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SUBJECT: Forwards Revision 4 of "Reload Design Methodology" & addl info requested in NRC 810602 ltr.

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June 16, 1981

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. J. F. Stolz, Chief
Operating Reactors Branch No. 4

Re: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287

Dear Sir:

In response to your letter dated June 2, 1981 requesting additional information regarding Technical Report NFS 1001, "Reload Design Methodology," please find the attached responses in Attachment 1 of this submittal. Attachment 2 transmits Revision 4 of Technical Report 1001, "Reload Design Methodology."

Very truly yours,

William O. Parker, Jr.

JLJ:scs

Attachments

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ATTACHMENT 1

DUKE POWER COMPANY
OCONEE NUCLEAR STATION

Response to NRC Letter of June 2, 1981

Question 492.1 (Section 6.7)

Provide a more detailed discussion on how the core outlet pressure - reactor outlet temperature curves are determined.

Response

The core outlet pressure - reactor outlet temperature curves (P-T Safety Limits, Figure 6.2) are determined by varying core outlet pressure and core inlet temperature using CHATA Command Routines 1 and 2 (CR 1/2). Using the equivalent two channel model, described in Section 6.6, core inlet temperature is varied at a constant pressure (one inlet temperature value per CHATA run) until the inlet temperature that yields a hot channel minimum DNBR of 1.4326 at that pressure has been determined. This single limiting combination of reactor coolant pressure and inlet temperature is then used to calculate the corresponding reactor vessel outlet temperature, using a simple reactor vessel heat balance.

This process is repeated over a range of pressures, typically 1800, 1900, 2000, 2100, 2200, and 2300 psia. For each of these pressures, a limiting inlet temperature is determined and a corresponding reactor outlet temperature is calculated. Finally, the resulting P-T Safety Limits are plotted for each allowable combination of operating reactor coolant pumps.

Question 492.2 (Section 6.8.2)

The method used to determine the Maximum Allowable Peaking (MAP) factor was to vary the hot channel power until the limiting DNBR was reached. Babcock and Wilcox varies the radial peaking factor rather than the power. Demonstrate that the Duke method is an acceptable and equivalent method when compared to the Babcock and Wilcox method.

Response

The Duke method is identical to the Babcock and Wilcox method; further, the operation of CHATA Command Routine 8 prohibits such a variation in this procedure. In addition to this response, it may also be helpful to review Reference 10 of NFS-1001, specifically page 10-3 and Appendix H, which describe the CHATA Command Routines.

The MAP curves are generated using CHATA Command Routines 1 and 8 (CR 1/8) and the equivalent two channel model described in Section 6.6. (This two channel model contains an average channel (Command Routine 1) that represents the overall core and a hot channel (Command Routine 8) that is "driven" by the average channel's pressure drop.

Command Routine 8 (CR8) accepts the average channel (CR1) pressure drop as a boundary condition, and varies hot channel flow and percent over power in the hot channel until the criteria of dP and minimum DNBR are satisfied in the hot channel.

The hot channel in CR8 is a single rod; therefore, for this single rod, overpower is functionally equivalent to pin peak. Usually the pin power input data field in the CR8 hot channel model is set equal to the core overpower fraction (for example 1.12) such that CR8 will output the allowable pin peak directly.

Question 492.3 (Section 6.8.2)

More information is needed on the generic DNBR curves or MAP curves.

Item 1: Provide a detailed discussion of how the curves are developed.

Response

MAP curves are developed using the equivalent two channel model described in Section 6.6 and further described in Duke's response to question 492.2, above. CHATA Command Routines 1 and 8 are used for MAP analyses.

Maximum allowable total peaking (MAP) limits are determined both for RPS DNB offset limits and for "operational" DNB offset limits. These two types of MAP curves are described in the response to Item 2 of this question.

CHATA Command Routines 1 and 8 are used to vary (in a series of hundreds of separate computer analyses) the axial flux shape peak and axial peak location. One computer run is required for each combination of axial peak and axial peak location, for example, an axial peak of 1.7 at 80% of the active fuel length. CHATA CR 1/8 is run such that the average channel model (CR1) calculates and transmits the dP boundary condition to the hot channel (CR8). The hot channel model then determines the maximum rod power (peak) and the hot channel flow that satisfy the dP and DNBR boundary conditions.

The inputs to CR 1/8 for MAP analyses are core operating conditions (temperature, pressure, power, and average channel flow), average and hot channel geometries, hydraulic characteristics, average channel pin power (pin peak = 1.0), and a specific axial flux shape to be assessed. To develop a set of MAP curves, axial flux shape is varied from an axial peak of 1.1 to 2.0, with the location of the axial peak varying from the bottom to top of the active fuel length in increments of 10 percent of active fuel length. Output from the hot channel model (CR-8) is the allowable hot channel overpower fraction (functionally equivalent to pin peak for this single rod model). The output pin peak is then multiplied by the axial peak to yield the maximum allowable total peak for the flux shape being analyzed.

Item 2: State the differences between the RPS DNB offset curves and the DNB operational offset curves.

Response

Two types of MAP curves are developed. One type is used for the RPS DNB offset limits. Multiple subsets of RPS MAP limits are determined, one subset for each allowable combination of operating reactor coolant pumps. The second type of MAP curves is used for DNB operational offset limits.

