Attachment 10

Peach Bottom Atomic Power Station Units 2 and 3

NRC Docket Nos. 50-277 and 50-278

Startup Test Plan

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1.0 Introduction

This document provides information to supplement the Peach Bottom Atomic Power Station (PBAPS) EPU License Amendment Request and provides additional information about startup testing using SRP 14.2.1- Generic Guidelines for Extended Power Uprate Testing Programs as a guide.

2.0 Purpose

2.1 Background

PBAPS began commercial operation in July 1974 (Unit 2) and December 1974 (Unit 3) with an Original Licensed Thermal Power (OLTP) of 3293 MWt. PBAPS received license amendments for a 5% stretch uprate to 3458 MWt in 1994 for Unit 2 and 1995 for Unit 3. Additional license amendments for a 1.62% Measurement Uncertainty Recapture (MUR) Power Uprate (PU) to a current licensed thermal power (CLTP) of 3514 MWt were approved in November, 2002 for both units.

This document provides detailed information on the testing Exelon intends to perform following the extended power uprate (EPU) implementation outages at PBAPS Units 2 and 3. PBAPS plans to implement a Constant Pressure Power Uprate (CPPU) to 3951 MWt. The planned EPU is approximately twelve percent (12%) above CLTP and twenty percent (20%) above OLTP. The planned EPU implementation outages are in 2014 and 2015 for PBAPS units 2 and 3 respectively. Following each of these outage PBAPS will conduct a comprehensive EPU startup test program to ensure the safe operation of the plants. These tests are described herein.

Additional modifications, unrelated to EPU, may also be installed during these outages and require testing during startup. A power ascension test procedure will be developed that incorporates the tests from this EPU startup test plan as well as any testing required from other modifications installed during these outages. This includes modifications that support EPU's increased power generation in the nuclear boiler system and secondary plant with higher performance requirements due to increases in flow rates, heat loads, electrical loads and power production, and core power, as applicable.

PBAPS will assure that the functions of plant equipment important to safety that rely on the integrated operation of multiple Structures, Systems and Components (SSCs) following an anticipated operational occurrence are adequately demonstrated prior to operation at the EPU power level.

The required EPU testing for PBAPS Units 2 and 3 was determined using information from several sources.

- The startup and power ascension testing that was done during initial plant startup as discussed in the PBAPS UFSAR Section 13.5.
- The testing that was done at the time of PBAPS's stretch power uprate in 1994 and 1995 and the Measurement Uncertainty Recapture (MUR) Power Uprate in 2002 and 2003. Information on this testing was obtained from the test plans and procedures used at those times.

- The guidance for extended power uprates in GE topical report NEDC-32424P-A "Generic Guidelines for General Electric Boiling Water Reactor Extended Power Uprate" (ELTR-1), including the NRC's Requests for Additional Information, GE responses and the NRC's staff position on the ELTR-1 documented in NRC letter dated February 8, 1996.
- The guidance for extended power uprates in GE topical report NEDC-32523P-A "Generic Evaluations of General Electric Boiling Water Reactor Extended Power Uprate" (ELTR-2), including Supplement 1, Volumes 1 and 2 and the NRC's staff position on the ELTR-2 documented in NRC letter dated September 14, 1998.
- The guidance for constant pressure power uprates (CPPU) in GE Topical Report NEDC-33004P-A "Constant Pressure Power Uprate" (CLTR), including the NRC's Requests for Additional Information, GE responses and the NRC's safety evaluation of the CLTR documented in NRC letter dated March 31, 2003.
- Information and data from plant transients that have occurred during PBAPS's operating history as applicable.
- The NRC Standard Review Plan (SRP), NUREG-0800, Section 14.2.1 "Generic Guidelines for Extended Power Uprate Testing Programs."
- Experience from other BWR plants that have implemented EPUs.

The NRC endorsed General Electric Licensing Topical Reports (NEDC-32424P-A, also called ELTRI and NEDC-32523P-A, also called ELTR2) for Extended Power Uprates. The NRC also accepted the test program of the CPPU Licensing Topical Report (NEDC-33004P-A called CLTR) for EPUs, but reserved the right to consider on a plant specific basis the CLTR recommendations against Large Transient Testing. The CLTR is the controlling document for the PBAPS 2 and 3 planned EPU. PBAPS will comply with the startup test requirements of the CLTR, but will take exception to performing Large Transient Testing as discussed in ELTR1. Accordingly, this document addresses large transient testing for PBAPS units 2 and 3.

2.2 Objective

This attachment describes the startup testing that Exelon will conduct associated with implementation of EPU at PBAPS, including justification for not performing large transient testing. The presentation of information is organized consistent with SRP14.2.1.

3.0 Summary of Conclusions

Based on the discussions in Section 5 and Tables 10-1 and 10-2 of this attachment, PBAPS will conduct an EPU test program to provide a controlled ascension to the proposed EPU power level. The test program will include sufficient testing to demonstrate that structures, systems and components will perform satisfactorily at EPU power levels. The EPU startup test plan is based on the initial startup test program and no tests were identified as being invalidated by EPU. The EPU startup test plan is integrated with other modification testing to demonstrate that all modifications have been adequately implemented.

PBAPS will develop the post modification testing for each of the modifications, listed in Attachment 9 to this LAR, in accordance with the PBAPS modification program. Performance testing for these, and any other, modifications installed during the EPU outages, will be integrated into a single, controlling Power Ascension Test Procedure, as necessary, to verify the aggregate effect of EPU and all modifications does not impact the safety performance of PBAPS Units 2 & 3.

Large Transient Testing for PBAPS Units 2 & 3 (See Section 5) is not required for EPU because:

1) PBAPS previously performed Large Transient Tests, as part of the initial startup test program, and documented the results;
2) Potential gains from further Large Transient Testing are minimal and produce an unnecessary and undesirable transient cycle on the primary system;
3) Analytical methods and training facilities adequately simulate large transient events without the need to impose actual events;
4) Plant operators will be trained in potential EPU transient events through the use of simulator models containing Balance of Plant (BOP) transients;
5) Probabilistic Risk Assessment (PRA) analysis indicates an increased risk of core damage and large early release if the tests are performed; and
6) Industry operating experience indicates that plants will continue to respond to these transients as designed following EPU implementation.

In view of previous test results and the plant response to prior documented events, the EPU startup testing program, as proposed in this attachment, is considered sufficient to validate the continued ability of the plant to safely operate within the required parameters and operational limits.

PBAPS requests that the NRC concur with the exception to perform Large Transient Testing. PBAPS has concluded that PBAPS and industry data provide an adequate correlation to allow the effects of the EPU to be analytically determined on a plant specific basis.

4.0 Testing Evaluations

4.1 Comparison to PBAPS Original, Stretch and MUR Startup Test Programs (SRP 14.2.1: III.A)

The CLTR provides the following guidance: 1) The same performance criteria will be used for EPU as in the original power ascension tests unless they have been replaced by updated criteria since the initial test program; and 2) because reactor pressure and core flow do not change, testing of system performance affected by steam pressure or core flow is not necessary with the exception of the tests listed in Section 10.4 of the CLTR. The testing planned for PBAPS to support implementation of EPU conforms to the guidance provided in the CLTR.

Power ascension tests performed at >80% of OLTP

Table 10-1, "Comparison of PBAPS Initial, Stretch and MUR Startup Testing and Planned EPU Testing," provides a comparison of the initial startup tests, the 5% stretch uprate and the MUR startup tests to the planned testing for the EPU. As shown in Table 10-1, the following tests were performed at 80% of OLTP or greater: SUT1, SUT 2, SUT 5, SUT 6, SUT 12, SUT 13, SUT 18, SUT 19, SUT 21, SUT 22, SUT 23, SUT 24, SUT 25, SUT 26,SUT27, SUT 29, SUT 30, SUT 90.

Additional details for planned EPU testing are provided in Table 10- 2, "Planned EPU Power Ascension Testing." Justifications for not performing certain transient testing are provided in section 5 of this Attachment. A listing of transient tests performed at 80% or greater during initial startup testing is provided below.

Power ascension transient tests performed at > 80% of OLTP

Table 4-1 shows startup transient tests performed at 80% OLTP or greater. This table is provided in accordance with SRP 14.2.1, paragraph III.A.1 and III.A.2. Initial startup tests, along with test power levels, are also provided in Table 10-1 of this attachment.

Table 4-1 Startup Transient Tests Performed at ≥80% OLTP

Initial Transient Test	Test Number	Power Level (OLTP)	UFSAR Table	Table 1 or 2 of SRP 14.2.1	EPU Testing Planned
Pressure Regulator	SUT 22	100	13.5.3	Table 1	Yes
Feedwater Pump Trip	SUT 23	100	13.5.1	Table 2	No*
Turbine Valve Surveillance	SUT 27	100	13.5.1	None	Yes
Full Main Steam Isolation Valve (MSIV) Closure	SUT 25	100	13.5.1	Table 2	No*
Recirculation Pump Trip (1 and 2 pump trip)	SUT 30	100	13.5.1	Table 2	No*

* See Section 5 for justification.

Tests at lower power invalidated by EPU

In accordance with SRP 14.2.1, paragraph III.A.2, the startup tests of Table 10-1, "Comparison of PBAPS Initial, Stretch and MUR Startup Testing and Planned EPU Testing," were reviewed for potential low power tests that would be invalidated by EPU. Table 4-2 identifies the tests performed during PBAPS initial startup at power levels less than 80% OLTP. Changes due to EPU were reviewed and it is concluded that there is no impact on the results of previous testing at lower power levels and since operation at low power levels is not changed for EPU, no tests were identified that would be invalidated by the PBAPS EPU, therefore it is not necessary to include these tests in the EPU startup test plan. All normal refueling and startup tests will be performed per procedural and tech spec requirements. Surveillance testing such as single MSIV closure and turbine valve testing will also be performed to determine the maximum power level future tests can be performed without exceeding any margins to trip setpoints.

