# EDWIN I. HATCH NUCLEAR PLANT

# UNIT 2

# EXTENDED POWER UPRATE STARTUP TEST REPORT
# for
# CYCLE 15

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**Edwin I. Hatch Nuclear Plant - Unit 2**
**Extended Power Uprate Startup Test Report**
**for**
**Cycle 15**

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ENCLOSURE

# EDWIN I. HATCH NUCLEAR PLANT - UNIT 2
# EXTENDED POWER UPRATE STARTUP TEST REPORT FOR CYCLE 15

## 1.0 EXECUTIVE SUMMARY

The Plant Hatch Unit 2 Extended Power Uprate Startup Test Report is submitted to the Nuclear Regulatory Commission (NRC) in accordance with regulatory commitments contained in Unit 2 Final Safety Analysis Report (FSAR) Section 13.6.4. The report summarizes the startup testing performed on Unit 2 following implementation of extended power uprate during the fourteenth refueling outage. Extended power uprate was implemented in accordance with Amendment No. 155 of Facility Operating License No. NPF-5. Unit 1 Amendment No. 214 will be implemented upon completion of the next refueling outage currently scheduled for Spring 1999.

Unit 2 was previously licensed to operate at a maximum reactor power level of 2558 MWt. The result of the extended power uprate program is a licensed power increase of 8%. The extended power uprate program followed an initial uprate program of 5% from the original licensed power level of 2436 MWt. The total increase in licensed reactor power from the original 2436 MWt to the extended power uprate level of 2763 MWt is 13.42%. All testing specified in Unit 2 FSAR Supplement 14B was addressed and evaluated for applicability to the new licensed power level.

The extended power uprate licensed thermal power represents the level at which all safety analyses and engineering evaluations were performed. The extended power uprate approach was to license the units at a power level that could realistically be achieved within several operating cycles. The maximum licensed power level was not realized during this startup due to turbine flow margin limitations. The power ascension testing program included seven Test Conditions starting with the original licensed power level up to the new 100% licensed power level of 2763 MWt. All tests were complete up to Test Condition 5, which represents 98% of the new licensed power level. Results of the testing and data gathering demonstrated that successful operation at the full licensed power level can be accomplished if the limitations of turbine control flow margin are removed. Therefore, if and when the unit operates at 99% or 100% of 2763 MWt, another startup test report will not be submitted to the NRC.

The Reactor Mode Switch was placed in STARTUP on November 7, 1998. The final synchronization to the grid was performed on November 9, 1998, marking the official end of the Unit 2 fourteenth refueling outage. All required extended power uprate startup tests were completed by January 28,1999. Special purpose procedures were written and implemented in combination with various surveillance test procedures described in this report. No unusual online adjustments were required for the following plant systems:

- Electrohydraulic Control (EHC) - Pressure Regulation.
- Feedwater.
- Reactor Recirculation.
- Reactor Core Isolation Cooling (RCIC).
- High Pressure Coolant Injection (HPCI).

All systems performed in a stable manner during both plant startup and transient testing. The unit is operating satisfactorily at 98% of the new licensed power level.

## 2.0 PURPOSE

This report, which is submitted in accordance with regulatory requirements, summarizes the testing performed on Unit 2 following the implementation of extended power uprate, which resulted in an increase in licensed reactor power equal to 13.42% of the original rated thermal power (RTP). The purpose of the Plant Hatch Unit 2 extended power uprate startup tests was to perform the applicable testing specified in Unit 2 FSAR Supplement 14B. All testing specified in Supplement 14B was evaluated for applicability to the new increased licensed power rating. Each test performed for extended power uprate is described in Section 6.0. Satisfactory completion of the startup tests demonstrated the acceptable performance of Unit 2 following the implementation of extended power uprate.

## 3.0 PROGRAM DESCRIPTION

The extended power uprate startup testing requirements were developed primarily from:

- Review of Unit 2 FSAR Supplement 14B.
- Section 10.3 of the General Electric (GE) Extended Power Uprate Safety Analysis Report for Edwin I. Hatch Nuclear Plant Units 1 and 2.
- GE Uprate Test Program recommendations.

The testing was conducted following the Unit 2 fourteenth refueling outage. The results of this testing verified the unit's ability to operate at 98% of the extended power uprate level. Where possible, testing took credit for existing surveillance procedures. Table 1 lists the FSAR Supplement 14B startup tests and delineates the testing performed for extended power uprate.

The majority of testing falls within the following categories:

- Verification the control systems (i.e., Condensate and Feedwater, EHC - Pressure Regulation, and Reactor Recirculation) are stable at extended power uprate conditions.
- Collection of data (i.e., radiation surveys, thermal performance, and plant steady-state) for comparison to previous plant rated conditions.

Table 2 presents the seven Test Conditions at which startup testing was performed. Reactor core flow can be any flow within the safe operating region of the power/flow map (Figure 1) that will produce the required power level. Testing at a given Test Condition was completed prior to proceeding to the subsequent Test Condition. Prior to increasing power, the Test Lead's approval was required, and prior to exceeding the old rated power level of 2558 MWt, the General Manager's approval was required.

## 4.0 ACCEPTANCE CRITERIA

1. Level 1 Variable or Criteria

   Data trend, singular value, or information relative to a Technical Specifications margin and/or plant design in a manner that requires strict observance to ensure the safety of the public, safe operation of the plant, continued operation at power, worker safety, and/or equipment protection.

   Failure to meet Level 1 criteria constitutes failure of the specific test. The Test Lead is required to resolve the problem, and if necessary, the test is repeated.

2. Level 2 Variable or Criteria

   Data trend, singular value, or information relative to system or equipment performance that does not fall under the definition of Level 1 criteria.

   Level 2 criteria do not constitute a test failure or acceptance; they serve as information only.

## 5.0 EXTENDED POWER UPRATE STARTUP TEST PROGRAM SUMMARY

The test program began when the Mode Switch was placed in STARTUP on November 8, 1998, and ended with all required extended power uprate startup tests complete on January 28, 1999. The unit was synchronized to the grid on November 9, 1998, marking the official end of the Unit 2 twelfth refueling outage. On November 23, 1998, 98% of the new uprated power level (2708 MWt) was first achieved.

The unit operates satisfactorily at 98 % of the new licensed power level. No unanticipated online adjustments were required to control the following systems:

- EHC - Pressure Regulation.
- Reactor Recirculation.
- RCIC.
- HPCI.

