



June 17, 2005

SERIAL: BSEP 05-0081

U. S. Nuclear Regulatory Commission
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Subject: Brunswick Steam Electric Plant, Unit No. 2
Docket No. 50-324/License Nos. DPR-62
Extended Power Uprate
Phase 2 Implementation Test Report

Ladies and Gentlemen:

In accordance with NEDC-33039P, "Safety Analysis Report for Brunswick Steam Electric Plant Units 1 and 2 Extended Power Uprate," dated August 2001 (i.e., the Power Uprate Safety Analysis Report (PUSAR)), Section 10.4, "Required Testing," and the Brunswick Steam Electric Plant (BSEP) Updated Final Safety Analysis Report (UFSAR), Section 13.4.2.1, "Startup Report," Carolina Power & Light Company, now doing business as Progress Energy Carolinas, Inc., is providing the implementation test report for the second and final phase of implementation of extended power uprate (EPU) for Unit 2.

Implementation of Phase 2 of EPU for Unit 2 was completed during the spring 2005 refueling outage which ended on April 9, 2005. Implementation testing was completed on May 1, 2005. The results of this testing demonstrated acceptable performance of the unit at the full licensed power level of 2923 megawatts thermal.

Please refer any questions regarding this submittal to Mr. Leonard R. Beller, Supervisor - Licensing/Regulatory Programs, at (910) 457-2073.

Sincerely,

A handwritten signature in black ink that reads "Leonard R. Beller". The signature is fluid and cursive, with a long horizontal line extending to the right.

Edward T. O'Neil
Manager - Support Services
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MAT/mat

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Enclosure:

Unit 2 Extended Power Uprate - Phase 2 Implementation Test Report

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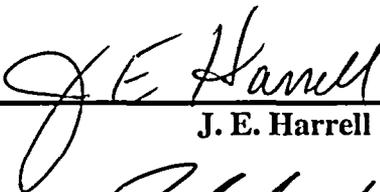
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Enclosure

**Unit 2 Extended Power Uprate
Phase 2 Implementation Test Report**

Brunswick Steam Electric Plant
Unit 2 Extended Power Uprate
Phase Two Implementation Test Report

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1.0 Executive Summary

The Brunswick Steam Electric Plant (BSEP), Unit 2 Extended Power Uprate (EPU) Implementation Test Report is submitted to the Nuclear Regulatory Commission (NRC) in accordance with the BSEP Updated Final Safety Analysis Report (UFSAR), Section 13.4.2.1. This report summarizes the testing performed as part of the second phase of the implementation of EPU on Brunswick Unit 2. Extended Power Uprate was approved by the NRC in Amendment No. 247 to Facility Operating License DPR 62 (i.e, Unit 2) on May 31, 2002. Testing for the final phase of implementation of EPU on Unit 2 was completed on May 1, 2005, with a final steady state operating power level of 2923 MWt.

Testing specified in the BSEP Power Uprate Safety Analysis Report (PUSAR), NEDC-33039P, was addressed. Special test procedures were implemented in combination with existing plant procedures, as described in this report. All required tests have been completed to support operation at the licensed power level of 2923 MWt. Testing was conducted over the period from April 6 to May 1, 2005. Test results were reviewed for acceptability and results reported to the Plant Nuclear Safety Committee (PNSC). Final results of the testing and equipment performance data gathering have demonstrated successful continued operation at the licensed power level of 2923 MWt.

2.0 Purpose

This report summarizes the testing performed on Unit 2 following the implementation of the final phase of the BSEP EPU, approved by the NRC in Amendment No. 247 to Facility Operating License DPR 62 (i.e, Unit 2) on May 31, 2002. While the amendment approved a new licensed thermal power of 2923 MWt, the implementation of the EPU has been conducted in two planned phases. This report summarizes the testing performed at power levels above 2825 MWt which demonstrated the acceptability of a steady-state operating thermal power of 2923 MWt (i.e., licensed thermal power) on Unit 2. The testing performed is described in Section 7.0 of this report.

3.0 Program Description

The EPU testing program was conducted as described in Section 10.4 of the BSEP PUSAR, NEDC-33039P.

The in-plant testing for the second phase of implementation on Unit 2 began on April 6, 2005 following completion of the Unit 2 refuel/maintenance outage, and was completed on May 1, 2005. The results of the testing validated continuous operation of Unit 2 at 2923 MWt.

Special Procedures (SPs) were developed to coordinate the implementation program and to control performance of specific one-time tests. Plant surveillance test procedures were used, to the extent possible, to satisfy required testing. Table 2 lists the test conditions

and is used in denoting the testing performed for the second phase of EPU implementation.

