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U.S. Nuclear Regulatory Commission
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Duane Arnold Energy Center
Docket 50-331
License No. DPR-49

Subject: Startup Test Report for Extended Power Uprate – Phase III

In accordance with the Duane Arnold Energy Center (DAEC) Updated Final Safety Analysis Report (UFSAR), Revision 18, Section 1.8.16 commitments, FPL Energy Duane Arnold, LLC hereby submits the Extended Power Uprate (EPU) Startup Test Report – Phase III. This report summarizes the startup testing performed on the DAEC over the period from August 22, 2006 to October 31, 2006. While some problems were encountered during the initial testing, as described in the enclosed report, the results of the final testing and data gathering demonstrated successful operation at the Phase III target power level of 1880 MWt.

Follow-up reports will be submitted in accordance with UFSAR 1.8.16, as testing is completed for the subsequent phase(s) of the EPU implementation.

This letter contains no new commitments and no revisions to existing commitments.

Gary Van Middlesworth
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FPL Energy Duane Arnold, LLC

Enclosure

cc: Administrator, Region III, USNRC
Project Manager, Duane Arnold Energy Center, USNRC
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DUANE ARNOLD ENERGY CENTER

EXTENDED POWER UPRATE

STARTUP TEST REPORT

PHASE - III

November, 2006

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Duane Arnold Energy Center
Extended Power Uprate
Startup Test Report
Phase - III

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1.0 Executive Summary

The Duane Arnold Energy Center (DAEC) Extended Power Uprate (EPU) Startup Test Report is submitted to the Nuclear Regulatory Commission (NRC) in accordance with regulatory commitments contained in the DAEC Updated Final Safety Analysis Report (UFSAR), Section 1.8.16. The report summarizes the startup testing performed as part of the implementation of EPU. EPU was approved by the NRC in Operating License Amendment No. 243 on November 6, 2001.

DAEC was previously licensed to operate at a maximum reactor power level of 1658 MWt. The result of EPU is a licensed power increase of 15.3% to a new maximum of 1912 MWt. The DAEC is implementing the EPU in planned phases that support a schedule for the necessary modifications needed to achieve the full EPU. The current phase, Phase III, has a target power level of 1880 MWt, a 2.2% increase in thermal power over the Phase II power level of 1840 MWt. The startup test report for Phase II can be found in Reference 1. It should be noted that no additional equipment modifications were required to achieve the Phase III power level. Operational data at 1840 MWt was evaluated and sufficient margin was available to allow a power level increase up to the target Phase III level of 1880 MWt.

All testing specified in the DAEC UFSAR Section 14.2 have been addressed and evaluated for applicability to EPU (Ref. 2). Special test procedures were written and implemented in combination with existing surveillance test procedures, as described in this report. All required tests were completed up to the target power of 1880 MWt. Testing was conducted over the period from August 22, 2006 to October 31, 2006. Test results were reviewed by an Expert Panel for acceptability. While minor equipment problems were encountered during the initial power increase above 1840 MWt, as discussed later in this report, the final results of the testing and data gathering demonstrated successful operation at the Phase III target power level of 1880 MWt.

2.0 Purpose

In accordance with UFSAR Section 1.8.16 requirements, this report summarizes the testing performed following the implementation of the DAEC EPU, approved as Amendment #243 to Operating License DPR-49. While Amendment # 243 approved a new licensed thermal power limit of 1912 MWt, an increase of 15.3%, the implementation of the EPU is being conducted in planned phases. This report summarizes the testing performed as part of Phase III, which resulted in a steady-state operating thermal power of 1880 MWt, a 2.2% increase in thermal power over the Phase II power level of 1840 MWt. Each test performed is described in Section 6.0 of this report. Follow-up reports, as required by UFSAR Section 1.8.16, will be made as the subsequent phases are implemented and core thermal power is increased up to the licensed limit.

3.0 Program Description

The EPU startup testing program requirements were developed primarily from:

- Review of the original startup testing program, as described in UFSAR Section 14.2;
- Section 10.4 of the DAEC Power Uprate Safety Analysis Report (PUSAR), NEDC-32980P;
- General Electric (GE) Uprate Test Program recommendations.

