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

Report Nos.: 50-400/92-29

Licensee: Carolina Power and Light Company
P. O. Box 1551
Raleigh, NC 27602

Docket Nos.: 50-400 License Nos.: NPF-63

Facility Name: Harris 1

Inspection Conducted: December 28 - 31, 1992

Inspector: Paul A. Burnett, Reactor Engineer 1-22-93 Date Signed

Approved by: Richard V. Crlenjak, Chief 1/22/93 Date Signed
Operational Programs Section
Operations Branch
Division of Reactor Safety

SUMMARY

Scope:

This routine, unannounced inspection was conducted in the areas of review of completed startup tests for operational cycle 5 and review of core performance surveillance tests performed during cycle 4.

Results:

Test methodology used in the graphical solutions of isothermal temperature coefficient at low power and in control rod reactivity determination was found to require improvement to obtain better resolution of the measured values (paragraph 2.d). Startup program strengths included prepared and thorough pretest briefings, careful and thorough annotation of chart records created during the tests, and statistical testing of source range instrumentation to confirm operability (paragraph 2.d).

Required core performance surveillance tests had been performed with acceptable periodicity and results throughout operating cycle 4 (paragraph 3).

One inspector followup item related to test method for the at-power determination of moderator temperature coefficient was closed in response to acceptable corrective action and performance by the licensee (paragraph 4).

No violations or deviations were identified.

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REPORT DETAILS

1. Persons Contacted

   Licensee Employees

   *J. M. Collins, Manager, Operations
   *R. J. Duncan, Manager, Reactor and Performance Engineering
   *J. F. Nevill, Manager, Technical Support
   *C. S. Olexik, Manager Regulatory Compliance
   *W. R. Ponder, Reactor Engineer
   *J. H. Westmoreland, Reactor Engineer
   *G. E. Vaughn, Vice President, Harris Nuclear Project
   *M. A. Verrilli, Regulatory Compliance Specialist

   Other licensee employees contacted during this inspection included engineers, security force members, and administrative personnel.

   NRC Resident Inspectors

   J. Tedrow
   M. Shannon

   *Attended exit interview on December 31, 1992.

2. Review of Cycle 5 Startup Tests (72700, 61708, 61710)

   a. Reference Documents

      In support of the inspection of the startup test program, the following reference documents were reviewed:

      (1) WCAP-13428, The Nuclear Design and Operations Package for Shearon Harris Nuclear Plant, Cycle 5, was the source for the predicted values (results) of the tests discussed in this report.

      (2) PLP-626 (Revision 1), Power Ascension Testing Program after a Refueling Outage, described, scheduled and controlled the testing and power ascension program. At the time of this inspection, tests related to RCS ΔT scaling and full flow ΔP scaling had not been signed off as completed. Discussions with licensee personnel confirmed that the data had been collected, and the scaling factors calculated and installed. Only administrative actions were required to close the procedure.

      (3) Cycle 5 Core Operating Limits Report (Revision 0) provides the cycle-specific parameter limits for those TS, which have cycle dependencies. It too was a source for acceptance criteria for the tests discussed below.

b. Pre-Critical Tests

(1) EPT-008 (Revision 5), Intermediate and Power Range Detector Setpoint Determination, was completed on November 6, 1992. From the end of cycle 4 to the beginning of cycle 5 leakage flux to the PRNI was estimated to have been reduced by a factor of 0.726. The flux reduction factor for the IRNI was 0.884.

(2) EST-704 (Revision 6), Shutdown and Control Rod Drop Test, was completed on November 27, 1992. RCS temperature was maintained above 551 °F and pressure was maintained between 2000 and 2250 psig. All three RCP were in operation. Drop times from the release of the stationary gripper coil to dashpot entry ranged from 1.39 to 1.63 seconds and averaged 1.54 seconds. All times were well below the TS 3.1.3.4 upper limit of 2.7 seconds.

(3) EPT-070 (Revision 2), Reactivity Computer Initial Setup and Calibration, was performed on November 25-27, 1992. Portions of the procedure were repeated daily during low power testing. The flux signal input to the computer was from PRNI channel N-41, which was taken out of service for this purpose. Channel restoration was completed on December 1, 1992, at the end of low power testing.

c. Initial Criticality

EPT-069 (Revision 3), Initial Criticality, was performed and completed on November 29, 1992. Initial steps of the procedure established the boron sampling frequency for the RCS and pressurizer (15 and 30 minutes respectively), started prescribed computer trend blocks, and established strip chart labelling requirements. Statistical reliability tests were performed for both channels of SRNI, and the inspector independently verified that those tests were acceptable. Initial countrates were on the order of 100 cps for each channel, with all control rods inserted and C_B equal to 2434 ppm.

Shutdown banks were withdrawn in C-A-B order. ICRR was measured and plotted at 50, 100, 150, and 228 steps withdrawn for banks A and B. At the end of this sequence, ICRR had decreased to 0.95 for each SRNI.