Table 4-2 Startup Tests Performed at <80% OLTP

Initial Test	Test Number	Power Level (OLTP)	EPU Testing Planned
RCIC system	SUT 14	20%	Surveillance Test
HPCI system	SUT 15	50%	Surveillance Test
Single MSIV Closure	SUT 25	50%, 75%	Station single MSIV surveillance test
Turbine Control Valve Trip	SUT 27	20%, 75%	Single valve surveillance test.
Generator Load Reject and Turbine Trip	SUT 31	25%	None, See Section 5 for justification

4.2 Post Modification Testing Requirements (SRP14.2.1: III.B)

Attachment 9 of the EPU License Amendment Request provides a listing of EPU implementation modifications that are currently anticipated and that are being prepared for implementation in the 2012 and 2013 outages or the EPU implementation outages in 2014 and 2015. PBAPS plans to complete the necessary modifications to achieve 120% OLTP prior to the conclusion of the 2014 and 2015 refueling outages for PBAPS Unit 2 and 3 respectively. The EPU startup test program will be conducted following these outages.

Modification Aggregate Impact

As can be seen from an inspection of the modifications listed Attachment 9 of the EPU License Amendment Request, most of the modifications are typical EPU component replacements or set point changes to accommodate the increased flows of EPU. These modifications do not change system function and are installed to maintain design margin at EPU conditions.

The High Pressure Turbine replacement modification and the Condensate Pump modifications have an impact on the reactor plant as they are directly tied to the primary system piping and steam flow to the turbine is increased by approximately 13%. However their function and interrelationship is essentially unchanged. Condensate System upgrades represent significant plant modifications. These changes include the replacement of condensate pump internals and motors and the addition of two new filter demineralizers. The individual changes will be adequately addressed during post modification testing and the aggregate impact will be addressed by feedwater system power ascension testing. See Table 10-2 Planned EPU Power Ascension Testing for a description of planned feedwater system testing.

Other modifications are being implemented at PBAPS as part of the EPU Project that may not directly involve power generation. The details of associated post modification and startup testing will be developed in accordance with the PBAPS modification program. The performance attributes of these modifications, if any, will be verified during post modification testing, surveillance testing, and plant startup and operational testing, as applicable.

The startup test plan will be integrated with a power ascension test procedure that will include EPU and all other modification testing required during power ascension. The sequence of completing modifications and performing post-modification tests and test activities will coincide with the appropriate plant mode and power level and comply with all requirements of the PBAPS operating license to ensure a smooth orderly return to power and power escalation through completion of power ascension testing. Power ascension testing will include appropriate hold points to provide time to assess the plant response, verify test acceptance criteria are met, and verify the test results and plant's operating performance at power levels above CLTP, which includes reviews by the PORC prior to exceeding 100% CLTP.

<u>Startup Test Plan</u>

Aggregate impact of EPU plant modifications, setpoint adjustments and parameter changes will be demonstrated by a test program established for a Boiling Water Reactor (BWR) EPU in accordance with startup test specifications as described in PUSAR Section 2.12.1, Approach to EPU Power level and Test Plan. The startup test specifications are based upon analyses and GE BWR experience with uprated plants to establish a standard set of tests for initial power ascension for EPU. These tests, which supplement the normal Technical Specification testing requirements and balance of plant monitoring, are summarized below:

- Testing will be performed in accordance with the Technical Specifications Surveillance Requirements on instrumentation that is re-calibrated for EPU conditions.

- Testing will be done to confirm the power level near the turbine first stage scram bypass setpoint.

- EPU power increases will be made in predetermined increments of $\leq$ 5% power starting at 90% CLTP Rated Thermal Power (RTP) so that system parameters can be projected for EPU power before the CLTP RTP is exceeded. Operating data, including fuel thermal margin, will be taken and evaluated at each step. Routine measurements of reactor and system pressures, flows and vibration will be evaluated for each measurement point, prior to the next power increment.
  Radiation measurements will be made at selected power levels to ensure the protection of personnel.

- Control system tests will be performed for the reactor feedwater/reactor level controls and pressure controls. These operational tests will be made at the appropriate plant conditions for that test at each of the power increments, to show acceptable adjustments and operational capability.

- Steam dryer/separator performance will be confirmed within limits by determination of steam moisture content during power ascension testing.

- Vibration monitoring of main steam, feedwater and other balance of plant piping and components will be performed to permit a thorough assessment of the effect of EPU on the plant.

The same performance criteria will be used as in the original power ascension tests, except where they have been replaced by updated criteria since the initial test program. Specific test acceptance criteria may have changed from initial startup due to implementation of modifications such as the digital feedwater control system. The revised acceptance criteria will be incorporated in the power ascension test procedure. Because dome pressure and core flow have not changed and recirculation drive flow has only increased slightly (<2%) for EPU to achieve rated conditions, testing of system performance affected by these parameters is not necessary with the exception of the tests listed above.

The tests to be performed and the power levels at which they will be performed are described in Table 10-1. The overall power ascension test procedure is designed to provide management oversight and control of the testing activities to assure PBAPS can operate safely up to the licensed EPU thermal power level. EPU testing beyond CLTP is performed along an established flow control/rod line to ascend to EPU power in uniform increments of ≤5%. This incremental testing approach ensures a careful, monitored ascension to 100% EPU power. As power is increased to each increment, the tests are performed to demonstrate acceptable performance and power-dependent parameters are evaluated for acceptability. If all test results are satisfactory, the results will be assembled and presented to the PBAPS PORC for approval prior to increasing power to the next level. The first review by the PBAPS PORC is required to occur prior to exceeding 100% CLTP with subsequent reviews completed prior to exceeding the next incremental step in power with a final review after reaching 100% EPU power.

EPU tests will have level 1 and 2 acceptance criteria. Level 1 criteria are associated with design performance. If a Level 1 test criterion is not met, the plant will be placed in a hold condition that is judged to be satisfactory and safe, based upon prior testing. Resolution of the problem will be immediately pursued by equipment adjustments or through engineering evaluation as appropriate. The problem resolution plan will be presented to the PORC for approval prior to implementing corrective actions. The applicable test portion will be repeated to verify that the Level 1 requirement is satisfied and the results presented to the PORC for approval prior to increasing reactor power.

Level 2 criteria are associated with performance expectations. If a level 2 criterion is not met, an evaluation will be initiated to identify the cause and actions necessary to correct the problem. The results of the evaluation will be presented to the PORC for approval prior to implementing corrective actions. If physical adjustments are required, the applicable test portion will be repeated to verify that the Level 2 requirement is satisfied prior to increasing reactor power.

The EPU testing program at PBAPS, which is based on the specific testing required for the PBAPS initial EPU power ascension, supplemented by normal Technical Specification testing and balance of plant monitoring, is confirmed to be consistent with the generic description provided in the CLTR.

5.0 Justification for Elimination of Power Ascension Tests

5.1 Guidelines of SRP 14.2.1 Paragraph III.C.2

Paragraph III.C.2 of SRP 14.2.1 provides specific guidance to consider when justifying elimination of large scale transient testing. The following table provides a cross reference between the guidance of SRP 14.2.1 paragraph III C.2 and this Attachment.

Table 5-1 Justification Cross Reference

Paragraph III C>2	Guidance Criteria	Discussion
(a)	Previous operating experience	Contained in paragraph 5.3 and 5.4 considering industry and PBAPS experience
(b)	New thermal hydraulic phenomena or system interactions	No new thermal hydraulic phenomena or new system interactions were identified as a result of PBAPS CPPU. No further discussion is provided.
(c)	Conformance with limitation of analytical methods.	PBAPS has no unique limitations associated with analytical methods. No analytical results are used as the sole justification for eliminating any tests. No further discussion is provided.
(d)	Plant staff familiarization with facility operation and EOPs.	Discussed in Section 5
(e)	Margin reduction in safety analysis for AOOs	Provided in Section 5 for specific tests as applicable and in the section on EPU analysis results.
(f)	Guidance in Vender topical reports	Discussed in Section 2
(g)	Risk implications	Discussed in Section 5

ELTR1 states MSIV Closure Events would be tested for EPU if the power uprate was more than ten percent (10%) above any previously recorded MSIV closure transient. Similarly, ELTR1 states a generator load rejection test would be performed if the uprate was more than fifteen percent (15%) above any previously recorded generator load rejection transient. ELTR1 applies to extended power uprates whether constant pressure or otherwise. The CLTR applies to constant pressure power uprates only.

With regard to the specific ELTR1 requirements for Large Transient Testing, PBAPS Unit 2 had a MSIV closure event at 100% power on November 7, 2003 and Unit 2 had a generator lockout at 100% power on July 22, 2003. Based on these two events, the ELTR1 criteria to perform testing would apply to PBAPS as shown below in Table 5-2.

Table 5-2 Transient Testing Applicability

Event	LER No.	Date	Power	EPU Power	% Increase	Required by ELTR1
MSIV Closure	2-03-04	9/15/2003	3514 MWt	3951 MWt	12.4%	Yes (EPU>10%)
Generator Load Reject	2-03-03	7/22/2003	3514 MWt	3951 MWt	12.4%	No (EPU<15%)

PBAPS takes exception to the ELTR1 criteria for MSIV closure testing and provides justification for elimination of large transient testing from the PBAPS Unit 2 and 3 EPU power ascension test plan below.

5.2 Justification for Not Performing Large Transient Testing

Prior Large Transient Testing

Large Transient Testing performed during initial plant startup testing determined integrated plant response after reaching full power. Startup tests were required to baseline plant responses and to individualize system performances. Startup test results indicate SSCs perform their intended functions. PBAPS Units 2 and 3 satisfied all acceptance criteria necessary during initial startup testing. Large transient testing was not performed for the stretch uprate in 1994 & 95 and for the MUR uprates in 2002. Further Large Transient Testing for EPU is not required because plant transient performance has been baselined by startup testing, actual events, post modification testing and by analytical techniques.

Minimal Gains from Large Transient Testing

Large Transient Testing provides information that has minor additional value to plant operation. Large Transient Testing challenges a limited number of systems and components, all of which have a history of safe performance at PBAPS Units 2 &3. PBAPS Units 2 and 3 have accumulated more than 72 operating years of experience dealing with plant transient response. Therefore, performance of additional testing to demonstrate plant response at EPU provides insignificant benefit.

