

Exelon Generation  
4300 Winfield Road  
Warrenville, IL 60555

www.exeloncorp.com

RS-03-019

February 4, 2003

U. S. Nuclear Regulatory Commission  
ATTN: Document Control Desk  
Washington, DC 20555-0001

Quad Cities Nuclear Power Station, Unit 1  
Facility Operating License No. DPR-29  
NRC Docket No. 50-254

Subject: Power Uprate Ascension Test Report for Quad Cities Nuclear Power Station,  
Unit 1

- References: (1) Letter from R. M. Krich (Commonwealth Edison Company) to U. S. NRC,  
"Request for License Amendment for Power Uprate Operation," dated  
December 27, 2000
- (2) Letter from U. S. NRC to O. D. Kingsley (Exelon Generation Company,  
LLC), "Quad Cities Nuclear Power Station, Units 1 and 2 – Issuance of  
Amendments for Extended Power Uprate," dated December 21, 2001

In Reference 1, Commonwealth Edison Company, now Exelon Generation Company (EGC), LLC, submitted a request for changes to the Facility Operating Licenses and Technical Specifications (TS) for Dresden Nuclear Power Station (DNPS), Units 2 and 3, and Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2, to allow operation at uprated power levels. The NRC approved this request for QCNPS in Reference 2.

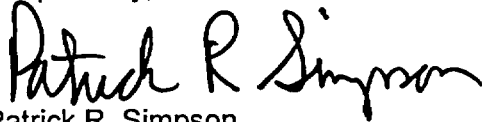
In Reference 1, EGC committed to provide a summary of the power ascension testing conducted during implementation of the power uprate. The attachment to this letter provides this test summary.

IE26

February 4, 2003  
U. S. Nuclear Regulatory Commission  
Page 2

Should you have any questions related to this letter, please contact Mr. Thomas G. Roddey at (630) 657-2811.

Respectfully,

A handwritten signature in black ink, reading "Patrick R. Simpson". The signature is fluid and cursive, with the first name "Patrick" being the most prominent.

Patrick R. Simpson  
Manager – Licensing  
Mid-West Regional Operating Group

Attachment: Quad Cities Nuclear Power Station, Unit 1 Extended Power Uprate Power  
Ascension Test Report

cc: Regional Administrator – NRC Region III  
NRC Senior Resident Inspector – Quad Cities Nuclear Power Station

**Attachment**

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

**Table of Contents**

<u>Section</u>	<u>Page</u>
1.0 Executive Summary.....	2
2.0 Purpose.....	3
3.0 Program Description.....	3
3.1 Program Development.....	3
3.2 Prerequisites to Power Ascension Testing.....	4
4.0 Acceptance Criteria.....	4
5.0 Power Ascension and Test Program Summary.....	5
6.0 Testing Requirements and Results.....	6
6.1 Tests Not Required for Power Uprate.....	6
6.2 Tests Required for Power Uprate.....	10
6.3 Additional Tests Performed.....	13
7.0 References.....	16
 <u>Tables</u>	
1 UFSAR Section 14.2.12.2.3 Tests.....	17
2 EPU Test Conditions.....	18
3 Tests Performed at EPU Test Conditions.....	19

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

**1.0 EXECUTIVE SUMMARY**

The Quad Cities Nuclear Power Station (QCNPS) Unit 1 extended power uprate (EPU) startup test report is prepared in accordance with commitments contained in Section 10.4, "Required Testing," of the Safety Analysis Report that accompanied the QCNPS EPU amendment request (Reference 1). This report summarizes the startup testing performed at QCNPS Unit 1 following implementation of EPU. EPU was implemented in accordance with Amendment No. 202 to Facility Operating License No. DPR-29, which the NRC approved in Reference 2.

QCNPS Unit 1 was previously licensed to operate at a rated thermal power (RTP) of 2511 megawatts-thermal (MWt). The result of the EPU is an RTP increase of approximately 17.7% to 2957 MWt. All testing specified in the QCNPS Updated Final Safety Analysis Report (UFSAR) Section 14.2.12.2, "Startup Tests," was addressed and evaluated for applicability to the new RTP.

