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BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-324/LICENSE NO. DPR-62
EXTENDED POWER UPRATE
CYCLE 16 STARTUP TEST REPORT - IMPELMENTATION TEST REPORT - PHASE 1

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," Progress Energy Carolinas, Inc. is providing the implementation test report for the first phase of implementation of extended power uprate (EPU) for Unit 2. In accordance with UFSAR Section 13.4.2.1, this report is submitted within 90 days of resumption of commercial operation.

Implementation of Phase 1 of EPU on Unit 2 was completed during Refueling Outage 15, which ended on April 6, 2003. The first phase of testing for Unit 2 was completed on April 15, 2003; the results of this testing demonstrated acceptable performance of the unit at the Phase 1 target power level of 2825 megawatts thermal.

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

Sincerely,

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Enclosure:
Brunswick Steam Electric Plant
Unit 2 Extended Power Uprate - Phase 1
Implementation Test Report

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BSEP 03-0071
Enclosure

Brunswick Steam Electric Plant
Unit 2 Extended Power Uprate - Phase 1
Implementation Test Report

Brunswick Steam Electric Plant

Unit 2 Extended Power Uprate – Phase 1

Implementation Test Report

Prepared by: _____
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1.0 Executive Summary

The Brunswick Steam Electric Plant (BSEP), Unit 2 Extended Power Uprate (EPU) Implementation Test Report (Phase 1) 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 implementation of EPU. 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. EPU was implemented on Unit 2 on April 2, 2003. The first phase of testing for Unit 2 was completed on April 15, 2003[1].

BSEP was previously licensed to operate at a maximum reactor power level of 2558 megawatts thermal (MWt) on Unit 2. The result of the EPU is a license power increase to a new maximum of 2923 MWt. BSEP is implementing the EPU in planned phases that support a schedule for the modifications required to achieve the licensed power level. The current phase has achieved a target power level of 2825 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 up to the target power level of 2825 MWt. Testing was conducted on Unit 2 over the period from April 2, 2003 to April 15, 2003. Test results were reviewed for acceptability by the Plant Nuclear Safety Committee (PNSC). Final results of the testing and equipment performance data gathering have demonstrated successful continued operation at the target power level of 2825 MWt.

2.0 Purpose

This report summarizes the testing performed on Unit 2 following the implementation of the initial phase of the BSEP EPU on April 2, 2003. While the amendment approved a new licensed thermal power of 2923 MWt, the implementation of the EPU is being conducted in planned phases. This report summarizes the testing performed which demonstrated the acceptability of a steady-state operating thermal power of 2825 MWt on Unit 2. The testing performed is described in Section 8.0 of this report. A follow-up report will be made as the subsequent phase is implemented on Unit 2 and core thermal power is increased up to the licensed limits on the unit.

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[1] Data at site boundary monitoring locations discussed in Section 8.2, Test No. 2, "Radiation Measurements," 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.

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 uprate license implementation on Unit 2 began on April 2, 2003, and was completed on April 15, 2003. The results of the testing validated continuous operation of Unit 2 at 2825 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 required to be performed for the EPU implementation.

The majority of the testing performed is categorized as follows:

- Verification that the control systems (i.e., Electro-Hydraulic Control (EHC) and Digital Feedwater Control) are stable at uprated conditions.
- Collection of system performance data to verify modifications made to support uprated operation were performing as expected, and to validate the limiting components for higher power operation.
- 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.

Above 2558 MWt and between test plateaus, intermediate power levels were established for monitoring and evaluating overall plant stability. Power ascension was stopped at these points and the plant stabilized. Monitoring of plant parameters was performed to assess the operation of the plant during the power ascension.

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 B216R1 refueling outage with baseline data being collected during power ascension to the previously licensed power level of 2558 MWt. Following evaluation of the test data, the power ascension was continued with testing and monitoring at appropriate power levels, with an achievable power level of 2825 MWt attained. Following a review of the results of the testing program with the PNSC, Plant General Manager approval was obtained to operate at a steady state power level of 2825 MWt.

6.0 Testing Requirements

Throughout the following subsections, the test numbers and titles are consistent with the original Startup Test Specification.