All systems performed in a stable manner. To provide additional reactor feedwater pump (RFP) suction pressure margin at higher power levels, the standby condensate booster pump was placed in operation.

Data collected at uprated conditions showed the increase in reactor power has little effect on reactor water chemistry and radiological conditions throughout the plant.

Table 3 identifies all the required extended power uprate startup tests and the Test Conditions in which each test was performed. No Level 1 test failures occurred. As stated previously, testing was performed up to Test Condition 5 (98% of RTP).

## 6.0 TESTING REQUIREMENTS

Each of the tests discussed in Unit 2 FSAR Supplement 14B was evaluated for applicability to extended power uprate. Throughout the following discussion, the test numbers and titles, and format are consistent with the FSAR.

1. Section 6.1 – This section identifies each Supplement 14B test not required to be performed for extended power uprate. The purpose of the test and the rationale for exempting the test from the power uprate program are discussed.

2. Section 6.2 – This section identifies each Supplement 14B test required to be performed for extended power uprate. The purpose of the test, a description of the test, Acceptance Criteria, and the test results are included.

3. Section 6.3 – This section identifies additional test/data collection that was performed to assess the performance of the unit at extended power uprate conditions. The purpose of the test, a description of the test, and the test results are included.

Table 1 identifies all the Supplement 14B tests and their applicability to extended power uprate. Table 2 lists the seven Test Conditions and the associated percent of licensed power level. Table 3 lists the Supplement 14B tests performed for extended power uprate and the Test Condition(s) for each test. Note that many surveillance tests similar to the original FSAR Chapter 14 tests are performed periodically, often during each startup. Therefore, the extended power uprate test program takes credit for many existing plant procedures.

## 6.1 <u>FSAR Supplement 14B Tests Not Required for Extended Power Uprate</u>

### 6.1.1 Test 14B.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 site procedures. Extended power uprate has no impact on this evolution; therefore, no additional testing was required for extended power uprate.

### 6.1.2 Test 14B.6 - Source Range Monitor Performance and Control Rod Sequence

The source range monitor (SRM) portion of this test demonstrates that the operational sources, SRM instrumentation, and rod withdrawal sequences provide adequate information to the operator during startup. The Technical Specifications and plant procedures ensure proper SRM response during startup. This portion of Test 14B.6 was not performed for extended power uprate.

The control rod sequence portion of Test 14B.6 demonstrates the ability to achieve, in a safe and efficient manner, criticality for each of the specified withdrawal sequences. The effect of rod motion on reactor power at various operating conditions is also determined. Extended power uprate does not change the manner in which criticality is achieved. The current withdrawal sequence is performed in accordance with the banked position withdrawal sequence (BPWS). The rod patterns for intermediate power levels up to the applicable power level are evaluated using a three-dimensional simulator code. This portion of Test 14B.6 was not specifically required for extended power uprate.

### 6.1.3 Test 14B.7 - Rod Sequence Exchange

This test demonstrates the ability to perform a representative sequence exchange of the control rod pattern at a significant power level. Extended power uprate does not change either the manner or methods used for sequence exchanges; thus, this test was not specifically repeated for extended power uprate.

### 6.1.4 Test 14B.9 - Intermediate Range Monitor Performance

This test ensures the ability to adjust the intermediate range monitors (IRMs) to obtain optimum overlap with the SRMs and the average power range monitors (APRMs). The Technical Specifications and plant procedures ensure proper IRM response during startup. This test was not specifically repeated for extended power uprate.

### 6.1.5 Test 14B.12 - Process Computer

This test verifies the performance of the process computer under plant operating conditions. Extended power uprate does not affect the functions of the process computer, however, some input variables required modification. This test was not specifically required for extended power uprate.

### 6.1.6 Test 14B.13 - Reactor Core Isolation Cooling System

This test verifies the proper operation of the RCIC System and provides baseline data for future surveillance testing. Acceptable RCIC System operation is periodically demonstrated during normal surveillance testing that includes adjustments for reactor dome pressure and the lowest safety relief valve (SRV) setpoint. Since extended power uprate is accomplished without changing reactor pressure, special testing was not required for extended power uprate.

### 6.1.7 Test 14B.14 - High Pressure Coolant Injection System

This test verifies the proper operation of the HPCI System at the operating pressure and provides baseline data for future surveillance testing. Acceptable HPCI System operation is periodically demonstrated during normal surveillance testing that includes adjustments for reactor dome pressure and the lowest SRV setpoint. Since extended power uprate is accomplished without changing reactor pressure, special testing was not required for extended power uprate

### 6.1.8 Test 14B.15 - Selected Process Temperatures

This test establishes the minimum recirculation pump speed needed to maintain water temperature in the bottom head of the reactor pressure vessel (RPV) within 145°F 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 the Technical Specifications. This test was not required for extended power uprate.

### 6.1.9 Test 14B.16 - System Expansion

This test verifies reactor drywell piping and major equipment are unrestrained with regard to thermal expansion. An analysis for extended power uprated conditions indicated the piping systems were acceptable for extended power uprate; therefore, further testing was not required.

### 6.1.10 Test 14B.17 - Core Power Distribution

This test determines core power distribution in three dimensions, confirms reproducibility of Traversing Incore Probe (TIP) System readings, and determines core power symmetry. Existing site procedures verify proper TIP operation and core power symmetry. Extended power uprate does not significantly impact these parameters. TIP operation is not affected by extended power uprate.

### 6.1.11 Test 14B.19 - 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. This test is the initial warranty run, which is not applicable to extended power uprate.

### 6.1.12 Test 14B.20 - Core Power - Void Mode Test

This test demonstrates stability in the power reactivity loop with increasing reactor power and determines the effect of control rod movement on reactor stability. Extended power uprate has only a minor impact on stability margin. Operation on a slightly higher flow control (rod) line is allowed. However, no testing related to thermal-hydraulic stability was specifically performed for extended power uprate.

### 6.1.13 Test 14B.22 - Feedwater Control System

The five objectives of this startup test are to:

- Demonstrate RPV water level control.
- Evaluate and adjust feedwater controls.
- Demonstrate the capability of the automatic flow runback feature to prevent a low water level scram following a single RFP trip.
- Demonstrate adequate response to feedwater heater loss.
- Demonstrate general reactor response to inlet subcooling changes.

