UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

Report Nos.: 50-369/92-07 and 50-370/92-07

Licensee: Duke Power Company
422 South Church Street
Charlotte, NC 28242

Docket Nos.: 50-369 and 50-370 License Nos.: NPF-9 and NPF-17

Facility Name: McGuire 1 and 2

Inspection Conducted: February 24 - 27 and April 6, 1992

Inspector: P. T. Burnett 8 April 1992 Date Signed

Accompanying Personnel: C. W. Rapp
Y. Nishiwaki

Approved by: Curt Rapp for R. V. Crlenjak, Chief 4/8/92 Date Signed
Operational Programs Section
Operations Branch
Division of Reactor Safety

SUMMARY

Scope: This routine, announced inspection addressed the review of post-refueling startup tests conducted on Unit 1 for cycle 8 and review of the routine core surveillance program for both units. Discussions were held with the licensee and a vendor on methodology to reduce the potential for overpower delta-temperature trips by controlling process noise in the hotleg temperature measurement.

Results: Both the post-refueling startup test program and the routine core surveillance program are basically sound. Two potential areas of improvement in the startup test program were identified:

- Enhanced procedural controls may be necessary to prevent over dilution of the volume control tank during extensive dilution of the core (paragraph 2.a).
- The acceptance criteria for control rod worth measurements may not be consistent with assumptions made in shutdown margin calculations (paragraph 2.c).

The licensee and its vendor have identified and analyzed a method to reduce process noise in hotleg temperature measurements by weighting

the RTD inputs to the T_{HOT} measurements. No inspector concerns were identified in the discussions to date, but the issue will be subject to further inspection when the licensee's safety analysis is available for review. Currently, the licensee intends to implement the change in late April 1992 (paragraph 3).

No violations or deviations were identified.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

*K. Breslin, Associate Engineer, Reactor Group
#M. Carroll, Nuclear Services/Safety Analysis
#M. Cash, Reactor Engineer
*B. Hamilton, Superintendent of Operations
*L. Kunka, Engineer, Compliance
#M. Mallard, Nuclear Operations
*T. McConnell, Station Manager
*K. Mullen, Associate Engineer, Compliance
#R. Sharpe, Compliance

Other licensee employees contacted included engineers and office personnel.

Other Organizations

#R. Puryear, Westinghouse, Duke Power Projects
#J. Srinivasan, Westinghouse

NRC Resident Inspectors

#P. K. VanDoorn, Senior Resident Inspector
*T. A. Cooper, Resident Inspector

*Attended exit interview on February 27, 1992.

#Attended meeting on process noise on April 6, 1992.

Acronyms and initialisms used throughout this report are listed in the last paragraph.

2. Unit 1, Cycle 8, Post-Refueling Startup Tests (72700)

PT/0/A/4150/21 (Approved November 14, 1991), Post Refueling Controlling Procedure for Criticality, Zero Power Physics, and Power Escalation Testing, was performed and completed over the period of December 7 - 31, 1991. No questions arose directly from the review of the completed procedure, which scheduled and controlled the procedures and tests discussed in the subparagraphs below.

The predicted values for the measurements discussed below were found in MCEI 0400-03, McGuire 1 Cycle 8 Startup and Operational Report, dated November 15, 1991.

a. Initial Criticality (72700)

This activity was performed under the guidance of PT/0/A/4150/28 (Approved August 27, 1991), Criticality following a Change in Core Nuclear Characteristics.

One concern was identified by the inspector during review of the completed procedure. Precaution step 6.4 states, "Ensure no flow path exists for demineralized water to flow back into the VCT while diluting the NC system." Procedure step 12.8 states, "Direct Operations to begin dilution directly to suction of charging pump." Discussions with reactor engineering personnel confirmed that the intent of those steps is to ensure that the VCT does not become more dilute than the NC system. An over-dilute VCT could lead to a continuing dilution of the NC system during recirculation following cessation of active dilution. The concomitant reactivity increase could lead to violation of the PDIL. At other facilities, the inspector has observed reactivity overshoot following initial cycle criticality because of over dilution of the VCT. More recently, it has been postulated in a PRA analysis that a far more severe, albeit very low-probability, accident could result from an over-dilute VCT concurrent with a station blackout.

