PSE&G

Public Service Electric and Gas Company P.O. Box 168 Hancocks Bridge, New Jersey 08038

Salem Nuclear Generating Station

January 12, 1979

Director
Nuclear Reactor Regulation
US NRC
Washington, D.C. 20555

Attention: Albert Schwencer, Chief
Operating Reactors Branch #1
Division of Operating Reactors

Dear Sir:

REQUEST FOR TECHNICAL SPECIFICATION VARIANCE
SALEM GENERATING STATION

On Friday, January 12, 1979, during the 12x8 shift, a boron concentration analysis of the Boric Acid Tanks and Boron Injection Tank showed the contents to be out of Technical Specification limits. Results were as follows:

Apparatus	Boron Concentration	Technical Specification
No. 11 Boric Acid Tank	17,469 ppm	20,100 - 21,800 ppm
No. 12 Boric Acid Tank	16,670 ppm	20,100 - 21,800 ppm
No. 1 Boron Injection Tank	16,162 ppm	20,100 - 21,800 ppm

ACTION statements 3.1.2.8 and 3.5.4.1 were implemented at 0600 hours. Batching was started to increase concentrations to within Technical Specification limits. Subsequent analysis showed the Boron Injection Tank to be within specification at 20,519 ppm and Action Statement 3.5.4.1 was terminated at 0656 hours. At 1055 hours, chemical analysis showed the Boron Injection Tank concentration to be 18,522 ppm, below the lower specification of 20,100 ppm. ACTION statement 3.5.4.1 was implemented at 1055 hours. Power reduction was started at 1155 hours to assure compliance with the specification time limitation. Batching of boric acid to the system was initiated. No. 12 Boric Acid Tank was isolated, No. 11 remained in service, to reduce the time required to increase the boron concentration of the system. No. 11 Boric Acid Tank capacity by itself satisfies Technical Specification requirements. Boric acid is recirculated between the Boric Acid and Boron Injection Tanks. The system concentration started to increase.

During the six hour period permitted by the Technical Specifications, the Manager - Nuclear Operations, Mr. H. J. Heller, in a telephone conversation with Mr. Charles Trammell, III, requested a Technical Specification variance to paragraph 3.5.4.1, to permit continued operation of the Unit beyond the specified six hour period. In response to this request, you granted a verbal extension of 18 hours (until 1155 hours on January 13, 1979) to be within the Technical Specification limits. As a result of this waiver, further power reduction was stopped at 1415 hours.

The basis for the justification of the variance requested above is that at 1055 hours, the BIT boron concentration of 18,522 ppm indicated that within the next 24 hours, the Technical Specification limits would be met. The operability of the Boron Injection Tank ensures that sufficient negative reactivity is injected into the core to counteract any positive increase in reactivity caused by RCS cooldown. Therefore, Action Statement 3.5.4.1 requires with the BIT inoperable, a shutdown margin equivalent of 1% $\Delta K/K$ at 200°F. It should be noted that during our power reduction to comply with Technical Specification Action Statement 3.5.4.1, the shutdown margin equivalent of 1% $\Delta K/K$ at 200°F was maintained at all power levels. See attached statement of assumptions and shutdown margin calculations.

Preliminary investigation into the cause of the low boron concentrations indicated an apparent personnel error during the transfer of highly concentrated boric acid from the Concentrates Holding Tank to the Boric Acid Tanks. Additionally, the Operating Instruction II-3.3.5 Boric Acid Solution Preparation and Transfer will be reviewed to improve operation of the system to minimize any possibilities of a similar occurrence in the future. The results of the investigation of this occurrence and a review of the procedural changes will be reviewed with operating personnel during a future training session.

These changes are deemed to involve a single safety issue and are deemed not to involve a significant hazards consideration and, therefore, are determined to be a Class III amendment as defined by 10CFR170.22.

