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

Report No.: 50-302/92-17

Licensee: Florida Power Corporation
3201 34th Street, South
St. Petersburg, FL 33733

Docket No.: 50-302 License No.: DRP-72

Facility Name: Crystal River 3

Inspection Conducted: July 8 - 15 and August 25 - 28, 1992

Inspector: Curt Rapp for 9/3/92
P. T. Burnett, Reactor Engineer Date Signed

Approved by: R. V. Crlenjak 9/3/92
R. V. Crlenjak, Chief Date Signed
Operational Programs Section
Operations Branch
Division of Reactor Safety

SUMMARY

Scope: This routine, unannounced inspection addressed the areas of review of precritical activities, witnessing initial criticality for cycle 9, witnessing and review of cycle 9 startup tests, and review of core-performance surveillance activities for the latter part of cycle 8 and early portion of cycle 9.

Results: Initial criticality for cycle 9 was achieved in a well-controlled and well-monitored fashion. The substitution of NI-15 for NI-1 as a source range monitor was properly reviewed, engineered, and administered. NI-15 functioned acceptably in that role. However, the inspector questioned the wisdom of the procedure change, which allowed both source range monitors to be replaced by wide range monitors at one time. (Paragraphs 2.c and 3)

Since the cycle 9 startup, considerable effort has been expended on trouble shooting startup range monitor NI-1. However, its operability and reliability are not fully resolved: There is no convincing evidence that the NI-1 proportional counter responds to neutrons. (Paragraph 2.c)

Zero power physics tests were performed acceptably, and the test results satisfied acceptance criteria for agreement with predicted values. (Paragraph 4)

Power escalation tests were performed acceptably, but test documentation was not as thorough as required and acceptance criteria were not well defined in all cases. (Paragraph 5)

Cycle 8 core performance surveillances had been performed with acceptable periodicity and results. (Paragraph 6)

Three open items were closed. One non-cited violation was identified in the review of a licensee event report: Procedures did not implement periodic updating of burnup-dependent computer alarms. (Paragraph 7)

Performance of reactor engineering was satisfactory in the areas of engineering support and surveillance of core performance. Only minor administrative omissions were observed in the review of reactor engineering activities. No additional violations or deviations were identified.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

*J. Alberdi, Manager, Nuclear Plant Operations
#W. Bandhauer, Nuclear Operations Support Superintendent
F. Bockhorst, Instrument Systems Engineer
G. Boldt, Vice President Nuclear Production
#*M. Culver, Senior Reactor Engineer
#*E. Froats, Manager, Nuclear Compliance
P. Haines, Nuclear Operations Technical Advisor
K. Lancaster, Superintendent, Nuclear Maintenance Work Controls
W. Marshall, Nuclear Operations Superintendent
#P. McKee, Director, Nuclear Plant Operations
#*R. McLaughlin, Nuclear Regulatory Specialist
#W. Rossfeld, Manager, Site Nuclear Services
#J. Weaver, Reactor Engineer
R. Widell, Director, Nuclear Operations Site Support
K. Wilson, Manager, Nuclear Licensing

Other licensee employees contacted included office, operations, engineering, and maintenance personnel.

Other Organizations

S. Robertson, BAW Fuel Corporation
P. Baker, BAW Fuel Corporation

Resident Inspectors

*P. Holmes-Ray, Senior Resident Inspector
#*R. Freudenberger, Resident Inspector
#T. Johnson, Senior Resident Inspector (Region I)

*Attended the exit interview on July 15, 1992.
#Attended the exit interview on August 28, 1992.

Acronyms and initialisms used throughout this report are defined in the final paragraph.

2. Cycle 9 Precritical Activities (72700, 61705)

a. Documents Reviewed

Prior to the initiation of the cycle 9 startup tests, the inspector reviewed the following documents:

(1) BAW-2158 (Revision 1), Crystal River 3, Cycle 9 Reload Report; describes and justifies the design bases for the cycle 9 core. The low-leakage core is designed for 565

EFPD, with zero fuel defects. The latter criterion necessitated removing all fuel with INCONEL grids, except for one assembly. The remaining recycled fuel assemblies are all of the Mark B4Z design and the 64 new fuel assemblies are Mark B9 design, both of which have ZIRCALOY intermediate grids.