The NRC approved the EPU license amendment request on December 21, 2001. The EPU test program began when QCNPS Unit 1 was synchronized to the grid on November 26, 2002, immediately following refueling outage Q1R17. Specific instrument setpoints changes and other plant modifications for EPU were completed during the refueling outage to allow operation above the previous RTP. All required EPU startup tests were completed by December 11, 2002. Turbine performance tests were completed on December 13, 2002. Tests were performed in accordance with special procedures in combination with various surveillance test procedures described in this report.

The power ascension testing program included six test conditions starting at 90% of the original RTP up to 2889 MWt, which was the highest achievable power level based on the main generator nominal limit of 912 megawatts-electric (MWe). All tests were completed at this final test condition. Because the final test condition exceeded 95% rated thermal power (RTP) of 2957 MWt and 95% of rated core flow, this final condition adequately represents the 100% test condition of the new RTP and no additional startup testing will be performed.

Results of the testing and data gathering demonstrated successful operation at uprated power. No unusual system or component adjustments were required for successful completion of the test program. All systems performed in a stable manner during both power ascension and dynamic testing.

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

## **2.0 PURPOSE**

This report is prepared in accordance with Section 10.4, "Required Testing," of the Safety Analysis Report that accompanied the EPU license amendment request (Reference 1), which requires that a summary report of the EPU Program be submitted after the completion of the uprate test program. The report includes descriptions of the quantitative results, any corrective actions that were required and brief discussions as to why it was not necessary to repeat specific startup tests listed in the UFSAR during the EPU test program.

## **3.0 PROGRAM DESCRIPTION**

The approach to the maximum EPU power was performed using site procedures developed for the power ascension and testing. Power ascension occurred in 3% power increments each day. When increasing power above the previous recorded maximum power level, changes were made in 1% increments. After system stabilization, another 1% increase was completed until the 3% increase for the day was complete. The daily 3% power increases were achieved by increasing reactor recirculation flow along a constant flow control line.

### **3.1 PROGRAM DEVELOPMENT**

The QCNPS EPU test program was developed in accordance with the generic guidelines provided in Licensing Topical Report (ELTR) NEDC-31897P-A, "Generic Guidelines for General Electric Boiling Water Reactor Power Uprates," and the license amendment request, including the safety analysis report. The QCNPS EPU Project Task Report T1005, "Startup Test Specification," along with other program task reports, provided the testing or equipment monitoring recommendations. Large transient tests described in the ELTR (i.e., generator load rejection test and MSIV full closure test) were not included as part of the QCNPS EPU test program. The NRC concurred with this deviation from the ELTR in the Safety Evaluation for the EPU license amendment (Reference 2). Consequently no large transients were included within the QCNPS EPU power ascension test program.

The EPU power ascension test program verified the following:

- Plant systems and equipment affected by power uprate are operating within design limits.
- Nuclear fuel thermal limits are maintained within expected margins.
- The response of the main steam pressure control system is stable.
- The response of the reactor water level control system is stable.
- Plant radiation levels are acceptable and stable.
- Reactor water and feedwater chemistry analyses are acceptable.
- Piping vibrations on main steam and feedwater piping are acceptable.
- Moisture carry-over from the reactor dryer/separator is less than pre-uprate condition.
- Turbine valve surveillance testing is acceptable at higher power levels.

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

- The overlap between the intermediate range monitors (IRMs) and the source range monitors (SRMs) and between the IRMs and the average power range monitors (APRMs) are within the design limits.
- APRM calibrations meet all acceptance criteria.
- Feedwater and Main Steam Flow element calibrations match within normal instrument tolerance.
- Reactor feedwater pump performance is satisfactory.

### **3.2 PREREQUISITES TO POWER ASCENSION TESTING**

Prior to the commencement of power ascension testing, the test procedure required the completion of numerous activities to assure that the plant was ready for EPU operation and testing. These activities included the following:

- The applicable plant operating procedures, administrative procedures, surveillance test procedures, calibration and maintenance procedures, chemical and radiological procedures and other similar procedures were reviewed and revised.
- The applicable plant instrumentation setpoint changes, re-scaling and/or calibrations were completed.
- Baseline data was taken as required by the test procedure.
- Commitments which were the result of the EPU Safety Analysis Report, the NRC EPU Safety Evaluation, and actions committed to in response to numerous requests for additional information were verified as either completed, included in the power ascension program, or evaluated as not impacting power ascension.
- Computer software programs were reviewed and revised as required to support the power uprate test program, including the safety parameter display system.
- Licensed operator training was completed prior to power ascension to EPU power levels. Training included the physical changes to the plant as a result of EPU. Simulator training was conducted to demonstrate accident situations and normal power operation at EPU power levels.
- The simulator was modified to reflect changes to parameters, setpoints, and EPU operation.
- Emergency operating procedures were revised and operators were trained on the changes prior to EPU power operation.

