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

Report Nos.: 50-269/89-39, 50-270/89-39, and 50-287/89-39

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

Docket Nos.: 50-269, 50-270, and 50-287   License Nos.: DPR-38, DPR-47, and DPR-55

Facility Name: Oconee 1, 2, and 3

Inspection Conducted: December 12-15 and 18-20, 1989

Inspector: P. T. Burnett   2-22-90 Date Signed

Approved by: G. A. Belisle, Chief For   2-22-90 Date Signed
Test Programs Section
Engineering Branch
Division of Reactor Safety

SUMMARY

Scope

This routine, unannounced inspection addressed the areas of post-refueling startup tests of Unit 3 and core performance surveillances on Units 1 and 2.

Results

The proposed startup sequence allowed criticality prior to performing control rod drop time measurements. The licensee responded promptly and professionally to the inspector's expressed concerns over the safety and propriety of that sequence. First the licensee changed the procedure for the current startup to require drop time testing prior to criticality. At the end of the inspection, the station manager confirmed a commitment to perform all future testing in the hot standby condition. (Paragraph 2.a)

During the startup of Unit 3, an intermediate range neutron detector (paragraph 2.b) and a power range neutron detector (paragraph 2.c) were found to be failed. At the end of the inspection, the licensee had not completed the investigation of these unusual failures.

The routine surveillance tests reviewed had been performed with acceptable frequencies and results.

No violations or deviations were identified.

REPORT DETAILS

1. Persons Contacted

   Licensee Employees

   *H. Barron, Station Manager
   E. Burchfield, Licensing Engineer (by telephone only)
   T. Curtis, Compliance Manager
   *D. Davidson, Production Specialist
   *J. Davis, Technical Services Manager
   *P. Gillespie, Associate Engineer, Performance
   *M. Hone, Nuclear Production Engineer
   D. Hubbard, Performance Manager
   E. LeGette, Assistant Engineer, Compliance
   G. Lareau, Reactor Engineer
   *R. Sweigart, Operations Superintendent
   M. Tuckman, Station Manager

   Other licensee employees contacted included engineers, operators, and office personnel.

   Other Organizations

   NRC Resident Inspectors

   P. H. Skinner, Senior Resident Inspector
   *L. D. Wert, Resident Inspector

   *Attended exit interview on December 20, 1989.

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

2. Unit 3 Post-Refueling Startup Tests (72700)

   a. Pre-Critical Activities

      The Startup Physics Test Program is described in FSAR Chapter 14.5, and is applicable to reload cores. Within the program, control rod drop time tests, required by TS 4.7.1c, are performed in the pre-critical test phase.

      In an intrastation letter issued on January 26, 1982, the licensee documented a review of the FSAR and the TS to establish what commitments, if any, required that post-refueling rod drop time tests be performed prior to criticality. No commitments or requirements were identified, but it was noted that standard TS for BAW reactors required that rod drop time testing be performed prior to reactor criticality after refueling.

On April 20, 1982, the licensee completed a safety evaluation (10CFR50.59 review) of a change in TT/2/A/711/06, Oconee 2, Cycle 6 Zero Power Physics Test. The essence of the change was that rod drop time testing was removed as a prerequisite for criticality. The procedure sequence was changed so that RCS boron concentration was established at or slightly above the predicted ARO critical concentration prior to any control rod withdrawal. The withdrawal of the control rods was then treated as the initial approach to criticality, and inverse multiplication measurements were made and extrapolations to criticality performed as the control rods were withdrawn in prescribed increments. Once criticality was established with ARO, the rods were dropped and the insertion time to 75% insertion measured and evaluated in accordance with TS 4.7.1c. The procedure, in section 9.0, further required that the reactor not enter the power mode (operate at or above 2% RTP) until control rod drop time testing had been completed with satisfactory results.

This sequence has been the station practice since that time, and is reflected in TT/3/A/0711/12, Unit 3 Cycle 12 Zero Power Physics Test (ZPPT). The change in procedure was not reflected in the May 1986 update of the FSAR.