One axial power imbalance envelope applies to the entire cycle. There will be two PDIL curves; the first applies for the first 200 EFPD, and the second after 200 EFPD to the EOC.

This report also includes the fuel vendors recommended acceptance criteria for the tests discussed below.

(2) BWFC-1001, Physics Test Manual Crystal River 3 Cycle 9, contains the predicted values of the parameters to be measured in the zero power tests discussed below.

(3) BWFC-1001, Physics Operating Manual Crystal River 3 Cycle 9, supplements the Physics Test Manual and presents additional control rod worth and reactivity parameter calculations for operation throughout the cycle.

b. Evaluation of Fuel Assembly NJ0486

Damage to the UEF of fuel assembly NJ0486 during replacement of the hold down spring; the subsequent repair of the damage; and justification for movement into the reactor vessel were discussed in Inspection Report 50-302/92-16. However, justification for operation of the fuel assembly was not reviewed for that report.

Two criteria had been established for operation of NJ0486. First, it had to mate properly with the core internals, the plenum. Second, the repairs could not fail and introduce loose parts into the system. These concerns were addressed to the satisfaction of the PRC in meeting 0919, on June 15, 1992.

After the head had been replaced, review of the video tapes of the core revealed that NJ0486 was rotated 90°. This problem was evaluated by BAWFC using a two-group, two-dimensional diffusion theory code, which is commonly used to predict core performance. The conclusion of the analysis was that the effect, although determinable, was too small to impact the analysis and licensing for the cycle 9 design. The review was accepted by the PRC.

Following review of the documents cited and discussions with plant personnel, the inspector had no questions or concerns regarding operation of NJ0486 in cycle 9.

c. Operational Problems with Source Range Channel NI-1

During the outage, coaxial cable to the NI-1 detector and the detector proper were replaced with new components. When placed back in service, the channel exhibited a very high countrate, and a chi-squared test indicated that much of the countrate came from electrical noise rather than Poisson-distribution events. A new discriminator curve was obtained and a new discriminator setpoint established from that curve. The NI-1 countrate dropped to the same order as NI-2, and an acceptable chi-squared test was obtained.

After several hours of apparently acceptable operation, but before startup could begin, NI-1 exhibited a rapid drop in countrate. Countrate later returned to the pre-drop level, and another acceptable chi-squared test was obtained. Over the next two days NI-1 repeated this behavior with a period of about 80 minutes. NI-1 did not respond to control rod motion from control rod operability tests; NI-2, an identical system on the opposite side of the reactor vessel, did respond. NI-2 also gave consistently good results with the chi-squared test.

Plant and vendor personnel could not resolve the problems with NI-1, and licensee management decided to substitute wide range channel NI-15 for NI-1. The detector for NI-15 is located close to the detector for NI-1. System modifications were approved to provide a CRT display of the NI-15 trend and countrate in the control room, for use by the operators and test engineers. Supporting procedure changes were also developed, reviewed, and approved.

PT-110 as revised allows NI-14 to be substituted for NI-2 as well as the substitution of NI-15 for NI-1 actually performed. The inspector asked the licensee to consider limiting the substitutions to only one at a time. NI-14/15 do not have scalers in the channels and, thus, cannot be subjected to the chi-squared test for operability. If NI-1 or -2 can be shown operable using the chi-squared test, then a qualitative check of the substituted system can be obtained by comparison with the fully tested system. The licensee is considering that request.

After startup, a different detector, pre-amplifier and cable, having the same specifications as those in NI-1, were substituted for the NI-1 components. The substitute components were installed outside of containment. The detector was activated by a neutron source. This system has performed well and continuously, with either of two substitute detectors, since it was assembled. The licensee believes that this system demonstrates that the problem is in the installed pre-amplifier, and plans to replace it with the pre-amplifier under test prior to the next startup. Although the problem of periodic reduction in countrate with NI-1 may be resolved, the inspector expressed a concern that the apparent insensitivity to neutrons, discussed above and in paragraph 3, is not explained by a periodically defective pre-amplifier. The successful chi-squared tests demonstrate that the system was responding primarily to products of radioactive decay, but the failures to respond to rod motion, when subcritical, or at very low power suggest that the products are gamma rays rather than neutrons.