During initial startup, these objectives were demonstrated through the performance of different tests. The tests performed specifically for extended power uprate are included in Section 6.2.22. The tests that were not performed for extended power uprate are as follows:

1. 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 show acceptable response relative to fuel thermal limits; i.e., minimum critical power ratio (MCPR) and fuel overpower.

   The LOFH transient was reanalyzed for extended power uprate, and fuel thermal limits were acceptable. Therefore, the LOFH test was not required for extended power uprate.

2. Single Reactor RFP Trip

   This test verifies the capability of the automatic recirculation pump runback to prevent a low water level scram following a single RFP trip. The only impact of extended power uprate on this design feature is that extended power uprate allows operation on a slightly higher flow control (rod) line. Therefore, the core power level will be slightly higher following the recalculation runback. This increase in power requires slightly higher flow from the remaining RFP to maintain level.

Prior to startup, transient analyses were performed to determine the required capacity of the remaining RFP. During startup, the actual pump capacity was verified to be larger than required for extended power uprate conditions. Therefore, tripping an RFP at high power was not necessary for extended power uprate.

### 6.1.14 Test 14B.23 - Turbine Valve Surveillance

This test demonstrates the ability of the pressure regulator to minimize disturbances to the reactor when either the turbine stop valves (TSVs) or the turbine control valves (TCVs) are closed. This test also demonstrates that the TSVs and the TCVs can be functionally tested at or near rated power without causing a scram.

Plant Hatch has years of experience testing individual TSVs and TCVs. During extended power uprate startup, the valves were tested, using existing site procedures, at power levels and pressures which experience shows no problems occur. This startup test was not specifically performed for extended power uprate.

### 6.1.15 Test 14B.24 - Main Steam Isolation Valves

The three objectives of this test are to:

- Functionally check the main steam isolation valves (MSIVs) for proper operation at selected power levels.
- Determine reactor transient behavior during and following simultaneous full closure of all MSIVs and following closure of one MSIV.
- Determine MSIV closure times.

Severe transient testing performed at high power during the initial startup demonstrates the adequacy of protection for these severe transients. Analysis shows that should these transients occur at extended power uprate conditions, the change in unit performance will be small; therefore, testing the unit's response to full closure of the MSIVs at the uprated power level was not required. MSIVs will continue to be surveillance tested per existing site procedures.

### 6.1.16 Test 14B.25 - Safety Relief Valves

This test verifies proper operation of the dual-purpose SRVs, including determination of capacity and verification of leaktightness following operation. SRV capacity was not affected by extended power uprate. This startup test, as described in the FSAR, was not specifically performed for extended power uprate.

### 6.1.17 Test 14B.26 - Turbine Trip and Generator Load Rejection Demonstration

This test demonstrates the response of the reactor and its control systems to protective trips initiated by the turbine and generator. Severe transient testing performed at high power levels during the initial startup demonstrated the adequacy of protection for these severe transients. Analysis shows that should these transients occur at uprated conditions, the change in unit performance will be small; therefore, testing the unit's response to turbine and generator trips at extended power uprate conditions was not required.

### 6.1.18 Test 14B.27 - Shutdown from Outside the MCR

This test demonstrates the ability to shut down the reactor from normal steady-state operating conditions to the point where cooldown is initiated and under control with reactor pressure and water level controlled from outside the main control room (MCR). Extended power uprate does not alter the capability of the reactor to be shut down from outside the MCR; therefore, this test was not repeated for extended power uprate.

### 6.1.19 Test 14B.28 - Flow Control

This test determines the plant's response to changes in recirculation flow and thereby, adjusts the local control loops. Also, the load following capability of the plant is established. Extended power uprate does not significantly affect either the recirculation flow control system or the licensed maximum core flow limits. Therefore, the recirculation flow control startup test was not required for extended power uprate.

### 6.1.20 Test 14B.29 - Recirculation System

The two objectives of this test are to:

- Determine the transient responses and steady-state conditions following recirculation pump trips (RPTs) and obtain jet pump performance data.
- Verify no recirculation system cavitation occurred.

This test determines the transient response during RPTs, flow coastdown, and pump restarts. Extended power uprate does not affect the ability of the Recirculation System to respond acceptably to these transients, as demonstrated during the initial startup test program. Therefore, further testing for extended power uprate was not required.

Extended power uprate modified the logic to speed limiter no. 2 to improve the plant's response to a single RFP event. A third runback feature was also implemented during the Unit 2 outage as a plant reliability feature. The third runback occurs on sensing low condensate booster or RFP suction pressure prior to the existing respective pumps' low suction trips. These features were functionally tested during startup testing as part of the design modification implementation procedures. Acceptable performance was demonstrated via the functional tests.

### 6.1.21 Test 14B.30 - Loss of Turbine-Generator and Offsite Power

This test demonstrates proper performance of the reactor, and plant electrical equipment and systems during the loss of auxiliary power transient. Extended power uprate does not change the ability of the electrical systems to function properly during a loss of the main turbine-generator and a loss of offsite power (LOSP). The ability of the reactor systems (e.g., HPCI and RCIC) to function properly at uprated conditions was demonstrated during normal system surveillance procedures. This test was not specifically required for extended power uprate.

### 6.1.22 Test 14B.33 - RWC System

This test demonstrates the specific aspects of the mechanical operability of the Reactor Water Cleanup (RWC) System. Detailed evaluations show the impact of the new licensed power causes minor changes in RWC System operating requirements. These changes are well within the system's design parameters. No specific RWC testing was performed for extended power uprate.

### 6.1.23 Test 14B.34 - RHR System

This test demonstrates the ability of the Residual Heat Removal (RHR) System to:

1. Remove decay heat from the NSSS so refueling and servicing can be performed.

2. Condense steam while the reactor is isolated from the main condenser.

The capability of the RHR System to remove residual and decay heat has been demonstrated many times over the years. Extended power uprate's effect on system performance is a small increase in reactor cooldown time. The RHR System will continue to perform acceptably. The steam condensing mode of RHR removed and thus, is not a factor. Therefore, the RHR System startup test was not performed for extended power uprate.

**6.1.24 Test 14B.35 - Offgas System**

This test demonstrates the ability of the Offgas System to operate within Technical Specifications limits. Extended power uprate was determined to have only a minimal impact on the Offgas System; therefore, no additional testing was required.

**6.1.25 Test 14B.36 - MSIV Leakage Control System**

This system was removed in 1994.