Section 7.0 identifies the UFSAR Section 14.2 tests that were not performed as part of the EPU Implementation Testing program. Each specific test which was not performed is identified and is followed by a brief discussion of the basis for concluding the test was not necessary.

Section 8.0 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 8.0 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 8.0. These power levels are given a corresponding letter designation. The Section 8.0 tests indicate the power level at which they were performed via this letter designation.

7.0 UFSAR Section 14.2 Tests Not Required for EPU Implementation

7.1 Test No. 3 – Fuel Loading

This test demonstrates the ability to safely and efficiently load fuel to the full core size. Fuel loading is performed during every refueling outage in accordance with established procedures. EPU has no impact on this evolution; therefore, no additional testing was required for EPU.

7.2 Test No. 4 – Full Core Shutdown Margin

The purpose of this test is to demonstrate that the reactor will be sub-critical throughout the fuel cycle with any single control rod fully withdrawn. Technical Specifications compliance ensures that adequate shutdown margin is available. Therefore, this test is not specifically required for EPU.

7.3 Test No. 5 – Control Rod Drive (CRD) System

The purpose of this test is to demonstrate that the CRD system operates properly over the full range of primary coolant temperatures and pressures from ambient to full power conditions. EPU did not involve a reactor pressure and/or coolant temperature increase. Therefore, no additional testing was required for EPU.

7.4 Test No. 6 – Source Range Monitor (SRM) Response and Control Rod Sequence

The purpose of this test is to demonstrate that the operational sources, SRM instrumentation, and rod withdrawal sequences provide adequate information to

achieve criticality in a safe and efficient manner. Compliance with Technical Specifications for SRM operability and Control Rod withdrawal sequence ensures proper system response and control. Therefore, no additional testing for determination of SRM Response and Control Rod Sequence in support of the EPU was required.

7.5 Test No. 7 – Intermediate Range Monitor (IRM) Performance

The purpose of this test is to ensure the ability to adjust the IRMs to obtain optimum overlap with the SRMs and the Average Power Range Monitors (APRMs). Compliance with Technical Specifications for IRM operability during unit startup ensures proper system response and control. Therefore, no additional testing for determination of IRM response in support of the EPU was required.

7.6 Test No. 8 – Local Power Range Monitor (LPRM) Calibration

The purpose of this test is to calibrate the LPRMs to read proportional to the neutron flux of the core. The LPRM system was not modified as part of the EPU implementation. Compliance with plant Technical Specification ensures proper LPRM operation. Therefore, specific testing associated with EPU was not required.

7.7 Test No. 10 – Process Computer

This test verifies the performance of the process computer under plant operating conditions. EPU does not affect the functions of the process computer; however, some input variables required updates. This test was not specifically required for EPU.

7.8 Test No. 11 – Reactor Core Isolation Cooling (RCIC) System

This test verifies the proper operation of the RCIC system over its required operating range of reactor pressure conditions. The RCIC system was not modified as part of the EPU implementation. EPU was accomplished without an increase in reactor operating pressure. Therefore, no additional testing of the RCIC system was required for EPU implementation. Compliance with Technical Specifications for RCIC operability during unit startup and operation ensures proper system response and control.

7.9 Test No. 12 – High Pressure Coolant Injection (HPCI) System

This test verifies the proper operation of the HPCI system over its required operating range of reactor pressure conditions. The HPCI system was not modified as part of the EPU implementation. EPU was accomplished without an increase in reactor operating pressure. Therefore, no additional testing of the HPCI system was required for EPU implementation. Compliance with Technical

Specifications for HPCI operability during unit startup and operation ensures proper system response and control.

7.10 Test No. 13 – Selected Process Temperatures

This test establishes the minimum recirculation pump speed needed to maintain the water temperature in the bottom head of the reactor pressure vessel within a specified tolerance of the reactor coolant saturation temperature determined by reactor pressure. This test ensures the measured bottom head drain line thermocouple is adequate to measure the bottom head coolant temperature during normal operations. Temperature stratification limits are defined in Technical Specifications. This test was not required for EPU.

7.11 Test No. 14 – System Expansion

The purpose of this test is to verify that the reactor drywell piping system is free and unrestrained with regard to thermal expansion, and that suspension components are functioning in the specified manner. The test also provides data for calculation of stress levels in nozzles and welds. An analysis for EPU conditions was performed and verified piping systems were acceptable for EPU conditions.

