ATTACHMENT 2

PEACH BOTTOM ATOMIC POWER STATION
UNITS 2 AND 3

Docket Nos. 50-277
50-278

License Nos. DPR-44
DPR-56

<u>Submittal of PBAPS TSAR, Rev. 1</u>
Supplement to
License Amendment Request (LAR) 01-01190
"PBAPS Measurement Uncertainty Recapture Power Uprate"

NON - PROPRIETARY
General Electric
Topical Safety Analysis Report for Peach Bottom Atomic Power Station Units 2 & 3,
NEDO-33064

GE Nuclear Energy

175 Curtner Ave., San Jose, CA 95125

NEDO-33064
Revision 1
DRF-0000-0000-5735
Class I
September 2002

SAFETY ANALYSIS REPORT
FOR
PEACH BOTTOM ATOMIC POWER STATION
UNITS 2 & 3
THERMAL POWER OPTIMIZATION

Prepared by: E. D. Schrull

Approved by: [signature]
Michael Dick, Project Manager
General Electric Company

Approved by: [signature]
Michael Baker, Project Manager
Exelon Generation, LLC

IMPORTANT NOTICE REGARDING CONTENTS OF THIS REPORT

PLEASE READ CAREFULLY

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY OF TERMS

Term	Definition
AC	Alternating Current
ADS	Automatic Depressurization System
AL	Analytical Limit
ALARA	As Low As Reasonably Achievable
ANS	American Nuclear Society
ANSI	American National Standards Institute
AOO	Anticipated Operational Occurrence
APRM	Average Power Range Monitor
ARI	Alternate Rod Insertion
ART	Adjusted Reference Temperature
ARTS	Average Power Range Monitor, Rod Block Monitor, Technical Specifications Improvement Program
ASME	American Society Of Mechanical Engineers
ATWS	Anticipated Transient Without Scram
AV	Allowable Value
B&PV	Boiler and Pressure Vessel
BHP	Brake Horse Power
BOP	Balance Of Plant
BWR	Boiling Water Reactor
BWROG	BWR Owners Group
BWRVIP	Boiling Water Reactor Vessel and Internals Project
CD	Condensate Demineralizer
CFR	Code Of Federal Regulations
CGCS	Combustible Gas Control System
CLTP	Current Licensed Thermal Power
CO	Condensation Oscillation
CPR	Critical Power Ratio
CRCWS	Control Room Chilled Water System
CRD	Control Rod Drive
CRGT	Control Rod Guide Tube
CS	Core Spray
CSC	Containment Spray Cooling
CSS	Core Support Structure
CST	Condensate Storage Tank
CW	Chilled Water
ΔW	Difference between the TLO and SLO drive flow at the same core flow
DBA	Design Basis Accident
DC	Direct Current
DCWS	Drywell Chilled Water System
ECCS	Emergency Core Cooling System
EDG	Emergency Diesel Generator
EFPY	Effective Full Power Year

Term	Definition
EHC	Electro-Hydraulic Control
EHS	Emergency Heat Sink
ELTR1	NEDC-32424P-A
ELTR2	NEDC-32523P-A
EOC	End of Cycle
EOL	End of Life
EOP	Emergency Operating Procedure
EPU	Extended Power Uprate
EQ	Environmental Qualification
Exelon	Exelon Generation, LLC
FAC	Flow Accelerated Corrosion
FFWTR	Final Feedwater Temperature Reduction
FIV	Flow-Induced Vibration
FPCCS	Fuel Pool Cooling And Cleanup System
FW	Feedwater
FWHOOS	Feedwater Heater(s) Out-Of-Service
GDC	General Design Criteria
GE	General Electric Company
GENE	GE Nuclear Energy
GL	Generic Letter
HELB	High Energy Line Break
HEPA	High Efficiency Particulate Air
HPCI	High Pressure Coolant Injection
HPCS	High Pressure Core Spray
HVAC	Heating, Ventilation, and Air Conditioning
IASCC	Irradiation Assisted Stress Corrosion Cracking
ICA	Interim Corrective Actions
ICF	Increased Core Flow
IEEE	Institute Of Electrical And Electronics Engineers
IPE	Individual Plant Examination
ISP	Integrated Surveillance Program
LCO	Limiting Conditions For Operation
LCS	Leakage Control System
LERF	Large Early Release Fraction
LHGR	Linear Heat Generation Rate
LOCA	Loss-Of-Coolant-Accident
LOOP	Loss Of Offsite Power
LPCI	Low Pressure Coolant Injection
LPCS	Low Pressure Core Spray
LPRM	Local Power Range Monitor
LPSP	Low Power Setpoint
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MBTU	Millions of BTUs
MCPR	Minimum Critical Power Ratio

Term	Definition
MCPRf	Flow Biased Minimum Critical Power Ratio
MELC	Moderate Energy Line Crack
MELLLA	Maximum Extended Load Line Limit Analysis
MeV	Million Electron Volts
Mlb	Millions Of Pounds
MLHGR	Maximum Linear Heat Generation Rate
MOV	Motor Operated Valve
MS	Main Steam
MSIV	Main Steam Isolation Valve
MSL	Main Steam Line
MSLBA	Main Steam Line Break Accident
MVA	Million Volt Amps
MWe	Megawatt-Electric
MWt	Megawatt-Thermal
NPSH	Net Positive Suction Head
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
NTSP	Nominal Trip Setpoint
NUREG	Nuclear Regulations (NRC Document)
OLMCPR	Operating Limit Minimum Critical Power Ratio
OLTP	Original Licensed Thermal Power
OOS	Out-Of-Service
P-T	Pressure-Temperature
PBAPS	Peach Bottom Atomic Power Station Units 2 & 3
PCLRT	Primary Containment Leak Rate Test
PCS	Pressure Control System
PCT	Peak Cladding Temperature
PSA	Probabilistic Safety Assessment
psi	Pounds Per Square Inch
psia	Pounds Per Square Inch - Absolute
psid	Pounds Per Square Inch - Differential
psig	Pounds Per Square Inch - Gauge
PWR	Pressurized Water Reactor
RBCCW	Reactor Building Closed Cooling Water
RBM	Rod Block Monitor
RCIC	Reactor Core Isolation Cooling
RCPB	Reactor Coolant Pressure Boundary
RG	Regulatory Guide
RHR	Residual Heat Removal
RIPD	Reactor Internal Pressure Difference
RIS	Regulatory Issue Summary
RPT	Recirculation Pump Trip
RPV	Reactor Pressure Vessel
RT_{NDT}	Reference Temperature Of Nil-Ductility Transition