### **4.0 ACCEPTANCE CRITERIA**

Plant parameters during power ascension were evaluated with two levels of acceptance criteria. The criteria associated with plant design variables are classified as Level 1. The criteria associated with expectations in regard to the performance of a system or component are classified as Level 2. The following paragraphs describe the actions required if a specific criterion is not satisfied.

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

**Level 1 Acceptance Criteria**

Level 1 acceptance criteria normally relate to the values of process variables assigned in the design of plant components or systems. If a Level 1 test criterion is not satisfied, the plant must be placed in a hold condition that is judged to be satisfactory and safe, based upon prior testing. Plant operating or test procedures or the Technical Specifications may guide the decision on the direction to be taken. Tests consistent with this hold condition may be continued. Resolution of the problem must be immediately pursued by equipment adjustments or through engineering evaluation as appropriate. Following resolution, the applicable test portion must be repeated to verify that the Level 1 requirement is satisfied. A description of the problem must be included in the report documenting successful completion of the test.

**Level 2 Acceptance Criteria**

If a Level 2 acceptance criterion is not satisfied, plant operating or test plans would not necessarily be altered. The limits stated in this category are usually associated with expectations of system performance whose characteristics can be improved by equipment adjustments. An investigation of the system performance, as well as the measurement and analysis methods, would be initiated.

Following resolution of a Level 2 acceptance criterion failure, the applicable test portion need not be repeated to verify the Level 2 requirement is satisfied.

**5.0 POWER ASCENSION AND TEST PROGRAM SUMMARY**

The EPU test program began when QCNPS Unit 1 was synchronized to the grid on November 26, 2002, and ended with the completion of EPU start-up tests on December 11, 2002. Baseline testing was initiated during the power ascension. Pressure control system testing was successfully performed on November 27 at approximately 25% power and again at 75% power on November 30. Main steam and feedwater piping vibrations were monitored at approximate power levels of 40%, 60% and 75% power.

Power ascension was limited by the maximum output of the main generator, nominally 912 MWe. Therefore, the maximum power achieved on December 11, 2002, was 2889 MWt, or 97.7% RTP. The more recent BWR plant start-ups have used 95% as a benchmark for the full power test condition (i.e., > 95% reactor power and > 95% of rated core flow is sufficient to meet the full power requirement). Since QCNPS Unit 1 achieved 97.7% reactor power and 96.6% core flow, no further testing will be required to allow power operation up to the RTP of 2957 MWt.

After power ascension to 2889 MWt was completed, two turbine performance tests were conducted on December 13, 2002. The results will be used to determine the total electrical output.

There were no Level 1 test criteria failures. Data collected at uprated conditions showed the increase in reactor power had little effect on reactor water chemistry and radiological conditions throughout the plant.



**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

## **6.0 TESTING REQUIREMENTS AND RESULTS**

Each of the tests discussed in UFSAR Section 14.2.12.2.3, "Power Escalation to 100% Power," was evaluated for applicability to EPU test program. Table 1 contains a listing of the original power escalation startup tests and their applicability to EPU. Throughout the following discussion, test numbers are used to specify specific start-up tests. These numbers are used because they are relatively common throughout the industry.

Section 6.1 identifies each Section 14.2.12.2.3 test not required to be performed for EPU. The purpose of the test and the rationale for exempting the test from the EPU program are discussed.

Section 6.2 identifies each Section 14.2.12.2.3 test that was performed for EPU. The purpose of the test, a description of the test, and the test results are included.

Table 2 lists six test conditions and the associated percent of RTP. Table 3 lists all the tests performed for EPU and the test condition(s) for each test. Note in the discussion below that many surveillance tests similar to the original UFSAR Chapter 14 tests are performed periodically. The EPU test program takes credit for these existing plant procedures and did not require additional tests.

### **6.1 Tests Not Required for Power Uprate**

#### **6.1.1 Test No. 7 - Calibration of Rods**

The purpose of this test is to determine the relationship between reactor power and control rod motion in standard sequences. These conditions are not significantly affected by EPU operation and therefore were not performed during power ascension testing.

