ENCLOSURE

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNIT 2

CYCLE 10 POWER ASCENSION TEST PROGRAM (PATP)
START-UP REPORT

(SEE ATTACHED)

FINAL REFUELING TEST REPORT

Unit 2 Cycle 10

Dates Performed: 09-29-97 through 11-05-97

Deficiencies: There was 1 Test Deficiency associated with FSAR acceptance criteria. The test deficiency is discussed in the Test Results section for 0-TI-299 and in Appendix one.

Remarks: This report will be submitted to the NRC per the requirements of TS 6.9.1.1, Startup Report, due to the installation of fuel that has a different design. This cycle is the first reload, (216 bundles), of GE13 fuel assemblies. This report addresses only those tests described in FSAR chapter 13.10 Refueling Test Program. Test results indicate that BFN Unit 2 systems are capable of meeting their design functions and that power operation can be safely and efficiently continued.

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INTRODUCTION

During the Unit 2 Cycle 9 outage 216 fresh fuel assemblies were loaded into the core. This is the first use of the GE 13 fuel design at BFN. Twelve control rod blades were replaced. This is the first use of General Electric's Marathon control rod blade at BFN. No control rod drives or local power range monitors were replaced. Major modifications completed during the outage include: (1) Installation of Power Range Neutron Monitoring by DCN W40116. (2) Modification of the Main Steam Relief Valve opening logic by DCN T40231. The signal opening the valves will come from the existing Anticipated Transient Without Scram pressure sensors. The setpoints for valve opening will remain 1105,1115, and 1125 psig. (3) Modification of the Reactor Feedpump discharge check valves by DCN T39698. Due to past experience with the valves not closing during reactor feedpump trips, this modification will route air to the actuator to provide more force to "bump" the valve in the closed direction. (4) Modification of the Feedwater Heater isolation logic by DCN T39744. The feedwater and /or condensate valves will not isolate on high level in the heaters. Instead the extraction steam will isolate and the moisture separator pumps will trip and their suction valves will close which will stop flow to the high pressure heaters experiencing a high level.

POWER HISTORY

Open Vessel Testing, Phase I

- In core shuffling was performed per 0-GOI-100-3C, Fuel Movement Operations During Refueling. Core shuffling started on September 29, 1997, with the first fuel move of 1202 planned in core steps being performed. The shuffle was completed on October 12, 1997.
- The Open Vessel portions of 2-TI-299, Control Rod Drive Testing were performed from October 13 to October 17, 1997.
- The Open Vessel portion of 2-TI-135, Process Computer and Core Performance was performed on October 14, 1997.

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Heatup to 55% Power Testing, Phase II

- Following completion of all prerequisites, control rod withdrawal for plant startup commenced at 08:47 on October 18, 1997. Initial criticality was achieved at 12:01 on October 18, and the verification of core shutdown margin was performed per 2-SI-4.3.A.1, Reactivity Margin Test.

- APRM calibration per 2-TI-136 APRM Calibration was completed at 14:30 on October 18, 1997. No APRM adjustment was required.

- Plant heatup to rated conditions continued. Rated temperature and pressure was reached at 17:41 on October 18, 1997.

- APRM calibration per 2-TI-136 was completed at 19:15 on October 18, 1997, No APRM adjustment was required.

- The reactor mode switch was taken to RUN at 19:45 on October 18, 1997.

- Testing per 0-TI-135, Process Computer and Core Performance began at 21:20 on October 18, 1997, and was completed satisfactorily for this test plateau at 03:58 on October 19.

- The main turbine generator was connected to the grid at 02:18 on October 19, 1997.

- Control rod scram time testing 2-TI-299 Control Rod Drive System Testing After Refueling began at 08:31 on October 19, 1997, at 35% reactor power. Scram time testing was completed at 15:07 on October 20. LPRM hook up verification was completed in conjunction with scram time testing.

- Starting at 16:00 on October 20, 1997, reactor power was increased to 48% core thermal power for performance of TIP calibrations.

55% to 100% Power Testing, Phase III

- Starting at 06:05 On October 21, 1997, reactor power was increased to 68.5%, 2-TI-131 Feedwater System Testing was completed at 14:30 on October 21.