The control banks were withdrawn in overlap, with ICRR measured and plotted every 50 steps, until D bank was 200 steps withdrawn. At the end of this sequence, ICRR had decreased to 0.70 and 0.71 for the two SRNI.

Prior to beginning dilution, new baseline countrates were established for each SRNI and the ICRR renormalized to 1.0. The procedure did not require another statistical reliability test, but the data were available from the determination of the new baseline countrates. The inspector performed an independent statistical reliability test. The test result for N-31 was on the limit of acceptability. The test result for N-32 was acceptable without qualification.

A dilution rate of 43 gpm was established and ICRR was measured every 15 minutes and plotted against the parameters of elapsed time, water added, and measured RCS C_B. Continuous dilution was stopped with ICRR at 0.10 and 0.12. Following an addition of 10 gallons of water and mixing of the RCS, criticality was obtained with C_B at 1906 ppm and D bank at 171 steps. At criticality, the reactor was operating in the source range, below P-6, with the IRNI on scale. The IRNI were then shown to overlap the SRNI by 1.25 decades. The records support a conclusion that initial criticality for cycle 5 was attained in a well-controlled, deliberate and safe manner.
Other steps of the procedure addressed determining the point of adding heat; the upper flux limit for low power testing was established below that point. The low flux limit assured that fuel doppler temperature effects would not invalidate the reactivity measurements to be made at low power. Finally the reactivity computer was checked against stopwatch period measurements over a range of -52 to +76 pcm. Agreement within ±4% at each observed reactivity was obtained.

d. Low Power Tests

The inspector reviewed the following completed test procedures, all of which were performed below the point of adding heat:

(1) EPT-067 (Revision 3), Boron Endpoint Measurement - All Rods Out, was completed on November 30, 1992. The measured CBC at ARO was 1946 ppm, which was in acceptable agreement of the predicted CBC of 1952 ± 62 ppm (62 ppm ≈ 440 pcm).

(2) EST-703 (Revision 5), Moderator Temperature Coefficient Measurement BOL after Each Refueling, was completed on November 30, 1992. The ITC was measured from the slope of the trace on an X-Y recorder for which the inputs were temperature and reactivity respectively. Separate measurements were obtained for both a 2.85 °F cooldown and a compensating heatup. The corresponding ITCs were +0.89 pcm/°F and +1.45 pcm/°F. The average ITC was corrected for a DTC of -1.86 pcm/°F resulting in a MTC of +3.03 pcm/°F, which is less positive than the TS 3.1.1.1.3 limit of +5.0 pcm/°F.

Although the numerical result is acceptable, the inspector is concerned with the quality of the measurement. The procedure requires temperature changes of 2-4 °F; the pretest briefing document mentions that 4°F is preferred. Past Westinghouse guidance has been that a 4°F minimum temperature change is required. The smaller change in temperature used makes determining the slope of the reactivity-temperature relationship more difficult. The temperature scaling was 0.5°F/cm on a 38 cm chart span, which could have easily accommodated a 10 cm span for a 5 °F temperature change. The reactivity scaling was 4 pcm/cm, with 25 cm total span available on the chart. The expected ITC was +1.43 pcm/°F. With the limited temperature change, less than 1 cm of axial displacement was used to determine the slope. With 1 pcm/cm scaling and a 5 °F change in temperature, only about 7 cm of the 25 available would have been used, but the resolution of the slope would have been much improved.

With both measured and predicted values of MTC approaching the TS 3.1.1.3 limit, reasonable effort to maximize the resolution of the measurement is expected.

(3) EPT-068 (Revision 4), Reactivity Worth of the Control and Shutdown Banks Utilizing the Rod Swap Technique, was completed on December 1, 1992. The first phase of this procedure performed the measurement of the differential and integral reactivity worth of the reference control rod bank, which is the expected highest worth bank in the core. Control bank B was identified as the reference bank. The reference bank worth was measured from the fully withdrawn position during dilution of the boron in the RCS. Typically, once dilution had increased core reactivity to ≈ +25 pcm, the reference bank would be inserted in a continuous motion until core reactivity was ≈ -25 pcm. The actual reactivity change was determined by analysis of the reactivity trace from the reactivity computer.

The measured and predicted worths of all rod banks are summarized in the table below.

Rod Bank Reactivity Worths

	Integral	Reactivity	(pcm)
Bank	Measured	Predicted	Difference(%)
Control B	1352	1312	+3.0
Shutdown C	354	314	+12.7
Control A	395	382	+3.5
Control C	914	806	+13.4
Shutdown B	999	879	+13.7
Shutdown A	954	993	-3.9
Control D	1282	1203	+6.6

The acceptance criterion for agreement between predicted and measured control rod worths was ±10% for the reference bank and the sum of all rod bank worths. For the balance of the control rod banks the acceptance criterion for agreement was the larger of ±15% or ±100 pcm. All acceptance criteria were satisfied.