The in-plant testing was begun on August 22, 2006 and was completed on October 31, 2006. The results of the testing verified the unit's ability to operate at the Phase - III target power level of 1880 MWt.

All startup testing specified in UFSAR Section 14.2 have been evaluated for applicability to the EPU testing program (Ref. 2). Special Test Procedures (SpTPs) were written to coordinate and control the startup testing program. Where possible, the testing program took credit for existing Surveillance Test Procedures (STP).

The majority of the testing falls within the following categories:

- Verification that the control systems (i.e., Condensate and Feedwater and EHC-Pressure Regulation) are stable at uprated conditions.
- Collection of system performance data to verify modifications made to support EPU operation were performing as expected.
- Collection of general plant data (i.e., radiation surveys, coolant chemistry, thermal performance) for comparison to previous plant rated conditions.

Table 2 presents the Test Conditions at which startup testing was performed in Phase III. Reactor core flow could 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 power level was completed and thoroughly reviewed prior to proceeding to the subsequent Test Condition. Test results were reviewed by an Expert Panel, a multi-disciplinary group, chaired by the Operations Manager, who made the recommendation to the Plant Manager that it was acceptable to increase power and proceed to the next Test Condition.

4.0 Acceptance Criteria

For each recommended test, individual test abstracts will define the purpose of the test, the appropriate test conditions and the associated acceptance criteria.

Test criteria for each test have up to two levels of importance. The criteria associated with plant safety are classified as Level 1. The criteria associated with design expectations are classified as Level 2.

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 plant must be placed in a safe condition, based upon prior testing, until the problem is resolved, and the test is satisfactorily repeated, if necessary.

2. Level 2 Variable or Criteria

   Data trend, singular value, or information relative to optimizing 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. It is not required to repeat a test due to a Level 2 criterion failure.

5.0 EPU Startup Test Program Summary

Post-modification testing was performed as part of startup from RFO19 on May 3, 2005 and baseline data was collected during power ascension to the Phase II steady state power level of 1840 MWt (Ref. 1). It should be noted that no additional equipment modifications were required to achieve the Phase III power level. Operational data at 1840 MWt was evaluated and sufficient margin was

available to allow a power level increase up to the target Phase III level of 1880 MWt. The EPU Phase III test program was begun on August 22, 2006.

Because of specific plant operating conditions above 1840 MWt, the Expert Panel had placed specific additional acceptance criteria on power ascension and testing beyond that specified in the startup test program description. Specifically, three key areas were highlighted:

1. Concerns with tight operating margins on the feedwater heater drain system with a temporary modification in place due to an out-of-service controller on the number "5A" feedwater heater caused the additional criterion of *any* feedwater heater dump valve opening as cause to abort the power ascension and testing.
2. Noticeable vibrations in small bore piping in the Feedwater and Condensate Systems identified in Phase II, were a focal point in Phase III. Specific acceptance criteria were created for the identified sections of piping. Monitored vibration levels above these criteria were also cause to abort power ascension and testing, pending further engineering evaluations.
3. Operation at 1840 MWt was known to be nearing the operating point in the main turbine control system where the turbine control valves (TCVs) would be transitioning from controlling reactor steamflow and pressure with all TCVs (1 - 4) throttling, to TCVs 1, 2, and 3 fully open against their mechanical stops, with only TCV 4 throttling steamflow and controlling reactor pressure. During this transition, a point is reached where the TCVs tend to drift back and forth between these two operational modes. Specifically, TCVs 1, 2 or 3 can float on and off their mechanical open stops. This condition is known to accelerate wear on both the TCVs and the EHC control system, necessitating more frequent maintenance. While not a plant safety concern, it is nonetheless an undesired condition. Therefore, the Expert Panel added an acceptance criterion to minimize any "chattering" of the TCVs against their full-open mechanical stops.

