

# SAFETY EVALUATION REPORT FOR PUBLIC SERVICE

## ELECTRIC AND GAS COMPANY'S REVISED REPORT ON ROD EXCHANGE

### METHODOLOGY

#### SUMMARY OF REPORT

The report (Ref. 1) describes a revised version of Public Service Electric and Gas Company's (PSE&G) rod exchange methodology. Rod exchange is an indirect means of measuring the reactivity worth of each individual bank by "swapping" it with the reference bank which is the highest worth bank. The report describes the core physics models and calculational procedures used to generate the analytical data, the plant test procedures, the test review and acceptance criteria and the comparisons of the rod exchange results with those from boron dilution for Salem 1 Cycles 1 and 3.

PSE&G's analytical method consists of using the ARMP Code Package. The model used represents a full core, in three dimensional geometry with twelve axial nodes and one radial node per assembly. Rod worths are calculated for each bank individually, for banks in the normal boron dilution test sequence and for each bank in the presence of the reference bank. A critical exchange reference position is calculated for each bank except the reference bank.

The test procedure consists of first measuring the worth of the highest worth bank by boron dilution and then measuring each bank by swapping it with the reference bank. The reference bank is determined as the bank with the highest worth when inserted into an otherwise unrodded core. For each test bank, a critical position of the reference bank is determined and used to calculate the worth of the test bank.

The proposed method measures all banks as opposed to measuring only the control banks by the boron dilution method. The rod exchange method has additional positive aspects for the licensee including less time involved and less water to process.

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## SUMMARY OF EVALUATION

The test procedure proposed by PSE&G is the same as that used by other rod exchange techniques and is acceptable. The staff has reviewed the analytical methods proposed by PSE&G and find them acceptable.

The method for obtaining the measured worth from the test data is similar to that used by VEPCO. NRC accepted this method in 1980 (Ref. 2). The method involves measuring the test bank worth in the presence of the reference bank. The calculated worth for the same configuration is compared with the measured worth. The staff finds this technique acceptable.

PSE&G has proposed two sets of criteria - one set is on exchange worths and one set is on dilution worths. The exchange worth criteria states that exchange worths as measured be compared with calculated worths for the same configuration. Each bank worth must be within  $\pm 15\%$  of the calculated worth for banks  $\geq 600$  pcm ( $1 \text{ pcm} = 10^{-5} \Delta k/k$ ) or within  $\pm 100$  pcm calculated for banks  $< 600$  pcm. Also the sum of all banks must be within  $\pm 10\%$  of the calculated sum. These exchange criteria are review criteria and failure to meet any one will result in review by the Station Operations Review Committee. Resolution will be based on composite start-up data and evaluation of the impact of the discrepancy.

The second set of criteria is based on dilution worth as defined by

$$\left( \frac{M - P}{P} \right) \times 100 \times (\text{dil ratio})$$

where: M = measured worth of the rod bank

P = predicted worth of the rod bank

dil ratio = total dilution mode rod worth predicted by the reactor safety evaluation divided by the total dilution mode rod worth predicted by PSE&G.

Dilution worth criteria are as follows:

1. Each bank worth be within  $\pm 15\%$  of calculated for bank  $\geq 600$  pcm or within  $\pm 100$  pcm for bank  $< 600$  pcm.

2. The sum of all banks must be within  $\pm 10\%$  of calculated worth. If dilution criteria are not met, banks D through A will be measured by boron dilution. The proposed method makes a direct comparison of measurement with calculation. The review criteria evaluates whether measurement and calculation agree within design tolerance. The dilution criteria compares how well the dilution worth as calculated by PSE&G compares with the dilution worth calculated by the group doing the safety evaluation. Since all other banks are compared with the reference bank, the staff has suggested an additional criterion be placed on the reference bank. The licensee has agreed to a  $\pm 10\%$  review criterion on the reference bank. With this additional criterion the staff finds the proposed criteria and remedial actions acceptable.

#### REGULATORY POSITION

The staff has reviewed the revised rod exchange methodology as proposed by PSE&G. Based on this review we find this method acceptable for the Salem Nuclear Generating Station. We do, however, require the additional review criterion of  $\pm 10\%$  on the reference bank.

Reviewer: M. Chatterton

### References

1. Letter from E. A. Liden to Steven A. Varga, November 24, 1982, " Safety Evaluation of the Revised PSE&G Rod Exchange Methodology ."
2. Letter from Robert L. Tedesco to W. N. Thomas, November 7, 1980 (on VEPCO Rod Swap Methodology).