- Starting at 17:10 on October 21, 1997, reactor power was increased. At 20:37 on October 21 83% power was reached. Power was held at 83% for feedwater heater work until 06:08 on October 22, 1997. At that time power increase at the rate of 30MWe/hr was initiated.
- At 15:55 on October 22, 1997, reactor power reached 96.3% of rated with 100% core flow. A 12 hour fuel preconditioning soak was begun.
- During the 12 hour soak period 0-TI-137, Core Power Distribution was performed, this section was completed at 01:25 on October 23.
- Due to system load demands power was held constant until after the morning peak on October 23. This allowed 0-TI-135, Process Computer and Core Performance to be completed.
- At 10:00 on October 23,1997, reactor power was reduced to about 63% at 55% core flow to perform a control rod adjustment. At 12:45 on October 23 reactor power reached 77.5% of rated. Fuel preconditioning at a rate of 30 MWe/hr was initiated, rated power was first reached at 20:45 on October 23, 1997.
- On October 24, 1997, 2-TI-82, Drywell Atmosphere Cooling System was completed.
- 2-TI-137,Core Power Distribution was completed on November 5, 1997.

TEST RESULTS

0-GOI-100-3C, Fuel Movement Operations During Refueling

Fuel shuffle began at 19:50 on September 29. There was one planned pause during the shuffle to do in-vessel inspections and control blade replacement. The fuel shuffle continued until completion on October 12, at 14:23.

There were two significant delays during fuel shuffling. The first occurred from 12:30 On September 30, to 03:30 on October 1, due to a failure of the grapple mounted camera. The second occurred on October 12, when an ESF actuation caused water clarity problems.

There were two Field Changes made during the shuffle. The first field change was made to allow o-ring replacement for control rod drives 10-23 and 26-43 and LPRM 32-25. The second field change was made to allow reseating fuel support castings for control cells 38-15 and 46-23, replacing a lower core plate plug at location 25-50, and to continue replacement of the o-ring seal of control rod drive 26-43.

The core verification was completed at 20:30 on October 12, 1997.

All criteria were successfully demonstrated and should be considered fully acceptable in meeting the criteria of FSAR section 13.10.2.1.

<u>2-SI-4.3.A.1, Reactivity Margin Test</u>

This test is performed in conjunction with the initial in-sequence critical to demonstrate that the reactor can be made subcritical with a margin of at least 0.38% ΔK/K with the strongest control rod fully withdrawn and at the most reactive time in core life. It also verifies that the actual critical rod configuration is within 1.0% ΔK of the predicted critical rod configuration.

Rod withdrawal for reactor startup and the shutdown margin demonstration began at 08:47 on October 18, 1997. The reactor was supercritical with a 119 second period at 12:01 on October 18. Criticality data was collected when control rod 30-19 (RWM group 6) was withdrawn to position 20, with a moderator temperature of 195 °F. The following results were obtained:

1. The unit 2 cycle10 shutdown margin was calculated to be 1.57% ΔK/K. This meets the requirements of technical specification 4.3.A.1, which requires a minimum shutdown margin of 0.38% ΔK/K.

2. The difference between the predicted and actual critical rod configuration was determined to be 0.139% ΔK. This meets the requirements of technical specification section 3.3.D, which requires that the difference between the predicted and actual critical rod patterns be no greater than 1.0% ΔK.

All test acceptance criteria were successfully demonstrated and should be considered fully acceptable in meeting the criteria of technical specifications 4.3.A.1, 3.3.D, and 4.3.D, and FSAR section 13.10.2.2. There were no test deficiencies.

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0-TI-299, Control Rod Drive System Testing After Refueling

The Phase I, Open Vessel portions of 2-TI-299, Control Rod Drive Testing were performed from October 13 through 17, 1997 with no test deficiencies noted. All control rod drives have been tested for coupling integrity and verified to have full insert and withdraw stroke times between 40 to 60 seconds. The rod position indications were also tested. Three control rods (46-47, 14-43, and 46-15) were missing the "- -" at full in over-travel. The red background does not illuminate at position 48 for control rod 10-23. The digit nine (9) does not display for control rod 02-27.