#### **6.1.2 Test No. 11 – Local Power Range Monitor (LPRM) Calibration**

The purpose of this test is to calibrate the LPRMs. The ability of the LPRMs to detect neutron flux is not affected by EPU. The plant Technical Specifications and surveillance procedures maintain the calibration of these instruments.

#### **6.1.3 Test No. 13 – 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 modification. Those changes were made in accordance with plant modification program. Therefore, this test is not required for EPU.

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

**6.1.4 Test No. 14 – Reactor Core Isolation Cooling (RCIC) 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. Because the EPU maintained a constant reactor pressure, there was no change in any of the RCIC pump or turbine operating characteristics. Therefore, no special testing is required for EPU.

**6.1.5 Test No. 15 – High Pressure Coolant Injection (HPCI) System**

This test verifies the proper operation of the HPCI system at the operating pressure. Acceptable HPCI system operation is periodically demonstrated during normal surveillance testing that includes adjustments for reactor dome pressure. Since EPU is accomplished without changing reactor pressure, special testing is not required for EPU.

**6.1.6 Test No. 18 – Axial Power Distribution**

This test determines core power distribution using the traversing in-core probe (TIP) system, confirms reproducibility of TIP system readings, and determines core power symmetry. Existing site procedures verify proper TIP operation and core power symmetry. EPU does not impact these parameters. Therefore, no special testing is required for EPU.

**6.1.7 Test No. 21 – Flux Response to Rods**

This startup test demonstrates stability in the power reactivity loop with increasing reactor power and determines the effect of control rod movement on reactor stability. EPU had only a minor impact on core stability. The interim corrective actions, stability regions and the Option III oscillation power range monitor trip enabled region on the power/flow map were revised for uprated power such that there is only minimal impact on the stability margin. Therefore, additional testing is not required for EPU.

**6.1.8 Test No. 24 – Bypass Valves**

The purpose of the bypass valve measurement test was to determine the reactor and turbine governor system response when opening a turbine bypass valve. Regulator settings would be optimized using the data from this test. The pressure control system regulator settings were tested and optimized as part of the pressure control system test. The bypass valves were full stroked during EPU testing to determine the new maximum safe power level to perform the surveillance in the future. Therefore, no additional bypass valve testing is required.

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

**6.1.9 Test No. 25 – Main Steam Isolation Valves (MSIVs)**

The objectives of this test are as follows:

- Determine the operational characteristics of the MSIVs at selected power levels.
- Determine reactor transient effects during simultaneous full closure of all MSIVs.

The MSIVs are no longer fully stroked as part of surveillances at power. The surveillance requirements are listed in the TS and follow the American Society of Mechanical Engineers (ASME) Code for cold shutdown tests. Therefore, the plant procedures and TS are sufficient and no additional testing is needed.

Full MSIV closure testing performed at high power during the initial startup demonstrates the adequacy of protection for this large transient test. A detailed evaluation was completed which concluded this transient test would not provide any new information regarding the way the reactor responds to a full MSIV closure test. Analysis shows that should these transients occur at EPU conditions, the change in unit performance will be small based on the constant reactor dome pressure for EPU conditions. Also the operating history of the plant has shown that previous transients are within the expected performance. Additionally, the EPU transient analysis shows that all safety criteria are met. Therefore, testing the plant's response to full closure of the MSIVs at the uprated power level is not required. The NRC concurred with this determination in Reference 2.

**6.1.10 Test No. 26 – Main Steam Relief Valve**

This test is designed to verify proper operation of the system relief valves and verify their leak tightness following operation. The EPU affects neither of these tests because the reactor dome pressure does not change with the power increase. Normal plant surveillance procedures ensure that the system is operating satisfactory and that the TS are met. Therefore, these tests are not required for EPU.

**6.1.11 Test Nos. 27 & 28 – Turbine Trip and Generator Trip Tests**

These tests demonstrate the response of the reactor and its control systems to protective trips initiated by the turbine and generator. Transient tests 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 since the reactor dome pressure remains the same for EPU condition. Therefore, testing the unit's response to turbine and generator trips at EPU conditions is not required. The NRC concurred with this determination in Reference 2.