**6.1.26 Test 14B.37 - Hydrogen Recombiners**

This test takes credit for pre-operational testing on the Recombiner System. The impact of extended power uprate on system performance was determined to be minimal and, at most, would require earlier manual initiation of the recombiners following a large-break loss of coolant accident (LOCA). No special testing for extended power uprate was required.

**6.1.27 Test 14B.38 - Primary Containment Cooling System**

This test demonstrates the ability of the Primary Containment Cooling System to maintain drywell temperatures within the temperatures assumed in the safety analysis. Extended power uprate was expected to have a minimal impact on drywell temperature. The ability of the cooling system to keep average drywell gas temperature below 150°F has been demonstrated for years. This Technical Specifications requirement was verified at uprated conditions, and no additional testing was required.

**6.2 FSAR Supplement 14B Tests Required for Extended Power Uprate**

**6.2.1 Test 14B.1 - Chemical and Radiochemical Tests**

Purpose: To determine the effects of extended power uprate on reactor coolant chemistry.

Description: Chemical and radiochemical samples were taken in accordance with plant procedures at 92.5%, 95%, 97.2%, and 98% of the new licensed power level.

Acceptance Criteria:

*Level 1:* Per Procedure 60AC-HPX-010-0S, Plant Sampling and Monitoring Program, and the Unit 2 Technical Requirements Manual (TRM).

*Level 2:* None.

Results: Procedure 60AC-HPX-010-0S was performed satisfactorily at 92.5%, 95%, 97.2%, and 98% of the new licensed power level. All Acceptance Criteria were satisfied, and results indicate an expected acceptable performance at 100% of the new licensed power level.

Chemistry data, as shown below, for extended power uprate were taken at normal chemistry conditions.

Chemistry Results

| Primary Reactor Coolant | Actual Data | | | | Acceptance Criteria |
|---|---|---|---|---|---|
| | 92.5% | 95% | 97.2% | 98% | |
| Conductivity (µmhos/cm$^2$) | 0.14 | 0.14 | 0.015 | 0.14 | ≤ 2.0 |
| Chlorides (ppb) | 2.2 | 0.9* | 1.7 | 1.1 | ≤ 200 |

*Grab sample.

### 6.2.2 Test 14B.2 - Radiation Measurements

Purpose: To measure radiation levels at selected locations and power conditions during plant operation to ensure the protection of plant personnel and continual compliance with the guidance of 10 CFR 20.

Description: Radiation levels were measured in accordance with plant procedures at various locations within the plant at 92.5%, 95%, 97.2%, and 98% of the new licensed power level.

Acceptance Criteria:

*Level 1:* Radiation doses of plant origin and occupancy times of personnel in radiation zones are controlled consistent with the guidance of 10 CFR 20, Standards for Protection Against Radiation.

*Level 2:* None.

Results: Radiation surveys were conducted in accordance with applicable sections of Departmental Instruction DI-RAD-03-1087N, Survey/Inspection Frequency and Work Scheduling. The radiation data were taken at normal water chemistry conditions. The dose rates were comparable to those experienced at the previous licensed power level. No postings were changed as a result increasing power. Radiation dose rates remain within the guidelines of 10 CFR 20.

### 6.2.3 Test 14B.4 - Shutdown Margin

Purpose: To demonstrate that throughout the fuel cycle, the reactor will be subcritical with the analytically determined highest-worth control rod capable of being fully withdrawn and all other rods fully inserted.

Description: Shutdown margin (SDM) demonstrations were performed in accordance with Procedure 42CC-ERP-010-0S, Shutdown Margin Demonstration. The demonstration was performed analytically during the Cycle 15 beginning of cycle (BOC), using an insequence critical control rod with the reactor core in a Xenon-free state. Correction factors were used to adjust to startup conditions.

Acceptance Criteria:

*Level 1:* SDM is $\geq 0.38\% \ \Delta k/k + R$, as specified in the Technical Specifications and Procedure 42CC-ERP-010-0S.

*Level 2:* None.

Results: For Unit 2 Cycle 15, the required SDM was $> 0.38\% \ \Delta k/k + R$. (SDM is lowest at BOC conditions; therefore, $R = 0\%$.) Demonstration of SDM was performed during withdrawal of an insequence control rod rather than solely by calculation.

As Unit 2 reached criticality, SDM was calculated in accordance with Procedure 42CC-ERP-010-0S. Cycle 15 SDM was determined to be $1.934\% \ \Delta k/k$, thus satisfying the Level 1 Acceptance Criteria.

### 6.2.4 Test 14B.5 - Control Rod Drive

Purpose: To demonstrate the control rods meet Technical Specifications requirements for scram times.

Description: Scram timing of control rods was performed in accordance with Procedure 42SV-C11-003-0S, Control Rod Scram Testing. Control rod drive (CRD) timing was performed in accordance with Procedure 34SV-C11-004-2S, CRD Timing.

Acceptance Criteria:

*Level 1:* Per Procedure 42SV-C11-003-0S and applicable Technical Specifications.

*Level 2:* Per Procedure 34SV-C11-004-2S.

Results: Scram time testing was performed for selected control rods during either the RPV leakage test or < 40% of licensed thermal power. Per Procedure 42SV-C11-003-0S, all Level 1 Acceptance Criteria were satisfied. The Scram

Time Acceptance Criterion is the required scram insertion time from the fully withdrawn position to the specified notch position. The results of the average notch insertion times for all rods are shown below. An individual control rod that fails to meet criteria is declared a SLOW rod. However, all 137 control rods met the Acceptance Criteria.

Scram Time Testing Results

| Position Inserted from Fully Withdrawn | Average Notch Insertion Time (sec) | Acceptance Criteria (sec) |
|---|---|---|
| 46 | 0.270 | 0.44 |
| 36 | 0.826 | 1.08 |
| 26 | 1.399 | 1.83 |
| 06 | 2.592 | 3.35 |

CRD timing data for insertion and withdrawal speeds met the Level 2 Acceptance Criteria of 38.4 sec to 57.6 sec specified in Procedure 34SV-C11-004-2S. For CRDs with an adjusted drive speed, the criteria ranged from 43.2 sec to 52.8 sec. The withdrawal speed of control rods 26-35 and 38-27 could not be adjusted within the timing criteria. A Deficiency Card was initiated to ensure maintenance during the next outage. An engineering evaluation was performed, and the results indicated the condition will not impact the rod withdrawal error analysis.