No new transients occur as a result of EPU. Transient analyses at EPU are comparable to analyses at current plant conditions. Changes in plant conditions for EPU are not expected to result in a significant change to current plant conditions and transient response. Therefore, large transient testing at PBAPS will not provide new insights and any gains from this testing are minimal.

The benefits from Large Transient Testing are outweighed by the potential adverse affects Large Transient Testing has on plant equipment. Large Transient Testing has a negative impact on the station and power grid, for which the unit supplies a significant base load. The scram and subsequent rapid reduction in power is controlled by normal operator actions. Therefore, the need to perform Large Transient Testing at PBAPS to demonstrate safe operation of the plant is unwarranted.

No new thermal-hydraulic phenomena or system interactions have occurred following actual MSIV closure, turbine trip and load reject events at PBAPS. The plant has responded as expected in accordance with design features.
The proposed EPU test program is included in the power ascension test procedure which tests the aggregate impact of EPU and plant modifications. Plant modifications to support EPU have minimal safety significance and will be implemented and tested as needed in advance of EPU implementation.

PBAPS Simulator Models Transients

Advances in analytical techniques, methods, models, and simulators have created a high level of confidence in determining plant responses and are cost effective alternatives to actual testing. Analyses demonstrate that plant shutdown is safely achieved under EPU conditions. PBAPS will perform simulator demonstrations of plant transient performance to support operator training at EPU conditions.

The PBAPS plant simulator is based on Unit 2 and has been benchmarked against both units 2 and 3. It provides accurate NSSS and BOP modeling of transients on both units to facilitate operator training on plant response to potential transients or events. The simulator will be updated to model EPU operation including all modifications and transient analyses prior to EPU implementation on the lead unit. The simulator will then be used for operator training prior to EPU implementation. PBAPS operator training on various plant upset conditions from postulated accident conditions to anticipated transients prepares them for the nature, timeline, and extent of the plant response to simulated transients. Therefore, initiating actual plant transient events for purposes of operator training will not be necessary.

Large Transient Testing risk assessment

PBAPS conducted an EPU probabilistic risk assessment (Attachment 12, Risk Assessment). It includes an assessment of performing two plant transient tests upon PBAPS EPU implementation. The evaluated tests were a generator full load reject and an MSIV isolation event. The risk assessment indicated the proposed tests represent an increase in the risk of core damage and large early release. This assessment does not include the potential equipment damage or challenges to the operators, which should be avoided. The CCDPs and CLERPs for a turbine trip and for a MSIV closure event are relatively small; however, they do have some risk significance.

Table 5-3 Conditional Probabilities for PBAPS EPU Startup Testing

Initiating Event	Initiating Event Frequency	Initiating Event Core Damage Frequency (CDF)	Conditional Core Damage Probabilities (CCDP)	Initiating Event Large Early Release Frequency (LERF)	Conditional Large Early Release Probabilities (CLERP)
Turbine Trip	0.754/yr	3.4E-7	4.4E-7	7.7E-8	1.0E-7
MSIV Closure	0.075/yr	4.6E-7	6.1E-6	2.9E-8	3.9E-7

The calculated CCDPs are 4.4E-7 and 6.1E-6 for non-isolation (turbine trip) and isolation (MSIV closure), respectively. Also, the calculated CLERPs are 1.0E-7 and 3.9E-7 for the non-isolation (turbine trip) and isolation (MS1V closure), respectively. These CCDPs and CLERPs represent the additional probabilities of core damage and large early release, caused by performing the proposed tests (i.e., the initiating events occur). If both tests are performed, the total additional probabilities would thus be 6.5E-6 (CCDP) and 4.9E-7 (CLERP). Note the analyses do not credit compensatory measures that may reduce the risk of core damage given that extra operators may be staged for the proposed tests.

5.3 Post EPU Industry Operating Experience

Steam Dryer Issues

Stresses imposed on steam dryers by the higher steam flows are being addressed in Attachments 15-17 of the PBAPS EPU application, and therefore will not be repeated here.

Industry Post EPU Transient Events

There have been several BWR-4 plants (similar to PBAPS) that have completed an EPU uprate. A review of industry transient events that occurred after NRC approval of the CLTR in March 2003, at greater than original power levels, was performed. Several examples of BWR-3/4/6 plant responses to MSIV closure and load reject/turbine trip events are detailed in the examples below. As indicated, the plants responded as expected in accordance with their design features. No unexpected conditions were experienced nor were any latent defects uncovered in these events beyond the specific failures that actually initiated the events. These events provide further evidence that large transient testing is unnecessary.

Dresden Nuclear Power Station- 17% Approved Power Uprate

LER 2004-002
On January 30, 2004, Dresden Unit 3 experienced a turbine trip and automatic reactor scram as a result of low lube oil pressure while operating at 97% (113.5% OLTP) rated thermal power. Immediately following the scram, the position of the Feedwater regulating Valves (FRVs) increased from 56% open to 63% open. The increase in the position, combined with the post-scram decreasing reactor pressure, caused an increase in total feedwater flow that led to the trip of the 'B' feedwater pump on low suction pressure. A RFP had not tripped on previous similar scrams, as the similar scrams occurred prior to the need to operate with 3 RFPs at full power. Additionally, subsequent FRV response to increasing reactor vessel level was not fast enough to prevent the level from reaching the Reactor Feedwater Pump (RFP) High Level trip setpoint and resulted in tripping of the 'A' and 'C' feedwater pumps. Reactor water level was subsequently restored to normal and the RFPs were restarted. All other system responses were as expected.

Subsequent investigations into the event determined that water had entered the HPCI piping rendering the system inoperable. Dresden Unit 3 has a separate HPCI vessel nozzle located approximately 50 inches below the main steam line nozzles. An evaluation determined that Feedwater Level Control System (FWLCS) would not maintain the post-scram reactor water level below that which would prevent water from entering the HPCI turbine steam line. The root cause was attributed to a FWLCS that had low margin to accommodate changes to the post-scram vessel level response. The condition was not known because a model capable of predicting the dynamic interaction between the FWLCS and other factors was not available. It is probable that the need to run 3 RFPs at the higher EPU power level was not recognized as having the potential to impact the FWLCS and feed water flow rates in response to a turbine trip, and therefore, a model was not developed and used to fully assess the impact to the plant performance until after the event occurred. This resulted in a failure to adequately evaluate or test the post scram response of the FWLCS prior to implementing extended power uprate.

It should be noted that, unlike Dresden, all 3 RFPs are used by PBAPS and required for operation at CLTP and EPU 100% power conditions, which precludes changes in hydraulic forcing functions the Dresden design work apparently failed to account for when they changed from operating 2 to 3 RFP. Feed water regulating valves are also not used at PBAPS. In addition, in the event of a turbine trip at high power levels, PBAPS procedures require tripping all 3 RFPs and restarting one RFP to control reactor vessel level. The PBAPS FWLCS is a dual redundant digital control system which controls reactor feedwater pump speed to regulate feedwater flow and maintain reactor level. The PBAPS FWLCS incorporates fault tolerance in its design so that any single failure, internal or external to the system, will not result in the loss of feedwater control. This system has proven reliable in controlling reactor level following transients (See the PBAPS transients presented Section 5.4.3). In addition, EPU analysis performed for this LAR have demonstrated adequate margin to the level 8 trip and the main steam nozzles. PBAPS does not have any steam nozzles lower than the main steam lines. The HPCI steam line is connected to the "B" main steam line and does not have a separate nozzle like Dresden, which provides additional margin against getting water in the HPCI steam line.

LER 2005-002
On March 24, 2005, at 0529 hours (CST), with Unit 2 at approximately 96 percent power, two unexpected control room alarms were received for exceeding the Electro-Hydraulic Control System maximum combined flow limit setpoint and open Turbine Bypass Valves. Several seconds later, high flow in the Main Steam System resulted in a signal to close the Main Steam Isolation Valves that initiated an automatic reactor scram. All control rods fully inserted and all other systems responded to the reactor scram as expected, except for non-safety related equipment, the Turbine Generator Lube Oil Pump and the 2B Reactor Auxiliary Oil Pump, which did not operate as required.

LER 2006-004
On July 4, 2006, Dresden Unit 2 experienced a closure of the **1A** MSIV while operating at 98% (115% OLTP) rated thermal power. The resulting redistribution of steam across the remaining steam lines caused a high steam flow condition. All MSIVs closed due to a Group I isolation signal and the plant experienced a reactor scram as designed. All systems responded as required. The Isolation Condenser was manually initiated to control reactor pressure. For PBAPS, closure of one MSIV at EPU conditions is expected to result in a high flux scram. However, a group I isolation is not expected to occur due to margin to the high steam flow set point that is changing from 137.5% to 140% of full power rated steam flow.

<u>Edwin I. Hatch Nuclear Plant - 15% Approved Power Uprate</u>

LER 2006-002
On April 5, 2006, Hatch Unit 2 was operating at 100% (115% OLTP) rated thermal power when a power-load unbalance was sensed resulting in a Turbine Control Valve fast closure and subsequent reactor scram. Reactor pressure spiked to approximately 1,125 psig which resulted in eight of the eleven Safety Relief Valves opening to relieve reactor pressure. Vessel water level was maintained well above the top of the active fuel throughout the transient and never decreased to the reactor scram actuation setpoint. Reactor water level was maintained through the use of the reactor feed pumps and
manual initiation of the RCIC and High Pressure Coolant Injection (HPCI) systems. There were no automatic safety system actuations on low level.

LER 2008-003
On July 4, 2008, Hatch Unit 1 was at 99.7% (115% OLTP) rated thermal power and experienced a turbine trip during testing of the Electrohydraulic Control (EHC) system. The resultant Turbine Control Valve fast closure initiated a reactor scram, as designed. Following the reactor scram, reactor pressure peaked at approximately 1,120 psig, resulting in four of the eleven Safety Relief Valves opening as designed to reduce pressure. The feedwater level control system controlled reactor water level with a minimum water level of approximately 2.5 inches above instrument zero (about 160 inches above the top of active fuel). All required safety systems functioned as expected given the water level and pressure transients caused by the turbine and reactor trips. Vessel water level was maintained well above the top of active fuel throughout the transient.