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

**6.1.12 Test No. 29 – Flow Control Capabilities**

The purpose of these tests is to determine that the plant response to step and fast ramp changes in recirculation flow is stable during and following the flow changes and to demonstrate load following capabilities of the flow control system.

Quad Cities EPU does not involve an increase in maximum core flow. The ELTR indicates in section 5.6.2 that the recirculation system will have to overcome a slight increase in the two-phase flow resistance due to an increase in the core average void fraction. It also indicates that the system will accommodate the expected insignificant increase at EPU condition when operating at maximum core flow. Therefore, the recirculation system is unaffected by the EPU, and this testing is not required.

Load following capabilities is an initial startup requirement that is not applicable to EPU testing and is therefore not required.

**6.1.13 Test No. 30 – Recirculation Pump Trips**

The two objectives of this test are to evaluate the recirculation flow to the reactor for power transient responses resulting from a recirculation pump trip and to calibrate jet pump flow instrumentation.

EPU does not involve a change in total core flow at full power operation. Additionally, the ELTR indicates that the recirculation system will accommodate an expected insignificant increase at EPU conditions when operating at maximum core flow. Also, in accordance with the ELTR the single recirculation pump trip test is not required for EPU's. Since the recirculation system is unaffected by the EPU no start-up testing is required.

EPU modified the recirculation system speed control circuitry to improve the plant's response to a single reactor feedwater pump trip event. A recirculation pump runback feature was installed during the recent refueling outage as a plant reliability feature. The runback occurs on a loss of the fourth running condensate pump or the third running reactor feedwater pump. These features were functionally tested during startup testing as part of the design modification implementation procedures. Acceptable performance was demonstrated via the functional tests.

**6.1.14 Test No. 31 – Loss of Auxiliary Power**

This test demonstrates proper performance of the reactor, and plant electrical equipment and systems during the loss of auxiliary power transient. EPU 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. The ability of the reactor systems (e.g., HPCI and RCIC) to function properly at uprated conditions was demonstrated during execution of normal system surveillance procedures. Therefore, this test is not required for EPU.

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

**6.1.15 Test No. 34 – Reactor Internal Vibration Monitoring**

The purpose of this test is to obtain vibration measurements on various reactor internal components to demonstrate the mechanical integrity of the system to flow induced vibration and to verify the accuracy of the analytical model. An analysis was performed evaluating flow induced vibration (FIV) effects on the reactor internals. The analysis used the initial start-up vibration monitoring coupled with previously installed structural reinforcements to determine the design continues to comply with the existing structural requirements.

Based on resonance vibrations discovered at Quad Cities Unit 2, replacement cover plates were installed to strengthen the steam dryer and alter the existing natural frequency. No unexpected frequencies were identified during vibration testing.

**6.2 Tests Required for Power Uprate**

**6.2.1 Test No. 1 – Chemical/Radiochemical Samples**

Purpose: To maintain control of and knowledge about the quality of reactor coolant chemistry and radiochemistry at EPU conditions.

Description: Samples were taken in accordance with plant procedures at each new power level and analyzed for conductivity, sulfates, chlorides and dissolved oxygen. Additionally, gaseous samples were taken and tested for activity levels.

Results: All Level 1 acceptance criteria were satisfied and results indicate predicted acceptable performance at 100% of the new RTP.

The Level 2 gaseous release acceptance criteria of  $< 1000 \mu\text{Ci/sec}$  was not met. The actual value was approximately  $2000 \mu\text{Ci/sec}$ .

This condition was evaluated and determined to be caused by past fuel failures. Actual gaseous release readings did not change appreciably during the power ascension. A second Level 2 criterion was selected to monitor gaseous release activity levels. The ratio of Xenon isotopes was measured which showed no new fuel related failures were present.

**6.2.2 Test No. 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 continued compliance with 10 CFR 20.

Description: Radiation levels were measured at selected areas around the plant for both gamma radiation and neutron radiation.

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

**Results:** All Level 1 acceptance criteria were satisfied. The dose rates were comparable to those experienced at the previous RTP. The results did not require any change to plant radiation postings. Radiation dose rates remain in compliance with the 10 CFR 20 limit. There were no Level 2 criteria requirements.

**6.2.3 Test No. 10 – IRM Calibration**

**Purpose:** To adjust the IRM system to obtain an optimum overlap with the SRM and APRM systems.

**Description:** Existing plant surveillance procedures were used to verify the overlap on each IRM channel met the requirements of the Technical Specifications.