Work order 97-009851-00 was initiated to resolve the full in over travel and red back ground problems. The digit nine missing for control rod 02-27 is a previously identified cable problem that will be addressed by DCN T25701A. All of these issues will be deferred to the next refueling outage.

Phase II control rod scram time testing per 2-TI-299 Control Rod Drive System Testing After Refueling began at 08:31 on October 19, at 35% reactor power. Scram time testing was completed at 15:07 on October 20. LPRM hook up verification was completed in conjunction with scram time testing. There was one test deficiency, LPRM 16-57 has both the B and C level detectors bypassed, it is impossible to determine by control rod motion if the cabling for these two detectors is correctly connected. This LPRM assembly will be replaced during a future refueling outage. Since this test is performed after each refueling outage no retest tracking mechanism is needed. This deficiency has been closed.

All test acceptance criteria were successfully demonstrated and should be considered fully acceptable in meeting the criteria of technical specifications 4.3.B.1.b and 4.3.C, and FSAR section 13.10.2.3.

0-TI-135, Process Computer and Core Performance:

Phase I was performed during the OPEN VESSEL test plateau on October 14, 1997, at zero reactor pressure with the reactor vessel head in place. The cycle dependent data was successfully installed and verified for Unit 2 Cycle 10. The 3D Monicore system was successfully initialized. There are no Technical Specification or FSAR acceptance criteria for this portion of the test.

Phase II was performed during the HEATUP to 55% test plateau on October 18, and 19, 1997.

The following were performed during this phase:

1. Verified no changes occurred to the installed BOC case since initial installation.
2. Verified that the control rod position log agreed with Panel 2-9-5 indications.
3. Verified that the LPRM readings log agreed with Panel 2-9-14 indications within 3 units.
4. Restarted 3D Monicore after the turbine generator was placed on-line.
5. Verified that the 3D Monicore core power and flow log and the ICS NSSS heat balance calculation of core thermal power agreed with a manual heat balance within ± 2%.
6. Verified that the 3D Monicore calculation of thermal limits for minimum critical power ratio (MCPR), maximum average planar linear heat generation rate (MAPLHGR), and maximum linear heat generation rate (LHGR) agreed within ± 2% of a qualified backup calculation and that MCPR occurred in the same location.

Phase III was performed during the 55 to 100% test plateau on October 23, 1997.

The following were performed during this phase:

1. Verified that the LPRM failure status log, LPRM deviations log, LPRM exposure corrections log, and LPRM exposure values log were consistent and reasonable.
2. Verified that the 3D Monicore core power and flow log and the ICS NSSS heat balance calculation of core thermal power agreed with a manual heat balance within ± 2%.
3. Verified that the 3D Monicore calculation of thermal limits for minimum critical power ratio (MCPR), maximum average planar linear heat generation rate (MAPLHGR), and maximum linear heat generation rate (LHGR) agreed within ± 2% of a qualified backup calculation and that MCPR occurred in the same location.

All test acceptance criteria were successfully demonstrated and should be considered fully acceptable in meeting the criteria of FSAR section 13.10.2.4. There were no test deficiencies.

0-TI-137, Core Power Distribution

This test calculates the total uncertainty associated with the TIP system, checks the core power distribution and gross TIP symmetry, and verifies the proper hookup of the TIP system. The data from these TIP sets is compared statistically using the computer program TI137 to determine the total average TIP uncertainty. In addition, gross TIP symmetry and core power distribution are checked by comparing symmetric traces from the TIP sets and by examining the normalized full power adjusted TIP readings. The computer program TI137 also calculates the percent difference for each symmetric TIP pair to determine if any asymmetries exist. This test was performed during Phase III (55% to 100% power) of the Power Ascension Test Program. Testing began on October 22, 1997, and was completed

on November 5, 1997. TIP sets were run with core thermal power at 93.1% power and at 99.9% power.

Sections 7.4 and 7.5 were performed with core thermal power at 93.1% on October 22, (this run was intended to serve as the performance at greater than 55% power). The total average TIP uncertainty for the first TIP run was determined to be 1.449%. Gross symmetry checks were well within the acceptance criteria of 25% for all of the symmetric pairs (the largest percent difference was 3.51%).