As discussed in more detail later in this report, reviews of specific plant conditions at Test Condition 2 - 1860 MWt caused a suspension of testing and reduction of power back to 1840 MWt, pending further evaluations and corrective actions. Corrective Action Program (CAP) documents were initiated to document these issues and corrective actions taken.

On August 26, 2006, initial testing at 1860 MWt was suspended when a 1-inch drain line in the feedwater system exceeded its allowable vibration limits (CAP 43859). Evaluations of the measured vibration were conducted and a modification was designed and installed to dampen the vibration back to within acceptable endurance limits.

Also noted during the brief excursion to 1860 MWt, the TCVs began to float on and off their mechanical open stops and a high-pitched noise began emanating from the EHC control system (CAP 44070). Consultation with the turbine vendor (General Electric) determined that the observed conditions were not a concern and power ascension was resumed.

On October 15, 2006, power ascension resumed and testing at 1860 MWt was satisfactorily completed on October 17, 2006. The Expert Panel made the recommendation to the Plant Operating Review Committee (PORC) and subsequently to the Plant Manager to raise power to Test Condition 3 (1880 MWt) and continue testing. Power ascension and testing at 1880 MWt commenced on October 17, 2006 and concluded on October 31, 2006.

The Expert Panel review of the last set of data at Test Condition 3 (1880 MWt) was conducted on October 26, 2006 and the formal recommendation to the Plant Manager regarding continued steady state operation at the Phase III target power level of 1880 MWt was made. Plant Manager concurrence was given to remain at 1880 MWt.

As discussed in Section 6.1, based upon review of test data at lower power levels, the test matrix at higher power was simplified and some test steps were not performed, as they would not have provided useful data.

The completed testing at the Phase III target power level of 1880 MWt demonstrated stable plant operation. Changes in plant chemistry and radiological conditions were minor, vibration measurements of main steam and feedwater piping were acceptable, and no plant equipment anomalies were noted.

6.0 Testing Requirements

Each of the Startup tests discussed in UFSAR Section 14.2 has been evaluated for applicability to EPU (Ref. 2). Pre-operational tests used to confirm construction of systems were per design are excluded and not discussed further. Several tests performed in EPU Phase I were not required to be re-performed in Phase III (Ref. 2). Throughout the following discussion, the test numbers and titles are consistent with the original Startup Test Specification.

Section 6.1: This section identifies each Section 14.2 test required to be performed for EPU. The purpose of the test, a description of the test, Acceptance Criteria, and the test results are included.

Section 6.2: This section identifies additional test/data collection that was performed to assess the performance of the unit at EPU conditions. The purpose of the test, a description of the test, and the test results are included.

Section 6.3 This section identifies additional activities conducted based upon recommendations from industry operating experience with EPU.

Table 1 identifies the tests/activities conducted as part of Phase III. Table 2 presents the Test Conditions for Phase III.

6.1 UFSAR Section 14.2 Tests Required for EPU- Phase III

6.1.1 Test No. 1 – Chemical and Radiochemical Monitoring

Purpose: The purpose of this test is to maintain control of and knowledge about the quality of the reactor coolant chemistry and radiochemistry at EPU conditions.

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

Test Conditions: 1, 2, and 3

Acceptance Criteria:

Level 1: a) Chemical factors defined in the Technical Specifications, Fuel Warranty, and Technical Requirements Manual are maintained within the limits specified.
b) The activity of gaseous and liquid effluents conforms to license limitations.

Level 2: Water quality is known at all times and remains within the guidelines of the water quality specifications.

Results: All Acceptance Criteria were met at all Test Conditions. No abnormalities were observed.

6.1.2 Test No. 2 – Radiation Monitoring

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

Description: Gamma dose rate measurements and, where appropriate, neutron dose rate measurements were made at specific limiting locations throughout the plant to assess the impact of EPU on actual plant area dose rates. UFSAR radiation areas will be monitored for any required posting changes.

Test Conditions: 1, 2, and 3

Acceptance Criteria:

Level 1: The radiation doses of plant origin and the occupancy times of personnel in radiation areas shall be controlled consistent with the guidelines of The Standard for Protection Against Radiation outlined in 10CFR20.