Accidents initiating from less than power operation conditions are described in the FSAR, but none specifically list control rod drop time as a parameter in the accident analysis. That may be simply a lack of sufficient detail in the description of the analysis. Some, such as continuous rod withdrawal from a subcritical condition, clearly require rod action to terminate the event, although the power excursion is turned and limited by the doppler effect in the U-238 in the fuel.

Under other procedures, some rod performance tests are performed prior to beginning the ZPPT. Those tests include full-stroke withdrawal and insertion of each rod using the normal drive function and scramming each rod from ten percent withdrawn.

The inspector questioned this deviation from the standard industry practice of testing systems prior to entering into a condition in which the system might be needed. There is no physical restraint to performing control rod scram time tests with a highly borated RCS in which both shutdown margin and the hot shutdown condition (1%dk/k subcriticality) are maintained. Furthermore, 10CFR50.36(c)(3) defines surveillance requirements as those activities necessary to assure that facility operation <u>will</u> be within safety limits.

In response to the inspector's concerns, and pending their reevaluation of their position, the licensee agreed to change procedure TT/3/A/0711/012 so that control rod drop time testing would be completed in the hot shutdown condition prior to the initial criticality for Unit 3, cycle 12. The inspector witnessed the drop time testing activities in the control room. The revised procedure was performed without difficulty, and acceptable results were obtained for each control rod.

At the exit interview, the licensee was not prepared to extend their commitment. However, before the inspector left the site, the station manager did make a commitment to perform control rod drop time testing in the hot shutdown condition, before initial criticality, for future operating cycles of all Oconee units.

b. Initial Criticality of Unit 3 for Cycle 12

The inspector witnessed the Unit 3, cycle 12 initial criticality from the control room. The approach began with all controls rods in and an RCS C_B of 1667 ppmB. Inverse multiplication measurements were made as the control rod groups were withdrawn in procedure-specified increments. The measured inverse multiplications were plotted against the reactivity inserted by the rod groups rather than rod position, as is done at most facilities using rod movement rather than dilution for the approach to criticality. The reactivity insertions were obtained from calculations performed specifically for the approach to criticality. This extra analytical effort appeared to payoff in curves that were easier to interpret and extrapolate to criticality than those based upon rod position.

At ARO, the reactor was slightly supercritical. A boron end point determination was made and the ARO critical C_B was determined to be 1669 ppmB, which was in good agreement with the predicted value of 1661 ppmB.

During measurements of overlap between the SRNIs and the IRNIs, it was discovered that one (NI-4) of two channels of IRNIs was inoperative. However, that was permitted by the TS, and testing continued. Acceptable overlap, more than one decade, was confirmed between the operative IRNI and the SRNIs.

c. Checkout of Reactivity Computers

A program was installed on the OAC, which permitted its use as a reactivity computer. The time-varying flux signal was obtained from the working IRNI. The reactivity computer was checked out by comparing its solutions with those obtained by measuring the reactor period with a stop watch and solving the inhour equation. The agreements for positive reactivity inputs of 500 and 1200 microrho were good, within 1 to 4%. For negative reactivity inputs of the same magnitudes, initial agreements were poor, of the order of 10%. These measurements were repeated and acceptable agreement, within 4%, was obtained by waiting longer before starting the period measurement.

Similar performance has been observed at other facilities using digital reactivity computers. The computers are able to solve the for negative perturbation immediately, but the manual measurement must wait longer for the dominant decay group to become the predominant driver of the flux meter or chart recorder, from which the timing measurements are made. This is just another example of the superiority of computer over manual solutions.

The licensee attempted to checkout and place into service a PC-based digital reactivity computer, which took its flux signal from one of the power range channels. This was unsuccessful; since the input was found to be too noisy to use. This problem has been observed at other facilities when the standard ion chamber power supply was used. The corrective action was to install a low-noise power supply to compensate for using the PRNI at a flux level orders of magnitude below its usual application. In some cases, it also has been necessary to install a precision electrometer in place of the normal current measuring instrumentation.