The majority of the testing performed is categorized as follows:

- Verification that the Digital Feedwater Control system is stable at uprated conditions.
- Collection of system performance data to verify modifications made to support uprated operation were performing as expected.
- Collection of general plant data (e.g., radiation surveys, coolant chemistry, thermal performance) for comparison to previous plant rated conditions.

Reactor core flow was permitted anywhere within the safe operating region of the power/flow map that would establish the required power. Power levels were established on or near the maximum permitted rod line in preparation for the various test conditions. Testing at specific power levels was completed and results evaluated prior to proceeding to the next testing plateau.

4.0 Acceptance Criteria

For each test performed in the power ascension test program, the test purpose, test conditions, and associated acceptance criteria were defined within the test.

Test criteria for each test had a maximum of two levels of acceptance criteria. Level 1 criteria were associated with safe unit operation. Level 2 criteria were associated with system/component performance expectations.

If a Level 1 criterion was not met:

- The plant would be placed in a hold condition judged to be satisfactory and safe, based upon prior testing.
- Tests consistent with that hold condition could be continued.
- Resolution of the problem would be immediately pursued by equipment adjustments or through engineering evaluation as appropriate. Following resolution, the applicable test portion was required to be repeated to verify that the Level 1 requirement was satisfied.

If a Level 2 criterion was not met:

- Plant operations or EPU power ascension test plans would not necessarily have to have been altered (i.e., the limits stated in this category were usually associated with expectations of system transient performance, and whose characteristics could be improved by equipment adjustments).

- For each controller-related parameter failing to satisfy its Level 2 criterion, either:
 - The temporary Level 2 test criterion failure was resolved by equipment adjustment and the applicable test portion was repeated to verify that the Level 2 requirement was satisfied, or
 - If resolution was not practical (i.e., equipment in service), a Level 2 test criterion exception was initiated for that portion of the test referring to the parameter failing to satisfy the Level 2 requirement.
- Test exceptions involving Level 2 criteria were evaluated before the conclusion of the EPU power ascension test program. The evaluation considered the magnitude of the parameter deviation from the Level 2 criterion, possible impact on plant operations, justification for the resolution, and any potential corrective action.

5.0 EPU Power Ascension Test Program Summary

Equipment post-modification testing was performed as part of the startup following the B217R1 refueling outage. The power ascension test program commenced on April 6, 2005, and the final power level of 2923 MWt (i.e. licensed power level) was achieved on May 1, 2005.

6.0 Testing Requirements

Section 7.0 identifies the UFSAR tests that were performed for the EPU implementation as identified in the PUSAR Section 10.4. The purpose of each test, a description of the test, Acceptance Criteria, and test results are included. Section 7.0 identifies additional test/data collection that was performed to evaluate the performance of the unit at EPU conditions. Descriptions of the tests/data collection and associated results are included.

Table 2 identifies the associated power levels referenced for the tests described in Section 7.0. These power levels are given a corresponding letter designation. The Section 7.0 tests indicate the power level at which they were performed via this letter designation.

7.0 UFSAR Section 14.2 Tests Required For EPU

7.1 *Test No. 1 – Chemical and Radiochemical Monitoring*

The purpose of this monitoring is to verify control of the quality of the reactor coolant chemistry and radiochemistry at EPU conditions is maintained.

Samples were taken and analyzed at uprated conditions to determine 1) the chemical and radiochemical quality of reactor water and reactor feedwater and 2) gaseous release.

Test Conditions: G

Acceptance Criteria:

- Level 1:
- a) Chemical factors defined in the Technical Specifications and Fuel Warranty must be maintained within the limits specified.
 - b) The activity of gaseous and liquid effluents conforms to license limitations.
 - c) Quality of the reactor water and reactor feedwater are known at all times and remains within the guidelines of the Progress Energy chemistry program.

Level 2: NA

Results:

All acceptance criteria were met at all Test Conditions. No abnormalities were observed.

7.2 Test No. 2 – Radiation Measurements

The purpose of this test is to monitor radiation measurements at the EPU conditions to assure that personnel exposures are maintained within prescribed limits, radiation survey maps are accurate, and that radiation areas are properly posted.

Dose rate measurements were made at specific locations throughout the plant to assess the impact of EPU on actual dose rates.

Test Conditions: G

Acceptance Criteria:

Level 1: The radiation doses of plant origin and the occupancy times of personnel in radiation zones shall be controlled consistent with the guidelines of The Standard for Protection Against Radiation outlined in 10 CFR 20.

