 4 of the VIPRE-01 manual, the default Blasius friction factor will be used.

The EPRI two-phase friction multiplier was selected based on the sensitivity study results given in Table 3-2. The EPRI two-phase friction multiplier yielded conservative MDNBRs.