### 6.2.5 Test 14B.8 - Water Level Measurement

Purpose: To check the wide- and narrow-range RPV water level instrumentation.

Description: A channel check of various water level instruments was performed at all Test Conditions.

Acceptance Criteria:

*Level 1:* None.

*Level 2:* Narrow-range water level instruments agree within either $\pm$ 1.5 in. of the average reading. Wide-range indicators agree within $\pm$ 6 in. of each other.

Results: The wide-range indicators were in agreement for all Test Conditions performed. The narrow-range indicators agreed within 1.8 in. for all Test Conditions. This variance was outside the Level 2 Acceptance Criterion; however, normal operating procedures allow a $\pm$ 4 in. agreement for these indicators. Therefore, the results of this test are acceptable.

### 6.2.6 Test 14B.10 - Local Power Range Monitor Calibration

Purpose: To calibrate the local power range monitors (LPRMs).

Description: The LPRM channels were calibrated to make the LPRM readings proportional to the neutron flux in the narrow-narrow water gap at the chamber elevation. This calibration was performed in accordance with Procedures 34SO-C51-001-0S, TIP System Operation; 42CC-ERP-003 0S, LPRM Calibration Current Calculation; and 42CC ERP-014-0S, Reactor Engineering Cycle Startup Tasks.

Acceptance Criteria: *Level 1:* Per Procedure 42CC-ERP-003-0S.

*Level 2:* None.

Results: Using site procedures, LPRMs were successfully calibrated at 98% of the new licensed power level. Average LPRM gain adjustment factor values for all operable LPRM channels were within specified limits.

### 6.2.7 Test 14B.11 - Average Power Range Monitor Calibration

Purpose: To calibrate the APRMs to actual core thermal power, as determined by a heat balance.

Description: Each APRM channel reading was adjusted to be consistent with core thermal power, as determined by the heat balance. This calibration was performed in accordance with Procedure 34SV-SUV-021-0S, APRM Adjustment to Core Thermal Power.

Acceptance Criteria: *Level 1:* At least two or more APRMs per RPS trip system are calibrated to RTP. These readings agree with heat balance values within $\pm$ 2%.

*Level 2:* None.

Results: APRM gain adjustments were performed at different power levels during the Extended Power Uprate Startup Test Program. Each adjustment was completed satisfactorily, and no problems occurred during the tests.

### 6.2.10 Test 14B.18 - Core Performance

Purpose: To evaluate core performance parameters to ensure plant thermal limits are maintained during the ascension to rated conditions.

Description: Core thermal power was measured at all Test Conditions up to 98 % of the new rated power, using the current plant methods of monitoring reactor power.

In accordance with Procedure 34SV-SUV-020-0S, Core Parameter Surveillance, demonstration of the fuel thermal margin was performed at each Test Condition. Fuel thermal margin was projected to the next test point to show expected acceptance margin and was satisfactorily confirmed by the measurements taken at each test point before advancing further.

Acceptance Criteria: *Level 1:* The following thermal limits are ≤ 1.000:

- MFLPD (Maximum Fraction of Limiting Power Density)
- MFLCPR (Maximum Fraction of Limiting Critical Power Ratio)
- MAPRAT (Maximum Average Planar Linear Heat Generation Rate Fraction)

*Level 2:* None.

Results: Thermal limits were continuously monitored during power ascension. The surveillance procedure was performed satisfactorily at each Test Condition, thus meeting all Acceptance Criteria. Results of various power levels are as follows:

Thermal Limit Power Levels

| Thermal Limit | Power Level | | | |
|---|---|---|---|---|
| | 88% | 92.6% | 95.1% | 98% |
| MFLCPR | 0.907 | 0.955 | 0.943 | 0.964 |
| MFLPD | 0.801 | 0.858 | 0.857 | 0.886 |
| MAPRAT | 0.867 | 0.889 | 0.882 | 0.938 |

### 6.2.11 Test 14B.21 - Pressure Regulator

Purpose:

1. To confirm recommended pressure control system tuning parameters provide acceptable performance by analysis of the transients induced in the reactor pressure control system by means of pressure step input to the pressure regulators.
2. To demonstrate affected plant parameters are within acceptable limits during pressure regulator-induced transients.
3. To verify variation in incremental regulation is within acceptable limits (linear).

Description: The pressure regulator testing was performed in accordance with Special Purpose Procedure 17SP-102892-QP-1-2S, EHC Pressure Regulator Test for Extended Power Uprate. The pressure control system settings were verified to be within the acceptable limits per the guidance of Service Information Letter (SIL) 589, "Pressure Regulator Tuning."

During startup, 3- and 6-psig step changes in reactor pressure were simulated, and the resulting transients were recorded. The data for each step change were analyzed for acceptable performance and scram margins prior to performing the next increased pressure step change. Step changes were first performed with pressure regulator "A" in control and second with pressure regulator "B" in control. This test was performed with the bypass valves controlling reactor pressure (~ 18% power) at intermediate power levels of 78, 82%, and 95%.

Starting at ~ 150 MWe, steam flow, MWe, first-stage pressure, and pressure regulator output ($E_L$) were recorded at every 2% power increase up to 98% of the new licensed power level. The data were plotted to confirm pressure regulation linearity.

Acceptance Criteria:

*Level 1:* The transient response of the turbine inlet (throttle) pressure to any test input cannot diverge (decay ratio $\leq$ 1). This can be visually verified by observing that the successive peaks of the same polarity are of equal or decreasing amplitude.

*Level 2:*

1. The decay ratio of the turbine inlet (throttle) pressure is $\leq$ 0.25 when operating above the minimum core flow of the master flow control range. Below the minimum core flow, the decay ratio must be $\leq$ 0.50. The decay ratio of each control system should be adjusted to $\leq$ 0.25, unless a performance loss at higher power levels is identified.

2. The response time from pressure setpoint input until the pressure peak of the turbine inlet pressure is $\leq$ 10 sec.

3. Pressure control system deadband and delay are small enough that steady-state limit cycles (if any) produce steam flow variations no larger than $\pm$ 0.5% of rated steam flow.

4. Peak vessel neutron flux and pressure remain below scram settings by 7.5% and 10 psig, respectively.

Results: Selected data obtained during each Test Condition are summarized in the Tables 4 and 5.