Level 2: NA

Results:

Radiation surveys were conducted at the EPU licensed power level (i.e., 2923 MWt) and compared to the levels observed prior to EPU implementation. Increases in radiation dose rates were within the expected ranges for the power increase achieved during this phase of implementation. In all cases the radiation dose rates remained in compliance with all applicable regulatory limits.

Data at site boundary monitoring locations will be collected during normal quarterly data collection and evaluated to assess the impact of EPU. The results of these evaluations will be maintained onsite and be available for NRC review. As required by Technical Specification 5.6.2, the Annual Radiological Environmental Operating Report is submitted by May 15 of each year. This report includes summaries, interpretations, and analyses of trends of the results of the Radiological Environmental Monitoring Program for the reporting period.

7.3 Test No. 16 ~ Core Performance

The purpose of this test is to 1) evaluate the core thermal power and core flow and 2) evaluate that core performance parameters are within limits to ensure a careful, monitored approach to the EPU maximum achievable power level.

Routine measurements of reactor parameters were taken at prescribed power levels. Core thermal power and fuel thermal margin were calculated using accepted methods to ensure compliance with license conditions. Power increases were made along the constant rod pattern line intended to be used for the increase to maximum uprated power in incremental steps to support a careful, monitored approach to the maximum achievable power, with core response predictions being performed at each power plateau prior to continuing power ascension.

Test Conditions: F, G

Acceptance Criteria:

- Level 1:
- a) All Average Planar Linear Heat Generation Rates (APLHGRs) shall be less than or equal to the limits specified in Technical Specifications.
 - b) All Minimum Critical Power Ratios (MCPRs) shall be greater than or equal to the MCPR operating limits as specified in Technical Specifications.
 - c) Steady state reactor power shall be limited to the maximum values on or below the lesser of either the LPU or Maximum Extended Load Line Limit Analysis (MELLLA) upper boundary.

- d) Core flow shall not exceed its maximum value depicted on the Power-Flow Map as found in the cycle Core Operating Limits Report (COLR).

Level 2: NA

Results:

Core performance and thermal limits were monitored throughout the entire power ascension test program. Power predictions were utilized during the power ascension program to support proper control rod configuration. All acceptance criteria were met throughout the power ascension.

7.4 Test No. 20 – Feedwater System Testing

The purpose of this test is to verify the feedwater control system has been adjusted to 1) provide acceptable reactor water level control over EPU operating conditions and subcooling changes and 2) confirm feedwater flow calibration.

Test Conditions:

Feedwater Flow Calibration C, F, G

Reactor Water Level Control C, F

Acceptance Criteria:

- Level 1:
- a) The decay ratio must be less than 1.0 (i.e., must not diverge) for each process variable that exhibits oscillatory response to feedwater system changes.
 - b) The system shall provide level control accuracy to within ± 2 inches of the optimum reactor water level setpoint during steady state operation in both single and three element control.
 - c) The system shall provide level control accuracy to within ± 1 inch of the reactor water level equilibrium during steady state operation in both single and three element control.
- Level 2:
- a) The system should have the following response characteristics to an approximate ± 4 inch level step change of the master level controller setpoint or an approximately 10% flow step change:

- Peak Overshoot (% of demand) $\leq 15\%$
 - Time to 10% maximum ≤ 3.0 seconds
 - Time from 10% to 90% maximum ≤ 15.0 seconds
 - Settling time to within $\pm 5\%$ of final value ≤ 30.0 seconds
 - Dead Time ≤ 2.0 seconds
 - Decay Ratio ≤ 0.25
 - Equilibrium Range ± 0.5 inch
- b) Following an approximate 2 inch level setpoint step adjustment in three element control or an approximate 10% flow step change, the time from setpoint step change until the water level peak occurs should be less than 35 seconds without excessive feedwater swings (i.e., changes in feedwater flow greater than 25% rated flow).
- c) For manual flow changes of approximately 10%, the average rate of response, computed between 10% and 90% of response, of the feedwater flow to the step flow demand shall be between 10% and 25% of rated pump flow per second
- d) During steady state conditions, the Reactor Feed Pump Turbine (RFPT) control valves must exhibit stable behavior, as determined by the RFPT system engineer. Excessive control valve oscillation can result in premature failure of the control valve and associated linkages.

Results:

The test performed involved the introduction of level setpoint step changes and flow step changes and verifying the feedwater control system maintained system performance within acceptable limits.

For verification of feedwater flow element calibration, the total output of the feedwater flow element transmitters was compared to the total output of the reactor feed pump suction flow transmitters to determine if the flow transmitter response was consistent at the uprated conditions. Average percent error was less than 1%, which is considered adequate.