RPS MAP curves are determined at two separate operating conditions (temperature and pressure) for each allowable combination of operating reactor coolant pumps, as shown in Table 492.3-1. These two sets of RPS MAP curves (high temperature and low pressure) are overlayed at each allowable pump combination, and the conservative overlay is chosen for RPS DNB offset limits. The result of the RPS MAP analysis is three separate families of curves (similar to Figure 6.3), one for four RC pumps operating, one for three pumps, and one for two pumps.

Operational MAP curves are developed for operation with four reactor coolant pumps and are based on the most conservative overlay of the RPS MAP curves and a new set of MAP curves that are determined at the conditions stated in Table 492.3-2.

Item 3: State how the MAP curves which have the reference design DNBR as their basis are obtained.

Response

The MAP curves referred to in this item are the "operational" MAP curves, previously described. As stated in the Response to Item 2, above, the operational MAP curves are the conservative overlay of 1) the RPS MAP curves at four pump conditions and 2) MAP curves determined at 102% power and based on the reference DNBR at 102% power. The purpose of this additional overlay at 102% power is to insure that the operational offset limits preserve the initial DNB ratio assumed for DNB limited accidents.

Item 4: State how the extremities of the P-T core protection envelope are considered in developing the DNB offset limits.

Response

The low pressure and high temperature extremities of the variable P-T envelope are used as operating conditions for the RPS MAP analysis by performing the RPS MAP analyses at the operating conditions stated in Table 492.3-1. The extremities for the four pump RPS MAP analyses carry-through into the operational MAP limits because the operational MAP curves are an overlay of the RPS MAP curves and the 102% power reference DNB condition.

Table 492.3-1

MAP Analysis Input Operating Conditions

4 Pump Operation

High Temperature

Core Power Level = 112% Rated
T RV outlet = 619F

*Pcore = 2063 psia (typical)

MDNBR = 1.4326

Low Pressure

Core Power Level = 112% Rated
* Tcore inlet = 544F (typical)

Pcore = 1800 psia

MDNBR = 1.4326

3 Pump Operation

High Temperature

Core Power Level = 87.2% Rated
T RV outlet = 619F

*Pcore = 2065 PSIA

MDNBR = 1.4326

Low Pressure

Core Power Level = 87.2% Rated
* Tcore inlet = 542 (typical)

Pcore = 1800 psia

MDNBR = 1.4326

2 Pump Operation

High Temperature

Core Power Level = 59.4% Rated
T RV outlet = 619F

* Pcore = 1870 psia

MDNBR = 1.4326

Low Pressure

Core Power Level = 59.4% Rated
* Tcore inlet = 552F (typcial)

Pcore = 1800 psia

MDNBR = 1.4326

* Pcore is that pressure which results in a MDNBR = 1.4326 with a RV outlet temperature at the high temperature setpoint.

* Tcore inlet is that temperature that results in a MDNBR = 1.4326 with a pressure at the low pressure setpoint.

Table 492.3-2

Operational MAP Input Operating Conditions

The following operating conditions describe the additional set of MAP curves that are developed at 4 pump conditions and are overlayed with the RPS MAP curves to form the operational MAP curves.

Core Power Level = 102% Rated*

Tcore inlet ≅ 557.2F (includes +2°F error)

Pcore = 2135.0 psia (includes -65 psi error)

MDNBR ≅ 2.38 (B&W-2)*

*NOTE: The maximum allowable total peak resulting from these constraints is the same as the maximum allowable peak that results from an analysis performed at 112% power and a DNBR of 2.05.

Question 492.4 (Section 7.3.1)

In determining the reactor protection system P-T set points, the applicant stated that the RCS high pressure trip set point was 2356 psig. In the Technical Specifications for Oconee Units 1, 2, and 3, the high pressure trip is at 2300 psig. Correct this discrepancy.

Response

The current value for the high pressure trip set point is indeed 2300 psig. This discrepancy will be corrected in the next revision of the report on the following pages:

1) Paragraph 2, page 7-0
2) Table 7-1, page 7-16
3) Figure 7-4, page 7-20

Question 492.5 (Section 7.3.1)

Provide the values that are used to error adjust the P-T set point curve. How are these numbers obtained?

Response

The error-adjustment of the P-T set point curve is the same as for previous Oconee reload designs. The error-adjustment for temperature is $+1^{o}F$. This conservatively accounts for the maximum temperature error in the instrumentation string. The pressure measurement error is $\pm$ 30 psi which is added to the minimum pressure difference between the core outlet and the pressure tap on the hot leg, $\Delta P = +30$ psi. The net error-adjustment for pressure is 0 psi.

Question 492.6 (Section 7.3.2)

On page 7-10 reference is made to the flux/flow ratio ratio calculated in Section 6.8. The flux/flow ratio is calculated in Section 6.9. Correct this discrepancy.

Response

This editorial correction will be in the next revision of the report.

Question 492.7 (Section 7.3.2)

Provide a reference for the 6.5 percent full power error-adjustment factor used in setting the RPS power-flow imbalance.

Response

The 6.5 percent full power error-adjustment is the same as for previous Oconee reload designs and is discussed in the B&W Topical Report, "RPS Limits and Setpoints", BAW-10121, on page 5-13. Although this report is based on the 205 class plant, this factor is the same for the Oconee Units (see Technical Specifications 2.3 and 4.1).