Term	Definition
RTP	Rated Thermal Power
RWCU	Reactor Water Cleanup
RWM	Rod Worth Minimizer
SBO	Station Blackout
SBPCS	Steam Bypass Pressure Control System
SDC	Shutdown Cooling
SFP	Spent Fuel Pool
SGTS	Standby Gas Treatment System
SJAE	Steam Jet Air Ejector
SLCS	Standby Liquid Control System
SLMCPR	Safety Limit Minimum Critical Power Ratio
SLO	Single (Recirculation) Loop Operation
SPC	Suppression Pool Cooling
SRP	Standard Review Plan
SRV	Safety Relief Valve
SRVDL	Safety Relief Valve Discharge Line
SV	Safety Valve
SW	Service Water
TBCCW	Turbine Building Closed Cooling Water
TCV	Turbine Control Valve
TFSP	Turbine First Stage Pressure
TIP	Traversing In-Core Probe
TLO	Two (Recirculation) Loop Operation
TLTR	NEDC-32938P, Thermal Power Optimization Licensing Topical Report
TPO	Thermal Power Optimization
TSAR	Thermal Power Optimization Safety Analysis Report
TSV	Turbine Stop Valve
UFSAR	Updated Final Safety Analysis Report
USE	Upper Shelf Energy
VWO	Valves Wide Open
WRNM	Wide Range Neutron Monitor

EXECUTIVE SUMMARY

This report summarizes the results of all significant safety evaluations performed that justify increasing the licensed thermal power at the Peach Bottom Atomic Power Station Units 2 & 3 (PBAPS) by 1.7%, from 3458 MWt to 3517 MWt. The actual power increase is governed by the results of the core thermal power uncertainty calculation, which currently allows for an increase to 3514 MWt, i.e., 1.62% above current licensed thermal power (CLTP).

This report follows the format and content for Boiling Water Reactor (BWR) Thermal Power Optimization (TPO) licensing reports documented in NEDC-32938P, "Generic Guidelines and Evaluations for General Electric Boiling Water Reactor Thermal Power Optimization," called "TLTR." Per the outline of the TPO Safety Analysis Report (TSAR) in the TLTR Appendix A, every safety issue that should be addressed in a plant-specific TPO licensing report is addressed in this report. For issues that have been evaluated generically, this report will reference the appropriate evaluation and establish that the evaluation is applicable to the plant.

Only previously Nuclear Regulatory Commission (NRC) approved or industry-accepted methods were used for the analyses of accidents and transients. Therefore, because the safety analysis methods have been previously addressed, they are not addressed in this report. Also, event and analysis descriptions that are provided in other licensing documents or the Updated Final Safety Analysis Report (UFSAR) are not repeated in this report. This report summarizes the results of the safety evaluations needed to justify a licensing amendment to allow for TPO operation.

The TLTR addresses power increases of ≤ 1.5% of CLTP, which will produce up to approximately 2% increase in steam flow to the turbine-generator. The amount of power uprate (≤ 1.5%) contained in the TLTR was based on the expected reduction in power level uncertainty with the instrumentation technology available in 1999. The present instrumentation technology has evolved to where power level uncertainty is reduced to as low as 0.3%, thereby supporting the evaluation of a power level increase of 1.7%. The higher steam flow is achieved by increasing the reactor power along the current rod and core flow control lines. A limited number of operating parameters are changed, some setpoints are adjusted and instruments are recalibrated. Plant procedures are revised, and tests similar to some of the original startup tests are performed.

Evaluations of the reactor, engineered safety features, power conversion, emergency power, support systems, environmental issues, design basis accidents, and previous licensing evaluations were performed. This report demonstrates that PBAPS can safely operate at a power level of 3517 MWt.

The evaluations were conducted in accordance with the criteria of TLTR Appendix B.

1. All safety aspects of the plant that are affected by a 1.7% increase in the thermal power level were evaluated, including the Nuclear Steam Supply System (NSSS) and Balance-of-Plant (BOP) systems.
2. Evaluations and reviews were based on licensing criteria, codes and standards applicable to the plant at the time of the TSAR submittal. There is no change in the previously established licensing basis for the plant, except for the increased power level.
3. Evaluations and/or analyses were performed using NRC-approved analysis or industry-accepted methods for the UFSAR accidents and transients affected by TPO.
4. Evaluations and reviews of the NSSS systems and components, containment structures, and BOP systems and components show continued compliance to the codes and standards applicable to the current plant licensing basis (i.e., no change to comply with more recent codes and standards is proposed due to TPO).
5. NSSS components and systems were reviewed to confirm that they continue to comply with the functional and regulatory requirements specified in the UFSAR and/or applicable reload license.
6. No safety-related hardware changes are needed for TPO uprate beyond potential setpoint changes. Any non-safety-related plant modification will be designed to applicable design requirements and implemented in accordance with 10 CFR 50.59.
7. All plant systems and components affected by an increased thermal power level were reviewed to ensure no significant increase in challenges to the safety systems.
8. A review was performed to assure that the increased thermal power level continues to comply with the existing plant environmental regulations.
9. An assessment, as defined in 10 CFR 50.92(c), was performed to establish that no significant hazards consideration exists as a result of operation at the increased power level.
10. A review of the latest UFSAR and of design changes / 10 CFR 50.59 evaluations implemented, but not yet shown in the UFSAR, ensures adequate evaluation of the licensing basis for the effect of TPO through the date of that evaluation. Additionally, 10 CFR 50.59 evaluations for changes not yet implemented were reviewed for the effects of increased power.

The plant licensing requirements have been reviewed, and it is concluded that this TPO can be accommodated (1) without a significant increase in the probability or consequences of an accident previously evaluated, (2) without creating the possibility of a new or different kind of accident from any accident previously evaluated, and (3) without exceeding any existing regulatory limits applicable to the plant, which might cause a significant reduction in a margin of safety. Therefore, the requested TPO uprate does not involve a significant hazards consideration.