Additional procedural controls appear to be necessary to assure over dilution does not occur. Operation in the alternate dilute mode will direct dilution water directly to charging pump suction. However, dilution water is also directed to the VCT spray header. Hence, dilution water will go directly to the VCT unless a valve is closed in response to a procedural requirement. Unless the procedure specifically requires that the charging flow be greater than the dilution flow, dilution water may backup into the VCT. The licensee is considering these observations. The licensee's response will be tracked under IFI 50-369 and 50-370/92-07-01: Assure procedural controls are adequate to prevent over dilution of the VCT.

c. Zero Power Tests (61708, 61710)

(1) PT/0/A/4150/10 (Approved July 10, 1991), Boron Endpoint Measurement, was performed on December 9, 1991, for the ARO configuration. The measured C_B of 1670 ppmB satisfied the acceptance criterion of agreement with the predicted value of 1681 ppmB within ±50 ppmB.

(2) PT/0/A/4150/12 (Approved August 5, 1991), Isothermal Temperature Coefficient Measurement, was measured at ARO on December 9, 1991. Four measurements were made: two while heating up and two while cooling down. Each had a temperature change of at least 4°F. The average ITC was -0.29 ±0.05 pcm/°F. The predicted ITC was +0.62 pcm/°F. The agreement between predicted and measured ITCs was acceptable.

After correction for a DTC of -1.45 pcm/°F, a MTC of +1.16 pcm/°F was obtained. TS 3.1.1.3 limits the MTC to +7 pcm/°F from zero to 70% RTP. From 70% to 100% RTP, the MTC must decrease to ≤0.0 pcm/°F.

(3) PT/0/A/4150/31 (Approved July 7, 1991), Determination of Rod Withdrawal Limits to Ensure Moderator Temperature Coefficient within Limits of Technical Specifications, was completed on December 9, 1991, to ensure compliance with TS 3.1.1.3 at all power levels. The analysis confirmed compliance with the specification at all power levels.

(4) PT/0/A/4150/11 (Approved September 6, 1991), Control Rod Worth Measurement, was completed on December 10, 1991. Control rod bank C was identified as the reference bank for future rod worth measurements. The measured worth of control bank C was 769 pcm, which was within 10% of the predicted worth of 824 pcm.

(5) PT/0/A/4150/11A (Approved December 20, 1 ·0), Control Rod Worth Measurement: Rod Swap, was completed on December 10, 1991. The results are tabulated below.

Reactivity Worth

Rod Bank	Predicted(pcm)	Measured(pcm)	Error(%)
Shutdown A	265	268	-1.1
Shutdown B	804	791	+1.6
Shutdown C	408	392	+4.1
Shutdown D	408	392	+4.1
Shutdown E	459	476	-3.6
Control A	311	343	-9.3
Control B	675	615	+9.8
Control C(ref)	824	769	+6.9
Control D	490	469	+4.5
TOTALS	4644	4515	+2.9

The acceptance criterion for the reference bank worth measurement was ±15% of the predicted worth and the acceptance criterion for the worth of each control rod bank measured by rod swap was the larger of ±30% of prediction or ±200 pcm of prediction. A final criterion was that the sum of all rod worths be ≥90% of prediction. Since all other measurements are dependent upon the precision of the reference bank measurement, these acceptance criteria do not appear consistent with the assumption used in SDM calculations that rod worth is known to ±10%. As shown above, the actual test results satisfy a more rigorous acceptance criterion. The licensee is reviewing the acceptance criteria for these measurements in that light. The licensee's review will be tracked under IFI 50-369 and

50-370/92-07-02: Determine appropriate acceptance criteria for control rod worth measurements consistent with SDM calculations.

d. Power Escalation Tests (61702, 61605)

(1) TT/1/A/9200/293 (Approved December 5, 1991), McGuire 1 Cycle 8 Incore and Nuclear Instrumentation System Interim Recalibration, was performed satisfactorily on December 12 1991, at 39% RTP and on December 13-14, 1991, at 78% RTP.

(2) TT/1/A/9200/290 (Approved December 5, 1991), McGuire 1 Cycle 8 Incore and Nuclear Instrumentation System Recalibration, was performed on December 18 - 19, 1991. One full-core flux map and eight quarter-core flux maps were obtained over a range of incore axial offset from -8.5% to + 4.7%. The power level for all maps was greater than 99% RTP. Correlation coefficients for the full-power current versus axial offset were greater than 0.99 for each ion chamber.

(3) TT/1/A/9200/292 (Approved December 5, 1991), McGuire 1 Cycle 8 Incore and Nuclear Instrumentation Systems Correlation Check, was performed on December 14th at 77% RTP, on December 18th at 100% RTP, and on January 19, 1992, at 97% RTP. Acceptance criteria were satisfied in all cases, and no further measurement of instrument correlations was required on those dates.

(4) TT/1/A/9200/289 (Approved December 11, 1991), McGuire 1 Cycle 8 Core Power Distribution, was performed on December 12th at 39% RTP, on December 14th at 78% RTP, and on December 18th at 100% RTP. In all cases, F_Q and F_{dH} were satisfactory for the power level at which they were measured and for the next planned power plateau.