During power escalation, it was found that one of the PRNIs was inoperative, but it was not the one connected to the PC-based reactivity computer.

d. Temperature Coefficient Measurements (61708)

The ITC was measured twice. During a heatup of 6.7°F a coefficient of +0.027E-04 dk/k/°F was obtained. The coefficient for a 9.1°F cooldown was -0.048E-04 dk/k/°F. The licensee had no acceptance criterion for agreement among the ITC measurements, but the typical industry criterion of agreement within a span of 0.10E-04 dk/k/°F was satisfied. Both results were corrected to 532°F, and a temperature-span weighted average of -0.016E-04 dk/k/°F was calculated for the ITC. After correcting for a calculated DTC of -0.168E-04 dk/k/°F, a MTC of +0.146E-04 dk/k/°F was obtained. This result was in tolerable agreement with the predicted value of +0.033E-04 dk/k/°F and well below the TS 3.1.7 limit of 0.90E-04 dk/k/°F.

e. Control Worth Measurements (61710)

Control rod worths of rod groups 7, 6, and 5 were measured in succession during boron dilution with reactivity changes measured using the OAC reactivity computer. The inspector witnessed part of this activity and independently analyzed the reactivity computer traces for group 7. The inspector's results were essentially identical to the licensee's. A plot of the resultant differential worth curve is given in Attachment 1. Because the typical reactivity increment of about 4.0E-04 dk/k was about double that commonly used in such measurements, there is no fine structure in the curve. Fine structure, the resolution of the intermediate grids in the fuel bundles is not an acceptance criterion for the test. However, resolving the grids also confirms that the rods in the group under test are moving uniformly.

Each individual rod group worth as well as the sum of the worths was within 10% of the predicted value, which satisfied the acceptance criterion for each.

From the change in boron concentration during the rod worth measurements, the licensee determined the differential boron worth to be -0.00867 dk/k/100ppmB. This result was in good agreement with the predicted value of -0.00836 dk/k/100ppmB.

As performed, the ZPPT conformed to the startup test program described in the FSAR and in ANSI/ANS-19.6.1-1985, Reload Startup Physics Tests for Pressurized Water Reactors.

f. Other Documents Reviewed

The following documents were reviewed to confirm the acceptance criteria used in the tests discussed above or to apply during power escalation testing:

(1) Oconee 3, Cycle 12, Core Operating Limits Report,

(2) Oconee 3, Cycle 12, Physics Test Manual, and

(3) TT/3/A/0811/12, Unit 3, Cycle 12, Power Escalation Test.

No violations or deviations were identified.

3. Surveillance of Core Power Distribution Limits and Nuclear Instruments (61702, 61705)

Completed copies of PT/0/A/0800/30, Weekly Core Power Distribution Comparison, were reviewed for the current cycles of Units 1 and 2 for the period from June to November 1989. The frequency requirements of TS 4.1.5 as well as limits on peaking factors, DNBR, and LHR were satisfied in all cases.

PT/1 or 2/A/600/001, Periodic Instrument Surveillance, documents adherence to reactor power imbalance and quadrant power tilt ratio limits with two-hour frequency. One month of records, for both Units 1 and 2, were reviewed for the current cycles. Test frequencies and results were acceptable in all cases.

Other procedures in this subject area that were reviewed for content and found acceptable included:

a. PT/0/A/0302/04, Backup Incore Detector System Operability Verification, and

b. PT/0/B/0302/06, Review and Control of Incore Instrumentation Signals.

No violations or deviations were identified.