Level 2: Not Applicable.

Results: Radiation surveys were conducted with hydrogen water chemistry in service. The general plant dose rates were comparable to those experienced at the previous (Phase II) power level. Radiation dose rates remain compliant with all applicable regulatory limits.

6.1.3 Test No. 19 – Core Performance

Purpose: The purpose of this test is to measure and evaluate the core thermal power and fuel thermal margin to ensure a careful, monitored approach to the EPU level.

Description: Core thermal power was measured using the current plant methods of monitoring reactor power. Demonstration of the fuel thermal margin was performed and was projected to the next test condition to show expected acceptance margin and was satisfactorily confirmed by the measurements taken at each test condition before advancing further.

Test Conditions: 1, 2, and 3

Acceptance Criteria:

Level 1: a) Average Planar Linear Heat Generation Rates (APLHGR) shall be less than or equal to the limits specified in the Core Operating Limits Report (COLR).
b) Minimum Critical Power Ratios (MCPR) shall be greater than or equal to limits specified in the COLR.

c) Maximum Linear Heat Generation Rate (LHGR) shall be less than or equal to the limits specified in the COLR.
c) Steady-state reactor power shall be limited to values on or below the Maximum Extended Load-Line Limit Analysis (MELLLA) upper boundary.
d) Core flow shall not exceed its rated value.

Level 2: Not Applicable.

Results: Per normal operating practices, thermal limits are continuously monitored during power ascensions. Specific core monitoring cases were performed at the specified Test Conditions. Projections at the next Test Condition were made to determine if adjustments in control rod position would be necessary to maintain thermal limits within Acceptance Criteria. By adjusting the control rod patterns in the core, the Acceptance Criteria were met at all power levels.

Independent of the test program, during a routine rod adjustment to account for fuel burn-up, core flow slightly exceeded rated conditions (CAP 44976). Because this event did not occur during actual EPU testing, but as a result of a routine plant evolution (control rod sequence exchange), the Level 1 acceptance criterion for this test was met.

6.1.4 Test No. 22 – Pressure Regulator

Purpose: The purposes of this test are to:
a) confirm the adequacy of the setting for the pressure control loop used in the analysis of the transients induced in the reactor pressure control system using the pressure regulators,
b) demonstrate the takeover capability of the backup pressure regulator upon failure of the controlling pressure regulator and to set spacing between the setpoints at an appropriate value,
c) demonstrate smooth pressure control transition between the control valves and bypass valves when reactor steam generation exceeds steam used by the turbine, and
d) demonstrate that other affected parameters are within acceptable limits during pressure regulator induced transient maneuvers in preparation for operation at uprated conditions.

Description: The pressure regulator system tuning was verified to be within the guidance of Service Information Letter (SIL) 589, "Pressure Regulator Tuning."

The backup regulator test was not required to be performed in Phase III, as the maximum power level for this test (1540 MWt) was reached in Phase I.

During testing, step changes in reactor pressure, of increasing magnitude (±1 to 2 psi, ±3 to 4 psi, ±5 to 6 psi, ± 7 to 8 psi, and ±9 to 10 psi), 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.

Test Conditions: 1 and 3

Acceptance Criteria:

Level 1: The transient response of the turbine inlet (throttle) pressure to any test input must not diverge.

Level 2: a) The decay ratio of the turbine inlet (throttle) pressure must be less than or equal to 0.25. (This criterion does not apply to tests involving simulated failure of one regulator with the backup regulator taking over.)
b) The pressure response time from initiation of pressure setpoint change to the turbine inlet (throttle) pressure peak shall be less than 10 seconds.
c) Pressure control system deadband, delay, etc., shall be small enough that steady state limit cycles (if any) shall produce steam flow variations no larger than ± 0.5 percent of rated steam flow.
d) The peak neutron flux and peak vessel pressure shall remain below the scram settings by 7.5 percent and 10 psi, respectively, for all pressure regulator transients.
e) The variation in incremental regulation, over the range from approximately 10% to 100% of rated core thermal power, shall meet the following:

Percent Steam Flow	Variation
0% to 85%	< 4 : 1
85% to 97%	< 2 : 1
97% to 99%	< 5 : 1

Results: All test steps were completed at Test Conditions 1 and 3 using the "A" regulator. All test steps were completed at Test Condition 1 using the "B" regulator. However, during the "B" regulator testing at Test Condition 3, failure of an optical isolator card in the Electro-hydraulic Control (EHC) System was identified during the ±1 to 2 psi test, which precluded taking further data with the "B" regulator in control (CAP

45019). This was evaluated by the Expert Panel, and based upon successful testing at Test Condition 1 and the one successful test at Test Condition 3 with the "B" controller, which is the back-up controller, the recommendation was made to conclude the pressure regulator testing at this point.

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 occurred. Pressure response time and margins to scram setpoints were adequate in all test cases. System linearity was confirmed.

6.1.5 Test No. 23 – Feedwater System

6.1.5.1 Test No. 23C – Feedwater Control System (Step Changes in Level)

Purpose: The purposes of this test are to adjust the feedwater control system for acceptable reactor water level control and to demonstrate stable reactor response to subcooling changes.

Description: Small step changes in reactor water level (±1, ±2, ±3, and ±5 inches) were inserted to evaluate level control stability and any oscillatory response. These step changes were performed in both "A" and "B" Level Control and each set in both single-element and three-element control. A total of 32 level setpoint change tests were planned at each Test Condition. System responses (steamflow, feedflow and vessel water level) were monitored for overall stability.

Small step changes in system flow were introduced by making level adjustments (±1 and ±2 inches) with the Master Feedwater Regulating Valve (FRV) in Automatic, and one individual FRV controller in Automatic and the other FRV controller in Manual. The tests were repeated with the individual FRV controller settings reversed. A total of 8 system flow tests were planned at each Test Condition. System responses (steamflow, feedflow and vessel water level) were monitored for overall stability.

Test Conditions: 1 and 3

Acceptance Criteria:

Level 1: The transient response of any feedwater level control system related variable to any test input must not diverge.

Level 2: a) Level control system-related variables may contain oscillatory modes of response. In these cases, the decay ratio for each controlled mode of response shall be less than or equal to 0.25.
b) Following a ± 3 inch level setpoint adjustment in three element control, the time from the setpoint change until the level peak occurs shall be less than 60 seconds without excessive feedwater swings (changes in feedwater flow greater than 25% of rated flow).

Results: Based upon previous test results, the test matrix was simplified at Test Conditions 1 and 3 by omitting the "B" single element level control tests for the ±1, ±2, and ± 5 inch level setpoint change tests, i.e., only the ±3 inch test was performed, as it has the explicit Level 2 acceptance criterion.

All tests performed met the Acceptance Criteria. At no time was unstable control system behavior observed and response time was within the 60-second criterion.

6.1.5.2 Test No. 23D – Feedwater Flow Element Calibration

Purpose: The purpose of this test is to confirm acceptable calibration of the feedwater flow elements at uprated power conditions.

Description: In order to verify accurate feedwater flow input to the process computer, feedwater flow data from the flow elements will be compared against a known flow source information (i.e., the ultrasonic flow meter).

Test Conditions: 1 and 3

Acceptance Criteria:

Level 1: Not Applicable.

Level 2: The accuracy of the feedwater flow venturi indication relative to the calibrated flow information shall be within acceptable tolerance for flow rates between 20 and 125

percent rated. The process signal noise shall be within acceptable tolerance of rated flow.

Results: The venturies were within the required tolerances at each Test Condition. No anomalies were observed.

6.1.6 Test No. 25E – Main Steam Flow Element Calibration

Purpose: The purpose of this test is to confirm acceptable calibration of the main steam flow elements at uprated power conditions.

Description: In order to verify accurate steam flow input to the process computer, steam flow data from the flow elements will be compared against a known flow source information.

Test Conditions: 1 and 3

Acceptance Criteria:

Level 1: Not Applicable.