Only about 20% of the available span of the reactivity computer chart recorder was used in these measurements. Null reactivity was spanned at 30% of scale vice 50% (mid scale), for no apparent reason. Reactivity was scaled at 20 pcm/cm, when 5 pcm/cm could have been easily accommodated and would have improved the resolution

of the reactivity increment four-fold. The small physical span of the reactivity change made resolution difficult. During an independent evaluation of the reactivity computer traces, the inspector noted differences as large as 5 pcm per increment between his values and those recorded by the licensee. Usually the agreement is within a fraction of a pcm.

The boron endpoint for the reference bank inserted was 1780 ppm, which was in good agreement with the predicted concentration of 1778 ppm. The change in CBC from the reference bank fully withdrawn to fully inserted was 168.4 ppm. This change and the measured worth of the reference bank were used to obtain a DBW of -8.02 pcm/ppm.

The inspector's observations on test methodology were discussed in detail with reactor engineering personnel prior to the exit interview. All agreed that their test method needed to be improved and could be improved to obtain better resolution of the ITC and reactivity change during control rod bank worth determinations. They also agreed that it was feasible and practical to compare measured and predicted DBW.

Several positive aspects of the licensee's test program were noted:

- Pre-job briefings were conducted before each test in accordance with a prepared checklist and briefing document.
- Charts were carefully and thoroughly annotated.
- Chi-squared tests to confirm operability of the SRNI were performed before the rod drop time test and before the initial criticality test.

e. Tests During Power Escalation

The following tests, completed during power escalation, were reviewed by the inspector:

(1) EST-711 (Revision 0), Incore/Excore Detector Calibration by the One Point Method, was completed at 74.5% RTP, on December 7, 1992.

(2) Power distribution monitoring was accomplished by the sequential performance of the two procedures listed below:

- FMP-101 (Revision 6), Incore Thermocouple and Flux Mapping.
- EST-710 (Revision 8), Hot Channel Factors Tests.

During power escalation, these procedures were performed at power levels of 28.5, 74.5, and 99.5 percent of RTP, over the period of December 3 - 7, 1992. Measured values of $F_Q(z)$ and $F_{\Delta H}$ were accept-

able in all cases and satisfied TS 3.2.2 and TS 3.2.3.b, respectively. In addition, the incore QPTR indicated a uniform power distribution.

3. Cycle 4 Core Performance Surveillances

The following surveillance procedures completed during the previous operating cycle were reviewed for frequency of performance and adequacy of results:

a. EST-710 (Revision 8), Hot Channel Factors Tests.

b. EST-711 (Revision 0), Incore/Excore Detector Calibration by the One Point Method.

c. EST-700 (Revision 5), Core Reactivity Balance.

All of the above tests were completed with the required periodicity and results throughout the previous operating cycle.

d. EST-720 (Revision 3), Normalization of Boron Letdown Curve, was completed on July 19,1991, at 49 EFPD. A normalization of the original letdown curve was not required.

4. Followup of Open Items (92701)

(Closed) IFI 50-400/89-18-01: When the MTC at EOL is measured by the boron change technique, it will be measured during both boration and deboration. Furthermore, the acceptance criterion will be that the two measurements agree within 10% of the mean.

Procedure EST-702, Moderator Temperature Coefficient - EOL Using the Boron Change Method, was revised (Revision 5) on November 10, 1989, in response to this item. The procedure was revised again on June 9, 1992 (Revision 6). The inspector reviewed a completed copy of the later issue, which was performed on June 11, 1992. The MTC was measured during both dilution and boration, and the results of the two measurements agreed within 10% of the mean. The mean MTC was less negative than the surveillance limit of the COLR and the limit imposed by TS 3.1.1.3. This item is closed.

5. Exit Interview

The inspection scope and results were summarized on December 31, 1992, with those persons indicated in paragraph 1. The inspector described the areas inspected and discussed in detail the inspection results. Dissenting comments were not received from the licensee. Proprietary information was reviewed in the course of this inspection, but is not contained in this report.

No violations or deviations were identified. IFI 50-400/89-18-01 was closed.

6. Acronyms and Initialisms Used Throughout This Report

ARO	all rods out
BOL	beginning of life
C_B	boron concentration in the RCS
CBC	critical boron concentration in the RCS
DTC	doppler temperature coefficient
F_{dH}	nuclear enthalpy rise hot channel factor
F_Q	heat flux hot channel factor
EFPD	effective full power days
EOL	end of life
EPT	engineering performance test
EST	engineering surveillance test
ICRR	inverse countrate ratio
IFI	inspector followup item
IRNI	intermediate range nuclear instrument(s)
ITC	isothermal temperature coefficient
MTC	moderator temperature coefficient
N	nuclear instrument number
OST	operations surveillance test
pcm	percent millirho, a unit of reactivity
PLP	plant program
ppmB	parts per million boron
PRNI	power range nuclear instrument(s)
RCP	reactor coolant pump(s)
RCS	reactor coolant system
RTP	rated thermal power
SDM	shutdown margin
SRNI	source range nuclear instrument(s)
TS	Technical Specification(s)