**Results:** All Level 1 and Level 2 acceptance criteria were satisfied. The overlap was performed following the refueling outage in accordance with existing site procedures. Additional overlap was required by the procedure to account for the uprated power difference.

**6.2.4 Test No. 12 – APRM 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 the new core thermal power limit, as determined by the heat balance. Existing plant surveillance procedures were used which were previously revised to account for the increase in RTP.

**Results:** All Level 1 acceptance criteria were satisfied. APRM gain adjustments were performed at different power levels during the EPU power ascension test, in accordance with TS and site surveillance procedures. There were no Level 2 criteria requirements.

**6.2.5 Test No. 19 – Core Performance**

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

**Description:** In accordance with site procedures, core thermal limit measurements and thermal power readings were taken at each 1% power increase. Existing methodologies and procedures were used to ensure the current operational practice was maintained.

**Results:** All Level 1 acceptance criteria were satisfied. Results show that for the highest power achieved, sufficient margin exists to 100% of the new RTP. There were no Level 2 criteria requirements.

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

	Core Flow (% Rated)	MFLCPR*	MAPRAT*	MFLPD*
Level 1 Limit	< 100%	1.0	1.0	1.0
Result at 2889 MWt / 97.7 % RTP	96.6	0.838	0.774	0.806

\* MFLCPR – maximum fraction of limiting critical power ratio

MAPRAT – maximum average planar linear heat generation rate ratio

MFLPD – maximum fraction of limiting power density

#### **6.2.6 Test No. 22 – Pressure Regulator Test**

Purpose: To determine the response of the reactor and the turbine pressure regulator system during induced step changes to the pressure regulators and acceptable performance of the back-up pressure regulator during simulated failure of the in-service pressure regulator.

Description: The pressure regulator testing was performed in accordance with a site temporary procedure. 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 the previous refuel outage.

During power ascension,  $\pm 3$ ,  $\pm 6$  and  $\pm 10$  psi step changes in reactor pressure were induced, and the resulting transients were recorded. The data for each step change was reviewed for acceptable performance and scram margins prior to performing the next larger pressure step change. Step changes were first performed for pressure regulator "A" in control and then with pressure regulator "B" in control. This test was performed at each power level. A fail-over test from one pressure regulator to the stand-by regulator was performed to verify proper control system response.

Results: All Level 1 and Level 2 acceptance criteria were satisfied. 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.

Regulator output linearity remained within the acceptance limits.

#### **6.2.7 Test No. 23 – Feedwater System**

Purpose: To adjust the feedwater level control system for acceptable reactor level control and to demonstrate stable reactor response to induced level and flow changes.

Description: The feedwater level control system testing was performed using a site temporary procedure.

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

The feedwater control system was modified from an analog system to a digital control system during the recent refueling outage. Because of this, extensive testing was performed as part of the design change process. In addition to other tests reactor level step changes and flow changes were induced into the control system to verify adequate control system response.

**Results:** All Level 1 and Level 2 acceptance criteria were satisfied. The feedwater control system response to level and flow changes was stable and satisfactory with only minor tuning adjustments. There were no signs of divergence during the induced transients.

### **6.3 Additional Tests Performed**

#### **6.3.1 System and Equipment Performance**

**Purpose:** To monitor key plant systems and equipment parameters during the power ascension and assure that equipment is operating as expected.

**Description:** The selected parameter data was collected at steady-state power levels and used to predict the performance at the next higher power level. Predictions provided a careful approach to the power increases by monitoring each small incremental change in performance.

**Results:** Over 100 plant parameters were monitored at each test condition. The performance of the systems and equipment demonstrated good agreement with expectations. Key systems monitored were main turbine, main generator and auxiliaries, main condenser, condensate and condensate booster, feedwater and feedwater heaters, transformers and auxiliaries, off-gas, reactor recirculation and the reactor. There were no Level 1 or Level 2 criteria associated with this monitoring.

#### **6.3.2 Test No. 24 – Turbine Valve Surveillances**

**Purpose:** To determine the maximum reactor power levels for periodic surveillance testing of the main turbine control, stop, bypass and combine intermediate valves.