1.0 INTRODUCTION

1.1 OVERVIEW

This report summarizes the results of all significant safety evaluations performed that justify increasing the licensed thermal power at the Peach Bottom Atomic Power Station Units 2 & 3 (PBAPS) by 1.7%, from 3458 MWt to 3517 MWt. The actual power increase is governed by the results of the core thermal power uncertainty calculation, which currently allows for an increase to 3514 MWt, i.e., 1.62% above current licensed thermal power (CLTP). For the purposes of this report, Thermal Power Optimization (TPO) Rated Thermal Power (RTP) is defined as 1.7% above CLTP or 3517 MWt.

This report follows the format and content for Boiling Water Reactor (BWR) TPO licensing reports documented in NEDC-32938P, "Generic Guidelines and Evaluations for General Electric Boiling Water Reactor Thermal Power Optimization," (TLTR) (Reference 1). Power uprates in GE BWRs of up to 120% of original licensed thermal power are based on the generic guidelines and approach defined in the Safety Evaluation Reports provided in References 2 and 3 (ELTR1 and ELTR2). Since their Nuclear Regulatory Commission (NRC) approval, numerous extended power uprate (EPU) submittals have been based on these reports. The outline for the TPO Safety Analysis Report (TSAR) in TLTR Appendix A follows the same pattern as that used for the extended power uprates. All the issues that should be addressed in a plant-specific TPO licensing report are included in this TSAR. For issues that have been evaluated generically, this report will reference the appropriate evaluation and establish that it is applicable to the plant.

BWR plants, as currently licensed, have safety systems and component capability for operation at least 1.5% above the CLTP level. The amount of power uprate (≤ 1.5%) contained in the TLTR was based on the expected reduction in power level uncertainty with the instrumentation technology available in 1999. The present instrumentation technology has evolved to where power level uncertainty is reduced to as low as 0.3%, thereby supporting the evaluation of a power level increase of 1.7%. Several Pressurized Water Reactor (PWR) and BWR plants have already been authorized to increase their thermal power above the Original Licensed Thermal Power (OLTP) level based on a reduction in the uncertainty in the determination of the power level through improved feedwater (FW) flow rate measurements. When a previous uprate other than a TPO has been accomplished, the ≥ 102% safety analysis basis is reestablished above the uprated power level. Therefore, all GE BWR plant designs have the capability to implement a TPO uprate, whether or not the plant has previously been uprated.

1.2 PURPOSE AND APPROACH

1.2.1 TPO Analysis Basis

PBAPS was originally licensed at 3293 MWt and was uprated by 5% to the CLTP level of 3458 MWt (Reference 4). The current safety analysis basis assumes that the reactor had been operating continuously at a power level at least 1.02 times the CLTP level. The analyses performed at 102% of CLTP remain applicable at the TPO RTP, because the 2% factor from Regulatory Guide (RG) 1.49, "Power Levels of Nuclear Power Plants," is effectively reduced by the improvement in the FW flow measurements. Some analyses may be performed at 100% TPO RTP, because the uncertainty factor is accounted for in the methods, or the additional 2% margin is not required (e.g., Anticipated Transient Without Scram (ATWS)).

The TPO uprate is based on the evaluation of the improved FW flow rate measurement provided in Section 1.4. Figure 1-1 illustrates the TPO power/flow operating map for PBAPS. The changes to the power/flow operating map are consistent with the generic descriptions given in TLTR Section 5.2. The approach to achieve a higher thermal power level is to increase core flow along the established Maximum Extended Load Line Limit Analysis (MELLLA) rod lines. This strategy allows the plant to maintain most of the existing available core flow operational flexibility while assuring that low power related issues (e.g., stability) do not change because of the TPO uprate.

No increase in the previously licensed maximum core flow limit is associated with the TPO uprate. When end of full power reactivity condition (all rods out) is reached, end-of-cycle coastdown may be used to extend the power generation period. Previously licensed performance improvement features are presented in Section 1.3.2.

The TPO uprate is accomplished with no increase in the nominal vessel dome pressure. This minimizes the effect of uprating on reactor thermal duty, evaluations of environmental conditions, and minimizes changes to instrument setpoints related to system pressure, etc. Satisfactory reactor pressure control capability is maintained by evaluating the steam flow margin available at the turbine inlet. This operational aspect of the TPO uprate will be demonstrated by performing Pressure Control System (PCS) and FW/level control system testing equivalent to the testing performed during the original startup of the plant. The TPO uprate does not affect the pressure control function of the turbine bypass valves.

1.2.2 Margins

The TPO analysis basis ensures that the power-dependent instrument error margin identified in RG 1.49 is maintained. NRC-approved or industry-accepted computer codes and calculational techniques are used in the safety analyses for the TPO uprate. A list of the Nuclear Steam Supply System (NSSS) computer codes used in the evaluations is provided in Table 1-1. Similarly, factors and margins specified by the application of design code rules are maintained, as are other margin-assuring acceptance criteria used to judge the acceptability of the plant.

1.2.3 Scope of Evaluations

The scope of evaluations is discussed in TLTR Appendix B. Tables B-1 through B-3 illustrate those analyses that are bounded by current analyses, those that are not significantly affected, and those that require updating. The disposition of the evaluations as defined by Tables B-1 through

B-3 is applicable to PBAPS. This TSAR includes all of the evaluations for the plant specific application. Many of the evaluations are supported by generic reference, some supported by rational considerations of the process differences, and some plant specific analyses are provided.

The scope of the evaluations are summarized in the following sections:

2.0 Reactor Core and Fuel Performance: Overall heat balance and power-flow operating map information is provided. Key core performance parameters are confirmed for each fuel cycle, and will continue to be evaluated and documented for each fuel cycle that implements TPO.

3.0 Reactor Coolant and Connected Systems: Evaluations of the NSSS components and systems are performed at the TPO conditions. These evaluations confirm the acceptability of the TPO changes in process variables in the NSSS.

4.0 Engineered Safety Features: The effects of TPO changes on the containment, ECCS, Standby Gas Treatment, and other Engineered Safety Features are evaluated for key events. The evaluations include the containment responses during limiting abnormal events, ECCS Loss-of-Coolant Accident (LOCA), and safety relief valve containment dynamic loads.