Clinton Power Station - 20% Approved Power Uprate

LER2002-003
On July 4, 2002, the Clinton Power Station tripped from 95% (114% OLTP) rated thermal power as a result of a faulty main power transformer sudden pressure relay (SPR) actuation. The SPR initiated a generator trip and lockout. The generator trip caused a Turbine Trip and a Turbine Control Valve fast closure, resulting in a reactor scram. The plant responded normally to the scram. As expected, reactor water level initially lowered below the Low Level 3 trip point and was restored in accordance with operating procedures. No safety relief valves lifted during the event.

LER 2004-001
On March 22, 2004, at about 1931 hours, an automatic reactor scram occurred with the plant at 93 percent power. Operators received a trouble alarm in the Main Control Room for the Hydrogen and Stator Cooling Cabinet followed by a Main Generator neutral over-voltage trip and Generator Trip System 2 Lockout. The Generator trip caused a Main Turbine trip and Turbine Control Valve fast closure, resulting in an automatic reactor scram. All control rods fully inserted. Following the reactor scram, reactor water level dropped, as expected, to the Low Level 3 trip setpoint, initiating the Reactor Protection System. Reactor water level was restored in accordance with operating procedures. No Main Steam Isolation Valves closed and no Safety Relief Valves lifted during this event.

Brunswick Steam Electric Plant - 20% Approved Power Uprate

LER 2005-005
On July 13, 2005, Brunswick Unit 1 scrammed from 100% (120% OLTP) rated thermal power due to the failure of the Main Generator No Load Disconnect Switch (NLDS). The switch failure caused a Turbine Trip and Turbine Control Valve fast closure which results in a Reactor Protection System (RPS) system actuation and reactor scram. Four of the Safety Relief Valves opened for one to two seconds in response to the pressure transient. The expected vessel coolant level shrink caused the vessel water level to decrease below the Low Level 1 setpoint, resulting in several containment isolation signals. Minimum water level momentarily satisfied the Low Level 2 actuation logic requirements causing an additional isolation signal and initiation of the HPCI system. The HPCI system did not inject due to water level recovering prior to the injection valve opening. Both plant and operator response to this event was as expected.

LER 2008-001
On August 30, 2008, at 1503 hours Eastern Daylight Time (EDT), a Power/Load Unbalance (PLU) actuation caused the Turbine Control Valves (TCVs) and the Main Turbine Bypass Valves (BPVs) to cycle. The initial cycle resulted in BPV No. 1 partially opening while a second cycle resulted in four BPVs going full open. At that time, the order was given to insert a manual scram. An automatic scram signal occurred just as the operator was beginning to insert the manual scram. Reactor water level momentarily dropped below Low Level 1 (LL1) during the response, resulting in Primary Containment Isolation System (PCIS) Group 2 and Group 6 isolations. LL1 actuations occurred as designed. All control rods fully inserted and all systems responded as designed.

The experience cited above indicates that other BWRs that have performed EPUs have successfully responded as planned to MSIV closure and load reject/turbine trip events. Based on this experience of other similar plants it is likely that PBAPS will perform similarly to these transients.

5.4 PBAPS Large Transient Testing Review and Analysis

PBAPS testing and operating history regarding the large transient tests shown in Table 5-2 was reviewed. This section presents the results of the review to justify not performing large transient testing for EPU at PBAPS.

5.4.1 MSIV Closure Test

Test Objectives

The MSIV closure startup test functionally checks the main steam isolation valves for proper operation at selected power levels, determines reactor transient response during and following simultaneous full closure of all MSIVs, determines isolation valve closure time and determines the maximum power at which a single valve closure can be made without a scram. A discussion of the test and acceptance criteria is contained in the PBAPS UFSAR Section 13.5.

Initial startup testing

All acceptance criteria for MSIV closure startup testing were satisfied. Proper MSIV operation was demonstrated and closure times verified at various power levels. During startup testing, MSIVs were closed and tested individually at 50, 75, and 80% power. Proper operation was demonstrated and closure times were within limits. Reactor response was monitored and steam flow margins calculated and all results were within limits. A full MSIV isolation was initiated from 100% power; MSIV closure times and reactor parameters were monitored and found acceptable when compared to predicted results.

Previous PBAPS Operating Experience

LER 2-03-04 dated Nov. 7, 2003

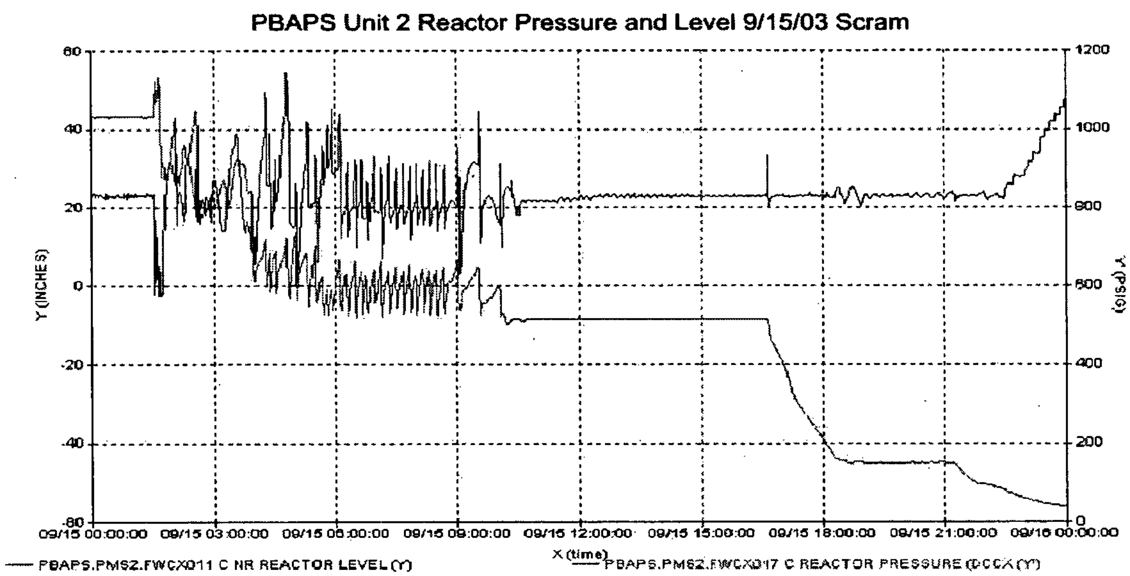
At approximately 0132 on 9/15/03, Units 2 and 3 automatically scrammed and received Primary Containment Isolations as a result of an interruption of power to the Reactor Protection System (RPS) and the Primary Containment Isolation System (PCIS) logic circuits. Unit 2 was in Mode 1 and operating at approximately 100% rated thermal power (3514MWt) when the event occurred. Unit 3 was in Mode 1 at approximately 90% rated thermal power in end-of-cycle coast down when this event occurred.

The Group I, II, and III Primary Containment Isolations on both units resulted in the closure of the Main Steam Isolation Valves (MSIVs) and other containment process and ventilation piping isolations. The Standby Gas Treatment (SGT) system actuated as designed on the PCIS isolation. On Unit 3, the 86D outboard MSIV did not initially close. However, the redundant inboard MSIV closed as designed. The 86D outboard MSIV went closed at approximately 0248 hours.

As a result of the Group I PCIS Main Steam Line Isolation, the Main Steam Safety Relief Valves (SRVs) actuated as designed to perform their overpressure protection safety function. SRVs on both Units 2 and 3 properly relieved pressure with the exception of the Unit 3 71 D SRV. This SRV did not re-close promptly as designed. The 71D SRV re-closed approximately 15 minutes after its actuation at approximately 400 psig reactor pressure which resulted in a larger pressure / temperature reduction than what would normally be desirable. However, this open SRV is bounded by the design basis event entitled, 'Inadvertent Opening of a Relief or Safety Valve'. It was determined that there were no detrimental effects to the reactor coolant system as a result of this event.

The most likely root cause of the MSIV 86D failure to close was identified to be external to the valve (an actuator or actuator sub-component such as a solenoid valve) which has been corrected. The actuator failure is also not related to power level or steam flow. Steam flow assists in closure of the valve so there would be no impact of EPU on this failure. The root cause of the SRV 71D failure to close was identified to be a pilot malfunction which was corrected. Since reactor pressure does not change with EPU there is no change to the operating conditions of the SRVs and there would be no impact of EPU on failure of the 71D to reseat.

There were complications to the post scram recovery due to the loss of off site power that initiated the event. However, both units reached cold shutdown conditions within 30 hours following the scram. The short term pressure and reactor level response for Unit 2 is shown below.



Plant staff familiarization with facility operation and EOPs

The EPU will not change any plant operations or EOP actions associated with MSIV closure. Since the dome pressure does not change, no SRV set point changes are required. The MSIV closure time is assisted by the increased steam flow. The MSIV closing times will be readjusted as necessary to ensure that the MSIV closure times satisfy plant technical specifications. These minor changes do not change the operation of the plant to address MSIV closure with increased steam flow.

Margin reduction in safety analysis for Anticipated Operational Occurrences (AOOs)

PUSAR Section 2.8.5.2, Decrease in Heat Removal by the Secondary System, states that because PBAPS is transitioning to GNF2 fuel, the CLTR method for evaluating this analysis is not applicable and the evaluation will be based on ELTR1. EPU analysis indicates that the predicted peak dome pressure for limiting MSIV events increases by 21 psi. from 1,293 psig to 1,314 psig. As a result, the margin to the dome pressure safety limit of 1,325 psig is decreased by 21 psi. In addition, a third spring safety relief valve (SSV) was added to maintain peak pressure below the ASME design limits for ATWS events. This new spring safety relief valve is identical to and has the same setpoint (1260 psig.) as the two existing valves. The operation and setpoints of the other pilot operated safety relief valves (SRV) has not been changed. This additional SSV does not change the existing functional relationship between the SRVs and the SSVs. It only adds additional pressure relief capacity. This analysis is updated each fuel reload. The EPU analyses conclude that adequate margins exist to accommodate cycle specific variances and to ensure that all ASME Code requirements continue to be satisfied.