7.12 Test No. 15 – Core Power Distribution

This test confirms core power distribution in three dimensions, confirms reproducibility of computer-stored Transversing Incore Probe (TIP) system segment-averaged values, and determines core power symmetry. Existing site procedures verify proper TIP operation and core power symmetry. EPU does not significantly impact these parameters. TIP operation is not affected by EPU. Therefore, special testing in support of EPU is not required.

7.13 Test No. 17 – Steam Production

This test demonstrates the ability to operate continuously at rated reactor power, demonstrating that the Nuclear Steam Supply System (NSSS) provides steam at a sufficient rate and quality. Evaluation determined that steam production would be provided at sufficient rate and quality to support EPU implementation. No specific testing in support of EPU implementation was required.

7.14 Test No. 18 – Flux Response to Rods

The purpose of this test is to demonstrate stability in the power-reactivity feedback loop with increasing reactor power and to determine the effect of control rod movement on reactor stability. Implementation of EPU had no effect on this response and no specific testing in support of EPU implementation was required.

7.15 Test No. 20 – Feedwater System

The purpose of this test is to demonstrate acceptable reactor water level control, to evaluate and adjust feedwater controls, to demonstrate the capability of the automatic flow runback feature to prevent low water level scram following a trip of one feedwater pump, to demonstrate adequate response to feedwater heater loss, and to demonstrate general reactor response to inlet subcooling changes. During initial plant startup, the objectives were demonstrated through the performance of testing. The testing performed for EPU implementation is included in Section 8.0. The tests that were not performed for EPU are:

Loss of Feedwater Heating (LOFH)

The LOFH test performed during initial startup testing demonstrates adequate response to LOFH. The transient event is caused by an equipment failure or operator error that causes isolation of one or more feedwater heaters. Plant-specific transient analyses from previous cycles demonstrate acceptable response relative to fuel thermal limits; i.e., minimum critical power ratio (MCPR) and fuel overpower.

The LOFH transient was reanalyzed for EPU and fuel thermal limits were acceptable. Therefore, the LOFH test was not required to be performed.

Single Reactor Feed Pump Trip

This test verifies the capability of the automatic recirculation pump runback to prevent a low water level scram following a single reactor feed pump trip. For EPU implementation, power ascension was performed along the maximum rod line used prior to implementation and the recirculation pump runback circuitry was not altered in support of EPU. Based on the maximum rod line and recirculation runback circuitry not being affected by EPU implementation, specific testing relating to a single reactor feed pump trip was not required.

7.16 Test No. 21 - Bypass Valve Testing

The purpose of this test is to demonstrate the maximum power level at which the turbine bypass valves may be tested without causing a scram. The bypass valve test signal is a manually actuated signal that the EHC control system automatically adjusts to compensate for the demand changes resulting from the bypass valve testing. Established plant procedures are used for testing the bypass valves at previously established power levels. No additional specific EPU implementation testing was performed on the bypass valves.

7.17 Test No. 22 – Main Steam Isolation Valves (MSIVs)

The objectives of this test are:

- Functionally check the main steam isolation valves for proper operation at power.
- Determine reactor transient behavior during and following simultaneous full closure of the MSIVs
- Determine MSIV closure times.
- Determine the maximum power level at which a single valve closure can be made without scram.

The EPU was accomplished without a change in reactor operating pressure. Based on this, impact on MSIV performance is not expected to change. Maximum power at which a single MSIV closure may be accomplished has not been re-evaluated following EPU implementation, with the previously identified power (MWt) being applied as the power level for MSIV testing.

Testing of simultaneous full closure of the MSIVs was not performed based on the NRC concurrence of test waiver as stated in the Safety Evaluation for Amendment 247, Paragraph 10.4.4.4, dated May 31, 2002.

7.18 Test No. 23 – Relief Valves

The purposes of this test are to verify proper operation of the primary system relief valves, determine their capacity and response characteristics, and verify their proper seating following operation. There was no change in valve operation affected by EPU, based on no change in reactor pressure. Technical Specifications establish the acceptance criteria for the relief valves, which are controlled via approved plant procedures. No additional testing for EPU implementation was required.