5.0 Instrumentation and Control: The instrumentation and control signal ranges and analytical limits for setpoints are evaluated to establish the effects of TPO changes in process parameters. If required, analyses are performed to determine the need for setpoint changes for various functions. In general, setpoints are changed only to maintain adequate operating margins between plant operating parameters and trip values.

6.0 Electrical Power and Auxiliary Systems: Evaluations are performed to establish the operational capability of the plant electrical power and distribution systems and auxiliary systems to ensure that they are capable of supporting safe plant operation at the TPO RTP level.

7.0 Power Conversion Systems: Evaluations are performed to establish the operational capability of various (non-safety) balance-of-plant (BOP) systems and components to ensure that they are capable of delivering the increased TPO power output.

8.0 Radwaste and Radiation Sources: The liquid and gaseous waste management systems are evaluated at TPO conditions to show that applicable release limits continue to be met during operation at the TPO RTP level. The radiological consequences are evaluated to show that applicable regulations are met for TPO including the effect on source terms, on-site doses and off-site doses during normal operation.

9.0 Reactor Safety Performance Evaluations: [Redacted] The plant will perform the standard reload analyses at the first fuel cycle that will implement TPO uprate.

10.0 Other Evaluations: High energy line break and environmental qualification evaluations are performed at bounding conditions for the TPO range to show the continued operability of plant equipment under TPO conditions. The Probabilistic Safety Assessment (PSA) / Individual

Plant Examination (IPE) is not updated, because the change in plant risk from the TPO uprate is insignificant. This conclusion is supported by the recently issued NRC Regulatory Issue Summary (RIS) 2002-03 (Reference 5). In response to feedback received during the public workshop held on August 23, 2001, the Staff wrote, "The NRC has generically determined that measurement uncertainty recapture power uprates have an insignificant impact on plant risk. Therefore, no risk information is requested to support such applications" (Guidance G.9).

1.2.4 Exceptions to the TLTR

None.

1.2.5 Concurrent Changes Unrelated to TPO

Included in this evaluation are the effects of the increase in maximum river water temperature Technical Specification Limit from 90°F to 92°F.

1.3 TPO PLANT OPERATING CONDITIONS

1.3.1 Reactor Heat Balance

The following typical heat balance diagrams at the TPO conditions are presented:

Figure 1-2 Reactor Heat Balance – 3514 MWt, 100% Core Flow

Figure 1-3 Reactor Heat Balance – 3517 MWt, 100% Core Flow

The small changes in thermal-hydraulic parameters for the TPO are illustrated in Table 1-2. These parameters are generated for TPO by performing coordinated reactor and turbine-generator heat balances that relate the reactor thermal-hydraulic parameters to the increased plant FW and steam flow conditions. Input from PBAPS operation is considered (e.g., steam line pressure drop) to match expected TPO uprate conditions.

1.3.2 Reactor Performance Improvement Features

The following performance improvement and equipment out-of-service features currently licensed at PBAPS are acceptable at the TPO thermal power:

Performance Improvement Feature
Increased Core Flow (ICF) (110% of rated)
Average Power Range Monitor, Rod Block Monitor, Technical Specifications Improvement Program (ARTS) / MELLLA
24 Month Fuel Cycle
Feedwater Heater Out-of-Service (FWHOOS) (55°F)
End of Cycle (EOC) Recirculation Pump Trip (RPT) Out of Service (OOS)
Turbine Bypass Valve (TBV) OOS

Performance Improvement Feature
Single Loop Operation (SLO)
Final Feedwater Temperature Reduction (FFWTR) (90.0°F)

1.4 BASIS FOR TPO UPRATE

Results are presented for the TPO core thermal power uncertainty calculation for PBAPS in Table 1-4, based on the use of the LEFM CheckPlus™ for feedwater mass flow and temperature measurements. At the time of this writing, the LEFM system is not yet manufactured. Therefore, results are presented for contract guaranteed LEFM accuracy, which is considered to be the bounding case. The contract guaranteed value is ±0.36% power. This value assumes that the profile factor uncertainty for the LEFM CheckPlus™ is bounded by ±0.30%, that the post-installation configuration of the LEFM CheckPlus™ System meets Caldon's uncertainty tolerances, and that the post-installation feedwater pressure loop accuracy is bounded by ±15 psi. This supports a TPO uprate of up to 1.64% power or 3514.7 MWt. For conservatism, the actual requested power increase is to 3514 MWt (1.62% increase).

The sensitivities, loop accuracies, and resulting power errors for the contributors to thermal power error are summarized in Table 1-4. The individual uncertainties in Table 1-4 are combined by the root sum of the squares for those that are independent of each other, and by the algebraic sum for those that are mutually dependent (errors derive from the same source or sources). The combination of the individual errors in Table 1-4 is by the root sum of the squares with the following exceptions, which are algebraically summed:

- Items 2 and 3, both due to feedwater pressure error;
- Items 5 and 6, both due to feedwater temperature error; and
- Item 15 was combined with a sub-item within Item 7, LEFM volumetric flow, called "thermal expansion uncertainty, materials." The actual magnitude of Item 15 is 0.04%; the magnitude of the thermal expansion uncertainty, materials sub-item is 0.07%. Thus, Item 15 equals 0.11% (0.04% + 0.07%). In addition, Item 7 also contains the 0.04% factor, which makes this simplification conservative.

The equation representing the combination of errors shown in Table 1-4 is as follows:

Total uncertainty = SQRT $[(\text{Item } 1)^2 + (\text{Item } 2 + \text{Item } 3)^2 + (\text{Item } 4)^2 + (\text{Item } 5 + \text{Item } 6)^2 + (\text{Item } 7)^2 + (\text{Item } 8)^2 + (\text{Item } 9)^2 + (\text{Item } 10)^2 + (\text{Item } 11)^2 + (\text{Item } 12)^2 + (\text{Item } 13)^2 + (\text{Item } 14)^2 + (\text{Item } 15)^2]$

1.5 SUMMARY AND CONCLUSIONS

This evaluation has investigated a TPO uprate to 101.7% of CLTP. The strategy for achieving higher power is to extend the current power/flow map. The plant licensing challenges have been reviewed to demonstrate how the TPO uprate can be accommodated without a significant increase in the probability or consequences of an accident previously evaluated, without creating the possibility of a new or different kind of accident from any accident previously evaluated, and without exceeding any existing regulatory limits or design allowable limits applicable to the plant which might cause a reduction in a margin of safety. The TPO uprate described herein involves no significant hazards consideration.

