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RECIP.NAME RECIPIENT AFFILIATION
CLARK,R.A. Operating Reactors Branch 3

SUBJECT: Forwards responses to Questions 4,5 & 8,re CEN-126(F),per NRC 810428 request.Changes in moderator temp in core bypass & downcomer regions are accounted for in combination.

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[illegible] comments [illegible] to questions 4,5 [illegible] 11-12(a)(1) [illegible]
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FLORIDA POWER & LIGHT COMPANY

June 18, 1981
L-81-253

Office of Nuclear Reactor Regulation
Attention: Mr. Robert A. Clark, Chief
Operating Reactors Branch #3
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

RECEIVED
JUN 22 1981
U.S. NUCLEAR REGULATORY COMMISSION

Dear Mr. Clark:

Re: St. Lucie Unit 1
Docket No. 50-335
CEAW Topical Report CEN-126(F)

In response to the information request of your letter dated April 28, 1981, we have enclosed answers to questions 4, 5, and 8. As discussed with your staff the answers will be submitted in three sets, the second of which will be forwarded shortly. At that time we will indicate a date as to when we expect to submit the remaining answers.

Very truly yours,

Robert E. Uhrig
Vice President
Advanced Systems & Technology

REU/DME/ah

Attachments

cc: Mr. James P. O'Reilly, Director, Region II
Mr. Harold F. Reis, Esquire

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Question 4a

ANISN is used to evaluate the percent change in detector response per degree change in moderator temperature. Are changes in moderator temperature in the core bypass, and downcomer regions accounted for separately?

Response

The changes in moderator temperature in the core bypass and downcomer regions are not accounted for separately, but rather in combination.

Question 4b

How are axial effects accounted for in the evaluation of the detector response sensitivity to power shifting due to moderator temperature changes?

Response

The moderator temperature in the downcomer is nearly uniform axially at any instant. The effect of moderator temperature changes on detector response is taken into account through the use of the temperature shadowing factor, which is not axially dependent. The effect of the axial temperature distribution within the core is taken into account in the QUIX calculation of the axial power distribution via feedbacks.

Question 5

Is the SHADRAC calculation done in 2-D or 3-D? If the calculation is 2-D, how are 3-D effects accounted for?

Response

The SHADRAC calculation is performed using a 2-D model to calculate assembly weighting factors. These factors are combined with assembly power distributions to calculate rod shadowing factors.

Three dimensional effects are accounted for within the QUIX code by convoluting the rod shadowing factor, shape annealing factor, and axial power distribution. The appendix to CEN-121(B)-P describes this process. Note that the original appendix contained a number of typographical errors. A revised appendix and a revised list of references are attached.

Question 8

A Temperature Shadowing Factor (TSF) has been assumed in the calculation. Since the TSF depends on water thickness and geometry, we would expect this value to be plant specific. Verify that the TSF used in CEN-126(F) is applicable to St. Lucie 1.

Response

The temperature shadowing factor that has been used in this report was calculated specifically for St. Lucie Unit 1.

9 References

1. CENPD-199-P, "C-E Setpoint Methodology," April, 1976.

2. CENPD-107, CESEC Topical Report, July, 1974.

3. CENPD-161-P, "TORC Code, A Computer Code for Determining the Thermal Margin of a Reactor Core," July, 1975.

4. System 80 PSAR, CESSAR, Vol. 1, Appendix 4A, Amendment No. 3, June 3, 1974.

5. Brasfield, H. C., et al, "Recommended Property and Reaction Kinetics Data for Use in Evaluating a Light Water Cooled Reactor Loss-of Coolant Involving Zircaloy - 4 or 304-SS Clad UO_2,"GEMP-482, 1968.

6. SHADRAC, "Shield Heating and Dose Rate Attenuation Calculation," G30-1365, March 25, 1966.

7. W. Engel, Jr., "A User's Manual for ANISN," K-1693, March 30, 1967.

8. DOT III Two Dimensional Discrete Ordinates Transport Code, ORNL-TM-4280, September, 1973.

9. MORSE Code With Combinatorial Geometry, E. A. Straker, et al. DNA 2860T, May, 1972.

APPENDIX

METHODS USED TO DETERMINE EXCORE DETECTOR RESPONSE DURING A

CEA WITHDRAWAL EVENT

The neutron flux power measured by the excore detectors during a CEA withdrawal event can be calculated by the following expression:

$$\frac{\text{Excore Detector Response } (t)}{\text{Excore Detector Response } (t=o)} = \left\{ \left(\frac{\sum_{i=1}^{NMESH} AxPD_i(t) \cdot RSF_i(t) \cdot SAF_i}{\sum_{i=1}^{NMESH} AxPD_i(t=o) \cdot RSF_i(t=o) \cdot SAF_i} \right) \cdot \left(1 + TSF \cdot \Delta T(t) \right) \right\} P\ (t) \qquad \text{Equation I-1}$$

where:

NMESH = number of axial nodes into which the core is divided. NMESH is equal to 20.

RSF_i = rod shadowing factor appropriate for the i^{th} axial node.

$AXPD(t)$ = normalized average power in the i^{th} node at time t.

TSF = temperature shadowing factor $(^oF)^{-1}$.

ΔT = $T_{in}\ (t) - T_{in}\ (t=o)$.

P (t) = actual core average power at time t.

SAF_i = shape annealing factor for the i^{th} node.

The rod shadowing factor for a given CEA bank is defined as the ratio of the excore detector response for full insertion of that bank to the excore detector response when all rods are out. The RSF's are determined using detailed two-dimensional power distributions representing the cumulative presence of the various rod banks and the shielding code SHADRAC (Reference 6). In this application SHADRAC calculates fast neutron spectra and fluence for the excore detectors in a three-dimensional system utilizing a moments method solution of the transport equation. The core, vessel internals, vessel, and excore detector locations are treated explicitly in the calculation.

The Temperature Shadowing Factor accounts for two temperature dependent effects on the excore detector responses. These are:

1. The effect on detector responses due to varying water density from moderator temperature changes. These are calculated by using computer code ANISN (Reference 7).

From ANISN the percent change in detector response per degree change in moderator temperature is calculated.

2. Detector response sensitivity to power shifting due to moderator temperature changes. This is calculated by applying the assembly weighting factors calculated from SHADRAC analyses to the PDQ power maps representative of two moderator temperatures. Again the percent change in detector response per degree change in moderator temperature is calculated.

The total Temperature Shadowing Factor (TSF) is the sum of the above mentioned effects.

The shape annealing factor is defined as the relative contribution to one detector's response from the i^{th} axial node, assuming a uniform axial power. This is calculated by a combination of two dimensional discrete ordinate (DOT) and Monte Carlo (MORSE) methods (References 8 and 9).