Level 2: The accuracy of the main steamline flow venturi relative to the calibrated feedwater flow shall be within ± 5 percent of rated steam flow at flow rates between 20 and 125 percent rated. The process signal noise shall be within ± 5 percent of rated steam flow.

Results: The main steamline flow venturies were within the required tolerances at each Test Condition. No anomalies were observed.

6.2 Additional Tests

6.2.1 Steady-State Data Collection

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

Description: Plant parameters, both Nuclear Steam Supply System (NSSS) and Balance of Plant (BOP) were recorded at various Test Conditions and evaluated for anomalous behavior prior to increasing power to the next Test Condition.

Test Conditions: 1, 2, and 3

Results: This data was gathered during Fall conditions which can cycle between high ambient temperature and humidity and lower temperatures and humidity on a daily basis, which can be demanding on plant operations.

It should be noted that a downpower for routine equipment testing (e.g., turbine valves and MSIVs) and control rod sequence exchange was planned to occur during the Phase III testing period. This additional maneuver (1880 MWt down to ~1070 MWt and back to 1880 MWt) was viewed as a addtional opportunity to gather plant data for the EPU Test Program.

One of the focus areas for this Phase of EPU testing was reaching the conditions where the main turbine control valves (TCVs), which operate in "partial arc" mode to control reactor dome pressure, reached the final operating range where TCVs 1, 2 and 3 are fully open against their mechanical open stops and TCV #4 is throttling steamflow to maintain reactor pressure at the desired state point. As this state point is approached, TCVs 1, 2 or 3 can "float" on and off their mechanical open stops, which increases wear in the system and accelerates required maintenance, which is not desirable for long-term operation. At Test Condition 2 (1860 MWt), the TCVs displayed this behavior and the EHC System began to make a high pitched noise at this condition (CAP # 44070). The Expert Panel recommended power be reduced back to 1840 MWt until the turbine vendor (General Electric (GE)) could be consulted and this condition evaluated prior to resuming power ascension and further testing conducted. Initial review by GE technical personnel indicated that this condition could be expected at this state point and was most likely attributable to flow noise in the EHC servo valves for TCVs 1, 2 and 3. GE personnel were on-site for resumption of power ascension to both 1860 MWt and 1880 MWt (Test Conditions 2 and 3) and observed, firsthand, the phenomena. It should be noted that at Test Condition 3 (1880 MWt), the TCVs had achieved their desired operating state and the high-pitched noise had greatly diminished in volume. GE's conclusion was that operation at 1860 MWt was acceptable.

Review of the steady-state plant data at 1880 MWt did not identify any anomalous behavior.

6.2.2 Power Conversion System Piping Vibration Monitoring

Purpose: The purpose of this test is to gather vibration and displacement measurements on the Main Steam and Feedwater (FW) system piping to evaluate the vibration stress effect due to the EPU.

Description: During the EPU power ascension, locations on Main Steam and Feedwater piping, coincidental with those in the initial startup vibration measurements report or evaluated as representative of the piping system, were monitored for vibration. Vibration measurements taken above that of the previous Test Condition will permit a thorough assessment of the impact of EPU.

Subsequent to Phase I, additional vibration monitoring points and associated acceptance criteria were generated for the Feedwater system piping. Specifically, nine additional monitoring points were added on the FW pump discharge piping and FW Regulating Valve areas for Phase II.

Test Conditions: 1, 2, and 3

Results: Since startup from RFO19, six of the original 38 sensors have failed - 2 on the Main Steam piping and 4 on the FW piping system. The loss of data from these 6 sensors was evaluated and determined to not impact the overall ability to monitor for excessive piping vibration (CAP 42316). Work Orders are in place to repair/replace the failed sensors during a future outage, as they are in inaccessible areas during power operation.

Screening criteria (frequency and magnitude) are established for evaluating the vibration data. If the "Negligible" values in the screening criteria are exceeded, Engineering evaluation of the data is required. All vibration data on the subject piping was within the Negligible range.