Table 1-1 Computer Codes Used For TPO Analyses

Task	Computer Code	Version or Revision	NRC Approved	Comments
Nominal Reactor Heat Balance	ISCOR	09	(1)	NEDE-24011
Reactor Internal Pressure Differences	ISCOR	09	(1)	NEDE-32227, Oct. 1993: NEDC-32082P, Aug 1992 MFN-212-78, May 12, 1978
Anticipated Transient Without Scram	ODYN	10	Y	NEDE-24154P-A, Feb. 2000

NA – Not Applicable

NOTES:

(1) The heat balance application of ISCOR is not considered to be NRC reviewed and approved. There is no special methodology used for heat balance application of ISCOR. Simple reactor system heat balance equations are used in ISCOR. The reactor core coolant hydraulics implemented in ISCOR is reviewed and approved per Letter MFN-212-78, D.G. Eisenhut (NRC) to R. L. Gridley (GE), "Safety Evaluation for the GE LTR, Generic Reload Fuel Application, Original Document NEDE-24011," May 12, 1978. The steady state thermal-hydraulic correlations used in ISCOR are discussed in Section 4 of GESTARII, NEDE-24011P-A, which is NRC approved.

Table 1-2 Thermal-Hydraulic Parameters at TPO Uprate Conditions

Parameter	Current Licensed Thermal Power	TPO Uprate Power (101.62% of CLTP)	TPO Uprate Power (101.7% of CLTP)
Thermal Power (MWt) (Percent Of Current Licensed Power)	3458 100	3514 101.6	3517 101.7
Steam Flow (Mlb/hr) (Percent Of Current Rated)	14.148 100	14.387 101.7	14.402 101.8
FW Flow (Mlb/hr) (Percent Of Current Rated)	14.116 100	14.355 101.7	14.370 101.8
Dome Pressure (psia)	1050	1050	1050
Dome Temperature (°F)	550 5	550.5	550.5
FW Temperature (°F)	380 9	381.5	381.6
Full Power Core Flow Range (Mlb/hr) (Percent Of Current Rated)	83.0 to 112.75 81.0 to 110.0	84.9 to 112.75 82.8 to 110 0	85.0 to 112.75 82.9 to 110.0

Table 1-3 Summary of Effect of TPO Uprate on Licensing Criteria

Key Licensing Criteria	Effect of 1.7% Thermal Power Increase	Explanation of Effect
LOCA challenges to fuel (10 CFR 50 Appendix K)	No increase in peak clad temperature (PCT), no change of maximum Linear Heat Generation Rate (LHGR) required.	Previous analysis accounted for ≥102% of licensed power, bounding TPO operation. No vessel pressure increase.
Change of Operating Limit MCPR	< 0 01 increase	Minor increase due to slightly higher power density and increased MCPR safety limit (slightly flatter radial power distribution)
Challenges to Reactor Pressure Vessel (RPV) overpressure	No increase in peak pressure.	No increase because previous analysis allowed ≥102% overpower, bounding TPO operation.
Primary containment pressure during a LOCA	No increase in peak containment pressure.	Previous analysis allowed ≥102% overpower, bounding TPO operation. No vessel pressure increase. No increase in energy to the pool.
Pool temperature during a LOCA	No increase in peak pool temperature.	Previous analysis allowed ≥102% overpower, bounding TPO operation. No vessel pressure increase. No increase in energy to the pool.
Offsite Radiation Release, design basis accidents	No increase (remains within 10 CFR 100)	Previous analysis allowed ≥102% overpower, bounding TPO operation. No vessel pressure increase.
Onsite Radiation Dose, normal operation	~1.7% increase, must remain within 10 CFR 20.	Slightly higher inventory of radionuclides in steam/FW flow paths.
Heat discharge to environment	No effect on existing environmental permit	Small % power increase has negligible effect.
Equipment Qualification	Remains within current pressure, radiation, and temperature envelopes.	No change in Harsh Environment terms (bounded by previous design using ≥102% power); minimal change in normal operating conditions.
Fracture Toughness, 10 CFR 50 Appendix G	< 2°F increase in RT_{NDT}	Small increase in neutron fluence.
Stability	No direct effect of TPO uprate because applicable stability regions and lines are extended beyond the absolute values associated with the current boundaries to preserve MWt-core flow boundaries as applicable for each stability option.	No increase in maximum rod line boundary. Characteristics of each reload core continue to be evaluated as required for each stability option.
ATWS peak vessel pressure	Slight increase, stays within existing ASME Code "Emergency" category stress limit.	Slightly increased power relative to safety relief valves (SRV) capacity.
Vessel and NSSS equipment design pressure	No change.	Comply with existing ASME Code stress limits of all categories.

Table 1-4 PBAPS Heat Balance Parameter Uncertainties

Item	Error Contributor	Sensitivity (power error to loop error)	Loop Error	Power Uncertainty Contribution, % 2 sigma, Bounding Case
1	Steam pressure, through steam enthalpy	0.00454 % per psi	23 psi	0.104
2	Feed pressure through feed enthalpy	0.00017% per psi feed pressure error	15 psi	0.0026
3	Feed pressure through feed density	0.00057% per psi feed pressure error	15 psi	0.008
4	Feed density due to correlation error (ER-157P)	N/A	N/A	0.04
5	Feed temperature through feed enthalpy	0.127 % per degree F feed temp error	0.6°F	0.076
6	Feed temperature through feed density	0.0719 % per degree F feed temp error	0.6°F	0.043
7	Volumetric flow, LEFM	N/A	N/A	0.30
8	CRD heat addition	1	0.01%	0.01
9	Reactor Water Cleanup (RWCU) heat	1	0 036%	0.036
10	Q radiating from reactor system	1	0	0
11	Recirculation Pump Power	1	0.020%	0.020
12	Heat contributors not accounted for in plant computer	1	0.010%	0 010
13	Steam enthalpy due to correlation uncertainty	N/A	N/A	0.10
14	Conversion constant truncation	N/A	N/A	0.007
15	Power uncertainty due to thermal expansion of LEFM spool pieces (ER-157P)	1	0.110%	Included in 0.30% Vol. Flow Uncertainty Above
	Total Power Uncertainty			**0.36%**