The licensee's long range plans are to completely replace NI-1 and NI-2 with systems of a newer and different design. Those systems will include scalers in each channel for quantitative analysis of system performance.

d. Precritical Tests

The following precritical tests were inspected:

(1) PT-100 (Revision 15), Controlling Procedure for Precritical Testing, schedules or provides instructions for performing tests required before entering into mode 2. The procedure was completed on July 10, 1992.

(2) SP-102 (Revisio[illegible]), Control Rod Drop Time Tests, was reviewed by the inspector, for consistency with TS 4.1.3.4 requirements, prior to performance. The inspector reviewed the test results after performance and confirmed that they were acceptable and that the recorder traces were attached to the procedure, as required by the procedure. (See VIO 50-302/90-23-01)

(3) Enclosure 1 to PT-110 (described below), Chi-Square Test for Source Range Detector Operability, was completed for both NI-1 and NI-2, as a prerequisite for beginning the approach to criticality. The inspector confirmed that the analysis was performed correctly. Several times during the approach to criticality, the inspector independently verified that NI-2 was continuing to perform acceptably, by performing additional chi-squared tests. Problems with NI-1 before and during the approach to criticality are discussed in paragraphs 2.c and 3.

3. Initial Criticality for Cycle 9 (72700, 61705)

PT-110 (Revision 16), Controlling Procedure for Zero Power Physics Tests, controlled the approach to criticality and subsequent low power tests. After the problems encountered with NI-1 and the substitution of NI-15, the procedure was revised so that dilution was performed after the safety groups had been fully withdrawn. Then the ICRR was plotted against rod reactivity insertion as rod groups 5, 6, and 7 were withdrawn in prescribed increments. Throughout rod withdrawal, NI-2 and NI-15 compared closely in ICRR, and the two plots were consistent in prediction of the critical position. NI-1 did not respond to any of the subcritical reactivity changes, nor to the first decade of flux increase beyond criticality. As discussed in paragraph 2.c above, the eventual response to power changes suggests that the detector is responding only to gamma rays.

More than a decade of overlap was observed between NI-2 and NI-15 and the intermediate range systems, NI-3 and NI-4.

Before the startup began, the shift was thoroughly briefed on test activities and individual responsibilities by the shift supervisor and test engineer. Cycle 9 initial criticality was achieved in a well-controlled and well-monitored fashion.

4. Low Power Physics Tests for Cycle 9 (72700, 61708, 61710)

The test procedures discussed below were reviewed by the inspector prior to performance, portions of the procedures were witnessed as they were performed, and the results and completed procedures were reviewed during the second phase of the inspection.

a. A portion of PT-110 controlled determination of the acceptable range of DRC performance. The reactivity indicated by the DRC was shown to agree with reactivity determined from stop-watch measurements of reactor period within ±5% over the range from -96 pcm to +97 pcm.

b. PT-116 (Revision 8), Sensible Heat Determination, was completed satisfactorily on July 14, 1992. The upper power level, for low power physics tests, was established a factor of 3.3 below sensible heat, to assure that reactivity measurements were not contaminated by doppler reactivity effects.

c. PT-111 (Revision 11), Hot Zero Power, All Rods Out Critical Boron Test, was completed satisfactorily on June 14, 1992. The measured ARO CBC of 2212 ppmB compared favorably with the predicted value of 2232 ppmB, and was within the acceptance criterion of agreement with ± 50 ppmB.

d. SP-103 (Revision 10), Moderator Temperature Coefficient Determination at Startup Following Refueling, was performed satisfactorily on July 14, 1992. Three measurements of ITC were performed for nominal RCS temperature changes of +5°F, -10°F, and +10°F. The results were +2.55 pcm/°F, +3.21 pcm/°F, and +2.71 pcm/°F, respectively. Agreement of all measurements within a spread of 1 pcm/°F is indicative of good measurement technique and control of the process variable. By procedure, only the second measurement was used to obtain the MTC by subtracting the zero power doppler coefficient. The result, +4.93 pcm/°F, was less than the TS 3.1 limit of +9 pcm/°F and was acceptable. Part of the DRC trace was noisier than desirable. The inspector used extreme values from the trace to recalculate the MTC. The result was less than the TS limit.