4. Core Thermal Power Evaluation (61706)

The following procedures related to core thermal power calculations were reviewed:

a. PT/0/A/0205/02, Thermal Power Calculation, is performed only when the Reactor Calculation Package is not running on the OAC. The procedure describes an acceptable method of performing the calculation, but there were no examples of it being performed during the period reviewed.

b. PT/0/A/0275/03, Calculation of Reactor Coolant Flow and Delta-T Power Constants, is used with the computer program CONST to determine RCS flow constants. It was last performed, for Unit 1, on March 9-16, 1989. No questions arose from review of the completed procedure.

c. PT/0/A/0205/01, Weekly Reactor Coolant Flow Data, was performed with acceptable frequency and results for both Unit 1 and Unit 2 in the three-month periods selected for review.

d. PT/0/A/0205/04, Determination of Feedwater Venturi Fouling Coefficient, is based upon simultaneous solutions of the primary and secondary side heat balances with primary side flow fixed at the rate determined by the precision heat balance at the start of the cycle. Since the primary flow was obtained at the start of the cycle from the precision heat balance and the flow coefficients for clean secondary side flow venturis, the later determination of venturi fouling appears to include some circular reasoning. The inspector asked the licensee to justify the propagation of error in recalibrating the secondary side flow venturis and to demonstrate that thermal power measurement uncertainties did not exceed those assumed in the FSAR.

Although there was no document reference number the licensee had prepared a 21 page typed evaluation of the propagation of error and uncertainty analysis for the fouling adjustment process In addition there were two pages of references and supporting tables of data. The package will be reviewed further in the regional office and documented in a later inspection report.

No violations or deviations were identified.

5. Shutdown Margin and Reactivity Anomaly (61707)

a. PT/1,2,3/A/1103/15, Reactivity Balance Procedure (Unit 1,2,3), is used whenever adequate SDM, reactivity status, or specific operating condition must be confirmed. In some applications the procedure confuses or blurs the distinctions between SDM and the hot or cold shutdown condition. SDM must be maintained in all operating conditions, including those in which the reactor may be critical. In the shutdown conditions, the reactor must be subcritical by at least 1%dk/k. Confirming subcriticality does not necessarily confirm an adequate SDM; since the SDM requirement is that reactor must be subcritical by 1%dk/k, with the highest worth control rod stuck out. The converse is also true. Review of a few completed procedures did not reveal an instance in which both SDM and subcriticality requirements were not satisfied. However, the procedure does not convincingly protect against such an occurrence.

b. PT/0/A/0800/03, All Rods Out Boron Comparison at Power, is performed every 10 ± 5 EFPD to satisfy TS 4.10, which requires that measured and predicted core excess reactivity agree within 1%dk/k. Completed procedures for both Units 1 and 2 were reviewed for the current operating cycles. In all cases, both the frequency of measurement and the measurement results were acceptable.

No violations or deviations were identified.

6. Exit Interview (30703)

The inspection scope and findings were summarized on December 20, 1989, 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. The inspector expressed concern that two nuclear instruments were found to be failed during the Unit 3 startup (paragraphs 2.b and 2.c). Licensee management echoed the concern and stated that the causes would be reviewed thoroughly. Proprietary information was reviewed in the course of this inspection, but is not included in this report.

7. Acronyms and Initialisms Used throughout This Report

ANS - American Nuclear Society
ANSI - American National Standards Institute
ARO - all rods out
BAW - Babcock and Wilcox Company
C_B - boron concentration in the RCS
CFR - Code of Federal Regulations
Delta-T- differential temperature or temperature change
dk/k - reactivity unit (rho)
DNBR - departure from nucleate boiling ratio
DTC - doppler temperature coefficient
E- - negative power of ten
EFPD - effective full power days

FSAR -	Final Safety Analysis Report
IRNI -	intermediate range nuclear instrument
ITC -	isothermal temperature coefficient
LHR	linear heat rate
MTC -	moderator temperature coefficient
NI -	nuclear instrument
OAC	operator aid computer
ppmB	parts per million boron
PRNI	power range nuclear instrument
PT	periodic test
RCS	reactor coolant system
RTP	rated thermal power
SDM	shutdown margin
SRNI	source range nuclear instrument
TS	Technical Specifications
TT	temporary test
ZPPT	zero power physics tests

Attachment:
Differential Worth
Curve

Attachment 1