Figure 1-1 Power/Flow Map for PBAPS at TPO Uprate Power

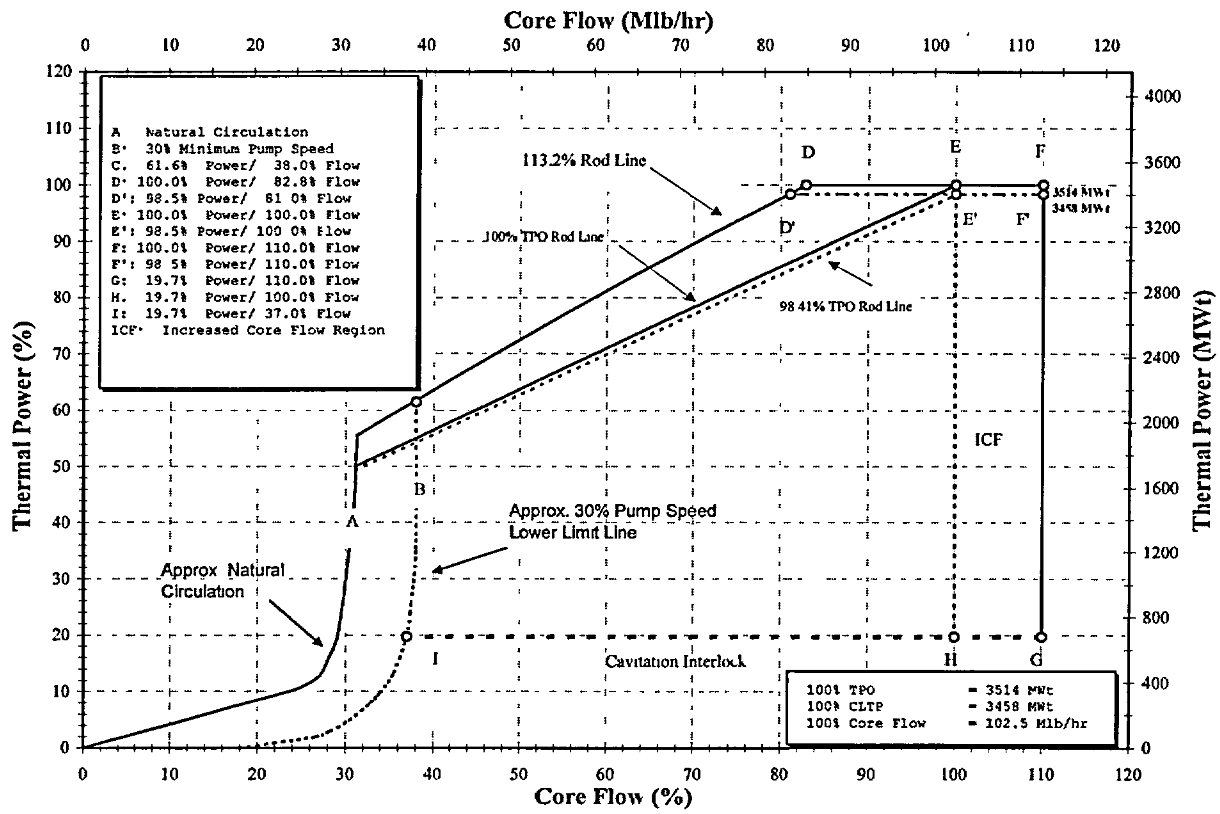
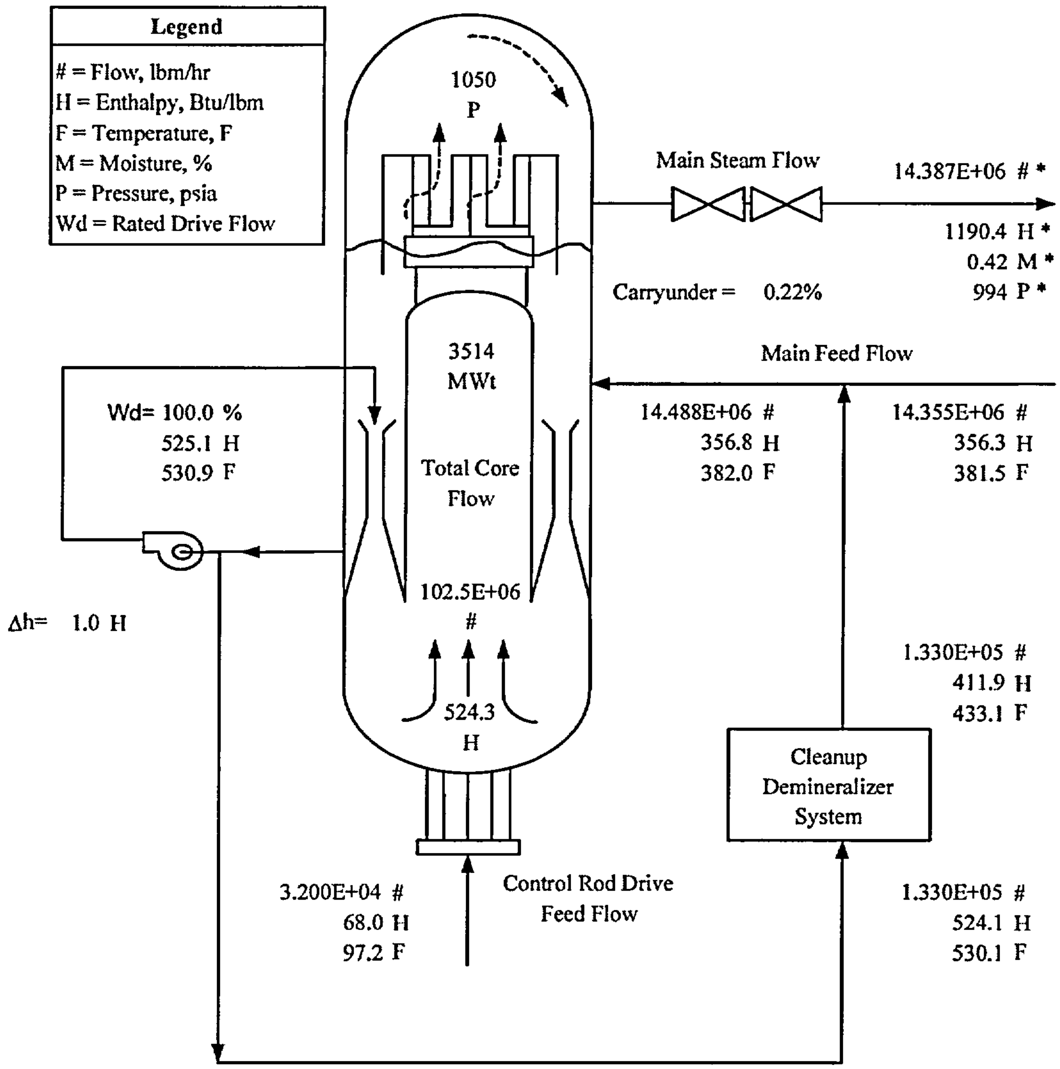