Sections 7.6 and 7.7 were performed with the core thermal power at 99.9% on November 5, 1997, (this run was intended to serve as the performance at greater than 75% power). The total average TIP uncertainty for this TIP set was determined to be 1.519%. Gross symmetry checks were well within the acceptance criteria of 25% (the largest percent difference was 4.12%).

The average value of the total average TIP uncertainty from the two successful TIP sets was calculated to be 1.484%, well within the acceptance criteria of 9.0%.

All test acceptance criteria were successfully demonstrated and should be considered fully acceptable in meeting the criteria of FSAR section 13.10.2.5. There were no test deficiencies.

<u>0-TI-136, APRM Calibration</u>

Plant data was collected during reactor heatup and ascension in power. The first performance of 0-TI-136 was conducted by the constant heatup rate method on October 18, core thermal power was determined to be 0.8% of rated. No adjustments to the APRMs were required for this performance of 0-TI-136; the APRMs were indicating reactor power of 1.5 to 1.7%. The second performance of 0-TI-136 was also on October 18. This performance was done by the bypass valve comparison method, core thermal power was determined to be 5.2%. No adjustments to the APRMs were required, the APRMs were indicating reactor of 6.3 to 6.8%. Both performances were during the Heatup to 55% power test plateau.

All test acceptance criteria were successfully demonstrated and should be considered fully acceptable in meeting the criteria of FSAR section 13.10.2.6. There were no test deficiencies.

2-TI-131, Feedwater Level Control System

The purpose of this Feedwater Level Control System test was to verify the Reactor Feedwater Pump Turbine (RFPT) and the Reactor Feedwater Control (RFWC) system are tuned properly to support plant operation. This test was performed during Phase III (55% to 100% power), on October 21, 1997 with the reactor power at approximately 70% of rated. Start-up Bypass valve tuning was not performed due to the lack of major maintenance on the Start-up Bypass valve. No testing of RFPTs 2A or 2B was performed based on the fact that no major maintenance was performed on either RFPT control valves or control linkages.

Performance of the RFWC system tuning consisted of two major portions. The first consisted of introducing an approximately 50 RPM demand change to a single RFPT and observing the RFPT speed and flow response. This was performed on the 2C RFPT with the remaining two RFPTs in automatic control.

The second portion of the FWLCS tuning was performed by introducing 4 inch level setpoint changes and evaluating the system response in both single and three element modes.

All test acceptance criteria were successfully demonstrated and should be considered fully acceptable in meeting the criteria of FSAR section 13.10.2.8. There were no test deficiencies.

2-TI-82, Drywell Temperatures

The purpose of this test is to verify the ability of the drywell (DW) atmosphere cooling system to maintain design temperature conditions in the drywell during reactor power operation. The test was performed on October 24, 1997, with reactor thermal power at 3290 MWth (99.9%). Bulk Volumetric Average DW temperature was calculated to be 118.45 °F, which is well below the acceptance criteria 150 °F. All test acceptance criteria were successfully demonstrated and should be considered fully acceptable in meeting the criteria of FSAR section 13.10.2.10. There were no test deficiencies

2-TI-130, Main Steam Pressure Control was not performed during this startup as no major maintenance or design changes were performed that could have significantly effected the performance of the pressure control system.

2-TI-132 Reactor Recirculation System was not performed during this startup as no major maintenance or design changes were performed that could have significantly effected the performance of the reactor recirculation system.

CONCLUSION

These test results demonstrate that BFN Unit 2 systems are capable of meeting their design functions and that power operation can be safely and efficiently continued.

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APPENDIX 1

Test Deficiencies

Test deficiency one to 0-TI-299 was written because proper connection of LPRM detectors 16-57-B and 16-57-C could not be verified by control rod motion. Both of these detectors are failed and bypassed in the APRM circuitry, and therefor no response to control motion is observed. These LPRMs will remain bypassed for the duration of unit 2 cycle 10. No retest is required since this test is required to be performed after each refueling outage as stated in FSAR section 13.10.2.3. This will assure that the replacement detectors will be subsequently tested. This test deficiency has been closed. All other LPRMs were verified to be properly connected. There were no other test deficiencies.