NFU 84-211

PSE&G

Public Service Electric and Gas Company P.O. Box 236 Hancocks Bridge, New Jersey 08038

Nuclear Department

Ref 1) Letter E. A. Liden (PSE&G) to Dr. T. E. Murley (NRC) Docket No. 50-311, dated June 13, 1984

Ref 2) Letter S. A. Varga (NRC) to R.A. Uderitz (PSE&G) Docket Nos. 50-272 and 50-311

July 30, 1984

Director of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Attention: Mr. Steven Varga, Chief
Operating Reactors Branch #1
Division of Licensing

Gentlemen:

REVISIONS TO THE
SALEM UNIT 2, CYCLE 2
STARTUP REPORT AND THE
PSE&G ROD EXCHANGE METHODOLOGY

The Salem 2, Cycle 2 startup report has been previously transmitted (Reference 1). The attachments represent revisions to the Startup Physics Tests Section. This revision provides additional information regarding the results of the rod exchange tests for Salem 2, Cycle 2.

Also attached are revisions to the PSE&G Rod Swap Methodology(2) which are being implemented as a result of the experience gained associated with the Unit 2, Cycle 2 startup tests.

The revisions to the above documents were suggested by M. Chatterton of the staff on July 10, during a discussion of the Cycle 2 test results. The attached revisions are in response to and are consistent with this request.

Very truly yours,

E. A. Liden
Manager - Nuclear
Licensing and Regulation

RAB:dgh
Attachments

IE 26
1/1

CC: Mr. D. Fischer
NRC Licensing Project Manager

Mr. L. Linville
NRC Senior Resident Inspector

ATTACHMENT 1

REVISIONS TO THE

SALEM 2, CYCLE 2

STARTUP REPORT

Zero Power Test Results

The zero power test schedule for Cycle 2 was essentially identical to that done for Unit 1 Cycle 5. The rod exchange technique was used for measuring the bank rodworth rather than the traditional boron dilution method. Comparisons of swap mode rodworth measurements and design values along with review criteria are shown in Table 2. Comparisons of dilution mode measurements and design values along with acceptance criteria are shown in Table 3.

As shown in Table 3, the dilution mode worth for bank C fails the acceptance criteria by 23 pcm. This failure was predicted prior to the test based on comparisons of PSE&G and Westinghouse rodworth calculations. The cause of the predicted deviations was a difference in the flux distributions as calculated by PSE&G and Westinghouse. Relative to PSE&G, the Westinghouse power distribution was radially tilted, with higher flux levels at the center. According to PSE&G analyses performed prior to the test, this tilt would cause some of the Westinghouse test predictions to deviate from measurements. PSE&G calculations predicted that the measurements of bank C and A would be 20% and 96 pcm lower than the W predictions. The observed deviations were 16% and 67 pcm lower respectively.

Additional confirmation of the presence of a radial flux tilt in the W models was obtained from the HZP flux map measurement, and a special dilution measurement of the bank C worth. Comparisons of the measured and predicted HZP flux distributions are shown in Figure 3 for Map #2200. The results confirm that the Westinghouse predictions were approximately 10% too high at the core center.

The special dilution measurement of the bank C worth was performed using the boron dilution technique. The measured value was 736 pcm, which confirms the exchange mode measurement shown in Table 3.

The deviation of the bank C measurement from vendor design predictions was reviewed by the Station Operations Review Committee. Based on the composite of test results, and the PSE&G calculations performed prior to the test, it was concluded that the deviation did not significantly effect the conclusions of the Salem 2, Cycle 2 Reload Safety Evaluation.

A Boron end point measurement was conducted with all rods out and was within the $\pm$ 50 ppm acceptance criteria. The measured value of 1364 ppm was 44 ppm lower than predicted.

An Isothermal temperature coefficient measurement was performed with all rods out. The value obtained was very close to the predicted value and well within tolerances.

Results of the zero power flux map (#2200) are shown in Table 4. A tilt in the power distribution of 2.3% was discovered in the N. W., quadrant and the resulting peaking factor Fxy exceeded the full power Technical Specification limits, but was below the zero power limits. The observed tilt was within the range predicted by the Fuel Vendor (Westinghouse).

Map 2200 was taken to evaluate the potential that the quantity $F\Delta H$ may violate the Technical Specification for low power, rodded operation at BOC. The vendor's evaluation of this potential violation on the appropriate accident analysis showed that there would be no adverse effects. NFG analyzed that the cause for the potential violation would be a radial, in-out flux tilt.

The results of Map 2200 (Figure 3) confirmed the existence of the radial tilt. Administrative limits on rod insertion were imposed to ensure that $F\Delta H$ would not be violated for low power rodded operation (See Figure 13).

ATTACHMENT 2

REVISIONS TO THE

SAFETY EVALUATION

OF THE

PSE&G ROD EXCHANGE METHODOLOGY

3.4 MEASUREMENT ACCEPTANCE CRITERIA

The purpose of rod worth measurements following a reload is to provide a partial audit of the accuracy of the design calculations. Review criteria are therefore necessary to assure that the deviations between measurements and predictions are conservative with respect to the allowances for calculational uncertainty used in the Reload Safety Evaluation.