The system response to step changes at each power level was satisfactory. No signs of divergence or oscillations occurred. Pressure response time and margins to scram setpoints were adequate in all cases. No limit cycles were observed. All Level 1 and Level 2 Acceptance Criteria were satisfied.

Pressure regulator linearity was recorded at every 2% power increase by comparing pressure regulator output ($E_L$) to MWe and turbine first-stage pressure. Regulator output remained linear.

### 6.2.12 Test 14B.22 - Feedwater Control System

Purpose: To verify the Feedwater Control System has been adjusted to provide acceptable reactor water level control at extended power uprate conditions. Section 6.1.13 discusses the five objectives of the original startup test and identifies the tests that were not be repeated for extended power uprate.

Description: The Feedwater Control System was modified for extended power uprate to ensure the Condensate and Feedwater System can provide a reliable steady-state supply of feedwater at the new licensed power level, as well as maintain the ability to deliver an additional 5% flow for analyzed transients. Proper operation of the Feedwater Control System was demonstrated via functional testing of the design modification. Functional testing of the modified controls was performed in accordance with Special Purpose Procedure 17SP-042198-PK-1-2S, DCR 97-049 Dynamic FT. Single RFP capacity was demonstrated during the performance of Special Purpose Procedure 03SP-091998-SA-1-2S, RFP Capability Test. Performance of these tests was integrated into the power ascension testing for extended power uprate.

The reactor feedpump turbine (RFPT) electrical stops were increased slightly prior to startup to compensate for extended power uprate operation on higher flow control (rod) lines.

I. Step Changes

Small step changes in water level (2 to 5 in.) were inserted to evaluate level control stability and any oscillatory response. Single-pump tests were conducted at lower power (~ 45% power), and dual-pump tests were performed at ~ 68% and 95% of the new licensed power level.

Acceptance Criteria:

*Level 1:* Level control system-related variables contain oscillatory modes of response. In these cases, the decay ratio for each controlled mode of response is $\leq 0.25$.

*Level 2:* None.

Results: Feedwater stability testing was performed at power levels of 45%, 68%, and 95%. Both 2-in. and 5-in. positive and negative level setpoint changes were input, and system response was monitored. These step changes were performed in both single-element and three-element control. System response was not oscillatory and showed no signs of divergence. The 95% power level test was not completed, because the RPV water level demand caused a condensate booster pump and RFP low suction pressure condition. However, the system controls at the 95% power level test were not oscillatory. The condensate booster pumps' and RFPs' low suction runback time delays were adjusted to accommodate the low suction pressure condition. All Acceptance Criteria related to system stability were satisfied.

II. RFP Capacity

The capacity of one RFP was verified during startup to determine the maximum power level at which one RFP can maintain RPV water level. The purpose of this test is to help determine if one RFP, in conjunction with a Reactor Recirculation System runback, can maintain RPV water level above the low RPV water level scram setpoint in the event of an RFPT trip.

Acceptance Criteria:

*Level 1:* None.

*Level 2:* RPV water level, RFPT speed and vibration, and RFP suction pressure remain within the limits specified below.

Results: The test was terminated at 71.4% the new licensed power level. Key parameters collected during this test are tabulated below.

Key Parameter Results

| Parameter | Parameter Value | Parameter Limit |
|---|---|---|
| Reactor thermal power (MWt) | 1977 | NA |
| RPV water level (in.) | 40 | ≥ 34 in. |
| RFPT speed (rpm) | 5700 | ≤ 5800 rpm |
| RFP suction pressure (psig) | 360 | ≥ 250 psig |
| RFPT vibration (mils) | 1.5 | < 4.5 mils |

### 6.2.13 Test 14B.32 - Recirculation System Flow Calibration

Purpose: To perform a calibration of the installed Recirculation System flow instrumentation, including specific signals to the plant process computer.

Description: At operating conditions that allow the Recirculation System to operate at the speeds required for rated flow at 100% uprated power, the jet pump flow instrumentation was adjusted to provide correct flow indication based upon jet pump flow. The total core flow signal to the process computer was calibrated to accurately read the total core flow. This recalibration of the Recirculation System was performed in accordance with Procedure 57CP-CAL-271-2S, Core Flow Measurement. The recirculation pump stops were adjusted, as required.

Acceptance Criteria: *Level 1:* Per Procedure 57CP-CAL-271-2S.

*Level 2:* None.

Results: Core flow calibration was performed per site procedures. Data were collected. Core flow calculations were performed, and the current M-ratios were determined. Jet pump flow summer amplifier gain adjustment factors were calculated and evaluated for reasonableness. Required adjustments were made in accordance with site procedures. All Acceptance Criteria were met.

Existing instrumentation associated with the recirculation pumps (e.g., recirculation pump motor vibration alarms) were monitored, and no indications of high vibration were observed.

### 6.2.14 Test 14B.31 - Drywell Piping Vibration

Purpose: To verify the acceptability of the vibration characteristics of the main steam and recirculation piping.

Description: The vibration of the main steam and feedwater piping was monitored during startup.

Results: High temperature accelerometers were installed in the drywell and condenser bay at selected locations considered to be most affected by the increase in steam/feed flow. The results of the monitoring program concluded the following:

1. Overall velocity levels were well below acceptable levels.

2. No noticeable trend in the vibration relative to power level occurred.

3. Vibration levels at most of the measurement locations were lower at 98% of the new licensed power level than at the previous maximum licensed power level.

4. Although the new maximum licensed power level was not achieved during the startup testing, the trend data indicate no significant change in the vibration levels for the 98% power level will occur.

## 6.3 Additional Testing

### 6.3.1 Steady-State Data Collection

Purpose: To obtain steady-state data of important plant parameters during startup.

Description: The selected data taken at power levels greater than the previous maximum licensed power level were extrapolated to predict conditions at 100% of the new licensed power level.

Results: Data were collected for over 100 plant parameters at each Test Condition. The data tracked very well. Extrapolations were made for various instruments recording turbine first-stage pressure, total reactor steam flow, condensate booster pump suction, RFP suction, reactor feedwater temperatures, and TCV positions.

At Test Condition 5, reactor steam dome pressure was 1035 psig, and turbine throttle pressure was 985 psig. The steamline pressure drop closely matched pre-test analyzed conditions.

### 6.3.2 Thermal Performance

Purpose: To obtain steady-state data on thermal performance when the unit reaches original 100% of power.