e. PT-112 (Revision 11), Hot Zero Power Regulating Rod Group Worth and Differential Boron Worth Measurement, was completed on July 15, 1992. During continuous dilution of the RCS, control rod groups 7, 6, and 5, were inserted in sequence using discrete insertion increments. The inspector independently analyzed the DRC traces for group 5, and arrived at the same integral worth reported by the licensee. The acceptance criteria for agreement between measurement and prediction were ±15% for individual group measurements and ±10 for the sum of the three groups. A shown in the table below, all acceptance criteria were satisfied.

	Integral Worth (pcm)		
Group	Measured	Predicted	Error(%)
5	1330	1280	-3.72
6	865	936	+8.25
7	995	953	-4.22
Total	3190	3169	-0.63

During the RCS dilution, the CBC changed from 2201 ppmB to 1802 ppmB. After correcting for the control rods inserted at the beginning and end of dilution, a DBW of -7.7 pcm/ppmB was obtained. The result was within ±15% of the predicted DBW.

5. Cycle 9 Power Escalation Tests

a. Core Quadrant Power Tilt and Multiplexor Problems

The QPTR is measured using the incore SPNDs. The outputs of the 364 SPNDs and 52 background detectors are input to the plant computer using a multiplexor. Multiplexor-induced problems with QPTR following the mid-cycle 8 outage and the resolution of those problems were discussed in Inspection Report 91-24. During the shutdown to end cycle 8, QPTR again exceeded limits as power was reduced. This time the problem was traced to the failure of a daughter board in the signal processing system, rather than to a zero signal problem at the multiplexor. Examination of the daughter board revealed that it had been damaged in handling at some unknown time. A printed circuit conductor was loose from the board, but was not completely severed.

The acceptance criterion for zero signal output current during multiplexor calibration is now ±5 Na, but the licensee is trying to hold the error to ±3 Na. A snapshot of all 416 points was taken on July 8,1992. Only six failed the acceptance criterion, but 33 were outside the ±3 nA limits. The licensee is evaluating basing the acceptance criterion on background corrected signals rather than the individual signals.

During power ascension QPTR was monitored closely, up to 40% RTP, as part of PT-120. None of the limits were challenged; hence, the most recent calibration criteria appear to be sufficient. The licensee is considering methods and frequencies to calibrate the multiplexor during operation. However, the method must be rapid, else the loss of data while a multiplexor is out of service will affect the calculations of fuel assembly and SPND depletion.

b. Power Ascension Tests

PT-120 (Revision 17), Controlling Procedure for Power Escalation Testing, scheduled tests and surveillance activities as power was increased. Most procedures were performed at either the IPL (40 - 75% RTP) or FP (95-100% RTP).

The high flux trip setpoints for the PRNIs were held to 50 - 55% indicated power until SP-312C, Heat Balance Verification, was completed at 40 %RTP. The trips were then increased to 80 % indicated power to support testing at 70% power. After completing IPL testing, the trip setpoints were increased to 104.5% RTP.

Core symmetry testing was completed below 40% indicated power. Radial peaking factors and hot channel factors were evaluated, with acceptable results, at both IPL and FP.

The PDIC was performed at IPL. The raw data were available in the test package, but the test results and intermediate steps were not. The licensee had exercised a procedure option to perform the analyses using a computer program. At the inspector's request the input and output data were added to the test package. The acceptance criterion in the procedure was based upon the sum of the residuals of the observed imbalances. The licensee is considering an acceptance criterion based upon the correlation coefficient of the fit between incore and excore measurements of imbalance. The licensee is also considering additional procedural controls on the use of computer programs in surveillance activities.