(5) PT/0/A/4150/08 (Approved April 24, 1991), Target Flux Difference Calculation, was completed acceptably, at 100% [illegible] on December 31, 1991.

(6) PT/0/A/4150/03 (Approved June 24, 1991), Thermal Power Output Measurement, was performed on December 14, 1991, at 89% RTP. Off-line and OAC calculations of thermal power agreed within 0.01% RTP. Control board gauges and computer points were shown to be in acceptable agreement.

(7) PT/0/A/4150/04 (Approved July 10, 1991), Reactivity Anomalies Calculation, was first performed for cycle 8, at 100% RTP, on December 18, 1991, at 5.4 EFPD burnup. After adjustment for the difference in predicted and measured ARO C_B, the anomaly was -17.3 pcm.

No violations or deviations were identified.

3. Unit 1 and Unit 2, Cycle 8, Operating Experience (61705)

Unit 1 is currently held to 97% RTP because two loops have OPdT alarms spiking simultaneously at 100% RTP. The unit does have an incore QPTR of 1.5% and hotleg flow is being traded between two loops, as has been observed at other four-loop units. Flow trading is confirmed by cold leg RTDs and steam generator output, but differences in response of hot leg streaming and RTD time constants lead to an apparent in-phase change of $T_{HOT}S$ rather than the actual out-of-phase change. Hence there are simultaneous rather than alternating alarms. This variation in the measured average hotleg temperature had been termed process noise.

Subsequent to the first phase of this inspection, Unit 2 started up for operating cycle 8. Although core designs are virtually identical, particularly with respect to low-leakage characteristics, the unit can operate at 100% RTP. Unit 2 exhibits similar flow trading characteristics, but does not have a significant incore QPTR, which may be the reason its process noise is less limiting.

A meeting was held on April 6, 1992, with those persons identified in paragraph 1 above, to discuss the process noise issue and proposed solutions to it.

The licensee and its vendor have identified and analyzed a method to reduce process noise in hotleg temperature measurements by weighting the RTD inputs to the T_{HOT} measurements. No inspector concerns were identified during the discussions, but the issue will be subject to further inspection when the licensee's safety analysis is available for review. Currently, the licensee intends to implement the change in late April 1992 following the review required by 10 CFR 50.59. The change involves changing resistors on a card, but will be treated as a procedure change rather than a modification. The circuitry is not described to this detail in the FSAR.

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One significant conclusion made by the licensee and vendor is that all of the streaming and process noise effects are external to and above the core; they do not represent a thermal limits problem. Another conclusion was that there was no evidence of increased core barrel movement.

Following the change in temperature averaging, the licensee will continue to monitor process noise and hotleg streaming effects on a regular, about monthly, basis.

Inspection activities will continue in this subject area.

4. Exit Interview

The inspection scope and findings were summarized on February 27, 1992, with those persons indicated in paragraph 1 above. The inspector described the areas inspected and discussed in detail the inspection findings. No dissenting comments were received from the licensee. Proprietary material was reviewed in the course of this inspection, but is not included in this report. The following items were identified to the licensee:

- IFI 50-369 and 50-370/92-07-01: Assure procedural controls are adequate to prevent over dilution of the VCT (paragraph 2.a).
- IFI 50-369 and 50-370/92-07-02: Determine appropriate acceptance criteria for control rod worth measurements consistent with SDM calculations (paragraph 2.c).

5. Acronyms and Initialisms

ARO	All Rods Out
C_B	Boron Concentration
DTC	Doppler Temperature Coefficient
F_{dH}	Nuclear Enthalpy Hot Channel Factor
F_Q	Nuclear Heat Flux Hot Channel Factor
EFPD	Effective Full Power Days
FSAR	Final Safety Analysis Report
IFI	Inspector Followup Item
ITC	Isothermal Temperature Coefficient
MTC	Moderator Temperature Coefficient
NC	Nuclear Coolant
OAC	Operator Assist Computer
OPdT	Overpower Differential Temperature
pcm	Percent Millirho
PDIL	Power Dependent Insertion Limits to Assure SDM
ppmB	Parts Per Million Boron
PRA	Probabilistic Risk Assessment
PT	Periodic Test
RTD	Resistance Temperature Device
RTP	Rated Thermal Power
SDM	Shutdown Margin
STS	Standard Technical Specification
T_{HOT}	Average Measured Hotleg Temperature
TT	Temporary Test
TS	Technical Specification
VCT	Volume Control Tank