Description: Thermal performance data were collected at steady-state conditions at up to 98% of the new licensed power level. The thermal performance data were collected in accordance with special purpose procedures. This test was designed to baseline the thermal performance of Unit 2 at uprated conditions and determine the gross/net generator electrical output change that occurs as a result of implementing extended power uprate. No Acceptance Criteria apply to this test.

Results: The test results were corrected to a constant condenser pressure of approximately 3.5 in. HGA to allow a consistent comparison of the tests with the design heat balance. The corrected unit load increase from the initial uprate to the extended power rate is ~ 60 MWe. The electrical output at the maximum tested power level was ~ 911 MWe.

TABLE 1

UNIT 2 FSAR SUPPLEMENT 14B TESTS (SHEET 1 OF 2)

| FSAR Test No. | Test | Required for Extended Power Uprate |
|---|---|---|
| 1 | Chemical and Radiochemical | Yes[a] |
| 2 | Radiation Measurements | Yes[a] |
| 3 | Fuel Loading | No |
| 4 | Shutdown Margin | Yes[a] |
| 5 | Control Rod Drive | Yes[a] |
| 6 | SRM Performance and Control Rod Sequence | No |
| 7 | Rod Sequence Exchange | No |
| 8 | Water Level Measurement | Yes[a] |
| 9 | IRM Performance | No |
| 10 | LPRM Calibration | Yes[a] |
| 11 | APRM Calibration | Yes[a] |
| 12 | Process Computer | No |
| 13 | Reactor Core Isolation Cooling System | No |
| 14 | High Pressure Coolant Injection System | No |
| 15 | Selected Process Temperatures | No |
| 16 | System Expansion | No |
| 17 | Core Power - Distribution | No |
| 18 | Core Performance | Yes[a] |
| 19 | Steam Production | No |
| 20 | Core Power Void Mode | No |
| 21 | Pressure Regulator | Yes[b] |
| 22 | Feedwater Control System | Yes[b] |
| 23 | Turbine Valve Surveillance | No |
| 24 | Main Steam Isolation Valves | No |
| 25 | Safety Relief Valves | No |

TABLE 1

UNIT 2 FSAR SUPPLEMENT 14B TESTS (SHEET 2 OF 2)

| FSAR Test No. | Test | Required for Extended Power Uprate |
|---|---|---|
| 26 | Turbine Trip and Generator Load Rejection | No |
| 27 | Shutdown from Outside the MCR | No |
| 28 | Flow Control | No |
| 29 | Recirculation System | No |
| 30 | Loss of Turbine-Generator and Offsite Power | No |
| 31 | Drywell Piping Vibration | Yes[c] |
| 32 | Recirculation System Flow Calibration | Yes[a] |
| 33 | RWC System | No |
| 34 | RHR System | No |
| 35 | Offgas System | No |
| 36 | MSIV Leakage Control | No |
| 37 | Hydrogen Recombiners | No |
| 38 | Primary Containment Cooling System | No |

a. Credit for existing procedures was taken.

b. During the original startup test program, this test was divided into several subtests to satisfy all criteria. Only some of the original subtests were required for extended power uprate testing.

c. The original FSAR test was not performed. Selected locations on the main steam and feedwater piping were monitored.

TABLE 2

TEST CONDITIONS

| Test Condition | Power Level (%) | MWt |
|---|---|---|
| 1 | 88 | 2436 |
| 2 | 92.6% | 2558 |
| 3 | 95% | 2625 |
| 4 | 97.2% | 2686 |
| 5 | 98% | 2708 |
| 6 | 99 | 2735 |
| 7 | 100 | 2763 |

TABLE 3

TESTS PERFORMED FOR EXTENDED POWER UPRATE

| FSAR Test No. | Test | Test Conditions < 1 | 1 | 2 | 3 | 4 | 5 | 6[1] | 7[1] |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Chemical and Radiochemical | | | | x | x | x | x | x |
| 2 | Radiation Measurements | | | | x | x | x | x | x |
| 4 | Shutdown Margin | x | | | | | | | |
| 5 | Control Rod Drive | x | | | | | | | |
| 8 | Water Level Measurement | | x | x | x | x | x | x | x |
| 10 | LPRM Calibration | | | | | | x | | x |
| 11 | APRM Calibration | x | | | | x | x | x | x |
| 18 | Core Performance | | x | x | x | x | x | x | x |
| 21 | Pressure Regulator | x | | | x | | | | |
| 31 | Piping Vibration | x | x | x | x | x | x | | |
| 32 | Recirc System Flow Calibration | | | | | | x | | x |
| N/A | Thermal Performance | | | | x | | x | | x |
| N/A | Steady-State Data Collection | | x | x | x | x | x | x | x |

1. Test Conditions 6 and 7 were not performed due to turbine control flow limitations. The remaining applicable FSAR tests are part of normal plant operating procedures. All special test procedures performed demonstrated acceptable operation at 100% power.

TABLE 4

PRESSURE REGULATOR "A" STEP CHANGE RESULTS

| | | Acceptance Criteria | | | | |
|---|---|---|---|---|---|---|
| Power Level | Pressure Step Change (psi) | Lvl –1 Decay Ratio ≤ 1<br>Lvl –2 Decay Ratio ≤ 0.25 | 1st Stg. Press. Resp. Time ≤ 10 sec | Steam Flow Variation ± 0.5% | Flux SCRAM Margin ≥ 7.5% | Press SCRAM Margin ≥ 10 psig |
| 18% | -3 | ≈ 0 | < 4 | 0.0177 | > 35 | > 158 |
| | +3 | ≈ 0 | < 4 | 0.0064 | > 35 | > 150 |
| | -6 | ≈ 0 | < 5 | 0.0153 | > 35 | > 150 |
| | +6 | ≈ 0 | < 5 | 0.0145 | > 35 | > 150 |
| 78% | -3 | ≈ 0 | < 2 | .0307 | > 12 | > 100 |
| | +3 | ≈ 0 | < 3 | .0307 | > 12 | > 100 |
| | -6 | ≈ 0 | < 3 | .0307 | > 13 | > 150 |
| | +6 | ≈ 0 | < 3 | .0307 | > 10 | > 100 |
| 82% | -3 | 0.247 | < 3 | 0.0449 | > 15 | > 100 |
| | +3 | 0.127 | < 3 | 0.0449 | > 15 | > 100 |
| | -6 | ≈ 0 | < 3 | 0.0449 | > 15 | > 100 |
| | +6 | ≈ 0 | < 3 | 0.0449 | > 10 | > 100 |
| 95% | -3 | 0..104 | < 3 | 0.041 | > 14 | > 40 |
| | +3 | 0..057 | < 3 | 0.041 | > 14 | > 40 |
| | -6 | 0.040 | < 3 | 0.041 | > 15 | > 40 |
| | +6 | ≈ 0 | < 3 | 0.041 | > 13 | > 40 |