EPU Power Ascension Testing

MSIV full closure testing at 100% rated power during EPU power ascension testing is not required at PBAPS because the plant response at EPU conditions is expected to be similar to the documented response during initial startup testing and actual transients that have occurred during plant operation. The transient analysis performed for the PBAPS EPU demonstrates that all safety criteria are met and for EPU that the MSIV closure event is limiting.

Deliberately closing all MSIVs from 120% OLTP power will result in an undesirable transient cycle on the primary system that can reduce equipment service life. As demonstrated during initial startup testing and confirmed by analysis, all equipment responses to the transient are within component and system design capabilities. However, placing accident mitigation equipment into service, under maximum loading conditions, uses available service life. Equipment service life should be retained for actual events rather than for demonstration purposes. Additional transient testing and the resulting impact will provide no additional plant response information beyond that documented during startup testing and from the evaluation of actual plant events. These events demonstrate the analysis is conservative and actual events will not challenge safety or design limits for this event.

The modifications to the feedwater system setpoints will not have an impact on this event because operational level control strategies and pressure control strategies maintain margin to the Level 8 trip setpoint which causes the feed water, HPCI and RCIC pumps to trip under CLTP and EPU conditions. The level 8 isolation signal provides the margin necessary to ensure reactor water level will not approach the elevation of the main steam lines.

The modification to the main turbine and the reduction in bypass capability has no impact because the turbine and the bypass system are isolated for this event.

Conclusion

PBAPS has reviewed the initial startup testing, recent PBAPS and industry operating experience, as well as analysis and PRA results. The original startup MSIV closure test was performed at 100% OLTP (3293 MWt), the plant response to a MSIV closure event has since been demonstrated at 100% CLTP (3514 MWt) which is equivalent to 89% EPU. Based on these plant historical data and EPU analytical results, it is concluded that the MSIV Closure Event results in conditions that are within design limits.

No new design functions in safety related systems are introduced as part of EPU that would need large transient testing validation. No physical modifications or setpoint changes are made to the pilot operated SRVs. One new spring safety valve (SSV) is installed for EPU to maintain margin to the ASME code limits during rapid pressurization events analyzed for EPU. The new SSV is the same as the existing two SSVs and has the same setpoint. This additional SSV does not change the existing functional relationship between the SRVs and the SSVs. It only adds additional pressure relief capacity. The increase in main steam flow and its impact is not significant with regard to the reactor pressure transient response. The changes to the feedwater system setpoints do not adversely change the feedwater level control response and the use of RCIC as the preferred level control system for this event.

In view of the above, the objective of determining reactor transient behavior resulting from the simultaneous full closure of all MSIVs can be satisfied for EPU without large transient testing through analysis. In addition, limiting transient analyses are included as part of the cycle specific reload licensing analysis. The need for re-performing this test at EPU conditions is not required because plant response is not expected to significantly change from that previously documented at CLTP conditions. Plant performance and analysis show adequate margin is available in vessel pressure and level limits that demonstrate acceptable reactor transient behavior. Therefore, this test is not warranted.

5.4.2 Generator Load Rejection

Test objectives

The startup testing for generator load rejection demonstrates the transient performance of the reactor and the station electrical supply system following a generator trip. A description of the test and acceptance criteria is contained in the PBAPS UFSAR Section 13.5

Initial startup testing

The initial startup testing at PBAPS was performed at 25% power and included loss of all off site power. Additional startup testing of turbine stop and control valve closure at power levels up to 100% OLTP verified the reactor transient responses and compliance with all acceptance criteria. These startup tests and recent PBAPS and industry operating experience, at increased power levels, demonstrates adequate plant response to this event and further testing is not considered necessary.

Previous operating experience

Since initial startup, a number of turbine trip or generator load reject events from full power have occurred at PBAPS Units 2 and 3, including the following examples:

LER 2-03-03 dated 9/16/03

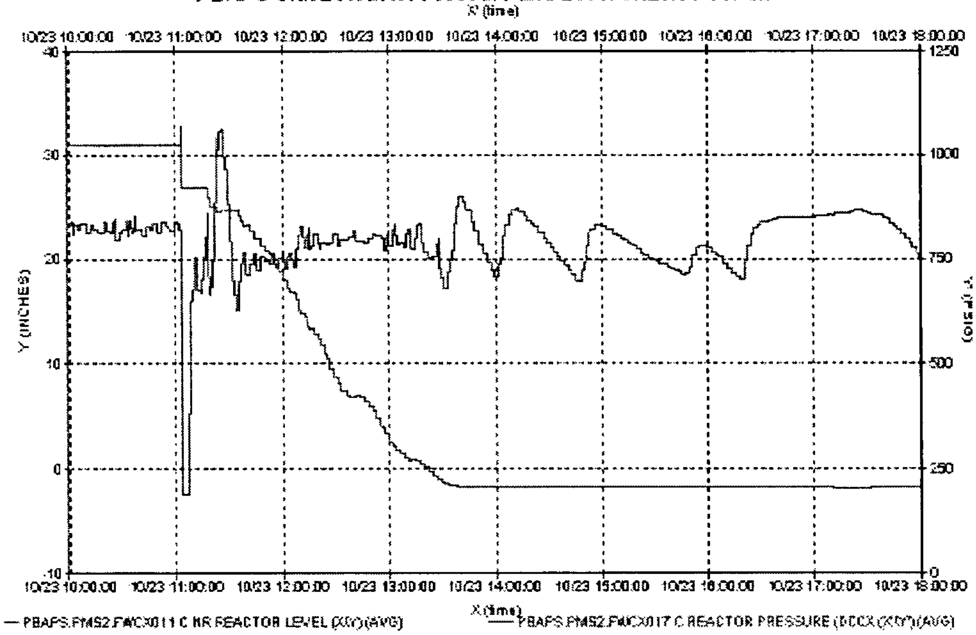
At approximately 1345 on 7/22/03, Unit 2 automatically scrammed from 100% rated thermal power as a result of a fast closure of the Main Turbine Control Valves. This was a result of a Main Generator lockout due to a generator neutral high voltage ground fault. Control rods fully inserted and Primary Containment Isolation System (PCIS) Group II /III isolations were received, as expected. At approximately 1358 hours, a Main Steam Line Isolation Valve closure occurred due to a Group I PCIS actuation. The actuation was a result of high area temperatures in the vicinity of the main steam lines caused by a loss of normal ventilation due to the Group II / III isolations. A reactor scram signal was also received as a result of the Group I isolation.

There were no actual safety consequences as a result of this event. All control rods inserted on the reactor scram signal. The Group I / II / III PCIS isolations resulted in the primary containment isolation safety function being met. All isolation valves closed as required. HPCI, MSRV, RPS and Recirculation Pump Trip safety functions operated as designed.

LER 2-01-004 dated 12/6/01

On 10/23/01, at approximately 1102 hours with Unit 2 operating at 100% rated thermal power, an automatic reactor scram occurred as a result of a main turbine trip caused by a generator lockout. As expected when the turbine tripped, reactor pressure increased resulting in five safety relief valves lifting initially to control reactor pressure. Reactor pressure was subsequently controlled by the main turbine bypass valves. Additionally, both Reactor Recirculation pumps received a trip signal when reactor pressure exceeded 1106 psig. An alternate rod injection signal was also generated due to the high pressure signal.
As expected for this type of event, reactor water level decreased resulting in PCIS group II and III isolations and a standby gas treatment start. All isolations performed as designed. No Emergency Core Cooling actuations occurred due to this event. All other systems responded as expected for the given plant conditions. The reactor level and pressure response to the scram is shown below.

PBAPS Unit 2 Reactor Pressure and Level 10/23/01 Scram



These events were determined to be bounded by the transient event analysis (Generator Load Rejection with and without Bypass) as described in USAR Section 14.5.1.

Plant staff familiarization with facility operation and EOPs

The EPU will not change any plant operations or EOP actions associated with a generator load reject turbine trip transient. Since the dome pressure does not change, no SRV set point changes are required.

Margin reduction in safety analysis for Anticipated Operational Occurrences (AOOs)

PUSAR Section 2.8.5.2, Decrease in Heat Removal by the Secondary System, states that because PBAPS is transitioning to GNF2 fuel, the CLTR method for evaluating this analysis is not applicable and the evaluation will be based on ELTR1. A generator load rejection is *not a limiting event and does not result in a reduction to the margin of safety*. The MSIV closure event is more limiting than the Turbine Trip event with respect to reactor overpressure. The EPU evaluations show a 40 to 50 psi difference between these two events (PUSAR Section 2.8.4.2). In addition, an evaluation of the MSIV closure event is performed with each reload analysis. The MSIV closure transient analysis has previously been discussed above.

EPU Power Ascension Testing

Turbine trip/generator load rejection tests from approximately 100% core power during EPU power ascension testing are not required for PBAPS. The plant response at EPU conditions is expected to be similar to those documented in the initial startup testing program and those experienced during the plant's operational period. The transient analysis performed for the PBAPS EPU demonstrates that all safety criteria are met and that EPU does not cause this event to become limiting. Deliberately causing a load reject and subsequent scram from 100% power will result in an undesirable transient cycle on the primary system that can cause undesirable effects on equipment and grid stability. The transient loading provides no benefit to safety equipment. Additional turbine trip/load reject testing would result in plant response that has been previously observed and the test would not provide new insight into SSCs performance.

Reactor pressure remains constant and the SRV set points do not change for EPU. The steam flow is increased for EPU and there are no changes to the steam bypass capacity. As a result of these changes an increase in peak reactor pressure will occur. Because of this change, the EPU analysis predicts that the SRVs will lift in the relief mode during a Turbine Trip and Generator Load Rejection Event. Opening SRVs is consistent with the original thermal power limit observations for this event.

The modifications to the feedwater condensate system have been evaluated for this event. Operational level control strategies as well as design requirements ensure that a Level 8 trip is avoided. This is consistent with the original startup and test Level 2 (SUT-31) acceptance criteria. Feedwater level control response testing will ensure that level control system and reactor feed pump response is consistent with the original start up and test requirements. Compliance with these requirements will ensure the Level 8 trip will be avoided. The feedwater control system response testing outlined in Table 10-1, Startup Testing Comparison, and Table 10-2, Planned EPU Power Ascension Testing, will verify the required system response to address the EPU modification and system changes.

