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Region 2, Atlanta, Office of the Director

SUBJECT: LER 80-023/01T-0:on 800709,during return to critical after maint/mod outage,actual critical configuration for Unit 1 differed from predicted critical configuration.Caused by underprediction & bias in core excess reactivity data.

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TITLE: Incident Reports

NOTES:M Cunningham:all amends to FSAR & changes to Tech Specs. 05000269

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DUKE POWER COMPANY
OCONEE UNIT 1

Report Number: RO-269/80-23

Report Date: August 5, 1980

Occurrence Date: July 9, 1980

Facility: Oconee Unit 1, Seneca, South Carolina

Identification of Occurrence: Reactivity Anomaly During Reactor Startup

Conditions Prior to Occurrence: Startup Mode

Description of Occurrence:

On the evening of July 9, 1980, Oconee 1 was initiating startup following an outage for repair of the 1B1 reactor coolant pump and implementation of control system modifications per the NRC Confirmatory Order relating to the February 26, 1980 event at Crystal River. This was the first startup of the unit since the beginning-of-cycle. At 2235 hours, as the control rods were being withdrawn to establish criticality, criticality occurred at 19% wd on control rod group 5--about 1.3% $\Delta k/k$ different from the predicted critical rod position of 39% wd on control rod group 6. The reactor was shut down and an engineering investigation was initiated.

Apparent Cause of Occurrence:

After an evaluation of core conditions and Reactivity Balance Procedure data by Oconee personnel, criticality was reestablished at 0656 hours on July 10, 1980. A reactivity anomaly of 1.30% $\Delta k/k$ was observed during this startup. Review of core power distribution data at low power levels confirmed that the reactivity anomaly was due not to unusual core conditions but primarily to inaccuracy in the core physics data used in the reactivity balance calculation. Following a reactor trip from about 15% full power, another criticality at 1800 hours on July 10, 1980 for which strict RCS boron control and sampling measures were taken indicated a slightly lower reactivity anomaly of about 1.2% $\Delta k/k$, which is considered to be a best estimate of the apparent anomaly. It should be noted that after the original reactivity anomaly was detected on July 9, the Reactivity Balance Procedure was revised temporarily to normalize the core excess reactivity curve to account for the observed anomaly. The reactivity anomalies indicated by this revised procedure were small ($\sim$ 0.1% $\Delta k/k$) for both of the reactor startups performed on July 10.

The original predicted core physics values supplied by B&W in the Oconee 1, Cycle 6 Physics Test Manual, as well as Duke's EPRI-NODE reactor simulator code, showed reactivity anomalies of about 0.9% $\Delta k/k$ for these startups. Adjustment of these predictions, per normal practice, to account for a beginning of cycle measured "all rods out" boron concentration that was 45

ppm less than predicted yields anomalies of about 1.3, 1.3, and 1.2% Δk/k for the three startups. This confirms that the data in the Reactivity Balance Procedure was consistent with the predicted values.

The major portion of the zero power reactivity anomaly is considered to be a combination of underprediction of the core excess reactivity (0.32% Δk/k), bias in the core excess reactivity data used in the Reactivity Balance Procedure (0.13% Δk/k), and the difference between predicted and measured control rod worth at the critical position (0.36% Δk/k). The remaining portion of the discrepancy is considered to be due to changes in the control rod worth redistribution from burnup effects.

Analysis of Occurrence:

For shutdown margin calculations at power, the worst case (lowest shutdown margin) occurs when the reactor is just critical at 0% wd on control rod group 5. Per B&W-supplied core physics data, the minimum required RCS boron concentration to assure a 1% shutdown margin with the most reactive rod stuck out of the core at 532°F, 97.4 EFPD, is 750 ppm. If this is adjusted by the full amount of the observed reactivity anomaly, 880 ppm boron would be required. The RCS boron concentrations on July 9 and July 10 were measured as 1017 ppm and 989 ppm, respectively. Thus, a shutdown margin greater than the required 1% Δk/k was maintained during this incident.

Shutdown margin calculations with the reactor shutdown include several conservatisms, including a 10% reduction in control rod worth and an additional 100 ppm conservatism for shutdown boron concentrations at cold conditions. Thus, even if a 1.3% Δk/k increase in core reactivity had occurred, the minimum shutdown margin maintained per the previous reactivity balance procedure would have been greater than 1% Δk/k.

In addition, the investigation of this anomaly with respect to the review of data and calculations, as well as the diagnostic testing performed at low power (described under "Corrective Action") proceeded in an orderly, prudent manner, consistent with current operating practices and Technical Specification allowances.