**Description:** Turbine valves were fully stroked at each power level in accordance with existing site procedures during power ascension. Conservative criteria were set to predict reactor and system response at each higher power level.



**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

**Results:** All Level 2 acceptance criteria were met. New maximum power levels were determined based on the data collected and provided for site procedure revisions. The bypass valves and combined intermediate valves were stroked at the maximum power achieved, 2889 MWt. The new maximum power level for routine control valve and stop valve stroke tests was determined to be < 91% RTP. This was based on measured values during testing. There were no Level 1 criteria requirements.

**6.3.3 Test No. 25D – Main Steam Flow Element Calibration Check**

**Purpose:** To confirm acceptable calibration of the main steam flow elements at EPU conditions.

**Description:** Data was collected at each power level during power ascension. The steam flow data was compared relative to the calibrated feedwater flow measurements.

**Results:** All Level 2 acceptance criteria were met. Steam flow measurements were within 5% of the feedwater flow measurements at each power level. The results indicate predicted acceptable performance at 100% RTP. There were no Level 1 criteria requirements.

**6.3.4 Test No. 23D – Feedwater Flow Element Calibration Check**

**Purpose:** To confirm acceptable calibration of the feedwater flow elements at uprated power conditions.

**Description:** Data was collected at each power level plateau during power ascension. The data was compared to the expected flow element output. Additionally, at selected power levels including maximum tested power, the flow element data was compared to an ultrasonic flow measurement device.

**Results:** All Level 2 acceptance criteria were met. The feedwater flow element measurements were within 1.0% of the expected feedwater flow. Results indicate predicted acceptable performance at 100% of the new RTP. There were no Level 1 criteria requirements.

**6.3.5 Test No. 23B – Maximum Feedwater Runout Capability**

**Purpose:** To determine if the maximum feedwater runout flow is consistent with the EPU transient analysis and licensing assumptions.

**Description:** A new reactor feedwater pump runout value was determined for three-pump operation for the EPU program. This value was implemented as part of a setpoint change. Reactor feedwater pump performance data was collected in accordance with existing site procedures. Calculations based on the manufacturer's pump curves were performed to verify proper operation.

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

Results: All Level 1 and Level 2 acceptance criteria were satisfied. Reactor feedwater pump performance data indicates predicted acceptable performance at 100% of the new RTP. Pump performance was determined to be on or above the pump curve at the highest power level tested, 97.7% RTP. This confirms there is adequate feedwater flow available at full EPU power.

**6.3.6 Steam Separator-Dryer Performance**

Purpose: To evaluate reactor steam separator-dryer moisture carryover performance.

Description: Samples were taken in accordance with plant procedures at each new power level and analyzed to determine the amount of moisture carryover from the reactor to the turbine.

Results: The Level 2 acceptance criteria was satisfied. The results indicate a moisture carryover of 0.033%. This is in contrast to the approximate 0.3% moisture carryover which existed prior to the EPU modifications to the steam dryer. There were no Level 1 criteria requirements.

**6.3.7 Test No. 33 – Drywell Piping Vibration**

Purpose: To ascertain the vibration measurements on the main steam and feedwater system piping in the drywell to evaluate the vibration stress effect due to EPU.

Description: Accelerometers were installed on representative main steam piping in the drywell to measure the flow induced vibration effect during extended power operation.

Results: All Level 2 acceptance criteria were satisfied. Results indicate predicted acceptable performance at 100% of the new RTP. The highest readings at the maximum achieved power level indicated the "B" Main Steam Line in the E-W direction was 65% of the maximum allowed value. Other measured vibration levels indicated at least a five-fold margin to the acceptance criteria. For example, the "B" feedwater piping vibration levels in the vertical direction at one location in the drywell at the highest power level achieved was measured at 2.1 mils against an acceptance criteria for infinite life of 16 mils. There were no Level 1 criteria requirements.

**6.3.8 Test No. 98 – Power Conversion Piping Vibration**

Purpose: To ascertain the vibration measurements on the main steam and feedwater system piping outside the drywell to evaluate the vibration stress effect due to EPU.

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

Description: Accelerometers were installed on representative main steam piping outside the drywell to measure the flow induced vibration effect during extended power operation.