Conclusion

The operating history of PBAPS demonstrates that previous turbine trip/load reject transient events from full power (OLTP and CLTP) are within expected peak limiting values. Based on past transient testing, past analyses and the evaluation of test or actual event results, the effects of a trip from EPU RTP can be analytically determined. No new design functions that would necessitate modifications and large transient testing validation are required of safety related systems for the EPU. No physical modification or setpoint changes were made to the pilot operated SRVs. One new spring safety valve is installed to maintain margin to code limits during rapid pressurization anticipated operational occurrences for EPU. Actual turbine trip transients at CLTP show significant margin to the spring safety valve setpoint of 1260 psig. The EPU turbine trip transient analysis indicates adequate margin remains to the code limits. The increase in steam flow and its impact on bypass capacity is not significant with regard to the reactor pressure transient response. The changes to the feedwater system do not adversely change the feedwater level control response and are predicted to improve the response.

In view of the above, transient mitigation capability is demonstrated by post modification testing and Technical Specification required testing. In addition, the limiting transient analyses are included as part of the cycle specific reload licensing analysis. From a safety-significance standpoint, turbine trip/load reject testing cannot be justified in that the transient cycle on the primary plant is undesirable and the potential benefits from such a cycle are not safety-significant. The response of the reactor and its control systems following trips of the turbine and generator has been demonstrated by numerous plant events and shown by EPU analysis to be acceptable. Therefore, this test is satisfied without requiring actual plant transient testing and this test is not warranted.

5.4.3 Other Large Transient Tests

The remaining large transient tests performed at $\geq$ 80% OLTP during the original power ascension of PBAPS Units 2 and 3 shown in Table 4-1 were reviewed for applicability to the EPU power ascension test plan. This section compares original start up test data, actual past plant events (if available), CLTR recommendations and the EPU analysis performed to justify eliminating these large transient tests for the EPU.

Recirculation Pump Trips

Test Objectives

The objective relating to recirculation pump trips is to evaluate the recirculation flow, power and level transients following trips of one or both recirculation pumps. A description of the test and acceptance criteria is contained in the PBAPS UFSAR Section 13.5

Original Test Results

Two single pump trips and one double pump trip were performed at various power levels up to approximately 95% OLTP and 104% core flow. Each trip was initiated by tripping the M-G set drive motor breaker. All level 1 criteria were satisfied and all plant systems responded satisfactorily following each trip. Forty seconds following the double pump trip, reactor level reached a peak of 35 inches then gradually returned to a normal level of 22 inches.

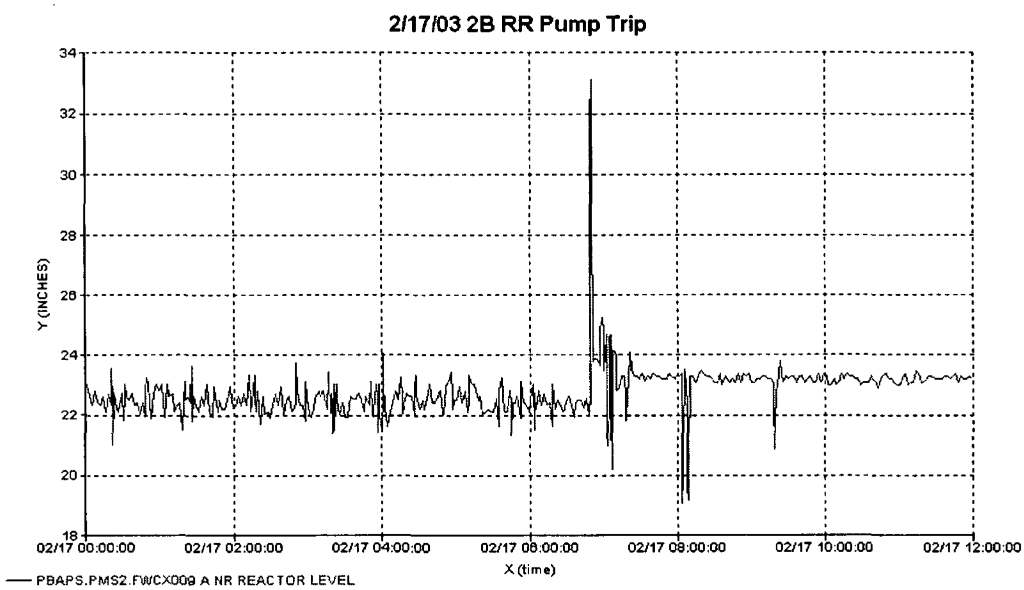
Subsequent Operating Experience

Since initial startup numerous recirculation pump trips and runbacks have occurred. All have been single pump transients. Examples of three such transients which occurred at or near 100% CLTP are shown below.

Table 5-4 PBAPS Recirculation Pump Trips

Date	Event	Initial Power	Post Trip Power Level	Margin to High Level (L-8) Trip
2/17/03	2B Recirc Pump Trip	100% (3514 MWt)	~35% (1200 MWt)	>10 in.
5/23/09	3A Recirc Pump Trip	74% (2600 MWt)	32% (1124 MWt)	>10 in.
2/3/10	2A Recirc Pump Trip	87% (3057 MWt)	41% (1440 MWt)	>10 in.

In each of the above transients the reactor did not scram and all plant systems responded as expected. The recirculation flow rate to provide 100% core flow is increased <2% over current operating conditions for a CPPU. ELTR 1 does not recommend recirculation pump trip testing because previous tests have shown the plant has large margins to the high level trip set point. In addition, ELTR1 states the margin is not expected to decrease significantly at uprated power level. The reactor level response to the 2/17/03 2B Recirc Pump trip is shown below.



Conclusion

PBAPS has reviewed the initial startup testing, recent PBAPS and operating experience as well as analysis and ELTR guidance. The plant response to a recirculation pump trip has been demonstrated at current licensed power. Supporting analysis included as part of EPU also demonstrates continued safe operation and expected plant response to the recirculation pump trip event after EPU. Due to the small increase in recirculation rate, the plant response is not significantly affected and no additional testing is required.

Therefore the objective of this test is considered satisfied without requiring new or additional transient testing.

Feedwater Pump Trips

Test Objectives

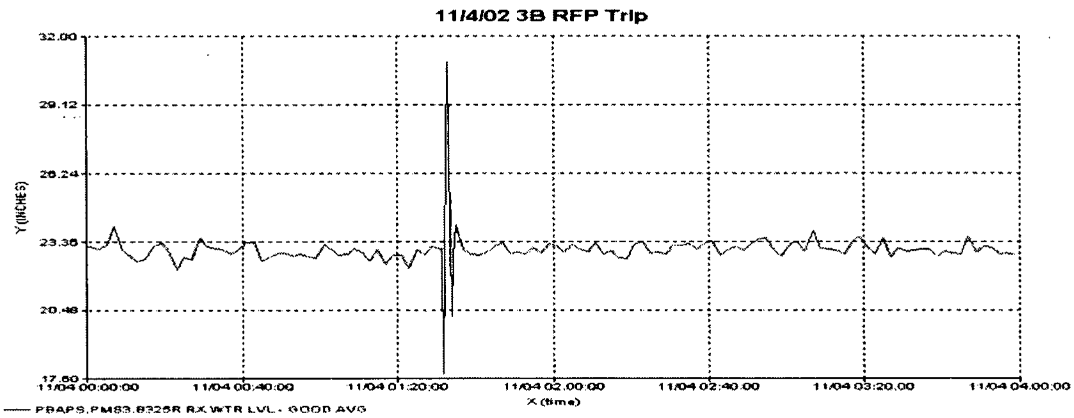
The original startup testing included trips of one of the three operating feedwater pumps at 75% and 100% power. The purpose of this test is to demonstrate the capability of the recirculation flow runback feature to prevent a low water scram following the trip of one feedwater pump. A description of the test and acceptance criteria is contained in the PBAPS UFSAR Section 13.5

Original Test Results

The original test results demonstrated that loss of one of three feedwater pumps at 100% OLTP had little effect on the operation of the plant. There was no change in steam flow, core flow or reactor pressure. The APRM reading and feedwater flow decreased but quickly recovered to original or close to original values. Reactor level also dropped during this transient but stabilized within minutes.

Subsequent Operating Experience

Since increasing power to the CLTP in 2002 PBAPS has had one feedwater pump trip at 100% CLTP. On 11/4/2002 the 3B reactor feedwater pump turbine tripped. The resulting low level was approximately17 inches which initiated a recirculation pump runback to 45% and the plant stabilized at 72% power and 53% core flow. The reactor level transient is show below.



The single feedwater pump trip (SFWPT) transient was analyzed at EPU operating conditions to determine if the L3 trip setpoint (1.0 inches) is avoided on a loss of one FW pump. With the current plant configuration, the SFWPT at EPU operating conditions would not result in a SCRAM on L3. The lowest reactor level reached is 3.6 inches above the L3 setpoint (PUSAR Section 2.8.5.2.3.2, Loss of One Feedwater Pump).

ELTR1 states that the single feedwater pump trip response is not affected by a power uprate. The response is affected by the flow control line and uprate uses the same MELLLA flow control that PBAPS operates at CLTP. Therefore, the analysis performed at EPU conditions is conservative when compared to the RFP trip transient of 11/4/02.

The PBAPS EPU analysis also included a total loss of feedwater (LOFW) event which demonstrates the ability to maintain reactor level above the top of active fuel. This analysis relied only on the RCIC system to restore reactor water level. Slightly more time is required for the automatic systems to restore level due to the additional decay heat from EPU, but the analysis shows that level is maintained 129 inches above the top of active fuel. After water level is restored, the operator manually controls water level, reduces reactor pressure and initiates RHR shutdown cooling. This sequence of events does not change or require any new operator actions, or shorten any operator response times as a result of EPU. Therefore operator actions for an LOFW transient do not change for EPU.