Corrective Action:

Immediate corrective actions were to:

- shut down the reactor
- verify chemistry sample results
- verify that there were no indications of ejected or misaligned control rods or loose parts.

The reactivity balance data was then reviewed for errors, and, none being found, the Reactivity Balance Procedure was revised based upon the observed critical rod position. This revision was made in a manner such that the boron concentration required for an indicated 1% Δk/k shutdown margin was increased by the amount of the observed reactivity anomaly.

After the reactor was returned to criticality, core power distribution measurements were made at low power levels to confirm that no unusual core conditions existed. Core power distribution data at higher power levels were also obtained and reviewed, and reactivity anomaly ("all rods out boron") at-power measurements were made to verify that no core reactivity change had occurred during the outage preceding this incident. The at-power ("all rods out") reactivity balance calculation indicated a difference of approximately 50 ppm between the measured and predicted core excess reactivities, which is within the normal tolerance of design calculations.

The Reactivity Balance Procedure has been revised to incorporate the measured beginning-of-cycle control rod worth data. B&W is calculating rod worth data for 100 EFPD, and this data will be incorporated in the procedure when it is available. In addition, the rod worth data for Units 2 and 3 are being reviewed for possible changes in their respective procedures.

Oconee personnel will review future core physics data supplied by B&W to ensure that it is consistent with the observed characteristics of previous Oconee cores. In addition, personnel from Duke's General Office will provide support in reviewing this core physics data, utilizing Duke's reactor core design computer codes.

NRC FORM 366 (7-77)

U. S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT

EXHIBIT A

CONTROL BLOCK: (1) (PLEASE PRINT OR TYPE ALL REQUIRED INFORMATION)

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DOCKET NUMBER | EVENT DATE | REPORT DATE

EVENT DESCRIPTION AND PROBABLE CONSEQUENCES (10)

0 2 During the return to critical after a maintenance/modification outage, the
0 3 actual critical configuration for Unit 1 differed from the predicted critical
0 4 configuration by 1.30% Δk/k. Subsequent restarts verified the existence of the
0 5 anomaly. In spite of this difference, a 1% Δk/k shutdown margin was main-
0 6 tained during shutdown and at power. Thus, this incident was not considered
0 7 to be significant with respect to safe operation, and the health and safety
0 8 of the public were not affected.

	SYSTEM CODE	CAUSE CODE	CAUSE SUBCODE	COMPONENT CODE	COMP. SUBCODE	VALVE SUBCODE
0 9	R C (11)	D (12)	Z (13)	Z Z Z Z Z Z (14)	Z (15)	Z (16)

(17) LER/RO REPORT NUMBER	EVENT YEAR		SEQUENTIAL REPORT NO.		OCCURRENCE CODE	REPORT TYPE		REVISION NO.
	8 0	—	0 2 3	/	0 1	T	—	0

ACTION TAKEN	FUTURE ACTION	EFFECT ON PLANT	SHUTDOWN METHOD	HOURS (22)	ATTACHMENT SUBMITTED	NPRD-4 FORM SUB.	PRIME COMP. SUPPLIER	COMPONENT MANUFACTURER
G (18)	G (19)	C (20)	Z (21)	0 0 0 0	Y (23)	N (24)	Z (25)	Z 9 9 9 (26)

CAUSE DESCRIPTION AND CORRECTIVE ACTIONS (27)

1 0 The reactivity anomaly was due to underprediction and bias in the core excess
1 1 reactivity data, differences between measured and predicted rod worths, and
1 2 burnup effects on rod worth redistribution. The reactor was shut down,
1 3 chemistry samples and reactivity calculations were verified, and data in the
1 4 reactivity balance procedure was revised.

	FACILITY STATUS	% POWER	OTHER STATUS (30)	METHOD OF DISCOVERY	DISCOVERY DESCRIPTION (32)
1 5	C (28)	0 0 0 (29)	NA	A (31)	Routine Startup of Reactor

	ACTIVITY RELEASED	CONTENT OF RELEASE	AMOUNT OF ACTIVITY (35)	LOCATION OF RELEASE (36)
1 6	Z (33)	Z (34)	NA	NA

PERSONNEL EXPOSURES

	NUMBER	TYPE	DESCRIPTION (39)
1 7	0 0 0 (37)	Z (38)	NA

PERSONNEL INJURIES

	NUMBER	DESCRIPTION (41)
1 8	0 0 0 (40)	NA

LOSS OF OR DAMAGE TO FACILITY (43)

	TYPE	DESCRIPTION
1 9	Z (42)	NA

PUBLICITY

	ISSUED	DESCRIPTION (45)	NRC USE ONLY
2 0	N (44)	NA	

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