3.4.1 DILUTION MEASUREMENT CRITERIA

For rod worth measurements obtained by the dilution/boration technique, typical measurements include only the four control banks. Typical review criteria for deviations between measurements and design predictions are shown in Table 3.3.

3.4.2 EXCHANGE MEASUREMENT CRITERIA

As described in Section 3.3.3, the design verification procedure associated with the rod exchange test directly quantifies the differences between RSE design calculations and measurements. Therefore, it is appropriate to apply the traditional dilution review criteria to the dilution mode measurements, as described in Section II of Table 3.4. However, since the PSE&G model is used in the exchange test to provide an intermediate evaluation step, additional review criteria for model verification are required.

The PSE&G model is used in the design verification procedure only in a relative manner. Observed differences between the model predictions and the exchange measurements are directly accounted for when verifying RSE rod worths. For this reason, the accuracy of the verification procedure is largely insensitive to biases in PSE&G predictions. However, it is reasonable to assume that the verification accuracy could be degraded given very large PSE&G model biases. Therefore, additional review criteria for PSE&G model verification have been established for the rod exchange test. These criteria are presented in Section I of Table 3.4. The basis for these review criteria are preseted below.

A review criteria of ±15% on the exchange mode worth of individual banks is appropriate based on Salem 1, Cycle 1 test experience. Exchange measurements of two shutdown banks (SD and SC) deviated by 15 to 16% from PSE&G predictions as described in Section 4, Table 4.1. However, the design verification accuracy for both banks were confirmed by independent dilution measurements as described in Section 4.0.

A review criteria of ±10% on the total exchange mode worth is appropriate based on Salem 1 Cycle 1 test experience and PSE&G model sensitivity studies.

Sensitivity studies were performed in which the PSE&G model was adjusted such that rod worth for each rod bank was increased by 10%. Predictions from the adjusted model were then used for Salem 1, Cycle 1 design verification evaluations. These results were compared to evaluations made using the unadjusted model. The comparison demonstrated that the effect on design verification accuracy was less than 1%.

The total predicted exchange mode worth for Salem 1, Cycle 1, differed from measurements by 10%. (See Table 4.1). However, the design verification accuracy for total bank worth was confirmed to better than 1% by independent dilution measurements.

3.4.3 REMEDIAL ACTION

Should the results of the rod exchange tests fail to meet the established review criteria the Station Operations Review Committee (SORC) will be informed. A test result which fails to meet Criteria I.1, I.2, I.3, or II.1 of Table 3.4 shall be reviewed by SORC. Final resolution shall be based on the composite of the associated test data, and an evaluation of the impact of the discrepancy on results of the analyses of the applicable events considered in the FSAR. Based on the results of this review, SORC may

decide to perform additional testing, which may be a repeat of the original test, or the performance of other confirmatory tests.

Should the results of the rod exchange tests fail to meet Criterion II.2 of Table 3.4, then the reactivity worth of control banks D through A shall be measured by successive insertion, using the boron dilution test technique. The review criteria shown in Table 3.3 shall be applied to these measurements. A dilution test result that fails to meet Criterion I.1 of Table 3.3 shall be reviewed by SORC. If the total dilution worth fails criterion I.2 of Table 3.3, then additional rod banks shall be measured until the criterion is met, or until all rods less the worst stuck rod, have been measured.

TABLE 3.3

REVIEW CRITERIA

FOR THE

BORON DILUTION MEASUREMENT

I DILUTION ROD WORTH

1. Individual banks

$|\Delta\%| \leq 15\%$ for banks $\geq$ 600 pcm

$|\Delta\rho| \leq 100$ pcm for banks < 600 pcm.

2. Total of all banks measured

$|\Delta\%| \leq 10\%$

$$\Delta\ \% = \frac{\text{measured-design}}{\text{design}} * 100\%$$

$\Delta\rho$ = measured-design

design = predictions made with RSE models

TABLE 3.4

REVIEW CRITERIA

FOR THE

ROD EXCHANGE MEASUREMENT

I. EXCHANGE MODE ROD WORTH

1 Reference bank

$|\Delta\%| \leq 10\%$

2 Individual banks

$|\Delta\%| \leq 15\%$ for banks $\geq$ 600 pcm

$|\Delta\rho| \leq 100$ pcm for banks < 600 pcm

3 Total of all banks

$|\Delta\%| \leq 10\%$

II. DILUTION MODE ROD WORTH

1 Individual banks

$|\Delta\%| \leq 15\%$ for banks $\geq$ 600 pcm

$|\Delta\rho| \leq 100$ pcm for banks < 600 pcm

2 Total of all banks

$|\Delta\%| \leq 10\%$

$$\Delta\% = \frac{\text{measured-design}}{\text{design}} * 100\%$$

$\Delta\rho$ = measured-design

design = predictions made with PSE&G models for exchange mode rod worths, or prediction made with RSE models for dilution mode rod worths.