Level 1 criteria were met for all test conditions following control loop tuning adjustments.

The majority of Level 2 criteria were met for all power levels. Response characteristic "Time to 10% maximum" was missed once, and "Peak Overshoot (% demand) was missed twice. Settling time was consistently of longer duration than the Level 2 criteria at low power levels. Pump flow response was

consistently slower than the Level 2 criteria. The remaining Level 2 criteria were met at all test conditions. In order to correct a pre-existing design deficiency Digital Feedwater Control System (DFWC) level filtering was removed prior to achieving 100 percent power. This resulted in control valve oscillations. A design change has been implemented to reinstall similar filtering which returned control valve stability to Level 2 criteria. The responsible system engineer and the feedwater power ascension team evaluated the overall performance of the system following the collating of the test data. Although the Level 2 criteria noted were not all consistently met, it was determined that the response of the system was excellent and system tuning was optimized for steady state and transient response. Attempts to change the tuning of the system to meet the criteria noted would result in impacts on other criteria (i.e., peak overshoot and control valve oscillations). Station management accepted a recommendation to not change the tuning of the Digital Feedwater Control System, with the exception of the level input filtering design change, based on evaluation of system performance and resulting recommendations by the system engineer.

7.5 Test No. 30 – Vibration Measurements

The purpose of the test was to gather vibration measurements on the main steam and feedwater system piping, both inside and outside the primary containment, to evaluate the vibration stress effect due to the EPU.

During the post-outage and implementation of the EPU power ascensions, designated main steam and feedwater piping locations were monitored for vibration and assessments were made regarding piping vibration impacts of the EPU.

Test Conditions: F, G

Acceptance Criteria:

Level 1: NA

Level 2: Acceptance criteria were established based on governing piping codes and standards.

Results:

Criteria were established for evaluation of the vibration data collected at the power ascension plateaus. A total of 15 locations, consisting of 37 channels, were monitored using remote sensors during the power ascension, with no locations approaching maximum allowable vibration. Evaluations determined that the resulting stress effect from the measured vibration was well within acceptance criteria. Two channels in the monitoring system failed during the testing. Engineering evaluated the loss of the data points and determined that sufficient

channels remained to support adequate predicting of the associated pipe stresses. Accessible areas were monitored by Engineering personnel via remote camera observation and/or walk downs. Observed systems vibrations in these areas were noted to be acceptable.

8.0 System Performance Monitoring

During power ascension following the B217R1 refueling outage up to the licensed power level (i.e., 2923 MWt), various parameters and equipment performance were monitored for proper operation. Included in this group were containment temperatures, Main Steam Isolation Valve (MSIV) pit temperature, main generator and supporting auxiliaries performance, main condenser performance (i.e., vacuum, condensate temperature), and balance-of-plant component cooling. All parameters and equipment performance responded consistently within projected ranges over the entire range of power operation.

9.0 Summary

The BSEP EPU Implementation was completed on May 1, 2005. Appropriate equipment was tested and parameters monitored during the power ascension program. All specified Level 1 criteria were met for the testing associated with the test program. Level 2 criteria were met or, where previously noted, evaluated for impact on equipment operation. Test results were reviewed and reported to the Plant Nuclear Safety Committee. Based on the results of the testing and monitoring, recommendation was made that Unit 2 be operated at a licensed power level of 2923 MWt with the recommendation being adopted by station management.

10.0 Tables

**Table 1
Glossary of Terms**

APLHGR	Average Linear Heat Generation Rate
BSEP	Brunswick Steam Electric Plant
COLR	Core Operating Limits Report
DFWC	Digital Feedwater Control
EPU	Extended Power Uprate
LPU	Licensed Power Uprate
MCPR	Minimum Critical Power Ratio
MELLLA	Maximum Extended Load Line Limit Analysis
MSIVs	Main Steam Isolation Valves
MWt	Megawatts Thermal
NRC	Nuclear Regulatory Commission
PNSC	Plant Nuclear Safety Committee
PUSAR	Power Uprate Safety Analysis Report, NEDC-33039P
RFPT	Reactor Feed Pump Turbine
SPs	Special Procedures
UFSAR	Updated Final Safety Analysis Report

TABLE 2: TEST CONDITIONS

Test	A	B	C	D	E	F	G
Power Level MWt	384 to 767	1754	2280	2558	2689	2806	2923
Test No. 1							✓
Test No. 2							✓
Test No. 16			✓			✓	✓
Test No. 20			✓			✓	✓
Test No. 30						✓	✓