Conclusion

PBAPS has reviewed the initial startup testing, recent PBAPS and operating experience as well as analysis and ELTR guidance. The initial test results and recent PBAPS operating experience, at increased power levels, demonstrate adequate plant response to this event and further testing is not considered necessary. The plant response to a reactor feedwater pump trip has been demonstrated at current licensed power. Supporting analysis included as part of EPU also demonstrates continued safe operation and expected plant response to the loss of feedwater event after EPU. Therefore the objective of this test is considered satisfied without requiring new or additional transient testing.

Table 10- 1 Comparison of PBAPS Initial, Stretch and MUR Startup Testing and Planned EPU Testing

Original Test Description	Initial Test Power Level % OLTP	Stretch Uprate Power Level %OLTP	MUR Uprate Power Level %OLTP	Test Planned for CPPU	Evaluation & Justification	CPPU Test Power Level % CLTP (~MWt)					
						≤90 (3165)	95 (3340)	100 (3514)	104.2 (3660)	108.3 (3805)	EPU (3951)
SUT-1 Chemical: A complete set of chemical and radiochemical samples were taken to ensure that all sample stations are functioning properly and to determine initial concentrations.	20,50,75,100	100, 105	99, 105, 106.5	Yes EPU Test 1A	Test will be performed See Table 10-2 for details		X	X	X	X	X
SUT-2 Radiation Measurement: A survey of natural background radiation throughout the plant site was made prior to fuel loading, during reactor heatup and at power levels of 25, 50, and 100 percent of rated power. Gamma radiation level measurements and, where appropriate, thermal and fast neutron dose rate measurements, were made at significant locations throughout the plant. All potentially high radiation areas were surveyed.	25,50,100	95,100,102.5,105	106.5	Yes EPU Test 2	Test will be performed See Table 10-2 for details		X	X	X	X	X
SUT-3 Fuel Loading: To load fuel safely and efficiently to the full core size	<15% Note 1	None	None	None	Fuel loading is performed in accordance with standard procedures.						
SUT-4 Shut down Margin: To demonstrate that the reactor will be subcritical throughout the fuel cycle with any single control rod fully withdrawn.	<15% Note 1	None	None	None	Shutdown margin is determined as part of every reload.						
SUT-5 CRD: CRDs are tested periodically during power ascension to verify proper operation over the full range of primary coolant temperatures and pressures.	25,50,75,100	<85	Operator rounds at 105 & 106.5	Normal surveillance tests will be performed	Note 2 PUSAR Section 2.8.4.1 confirms compliance with CLTR generic disposition for the CRD system.			X	X	X	X
SUT-6 Control Rod Sequence: To verify the acceptability of the specified control rod withdrawal sequence.	25,40,50,60,100	None	None	None	Control rod sequences are developed in accordance with approved procedures.						
SUT N/A Steam Dryer: 1) Perform the station test to verify that moisture carryover is within limits. 2) Obtain strain gauge data and confirm stresses are with limit curves	None	None	None	Yes 1)EPU Test 1B 2) Separate test program coordinated with this program.	1) Dryer performance monitoring See Table 10-2 for details 2) See Attachment 17 for details	X	X	X	X	X	X
SUT N/A WRNM Calibration: To calibrate the WRNM system to EPU power level and confirm overlap with the APRM system.	Startup	Startup	Startup	Yes EPU Test 10	Test will be performed See Table 10-2 for details	X					

Original Test Description	Initial Test Power Level % OLTP	Stretch Uprate Power Level %OLTP	MUR Uprate Power Level %OLTP	Test Planned for CPPU	Evaluation & Justification	CPPU Test Power Level % CLTP (~MWt)					
						≤90 (3165)	95 (3340)	100 (3514)	104.2 (3660)	108.3 (3805)	EPU (3951)
SUT N12 APRM/ PRNM Calibration: To calibrate the APRM/ PRNM system to the EPU power level	20,35,50,75,100	<85,90,95,100,102.5 & 105	105,106.5	Yes EPU Test 12	Test will be performed See Table 10-2 for details	X	X	X	X	X	X
SUT 13 Process Computer: To verify the performance of the process computer under plant operating conditions.	20	None	None	None	No changes made to the process computer that would invalidate the original test.						
SUT 14 RCIC: To demonstrate the ability of the RCIC system to provide the required flow at various turbine steam supply and pump discharge pressures and to start from cold standby conditions.	20 (Manual)	<85, 105	106.5	Normal surveillance tests at 150 and 1050 psig are performed.	Note 2 PUSAR Section 2.8.4.3 confirms compliance with the CLTR dispositions for RCIC.	X					X
SUT 15 HPCI: To demonstrate the ability of the HPCI system to provide the required flow at various turbine steam supply and pump discharge pressures and to start from cold standby conditions.	50(Manual)	<85,105	106.5	Normal surveillance tests at 150 and 1050 psig are performed.	Note 2 PUSAR Section 2.8.5.6.2.1 confirms compliance with the CLTR dispositions for HPCI.	X					X
SUT 17 System Expansion: The purpose of this test is to verify that (1) the drywell piping is free and unrestrained in regard to thermal expansion and that suspension components are functioning in the specified manner (2) provides data for calculation of stress levels in nozzles and weldments.	20	None	None	None	Note 2 No testing is necessary, there are no changes in primary system piping temperatures.						
SUT 18 Core Power Distribution: The purpose of this test is to (1) obtain axial power distributions at various conditions of rod patterns, power levels, recirculation flow rate and sub cooling. (2) Verify the reproducibility of each TIP system, (3) Determine power distribution symmetry of octant-symetric control rod patterns.	20,50,75,100	105	Satisfied during startup	Normal surveillance tests are performed	Reactor core is loaded in accordance with approved procedures and this test is satisfied during startup.	X					X
SUT 19 Core Performance: The purpose of this test is to evaluate the core and thermal hydraulic performance to ensure parameters are within limits.	20,40,50,60,75,100	95,100,102.5,105	99,105,106.5	Yes EPU Test 19	Test will be performed see Table 10-2 for details	X	X	X	X	X	X
SUT 21 Flux Response to Rods: The purpose of this test is to demonstrate the relative stability of the power-reactivity feedback loop with regard to small perturbations in reactivity caused by rod movement with increasing power.	20,40,50,60,75,100	None	None	None	Reactor core is loaded in accordance with approved procedures. No changes have been made that invalidate previous tests.						

Original Test Description	Initial Test Power Level % OLTP	Stretch Uprate Power Level %OLTP	MUR Uprate Power Level %OLTP	Test Planned for CPPU	Evaluation & Justification	CPPU Test Power Level % CLTP (~MWt)					
						≤90 (3165)	95 (3340)	100 (3514)	104.2 (3660)	108.3 (3805)	EPU (3951)
SUT 22 Pressure Regulator: Verify the system response to (1) Set point changes and (2)verify the take over of the Backup Regulator	1)20,40,50,60,75, 100 2) 20,50,75,100	1) <85,102.5 2) None	1) 99,105, 106.65 2) None	1) Yes EPU Test 22 2) Yes	Test will be performed for both regulators, see Table 10-2 for details.	X X	X X	X X	X X	X X	X Note 5
SUT 23 FW System: Verify the system response to 1) a RFP Trip and 2)Level Setpoint changes 3) Confirm the feedwater flow calibration 4) Determine if the maximum feedwater runout capability is compatible with the licensing assumptions for EPU conditions.	1) 75,100 2) 20,40,50,60,75,100	1) Not performed 2) 102.5	1) Not performed 2)99,105,106.5	1) None 2)Yes 3) Yes 4) Yes EPU Test 23	1) See Section 5 2)-4) Test will be performed see Table 10-2 for details.	X	X	X	X	X	X Note 5
SUT 24 Bypass Valves: Demonstrate 1) the ability of the pressure regulator to minimize the reactor pressure disturbance during a small step change in reactor steam flow and 2) that the bypass valves can be tested at rated power without causing a high flux scram.	20,40,50,60,75,100	None	None	Surveillance Testing EPU Test 24	The surveillance test will be performed to determine the maximum power level that the test can be performed without a scram or isolation.	X	X	X	Based on prior test data	Based on prior test data	Based on prior test data
SUT 25 Main Steam Iso. Valves : 1) Single valve closure to functionally check MSIV operation at different power levels 2) Determine reactor transient behavior following closure of all valves	1)50,75 2)100	1) 75 2) Not performed	1) and 2) Not performed since there was no pressure or control changes	1) ST performed at ~75% CLTP. EPU Test 25 2)None	1) Test to determine the maximum power level the MSIV surveillance testing can be performed without a scram or isolation. 2)See Section 5	X	Based on prior test data	Based on on prior test data	Based on prior test data	Based on prior test data	Based on prior test data
SUT 26 Relief valves: The purpose of this test is to (1) demonstrate operability of the MSRVs (2) verify capacity of the MSRVs and (3) demonstrate leak tightness of the MSRVs after operation.	100	None	None	None	Notes 2 and 3 There are no changes to the pilot operated relief valves required for EPU. The additional spring safety valve added for CPPU is identical to the existing two and is bench tested prior to installation.						
SUT 27 Turbine Valve Testing : 1) Stop valve trip 2) Control valve trip	50,100 20,75	1) ST partial closure 100,102.5,105	1) and 2) Not performed since there was no pressure or control changes	ST partial closure EPU Test 24	Test to determine the maximum power level turbine valve surveillance testing can be performed without causing a scram. *See Table 10-2 for details*	X	Based on prior test data	Based on prior test data	Based on prior test data	Based on prior test data	Based on prior test data
SUT 29 Flow Control (Recirc): This test determines (1) The plant response to changes in Recirc. flow and (2) plant	20,40,50,60,75,100	None	Not performed since there was no pressure or	None	The increase in recirc flow rate is <2% from CLTP, therefore the plant						