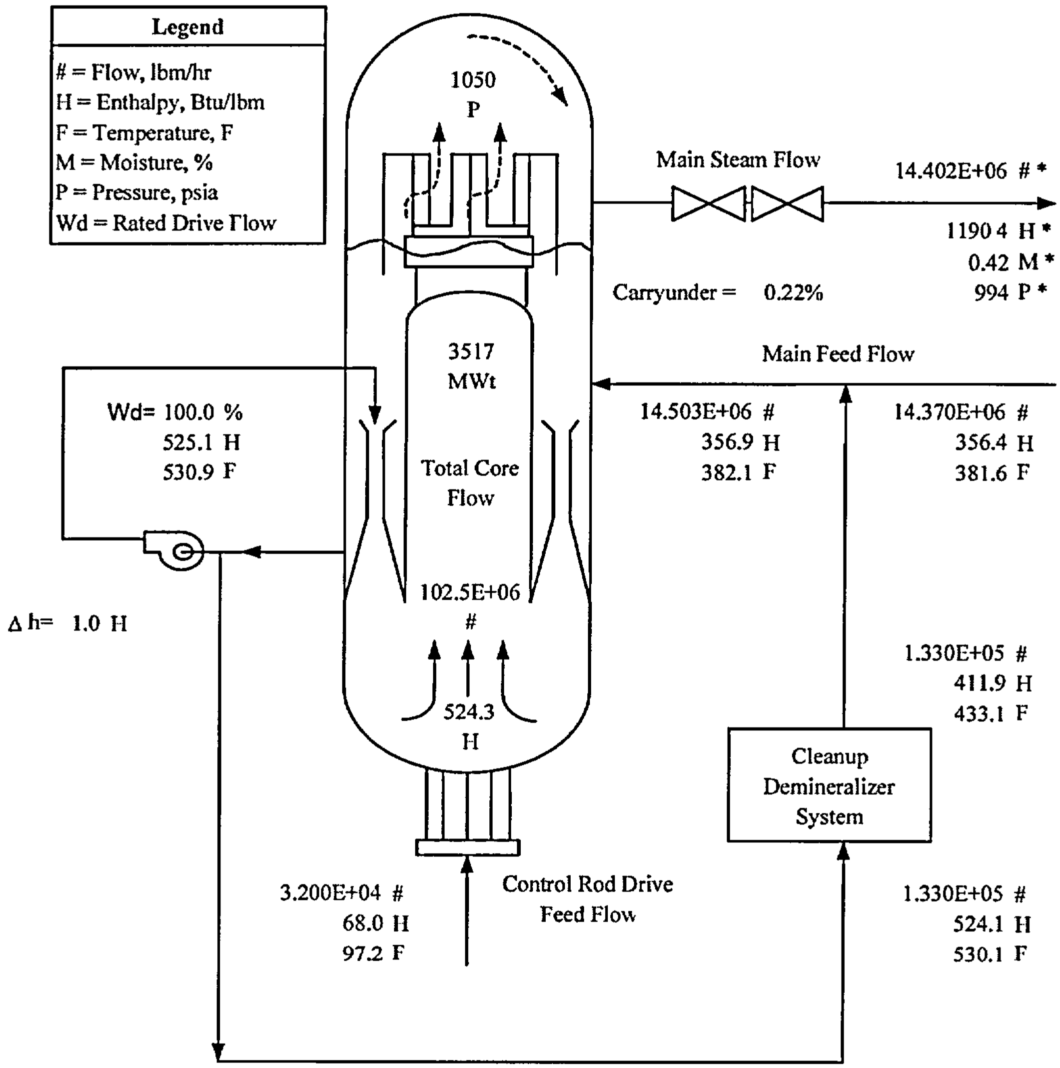
Figure 1-2 Reactor Heat Balance – 3514 MWt, 100% Core Flow



* Conditions at upstream side of TSV

Core Thermal Power	3514.0
Pump Heating	10.5
Cleanup Losses	-4.4
Other System Losses	-0.6
Turbine Cycle Use	3519.5 MWt

Figure 1-3 Reactor Heat Balance – 3517 MWt, 100% Core Flow



* Conditions at upstream side of TSV

Core Thermal Power	3517.0
Pump Heating	10.5
Cleanup Losses	-4.4
Other System Losses	-0 6
Turbine Cycle Use	3522.5 MWt

2.0 REACTOR CORE AND FUEL PERFORMANCE

2.1 FUEL DESIGN AND OPERATION

At the TPO RTP conditions, all fuel and core design limits are met by the deployment of fuel enrichment and burnable poison, control rod pattern management, and core flow adjustments. New fuel designs are not needed for the TPO to ensure safety. However, revised loading patterns, slightly larger batch sizes, and potentially new fuel designs may be used to provide additional operating flexibility and maintain fuel cycle length. NRC-approved limits for burnup on the fuel are not exceeded. Therefore, the reactor core and fuel design is adequate for TPO operation.

2.2 THERMAL LIMITS ASSESSMENT

Operating thermal limits ensure that regulatory and/or safety limits are not exceeded for a range of postulated events (e.g., transients, LOCA). This section addresses the effects of TPO on thermal limits. Cycle-specific core configurations, which are evaluated for each reload, confirm TPO RTP capability and establish or confirm cycle-specific limits.