TABLE 5

PRESSURE REGULATOR "B" STEP CHANGE RESULTS

| Power Level | Pressure Step Change (psi) | Acceptance Criteria | | | | |
|---|---|---|---|---|---|---|
| | | Lvl –1 Decay Ratio ≤ 1<br>Lvl –2 Decay Ratio ≤ 0.25 | 1st Stg. Press. Resp. Time ≤ 10 sec | Steam Flow Variation ± 0.5% | Flux SCRAM Margin ≥ 7.5% | Press SCRAM Margin ≥ 10 psig |
| 18% | -3 | ≈ 0 | < 6 | 0.0125 | > 35 | > 158 |
| | +3 | ≈ 0 | < 6 | 0.0128 | > 35 | > 150 |
| | -6 | ≈ 0 | < 6 | 0.0135 | > 35 | > 150 |
| | +6 | ≈ 0 | < 4 | 0.0127 | > 35 | > 150 |
| 78% | -3 | 0.144 | < 3 | 0.0336 | > 12 | > 100 |
| | +3 | ≈ 0 | < 3 | 0.0336 | > 10 | > 100 |
| | -6 | 0.081 | < 3 | 0.0336 | > 14 | > 100 |
| | +6 | 0.076 | < 3 | 0.0336 | > 10 | > 100 |
| 82% | -3 | 0.039 | < 3 | 0.0311 | > 15 | > 100 |
| | +3 | ≈ 0 | < 3 | 0.0311 | > 15 | > 100 |
| | -6 | ≈ 0 | < 3 | 0.0311 | > 15 | > 100 |
| | +6 | ≈ 0 | < 3 | 0.0311 | > 15 | > 100 |
| 95% | -3 | ≈ 0 | < 3 | 0.044 | > 15 | > 40 |
| | +3 | ≈ 0 | < 3 | 0.044 | > 14 | > 40 |
| | -6 | ≈ 0 | < 3 | 0.044 | > 14 | > 40 |
| | +6 | ≈ 0 | < 3 | 0.044 | > 13 | > 40 |

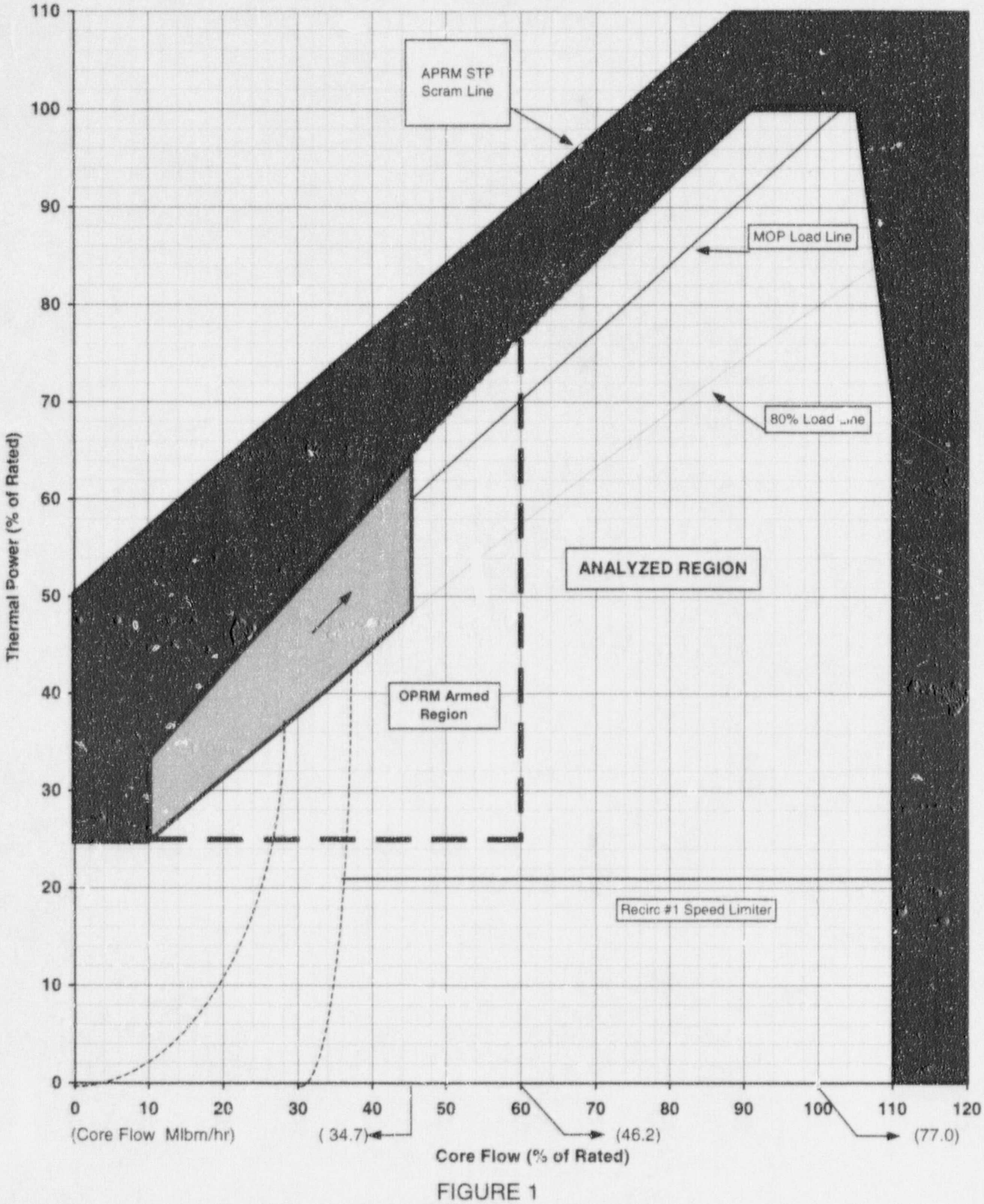


FIGURE 1
UNIT 2 POWER/FLOW MAP