Yours very truly,

H. J. [signature]

Manager - Salem Generating Station

JMZ:dmh

The attached worksheet shows that had the plant tripped from 100% power with the rods at the insertion limit, the shutdown margin was met at 200°F for the next 24 hours. The following conservatisms were used:

1. Highest power level 100%
2. Lowest rod worth - insertion limit and cold rod worth
3. No credit for Xenon peaking
4. 900 gallons of 16,000 ppm boric acid in Boron Injection Tank
5. Highest worth rod stuck out
6. Lowest boron worth (547°F)

SHUTDOWN MARGIN CALCULATION WORK SHEET

Calculated: Date 1-12-79 Time 1050

1.0 PREVIOUS CRITICAL CONDITIONS

- 1.1 Shutdown: Date N/A Time ______
- 1.2 Shutdown rate ("X" if a trip) X %/MIN
- 1.3 Power Level 100 %
- 1.4 Boron Concentration 300 ppm
- 1.5 Control Bank Position Bank D at 170 Steps
- 1.6 Core Exposure 12,500 MWD/MTU
- 1.7 Integral Rod Worth (Fig. 4, HZP) 140 pcm

2.0 CONDITIONS FOR WHICH SHUTDOWN MARGIN IS TO BE CALCULATED

- 2.1 Date 1-12-79 Time 1050 for 24 hours
- 2.2 Boron Concentration 518 ppm
- 2.3 RCS Temperature 200 °F
- 2.4 Rod Bank Positions:
  - Control Banks Bank ABCD at 0 Steps
  - Shutdown Banks (0 or 228) 0 Steps
- 2.5 Integral Rod Worth
  - a) Control Banks (Fig 4 or Fig 15) C/B 1990 pcm
  - b) Shutdown Banks (S/D banks out: use zero, S/D banks in: Fig 16) S/D 2420 pcm
  - c) Total Worth (sum) Total 4410 pcm

NOTE

For cold shutdown conditions be sure to use CZP curves for worth.

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3.0 REACTIVITY DUE TO RODS
(1.7) - (2.5c) — -4270 pcm

4.0 POWER DEFECT
Reactivity gain due to power reduction from (1.3) at boron conc. in (1.4) (Fig. 2) — 1630 pcm

5.0 XENON REACTIVITY

5.1 Xenon reactivity at time of shutdown (Fig. 6 or Reactor Engineer) — -3160 pcm
5.2 Elapsed time from shutdown (1.1) to (2.1) — ≤ 24 hrs
5.3 Xenon reactivity at time in (5.2) (Fig. 8 or Reactor Engineer) — ≥ -3160 pcm
5.4 Reactivity change: (5.3) - (5.1) — 0 pcm

NOTE: Samarium is ignored. See Precaution 6.

6.0 REACTIVITY DUE TO COOLDOWN

Isothermal temperature defect at T_{avg} in (2.3) and boron concentration at time of cooldown — 3070 pcm

7.0 REACTIVITY DUE TO BORON CONC. CHANGE

7.1 Average boron concentration (item 1.4 + item 2.2) ÷ 2 = — 409 ppm
7.2 RCS temp. at which boric acid was added — 547 °F
7.3 Differential boron worth at concentration in (7.1) and temp. in (7.2) (Fig. 12) = — -10.8 pcm/ppm
7.4 Change in boron concentration (item 2.2) - (item 1.4) = — 218 ppm
7.5 Reactivity (item 7.4) x (item 7.3) = — -2354 pcm

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8.0 REACTIVITY CHANGE (TOTAL)

8.1 Enter item 3.0 (Rods) -4270 pcm

8.2 Enter item 4.0 (Power) 1630 pcm

8.3 Enter item 5.4 (Xenon) 0 pcm

8.4 Enter item 6.0 (Δ Temp) 3070 pcm

8.5 Enter item 7.5 (Boron) -2354 pcm

8.6 Total reactivity change (sum) -1924 pcm

9.0 K_{eff} DETERMINATION

9.1 Reactivity change (ρ) in $\Delta K/K$
(item 8.6) x 10^{-5} = -.01924

9.2 $K_{eff} = 1/(1-\rho) = 1/(1-\text{item } 9.1)$ = K_{eff} .9811

10.0 CALCULATION OF SHUTDOWN MARGIN

10.1 Available shutdown margin

a) Total reactivity change (item 8.6) -1924 pcm

b) Allowance for all withdrawn tripable rod banks:

Control Banks: (item 2.5a)-(Fig.15) 0 pcm

Shutdown Banks: (item 2.5b)-(Fig.16) 0 pcm 2

c) Allowance for one stuck rod (Fig.17) 810 pcm

d) Total shutdown margin available (sum) -1154 pcm

10.2 Required shutdown margin (Tech. Spec. 3.1.1.1 or 3.1.1.2) 1 % x 10^3 = (-) 1000 pcm

NOTE

If this calculation was completed for present reactor conditions (Section 2.0) and if the shutdown margin available (10.1d) is less than required (10.2) initiate rapid boration until required shutdown margin is attained: Use OI II-3.3.8, Rapid Boration. If this calculation was completed for "desired" conditions (Section 2.0) and insufficient shutdown margin exists at these conditions continue with Section 11.0.

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11.0 CALCULATION OF BORON CONCENTRATION FOR SHUTDOWN MARGIN

This section can be used to determine the boration required before the reactor is taken to a desired condition (rod bank postion, temp.) to maintain required shutdown margin.

11.1 Difference (item 10.2)-(item 10.1d) = N/A pcm

11.2 RCS Temp. (presently) ______ °F

11.3 Boron concentration (item 2.2) ______ ppm

11.4 Boron worth at concentration in (11.3) and temp. in (11.2) (Fig.12) ______ pcm/ppm

11.5 Concentration change (11.1) ÷ (11.4) = ______ ppm

NOTE

If the concentration change (11.5) is greater than 200 ppm, the boron worth (11.4) is to be found at a concentration of:

$$\frac{(2\text{x item } 11.3)+(\text{item } 11.5)}{2}$$

then, recalculate the concentration change (11.5).

11.6 Required boron concentration (11.3)+(11.5) = ______ ppm

NOTE

This concentration (11.6) will meet shutdown margin requirements for conditions of Section 2.0

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FIGURES REQUIRED

REACTOR ENGINEERING MANUAL FIGURES:

1.
2. Power Defect vs Power
3. Integral Rod Worth vs Steps Withdrawn-P/L Bank
4. Integral Rod Worth vs Steps Withdrawn-Control Banks
5.
6. Equilibrium Xenon Reactivity vs Relative Power
7.
8. Xenon Reactivity Following Plant Trip
9.
10. Samarium Reactivity After Shutdown
11. $T_{average}$ vs Relative Power
12. Differential Boron Worth vs Boron Concentration
13.
14.
15. Total Control Banks Worth vs Exposure
16. Total Shutdown Banks Worth vs Exposure
17. Most Reactive Stuck Rod Worth vs Exposure
18. Isothermal Temperature Defect vs Temperature
19.

20a Cold Shutdown Boron Concentrations

20b Hot Standby Boron Concentrations

Completed by: Ed Roscioli / J. Nichols DATE 1-12-79 TIME 1030

Shift Supervisor: [signature] DATE 1/12/79 TIME 1300

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$$C_F = C_i + [C_o - C_i]\, e^{-\frac{MA}{MS}}$$

C_F = final concentration (ppm)

C_i = concentration of influent (ppm)

C_o = initial concentration

MA = mass added (influent)

MS = system mass = 527,100 lbm

MS = 527,100 lbm

C_i = 16,000 ppm

C_o = 300 ppm

$MA = 900 \text{ gallon} \times 8.1812 \frac{\text{lbm}}{\text{gallon}}$

$8.1812 \frac{\text{lbm}}{\text{gallon}}$ = water at 150°F and 15 psia

MA = 7363.09 lbm

$$C_F = 16{,}000 + [300 - 16{,}000]\, e^{-\frac{7363.09}{527{,}100}}$$

C_F = 517.79 ppm

Calculated by:
Jeff Jackson/John A. Nichols