Results: The vibration monitoring program measured pipe displacement during power ascension on the main steam piping. All monitored locations were found to meet the acceptance criteria established from ASME OM-3 stress criteria. The highest measured vibration levels were found on the #4 control valve in the vertical direction. The values were measured at 18.2 mils versus an acceptance criteria of 20 mils. Other monitored locations were found to be between 2% and 60% of the acceptance criteria.

The small bore main steam piping vibration levels were also monitored and found to be within the acceptance limits.

Analysis of data collected on QCNPS Unit 2 and the acceptability of the inside containment measured response provided the basis for the predicted acceptability of Feedwater System piping outside containment. This conclusion was reached due to the minimal increases seen inside containment and the fact that no piping configuration changes were made to the feedwater system.

## **7.0 REFERENCES**

1. Letter from R. M. Krich (Commonwealth Edison Company) to U. S. NRC, "Request for License Amendment for Power Uprate Operation," dated December 27, 2000
2. Letter from U. S. NRC to O. D. Kingsley (Exelon Generation Company, LLC), "Quad Cities Nuclear Power Station, Units 1 and 2 – Issuance of Amendments for Extended Power Uprate," dated December 21, 2001

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

**Table 1  
UFSAR Section 14.2.12.2.3 Tests  
(Power Escalation only)**

UFSAR Section	Test No.	Power Ascension Test	Required for EPU
<b>14.2.12.2.3</b>		<b>From Rated Temperature to 100% Power</b>	
A	1	Chemical/Radiochemical Samples	Yes
B	2	Radiation Measurements	Yes
C	10	IRM Calibration	Yes
D	25	MSIVs	No
E	14	RCIC System	No
F	15	HPCI System	No
G	30	Recirculation Pump Trips	No
H	29	Flow Control Capabilities	No
I	27	Turbine Trip Tests	No
J	28	Generator Trip	No
K	22	Pressure Regulator Test	Yes
L	24	Bypass Valves	No
M	23	Feedwater System	Yes (1)
N	21	Flux Response to Rods	No
O	26	Main Steam Relief Valves	No
P	11	LPRM Calibrations	No
Q	12	APRM Calibrations	Yes
R	19	Core Performance	Yes
S	7	Calibration of Rods	No
T	18	Axial Power Distribution	No
U	13	Process Computer	No
V	31	Loss of Auxiliary Power	No
W	34	Reactor Internal Vibration Monitoring	No

- (1) Reactor Feedwater Pump trip tests were not performed as part of EPU testing. Simulated functional testing was completed as part of the Engineering Design Change process.

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

**Table 2  
EPU Test Conditions**

Test Condition (1)	Power Level (%)	MWt
1	75	2226
2	85	2500
3	88	2607
4	91	2693
5	94	2779
6	97.7	2889

(1) Additional testing was performed below 75% power to establish baseline data and confirm acceptable control settings.

**Quad Cities Nuclear Power Station, Unit 1  
Extended Power Uprate  
Power Ascension Test Report**

**Table 3**

**Tests Performed At EPU Test Conditions**

Test Description	Test No.	Test Condition					
		1	2	3	4	5	6
Chemical/Radiochemical Samples	1		X	X	X	X	X
Radiation Measurements	2		X	X	X	X	X
IRM Calibration	10	X (1)					
APRM Calibrations	12	X (2)	X	X	X	X	X
Core Performance	19	X	X	X	X	X	X
Pressure Regulator Test (4)	22	X	X	X	X	X	X
Feedwater System (5)	23A		X	X	X	X	X
Maximum FW Runout Capability	23B	X	X	X	X	X	X
FW Flow Element Calibration Check	23D	X	X	X	X	X	X
Turbine Valve Surveillances	24	X	X	X	X	X	X
Main Steam Flow Element Cal Check	25D	X	X	X	X	X	X
Piping Vibration Monitoring (3)	33 & 98	X	X	X	X	X	X
Steam Dryer Performance	NA		X	X	X	X	X
System/Equipment Performance	NA	X	X	X	X	X	X

**Notes:**

- (1) IRM Performance demonstrated by overlap checks with the APRMs at approximately 10% power.
- (2) APRM gain adjustments checked at each power level and adjusted as necessary.
- (3) Baseline vibration data also collected at 40% and 60% EPU power. This includes Drywell piping and Power Conversion piping monitoring.
- (4) Baseline performance verified at 25% power.
- (5) Feedwater Level Control testing performed at numerous power levels in accordance with the modification test schedule.