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SUBJECT:
PROPOSED TECH SPEC CHANGES AND ANALYSIS OF QUADRANT POWER TILT AND CHANGE IN POWER PEAK.

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DUKE POWER COMPANY

POWER BUILDING
422 SOUTH CHURCH STREET, CHARLOTTE, N. C. 28242

March 20, 1978

WILLIAM O. PARKER, JR.
VICE PRESIDENT
STEAM PRODUCTION

TELEPHONE: AREA 704
373-4083

Mr. Edson G. Case, Acting Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. Robert W. Reid, Chief
Operating Reactors Branch No. 4

Reference: Oconee Unit 1
Docket No. 50-269

Dear Sir:

During the NRC staff review of our proposed Technical Specifications, submitted by letter of January 23, 1978, prescribing the operating limits for Oconee 1 Cycle 4 past 100 EFPD, the staff indicated concern in our continued use of the quadrant power tilt limit of 6.03%. The Technical Specifications issued by your letter of February 17, 1978, limited the allowable quadrant power tilt value to 3.41%. During the February 28, 1978 meeting between the NRC staff, Duke and B&W, detailed information was presented to the staff on the analytical basis of the 6.03% tilt limit, and it was demonstrated how the conservatively established effects of the assumed 6.03% tilt are factored into other operating parameters in order to ensure acceptable margins of safety. At this meeting, in order to return the tilt limit to 6.03%, Duke Power Company agreed to insert into the Technical Specifications a provision to inform the NRC if the quadrant power tilt in Oconee 1 Cycle 4 should exceed a certain value. Accordingly, the attached proposed revision to the Oconee Nuclear Station Technical Specifications (Attachment 1) is submitted. This proposed revision includes the 6.03% tilt limit and has a provision for notifying the NRC in case the tilt exceeds 3.5%. We request that approval of these changes to the Technical Specifications be granted expeditiously.

Attachment 2 is B&W's data base and pertinent discussion of the correlation between quadrant power tilt and power peaking, which has been used in the tilt limit analysis. This information is submitted in response to an NRC staff request which occurred during the February 28 meeting.

Very truly yours,

William O. Parker, Jr.

PMA:ge
Attachments

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MAIL POST MARK

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WILLIAM O. PARKER, JR., being duly sworn, states that he is Vice President of Duke Power Company; that he is authorized on the part of said Company to sign and file with the Nuclear Regulatory Commission this request for amendment of the Oconee Nuclear Station Technical Specifications, Appendix A to Facility Operating Licenses DPR-38, DPR-47 and DPR-55; and that all statements and matters set forth therein are true and correct to the best of his knowledge.

William O. Parker, Jr.

William O. Parker, Jr., Vice President

Subscribed and sworn to before me this 20th day of March, 1978.

Vivian B. Rohkens

Notary Public

My Commission Expires:

February 15, 1982

ATTACHMENT 2

ANALYSIS OF QUADRANT POWER TILT
AND CHANGE IN POWER PEAK

As requested at the meeting between Duke Power, B&W and NRC personnel on February 28, the data on calculated power peak increase due to quadrant power tilt have been replotted and are presented in the attached figure. These data are from Figure 3-5 of BAW-10078 and recent investigations of the Oconee 1, Cycle 4 tilt behavior. The following discussion characterizes the method of tilt inducement used in the various calculations.

The calculations were performed in both 2-D and 3-D full core geometry using the PDQ07 and FLAME3 computer codes. Two dimensional geometry was used whenever the tilt effects were uniform axially. In these cases the radial power peak change conservatively reflected the total peak change. This fact was confirmed by selected 3-D check cases. The value of tilt against which the peak increase was plotted was obtained by integrating the mesh block or nodal powers to get the power produced in each quadrant. The expression for tilt is

$$\% \text{ Quadrant Tilt} = \frac{\text{Quadrant Power}}{\text{Average Quadrant Power}} - 1 \times 100,$$

and for the attached figure represents what can be called the "actual" quadrant tilt.

Following the legend in the attached figure, the first tilt type considered was that due to multiple rods out of sequence (symbol X). Two of these values are from Figure 3-5 of BAW-10078, and one from recent 3-D FLAME investigations of potential Oconee 1 multiple misaligned rods. These three cases represent from two to six rods misaligned. In the Oconee 1 case, rods in diagonally opposite quadrants were moved in opposite directions. The core was modeled with 24 axial nodes of six inches each. Bank 7 was misaligned such that one rod (on a minor axis) was one node above the bank average and the diagonally opposite rod was one node below the bank average.

The next type of tilt, shown with the symbol ⍋, was that caused by a dropped rod. In addition to the four cases from Figure 3-5 of BAW-10078, eleven additional cases were calculated for Oconee 1, Cycle 4. Every potential dropped rod location, including those on the major axes, was investigated.

The third tilt type was that caused by a single rod out of sequence (symbol ⊡). These ten cases were all reported in BAW-10078. The results are all clustered at low tilt and peak increase values. These were 3-D PDQ07 cases.

The fourth tilt type shown (symbol ⍝) was that due to various numbers of individual APSR fingers (one to three) assumed to be broken off and resting on the bottom in three different assembly locations. Three-dimensional

FLAME calculations for the beginning of Oconee 1, Cycle 4 were run at 40% FP, and without xenon, to amplify peaking effects.

The fifth tilt type was generated assuming several (three to six) misloaded assemblies (symbol ◈). Enrichment deviations of from ± .01 w/o (six locations) to -.90 w/o (three locations) were investigated. Again, the beginning of Cycle 4 of Oconee 1 was the configuration analyzed.

The sixth and final tilt type investigated (symbol ⊙) was that caused by a non-symmetric burnup distribution in two fuel batches being carried over into Cycle 4 of Oconee 1. Partial results of these calculations are given in BAW-1477, "Oconee 1 Cycle 4, Quadrant Flux Tilt." FLAME was used to simulate an end of Cycle 3 burnup asymmetry of +2% in one core quadrant and -2% in the diagonally opposite quadrant. The fuel was then shuffled into the Cycle 3 pattern and depleted in full core geometry to 50 EFPD. The power level was set at 40% FP to 4 EFPD, at 75% FP from 4 to 23 EFPD, and at 100% FP from 23 to 50 EFPD. A total of 26 variations of power level and burnup supplied data for the points plotted.

As can be observed from the figure, all of the over 60 data points fall below the line which has a slope of 1.495. This was the value assumed in assigning a 9.01% peak increase to an allowable tilt of 6.03% for the Oconee 1, Cycle 4 Technical Specifications.

PERCENT CHANGE IN PEAK POWER VS QUADRANT TILT