6. Review of Completed Core Surveillance Procedures for Cycle 8 (61702, 61705 61707, 61708)

The inspector reviewed the following completed surveillance procedures for content and timely performance:

a. SP-101 (Revision 16), Moderator Temperature Coefficient Determination at 300 ppm Boron, was performed on February 19, 1992, at a nominal CBC of 303 ppmB. Two temperature changes of -3.94 °F and +3.21 °F were performed. For each temperature change, reactivity changes from changes in control rod position, thermal power, xenon concentration, boron concentration, and burnup were equated to reactivity from the temperature change and the change in axial imbalance. Solution of the two simultaneous equations yielded an ITC of -23.8 pcm/°F and a corresponding MTC of -21.3 pcm/°F. The latter was less negative than the predicted MTC of -

25.1 pcm/°F. Extrapolated to the EOC, the measured MTC was -31.2 pcm/°F, which satisfies the TS 3.1.1.3 limit of -32.4 pcm/°F.

b. SP-104 (Revision 25), Hot Channel Factors Calculations, was performed four times during 1992 prior to the cycle 8 shutdown on May 1, 1992. The 31 EFPD surveillance interval was satisfied in all cases, as were the F_Q, F_{dH}, and LHGR limits.

c. SP-421 (Revision 35), Reactivity Balance Calculations, was performed on 15 occasions from January 1,1992, to the end of cycle. Four surveillances, at or near RTP, were performed at nominal 31 EFPD intervals and confirmed that the reactivity anomaly was less than 1.0 %dK/K in all cases. The other performances of the procedure were to confirm SDM in modes 3, 4, or 5. SDM was satisfactory in all cases.

7. Review of Open Items

a. (Closed) VIO 90-23-01: Failure to retain the rod-drop-time Visicorder traces, a quality record.

The inspector observed that the rod-drop-time traces were attached to SP-1[illegible], Control Rod Drop Time Tests, after it was completed.

b. (Closed) UNR 91-19-01: Determine the safety significance of the out-of-calibration steam pressure transmitters.

The licensee's evaluation was performed promptly in response to the opening of this item. The evaluation showed that the errors in steam pressure measurements had no significant effect on the heat balance. The actual errors were in the conservative direction.

c. (Closed) LER 92-014: Technical Specification Surveillance Violation Due To Failure To Recognize Inoperable Rod Index Computer Alarms. Some operating limits, which are monitored by computer alarms, are a function of burnup, and must be updated during the cycle. Updating was not performed during cycle 8, which led to a non-conservative alarm setpoint for rod insertion limits. No procedure enforced updating; since the burnup periods varied from cycle-to-cycle.

The corrective action is in place and is acceptable. SP-104, Hot Channel Factor Calculations, which is performed monthly, was revised to monitor the cycle 9 computer updating requirements. This procedure is routinely updated for every fuel cycle. The event will be cited as a NCV.

NCV 50-302/92-17-01: Procedures did not enforce burnup dependent updating of computer alarms.

8. Exit Interview

The inspection scope and findings were summarized on July 15 and August 28, 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 the inspection, but was not included in this report. The item described below was discussed.

NCV 50-302/92-17-01: Procedures did not enforce burnup-dependent updating of computer alarms. (Paragraph 7.c)

9. Acronyms and Initialisms Used in This Report

ARO	all rods out
BOC	beginning of cycle
BAW	Babcock and Wilcox
BWFC	BAW Fuels Corporation
CBC	critical boron concentration
DBW	differential boron worth
DRC	digital reactivity computer
EFPD	effective full power days
EOC	end of cycle
F_{dH}	enthalpy rise hot channel factor
F_Q	heat flu hot channel factor
FP	full power test plateau
IPL	intermediate power level test plateau
ITC	isothermal temperature coefficient
LHGR	linear heat generation rate
NI	nuclear instrument
pcm	percent millirho (reactivity unit)
PDIL	power-dependent insertion limits
ppmB	parts per million boron
PRC	plant review committee
PT	preoperational test
QPTR	quadrant power tilt ratio
RCS	reactor coolant system
RTP	rated thermal power
SDM	shutdown margin
SPND	self-powered neutron detector
UEF	upper end fitting