7.19 Test No. 24 – Turbine Stop Valve Trip

The purpose of this test is to demonstrate the response of the reactor system to a fast closure of the turbine-generator stop valves and to evaluate the response of the bypass, relief valve, and reactor protection systems. Implementation of EPU did not affect the EHC pressure response, relief valve setting, or the reactor protection system operation. Therefore, specific Turbine Stop Valve Trip testing was not required to support EPU implementation.

7.20 Test No. 25 – Generator Load Reject

The purpose of this test is to demonstrate the response of the reactor and its control systems to a protective trip of the main generator. Based upon analysis of the Unit 2 Load Reject event in September 2000, Progress Energy Carolinas, Inc. (PEC) notified the NRC of the intent to not perform this test. The NRC concurred with this position in the Safety Evaluation associated with issuance of EPU.

7.21 Test No. 26 – Flow Control

The purpose of this test is to determine the plant response to changes in recirculation flow and thereby adjust the local control loops and to examine the plant overall load following capability in order to establish correct interfacing of the pressure and flow control systems, including final settings of the master and local flow controllers. The master flow controllers are no longer a part of the plant recirculation system, eliminating that portion of the test requirements. Implementation of EPU did not impact the other portions of the recirculation flow control system. Therefore, specific testing for EPU implementation was not required to be performed.

7.22 Test No. 27 – Recirculation System

The purpose of this test is to confirm the margin from limits during single pump trips and restarts, to collect recirculation system performance data, and to confirm that cavitation will not occur in the normal operating regions of the power/flow map. EPU implementation did not result in an increase in reactor recirculation and/or total core flow. Also, the cavitation protection limit associated with low flow conditions was not changed. Established plant procedures and compliance with Technical Specifications ensures proper operation of the Recirculation system. Based on evaluation for EPU implementation, Recirculation Pump trip testing was not performed.

7.23 Test No. 28 – Loss of Turbine Generator and Offsite Power

The purpose of this test is to demonstrate proper performance of the reactor and the plant electrical equipment and systems during the loss of auxiliary power transient. The performance of the electrical distribution system is confirmed by individual equipment tests (i.e., equipment protective relay settings), thus, an integrated test of the entire electrical distribution system is not required.

7.24 Test No. 29 – Recirc MG Set Speed Control

The purposes of this test are to determine the characteristics of the recirculation control system to obtain acceptable speed control system performance of the controller elements and to determine the maximum allowable pump speed. The Recirculation MG control system is not changed for EPU, thus specific testing of the system is not required.

7.25 Test No. 31 – Shutdown From Outside the Control Room

The purpose of this test is to demonstrate the capability to shutdown the plant from outside the control room. EPU does not alter the capability of the reactor to be shut down from outside the main control room; therefore, this test was not required to be performed.

7.26 Test No. 32 – Residual Heat Removal System

The purpose of this test is to demonstrate the ability of the Residual Heat Removal (RHR) system to remove residual and decay heat from the nuclear system so that refueling and nuclear servicing can be performed. The capability of the RHR system to remove residual and decay heat has been demonstrated over the life of the plant. The effect of EPU on system performance is limited to an increase in reactor cooldown time; therefore, RHR system testing was not required to be performed.

7.27 Test No. 33 – Turbine Stop Valve Testing

The purpose of this test is to determine the maximum power at which the turbine stop valves may be tested without resulting in a unit trip. Based on limitations of testing of other valves in the steam path, previously established power level for turbine stop valve testing has been adopted; therefore, turbine stop valve testing at higher power levels has not been performed.

7.28 Test No. 34 – Recirculation System Flow Calibration

The purpose of this test is to perform a complete calibration of the installed recirculation system flow instrumentation. Based on the flow instrumentation not being affected by EPU implementation, no specific testing associated with the EPU was required.

7.29 Test No. 35 – Water Level Measurements

The purpose of this test is to verify the calibration and channel agreement of the various water level instruments under various plant conditions. The level instrumentation was not affected by the EPU implementation; therefore, no specific testing was required to be performed.