Original Test Description	Initial Test Power Level % OLTP	Stretch Uprate Power Level %OLTP	MUR Uprate Power Level %OLTP	Test Planned for CPPU	Evaluation & Justification	CPPU Test Power Level % CLTP (~MWt)					
						≤90 (3165)	95 (3340)	100 (3514)	104.2 (3660)	108.3 (3805)	EPU (3951)
load following capability			control changes		response to a recirc flow change is not significantly impacted. See Note 4.						
SUT 30 Recirc System: This test evaluates plant response following 1) 1 pump trip and 2) 2 pump trip and 3) Calibrate the reactor core flow measurement system	50,75,100 50,75,100 20,50,75,100	None	1) and 2) Not performed since there was no pressure or control changes 3) 99,105,106.5	1) -2) None 3) Normal core flow calibration per station procedures	1)- 2) See Section 5 3) Included in EPU Test 19	X	X	X	X	X	X
SUT 31 Loss of TG & off site power: The purpose of this test is to demonstrate that the reactor can safely with stand a loss of the turbine-generator and all off-site power.	25	Not performed	Not Performed	None	See Section 5						
SUT 32 Recirc Loop Control: The purpose of this test is to determine the as-built characteristics of the recirculation control system and to adjust control systems parameters for optimum performance.	40,50	None	None	None	Note 4. The as built characteristics of the recirc system do not change with EPU.						
SUT 90 Vibration: *The purpose of this* test is to monitor vibration in key components and piping systems.	50,100		106.5 (key components only	Key components and Piping EPU Test 100	Test will be performed See Table 10-2 and Attachment 13 for details.	X	X	X	X	X	X
SUT Various Plant Parameter Monitoring: This test performs routine component and system performance monitoring of power dependent parameters.	Various	Various	Various	Yes EPU Test 101	Test will be performed see Table 10-2	X	X	X	X	X	X

Notes:
1. These tests were performed with the vessel open or during initial heat-up only.
2. CLTR Section 10.4 states that since there is no change in reactor dome pressure or core flow and recirculation flow may only slightly increase for CPPU, testing of system performance affected by these parameters is not necessary. Some tests may be performed to complete normal surveillance testing requirements.
3. The CLTR response to RAI Set 10 Number 1, Response 1b stated that testing of safety/relief valves is not required because changes made are consistent with the ASME code and are incorporated in the analysis performed for CPPU.
4. PUSAR Section 2.8.4.6 confirms that CPPU does not significantly affect the Reactor Recirculation system and PBAPS complies with the conclusions of the CLTR. The installation of ASDs may, however, require additional testing beyond that normally required for a CPPU. The final post modification testing will be developed in accordance with the Exelon modification process.
5. Tests 22 and 23 will be limited at 100% EPU power to those tests which will not increase reactor power above 3951 MWt.

Table 10- 2 Planned EPU Power Ascension Testing

Title	Test Number	Test Description
Chemical and Radiochemical	EPU Test 1A	Samples will be taken and measurements will be made at selected EPU power levels to determine 1) the chemical and radiochemical quality of reactor water and reactor feedwater and 2) gaseous release. Testing will utilize PBAPS station procedures.
Steam Dryer/Separator Performance	EPU Test 1B	Samples will be taken and measurements made at selected EPU power levels to determine steam dryer/separator performance (i.e., moisture carryover). For this testing main steam moisture content is considered equivalent to the steam dryer/separator moisture carryover. Sampling and analysis will be performed in accordance with PBAPS station procedures.
Radiation Measurements	EPU Test 2	At selected EPU power levels, gamma dose rate measurements and, where appropriate, neutron dose rate measurements will be made at specific limiting locations throughout the plant to assess the impact of the uprate on actual plant area dose rates. UFSAR radiation zones will be monitored for any required changes. Monitoring will be performed using PBAPS station procedures
WRNM Calibration	EPU Test 10	Each WRNM channel reading will be adjusted to be consistent with core thermal power, referenced to the EPU level. Test WRNM scram and rod block settings and assure WRNM overlap with the APRM. Testing and calibration will be performed in accordance with PBAPS station procedures.
PRNM/APRM Calibration	EPU Test 12	Each APRM channel reading will be adjusted to be consistent with the core thermal power, referenced to the EPU level, as determined from the heat balance. Assure that the APRM flow-biased scram and rod block setpoints in the PRNM system are consistent with EPU operation. Confirm all APRM trips and alarms prior to entering the EPU operating domain. Calibration will be performed in accordance with PBAPS station procedures.
Core Performance	EPU Test 19	Routine measurements of reactor parameters are taken near 90% and 100% of CLTP along a constant flow control/rod line to be used to increase to maximum EPU power. Power increase is along this established flow control line in incremental steps of 5% or less to ensure a careful, monitored approach to maximum EPU power.

Title	Test Number	Test Description
		Measured reactor parameters and calculated core performance parameters are utilized to project those values at the next power level step. Core thermal power and core performance parameters are calculated using accepted methods to ensure current licensed and operational practice are maintained. Each test condition's actual parameters will be evaluated against their projected values and operational limits before increasing power to the next step and the final increase to maximum EPU power.
Pressure Regulator	EPU Test 22	The pressure regulator requires only the following changes for EPU: 1. Pressure regulator setpoint 2. Confirming the dynamic tuning parameters Before startup, the pressure regulator system will be tested and dynamically calibrated. GE Service Information Letter (SIL) No. 589 discusses the tuning of the pressure regulator parameters. The pressure control system response to a pressure setpoint change is accomplished by first making a 3 psi. down setpoint change which is followed by a 3 psi up setpoint change after conditions stabilize. Following the 3 psi pressure change, the same testing is performed for a 6 psi change. The pressure regulators are tested individually and sequentially. Perform data gathering for incremental regulation and turbine first stage pressure scram bypass permissive setpoint validation.
Feedwater System	EPU Test 23	The feedwater control system response to reactor water level setpoint changes is evaluated in the indicated control mode (i.e., single element for power 0-30% and three element for power >30%). At each test condition, level setpoint change testing is performed by first making an up setpoint value change, which effects the level setpoint change desired, followed by a down setpoint value change of the same value, after conditions stabilize, in accordance with the following setpoint change sequence. 1) +2 inches | 3) +3 inches | 5) +4 inches 2) -2 inches | 4) -3 inches | 6) -4 inches The 2 and 3 inch level setpoint steps are informational and recommended to demonstrate the level control response prior to performing the formal level setpoint

Title	Test Number	Test Description
Feedwater System (cont)		steps (i.e., 4 inches). The results from the informational level setpoint steps are utilized to anticipate the responses to the formal demonstration test steps, so that effects on the reactor from the 4 inch steps may be anticipated (i.e., power increases, level alarms). The normal feedwater control system mode is three-element control, with single element control being used primarily during plant startup and under certain degraded conditions. The feedwater control system in three-element control mode should be adjusted, not only for stable operational transient level control (i.e., decay ratio), but also for stable steady-state level control (i.e., minimize feedwater flow limit cycles). In single element control mode, the system adjustments must achieve the operational transient level control criteria, but, for steady state level control, the temporary backup nature of this mode should be considered. For tests calling for manual flow step changes, at each test condition the feedwater control system is placed in a manual/auto configuration (i.e., one Reactor Feedwater Pump (RFP) in manual and the others in automatic controlling water level). Preferably the flow step changes are made by inserting the step demand change into the RFP controller in manual or alternately by changing the setpoint of that controller faster than its output ramp rate, in accordance with the following setpoint change sequence expressed in percent of rated EPU feedwater flow. After completion of testing on one controller, the manual/auto configuration is switched and the sequence is repeated on the other controllers. 1) Increase 5% — 3) Increase 10% 2) Decrease 5% — 4) Decrease 10% The 5% flow step changes are informational and recommended to demonstrate the RFP response prior to performing the formal test flow step changes (i.e., 10%). The results from the smaller informational flow steps are utilized to anticipate the responses to the formal demonstration test, so that any effects on the reactor may be anticipated (i.e., level changes, power increases). During the EPU power ascension, pressure, flow and controller data is gathered on the feedwater system

Title	Test Number	Test Description
		performance. This measured data is compared against expected values, which are based on information such as RFP performance curves, RFPT speed control curves, condensate pump performance curves, feedwater system flows and pressures, and vessel dome pressure. This data is used to predict Feedwater flow runout at EPU conditions and to verify that the runout flow does not exceed that used in the transient analyses.
Turbine Valve Surveillance (Stop, Control and Bypass valves)	EPU Test 24	The station surveillance test will be performed on at least one TCV, TSV and Bypass valve in each EPU test condition. After each EPU test condition's test, margins to scram / trip setpoints for each valve type are determined and margins projected to the next test condition. The EPU surveillance test power level is the highest power level where all margins remain acceptable. Scram / trip margins may be more conservative values as appropriate for operational practices and preferences (e.g., APRM flow biased simulated thermal power rod block alarm not received during the tests).
MSIV Surveillance	EPU Test 25	The station surveillance test will be performed on one MSIV at approximately 75% CLTP and other power levels if necessary to verify the margins to scram/trip setpoints. The results of this test will be used to determine the maximum power level the MSIV surveillance test may be performed without a scram or isolation.
Main Steam and Feedwater Piping Vibration	EPU Test 100	During the EPU power ascension, designated main steam and feedwater piping points (i.e., locations and directions) will be monitored for vibration. Vibration monitoring points will be designated based on EPU piping vibration analysis and engineering judgment. Monitoring points may be coincidental with those in the initial startup piping vibration test or be selected as those points with the highest predicted vibration. Alternately, vibrations monitoring points can be coincidental with exposed piping attachments provided that acceptance criteria is established for those points based piping system vibration analysis. Vibration measurements taken above CLTP will permit a thorough assessment of the effect of the EPU in comparison to any previous piping vibration analysis or evaluation (See Attachment 13).
Plant Parameter Monitoring and Evaluation	EPU Test 101	Routine measurements of the power-dependent parameters from systems and components, affected by the EPU, are taken at ≤95% and 100% of CLTP. Power increase is in incremental steps of 5% or less to ensure a careful, monitored approach to maximum EPU power. Power-dependent parameters that are calculated will be

Title	Test Number	Test Description
		calculated using accepted methods to ensure current licensed and operational practices are maintained. Measured and calculated power-dependent parameters are utilized to project those values at the next power level step prior to increasing to that test condition. Each step's projected values will be evaluated to have satisfactorily confirmed its actual values before advancing to the next step and the final increase to maximum EPU power.