It should be noted that during Phase II of EPU, modifications were made to the Condensate pumps and motors to allow for a higher feedwater flow capability necessary to achieve the target power level of 1840 MWt. The change in pump characteristics, in particular pump vane passing frequency, was known to impact the vibration characteristics of the piping systems. Thus, this piping was targeted for monitoring as part of post-modification testing of this modification. Results of this monitoring follow:

The vibration at the critical location on the "A" FW pump 6-inch recirculation piping was flagged during Phase II testing as a follow-up issue for Phase III. However, during walkdowns of this piping during vibration monitoring at Phase III, Test Condition 1, a discrepancy was found between the piping support drawing and the actual as-built configuration (CAP 44324). The as-built configuration was actually more robust than the design drawing, which yielded additional margin to

the previous calculations for allowable vibration on this piping. Based upon the new information, the observed piping vibration at Test Conditions 1, 2, and 3 are well below the allowable limit and are no longer a specific concern.

During vibration monitoring at Test Condition 2 (1860 MWt), the 3-inch condensate reject line was observed as having high vibration (CAP 44867). Engineering evaluation determined that the original vibration acceptance criterion was overly conservative and revised the criterion for monitoring the piping during power ascension for Phase III. The measured vibration values on this piping were 26%, 77%, & 71% of the revised allowable limit at Test Conditions 1, 2, and 3, respectively. No further action is warranted for Phase III.

Right after plant restart from RFO19, a 1-inch drain line was observed as having high amplitude vibration and broken U-bolt support (CAP 36855). Subsequent evaluation (CE 2760) determined that the measured vibration value at Phase II, Test Condition 3 (1840 MWt) was 99% of the allowable (endurance) limit. A Corrective Action (CA 40523) was initiated to design a permanent fix for this vibration. Because this modification was not yet in place, a more-detailed vibration evaluation was conducted for EPU Phase III, which determined that the previous analysis was conservative and that margin to the fatigue limit was available. However, particular emphasis was placed upon monitoring this drain line by the Expert Panel as condition for further power ascension in Phase III. Predictions of piping vibration were made for this drain line at Test Condition 2 (1860 MWt) and acceptance criteria was included in the testing procedures. Initial in-situ vibration measurements of this drain line at 1860 MWt were above the acceptance criteria and power was reduced back to 1840 MWt (CAP 43859). Further evaluation was conducted and it was decided to add more support to this drainline to reduce the vibration. This interim modification (Engineering Change Package (ECP) – 1795) was installed and revised acceptance criteria were generated for this line. The post-modification measured vibration was well below the new acceptance limit. The decision was made by the Expert Panel to resume power ascension to Test Condition 2 (1860 MWt) and continue testing. The measured vibration at Test Conditions 2 and 3 remained well below the new acceptance limit for this drainline. The permanent modification to shorten this drainline is scheduled for the next Refuel Outage - winter 2007.

6.2.3 General Service Water (GSW) Heat Exchanger Performance Monitoring

Purpose: To gather data on GSW system performance to optimize cooling capacity to individual components.

Description: Obtain GSW flow (ultrasonic), GSW inlet temperature (contact pyrometer), GSW outlet temperature, and throttle valve positions for various component heat exchangers. The GSW system piping was replaced for EPU with piping of a larger size to increase the cooling to critical components, such as generator stator hydrogen cooling. This testing was to confirm adequate cooling and to provide data for further system balancing (i.e., optimize cooling to critical components.)

Test Conditions: N/A

Results: As noted in footnote (c) to Table 2, the Phase II data was collected during Summer conditions (i.e., high ambient temperatures and humidity), which are the most challenging for cooling GSW loads. Previous review of that data indicated that all components were receiving adequate cooling. Because no modifications have taken place subsequent to Phase II affecting GSW loading, and because Phase III was taking place in the Fall, with less challenging ambient conditions, the Expert Panel waived this testing for Phase III.