7.30 Test No. 36 – Reactor Water Cleanup

This test demonstrates specific aspects of the mechanical operability of the Reactor Water Cleanup (RWCU) system. EPU did not change the operating characteristics (e.g., pressure, temperature, flow) of the system; therefore, no specific system testing was required to be performed.

8.0 UFSAR Section 14.2 Tests Required For EPU

8.1 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 the previous maximum power and at uprated conditions to determine 1) the chemical and radiochemical quality of reactor water and reactor feedwater and 2) gaseous release.

Test Conditions: **L, R**

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 PEC chemistry program.

Level 2: NA

Results:

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

8.2 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 and at site boundary monitoring locations to assess the impact of EPU on actual dose rates.

Test Conditions: **L, R**

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, at in-plant locations, were conducted at the EPU maximum power level achieved for the current operating cycle and compared to the levels observed prior to EPU implementation. Increases in radiation does 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.

8.3 Test No. 9 – APRM Calibration

The purpose of this test is to calibrate the Average Power Range Monitor (APRM) system to the EPU power level.

Each APRM channel reading was adjusted to be consistent with the core thermal power, referenced to the uprated licensed power level, as determined from the thermal heat balance.

Test Conditions: **L**

Acceptance Criteria:

Level 1:

a) The APRM channels must be calibrated to read equal to or greater than the actual core thermal power.

b) Technical Specifications and Fuel Warranty limits on APRM scram and rod block setpoints shall not be exceeded.

c) In the startup mode, all required APRM channels must produce a scram signal at less than or equal to 22.7% of rated thermal power.

Level 2: NA

Results:

All APRMs were calibrated to support operation at the EPU conditions. All acceptance criteria were met.

8.4 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: **G, L, N, R**

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.

8.5 Test No. 19 – EHC Pressure Step Changes/EHC Regulator Failover

The purpose of this test is to 1) confirm the adequacy of the settings of the pressure control loop by inducing transients in the reactor pressure control system (i.e., EHC) using the pressure regulators, 2) demonstrate the takeover capability of the backup pressure regulator via simulated failure of the controlling pressure regulator, and 3) validate the turbine first stage pressure scram bypass setpoint.

Test Conditions:

Turbine First Stage Pressure Scram Bypass	**A**
EHC Pressure Regulator Step Changes	**E, G, L, M, P**
EHC Pressure Regulator Failover	**E, L**

Acceptance Criteria:

Level 1:
a) Turbine First Stage Pressure Scram Bypass will disable at $\leq$26% uprated power level.

b) The decay ratio must be less that 1.0 for each process variable that exhibits oscillatory response to pressure regulator changes.

Level 2:
a) The decay ratio of any oscillatory variable must be $\leq$0.5, with recommendation that each control system be adjusted to meet $\leq$0.25 unless there is an identifiable performance loss at higher power levels.

b) Pressure control system dead band, delay, etc., shall be small enough that steady state limit cycles, if any, shall produce turbine steam flow variations no larger than $\pm$0.5% of rated flow.

c) The response time from setpoint input until pressure peak must be within 20 seconds in the recirculation system manual mode.

d) The normal difference between pressure regulator setpoints must be small enough that the peak neutron and thermal flux and/or peak vessel pressure shall remain below the scram settings by 7.5% and 10 psi, respectively. This criterion is also applicable to pressure regulator failure tests.

Results:

During power ascension, turbine first stage pressure and reactor power were monitored and determination made that the first stage turbine pressure scram bypass was disabled prior to exceeding a reactor power of 26%.

At the power levels specified, EHC pressure step changes were performed with the "A" pressure regulator in service and, subsequently, the "B" pressure regulator in service. Additionally, at the power levels specified, EHC pressure regulator failover was performed, first from the "A" regulator to the "B" regulator and, then, from the "B" regulator to the "A" regulator.

All Level 1 and Level 2 criteria were met for all levels of testing (i.e., First Stage Turbine Pressure Scram Bypass, EHC Pressure Step Changes, EHC Regulator Failover Testing).