6.3 Industry Operating Experience with EPU

6.3.1 Steam Dryer Inspections and On-line Monitoring (SIL 644, Rev. 1)

While not part of the formal EPU Startup Test Program, the results of the steam dryer inspections and subsequent on-line monitoring of moisture carryover is a key attribute of demonstrating safe and reliable steam dryer operation at uprated power levels. Service Information Letter (SIL) 644, Rev. 1 provides the latest recommendations for performing these inspections and on-line monitoring.

Steam dryer inspections were conducted, per the SIL, during RFO19. These inspections did not find any major problems, only minor indications in the drain channel and a single indication in the cover plate upper support ring, which is consistent with BWR operating experience prior to EPU operation. The likely cause of the DAEC dryer indications is Intergranular Stress Corrosion Cracking (IGSCC), which is not power level dependent. In addition, the indications identified by the inspections performed during RFO18 were specifically re-inspected and evaluated during RFO19. None of the previous indications were found to have propagated further. A Justification for Continued Operation (JCO) was prepared that concluded plant startup and operation with the existing dryer cracking was acceptable for the upcoming (i.e., current) operating cycle. The DAEC dryer will be re-inspected during the next refuel outage, currently scheduled for February 2007.

On-line moisture carryover measurements have been conducted routinely during this operating cycle at the Phase II power level (1840 MWt). Additional moisture carryover measurements were conducted at both Test Conditions 2 and 3 as part of Phase III testing activities. There is no significant increasing trend (statistically or qualitatively) in this moisture carryover data, thus there is no indication of steam dryer damage (per the guidelines of SIL 644, Rev. 1, Appendix D). Periodic monitoring will continue during the remainder of this operating cycle.

7.0 References

1. NMC letter, "Startup Test Report for Extended Power Uprate – Phase II," NG-05-0516, September 29, 2005.

2. NMC letter, "Response to Request for Additional Information Regarding License Amendment Request (TSCR – 056): "Elimination of License Condition 2.C(2)(b) for Performance of Large Transient Tests for Extended Power Uprate," NG-04-0478, August 9, 2004.

3. NRC letter, "Duane Arnold Energy Center – Issuance of Amendment Re: License Amendment Request TSCR-056, Modify License Condition 2.C.(2)(b) to Eliminate Main Steam Isolation Valve Closure Test for Extended Power Uprate (TAC No. MC2320)," March 17, 2005.

Table 1

Test Matrix – Phase III

Test No.	Test Title	Test Conditions (% of OLTP – 1593 MWt)		
		112.4	114.3	115.5
		1840 MWt	1860 MWt	**1880 MWt**
1	Chemical and Radiochemical Monitoring	X	X	X
2	Radiation Monitoring	X	X	X
19	Core Performance	X	X	X
22	Pressure Regulator			
	c) Step Changes in Pressure	X		X
23	Feedwater System			
	c) Step Changes in Level	X		X
	d) FW Flow Element Calibration	X		X
25	Main Steam Isolation Valves			
	b) Full MSIV Closure Test	(b)		
	e) Flow Element Calibration	X		X
	General Plant Data Collection	X	X	X
	Steam and Feedwater Piping Vibration Monitoring	X	X	X
	General Service Water (GSW) Heat Exchanger Performance Monitoring	(a)	(c)	(c)
	Steam Dryer Inspections and On-line Monitoring (SIL 644, Rev. 1)	X(d)	X	X

(a) Previously performed as part of Phase II testing program.
(b) Per License Amendment # 257, this test is no longer required to be performed. (Reference 3)
(c) Phase II testing occurred during peak Summer temperatures, which are most challenging for GSW loads, and because no modifications have been made as part of Phase III, the Expert Panel waived this testing for Phase III.
(d) Steam Dryer Inspections were conducted during RFO19. On-line monitoring only was conducted as part of Phase III testing.

Table 2

Test Conditions – Phase III

Test Condition	Thermal Power (MWt)	% of Current Licensed Power Level (1912 MWt)	% of Original Rated Thermal Power (1593 MWt)
1	1840	96.2	115.5
2	1860	97.3	116.8
3	1880	98.3	118.0

Figure 1
DAEC Power/Flow Operating Map for EPU