8.6 Test No. 20 – Feedwater System Testing

The purpose of the 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	**G, L, M, P**
Reactor Water Level Control	**B, C, E, G, L, M, P**

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: The system should have the following response characteristics to a ±4 inch or less level step change of the control outputs:

- Peak Overshoot (% of demand) ≤15%
- Time to 10% maximum ≤1.1 seconds
- Time from 10% to 90% maximum ≤1.9 seconds
- Settling time to within ±5% of final value ≤14 seconds
- Dead Time ≤2 seconds
- Decay Ratio ≤0.25

Results:

The test involved the introduction of level setpoint step changes and verifying the feedwater control system maintained system transient response 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.

Level 1 criteria were met at all test conditions.

Certain Level 2 criteria were not met for the 4 inch level changes. Specific criteria not consistently met were decay ratio, settling time, time to 10% of maximum, and time from 10% to 90% of maximum. The responsible engineer evaluated the overall performance of the system following the collating of the test data. Although the Level 2 criteria noted were not 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 excessive wear on the turbine throttle control linkages due to excessive response/hunting of the control mechanism. Station management accepted a recommendation to not change the tuning of the Digital Feedwater Control system, based on evaluation of system performance and resulting recommendations by the system engineer.

Related to the Feedwater Control System is the replacement of Feed Pump Steam Admission Control from an electric motor positioning scheme to a Woodward Governor control system. The specific acceptance criteria for this modification was a decay ratio for process variable response of less than 1.0. Testing for this modification was performed at 60% power with acceptance criteria being satisfied.

8.7 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: **C, F, G, H, J, K, L, M, P, R**

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 were monitored using 37 individual vibration channels with remote sensors during the power ascension, with no locations reaching 40% of the allowable. Evaluations determined that the resulting stress effect from the measured vibration was well within acceptance criteria. 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 negligible.

9.0 System Performance Monitoring

During power ascension following the B216R1 refueling outage up to the current power level of 2825 MWt, various parameters and equipment performance were monitored for proper operation. Included in this group were containment temperatures, MSIV pit temperature, main turbine thermal expansion, 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.

10.0 Summary

The Brunswick Steam Electric Plant (BSEP), Unit 2 Extended Power Uprate (EPU) Implementation was conducted starting on April 2, 2003. Appropriate equipment was tested and parameters monitored during the power ascension program up to the target

power level of 2825 MWt. 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 evaluated by a subject matter expert team and reviewed with the Plant Nuclear Safety Committee. Based on the results of the testing and monitoring, recommendation was made that Unit 2 be operated at a target power level of 2825 MWt with the recommendation being adopted by station management.

11.0 Tables

Table 1
Glossary of Terms

APLHGR	Average Linear Heat Generation Rate
APRMs	Average Power Range Monitors
BSEP	Brunswick Steam Electric Plant
COLR	Core Operating Limits Report
CRD	Control Rod Drive
EHC	Electro-hydraulic Control
EPU	Extended Power Uprate
HPCI	High Pressure Coolant Injection
IRM	Intermediate Range Monitor
LOFH	Loss of Feedwater Heating
LPRM	Local Power Range Monitor
LPU	Licensed Power Uprate
MCPR	Minimum Critical Power Ratio
MELLLA	Maximum Extended Load Line Limit Analysis
MG	Motor/Generator
MSIVs	Main Steam Isolation Valves
MWt	Megawatts Thermal
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
PNSC	Plant Nuclear Safety Committee
PUSAR	Power Uprate Safety Analysis Report, NEDC-33039P
RCIC	Reactor Core Isolation Cooling
RHR	Residual Heat Removal
RWCU	Reactor Water Cleanup
SPs	Special Procedures
SRM	Source Range Monitor
TIP	Transversing Incroe Probe
UFSAR	Updated Final Safety Analysis Report

TABLE 2: TEST CONDITIONS

Test	A[1]	B	C	D	E	F	G	H	J	K	L	M	N	P	R
Power Level MWt	570 to 720	660	1280	1535	1755	1900	2300	2365	2430	2495	2558	2680	2755	2805	2825
Test No. 1											✓				✓
Test No. 2											✓				✓
Test No. 9											✓				
Test No. 16							✓				✓		✓		✓
Test No. 19	✓				✓		✓				✓	✓		✓	
Test No. 20		✓	✓		✓		✓				✓	✓		✓	
Test No. 30			✓			✓	✓	✓	✓	✓	✓	✓		✓	✓

[1] First Stage Turbine Bypass data was collected at approximately 30 MWt intervals.