The historical 25% of RTP value for the Technical Specification Safety Limit, some thermal limits monitoring Limiting Conditions for Operation (LCOs) thresholds, and some Surveillance Requirements (SRs) thresholds, is based on [Redacted] The historical 25% RTP value is a conservative basis, as described in the plant Technical Specifications, [Redacted] Therefore, the Safety Limit percent RTP basis, some thermal limits monitoring LCOs, and some SR percent RTP thresholds remain at 25% of RTP.

2.2.1 Safety Limit MCPR

The Safety Limit Minimum Critical Power Ratio (SLMCPR) is dependent upon the nominal average power level and the uncertainty in its measurement. Consistent with approved practice, a revised SLMCPR is calculated for the first TPO fuel cycle and confirmed for each subsequent cycle. NRC approved methods are used by the fuel vendor for reload licensing analysis.

2.2.2 MCPR Operating Limit

[Redacted] Because the cycle-specific SLMCPR is also defined, the actual required OLMCPR can be established. This ensures an adequate fuel thermal margin for TPO uprate operation.

The power and flow dependent thermal limits are not changed with TPO. [Redacted]

2.2.3 MAPLHGR and Maximum LHGR Operating Limits

The Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) and maximum LHGR limits are maintained as described in TLTR Section 5.7.2.2. No significant change results due to TPO operation. The LHGR limits are fuel dependent and are not affected by the TPO. The ECCS performance is addressed in Section 4.3.

2.3 REACTIVITY CHARACTERISTICS

All minimum shutdown margin requirements apply to cold shutdown (≤ 212°F) conditions and are maintained without change. Checks of cold shutdown margin based on Standby Liquid Control System (SLCS) boron injection capability and shutdown using control rods with the most reactive control rod stuck out are made for each reload. The TPO uprate has no significant effect on these conditions; the shutdown margin is confirmed in the reload core design.

Operation at the TPO RTP could result in a minor decrease in the hot excess reactivity during the cycle. This loss of reactivity does not affect safety, and does not affect the ability to manage the power distribution through the cycle to achieve the target power level. However, the lower hot excess reactivity can result in achieving an earlier all-rods-out condition. Through fuel cycle redesign, sufficient excess reactivity can be obtained to match the desired cycle length.

2.4 STABILITY

PBAPS is currently operating under the requirements of reactor stability Interim Corrective Actions (ICAs). An evaluation was performed to determine the effect of TPO on the core stability ICAs per the guidelines in Reference 1. To ensure adequate level of protection against the occurrence of a thermal-hydraulic instability, the instability exclusion region boundaries are unchanged with respect to absolute power level (MWt).

2.5 REACTIVITY CONTROL

The generic discussion in TLTR Sections 5.6.3 and J.2.3.3 applies to PBAPS. The Control Rod Drive (CRD) and CRD Hydraulic Systems and supporting equipment are not affected by the TPO uprate and no further evaluation of CRD performance is necessary.

3.0 REACTOR COOLANT AND CONNECTED SYSTEMS

3.1 NUCLEAR SYSTEM PRESSURE RELIEF / OVERPRESSURE PROTECTION

The pressure relief system prevents overpressurization of the nuclear system during abnormal operational transients. The plant SRVs and safety valves (SVs) along with other functions provide this protection. Evaluations and analyses for the CLTP have been performed at 102% of CLTP to demonstrate that the reactor vessel conformed to American Society Of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code and plant Technical Specification requirements. There is no increase in nominal operating pressure for the PBAPS TPO uprate. There are no changes in the SRV or SV setpoints or valve out-of-service options. There is no change in the methodology or the limiting overpressure event. Therefore, the generic evaluation contained in the TLTR is applicable and the SRV setpoint monitoring program is not affected.

PBAPS also has two safety valves (SVs) that discharge directly to the drywell and provide additional high end overpressure protection. These valves are not affected by the TPO uprate, because there is no increase in nominal operating pressure and no change in set pressure.

The analysis for each fuel reload, which is current practice, confirms the capability of the system to meet the ASME design criteria.

3.2 REACTOR VESSEL

The RPV structure and support components form a pressure boundary to contain reactor coolant and moderator, and form a boundary against leakage of radioactive materials into the drywell. The RPV also provides structural support for the reactor core and internals.

3.2.1 Fracture Toughness

TLTR Section 5.5.1.5 describes the RPV fracture toughness evaluation process. The end of life (EOL) fluence is calculated for the TPO uprate conditions and from the fluence for current conditions to evaluate the vessel against the requirements of 10 CFR 50, Appendix G. The results of these evaluations indicate that:

- The upper shelf energy (USE) is bounded by the BWR Owners Group (BWROG) equivalent margin analysis, thereby demonstrating compliance with 10 CFR 50, Appendix G.
- The beltline material reference temperature of the nil-ductility transition (RT_{NDT}) remains below 200°F.
- The surface fluence increases for EOL (32 and 54 effective full power year (EFPY)) (40 year and 60 year life, respectively) due to TPO. The 32 and 54 EFPY shifts are increased, and consequently, require a change in the adjusted reference temperature (ART), which is the initial RT_{NDT} plus the shift. These values for Unit 2 are provided in Tables 3-1a and 3-1b for the 32 and 54 EFPY, respectively; these values for Unit 3 are provided in Tables 3-2a and 3-2b for the 32 and 54 EFPY, respectively. The current Technical Specification pressure-temperature

(P-T) curves for Unit 2 are non-beltline limited and remain non-beltline limited with TPO conditions up to 32 EFPY. The current Technical Specification P-T curves for Unit 3 are non-beltline limited. Considering TPO conditions, the Unit 3 P-T curves become beltline limited at 22 EFPY and will require modification for operation beyond 22 EFPY.

- The reactor vessel material surveillance program consists of three capsules for each unit. One capsule containing Charpy specimens was removed from the PBAPS Unit 2 vessel after 7.53 EFPY of operation; it was tested, reconstituted, and placed back into the vessel during the 2R08 Refueling Outage. One capsule containing Charpy specimens was removed from the PBAPS Unit 3 vessel after 7.57 EFPY of operation; it was tested, reconstituted, and placed back into the vessel during the 3R08 Refueling Outage. The remaining two capsules in each unit have been in their respective reactor vessels since plant startup. PBAPS Units 2 and 3 are part of the BWR Vessel and Internals Project (BWRVIP) Integrated Surveillance Program (ISP) and will comply with the withdrawal schedule specified for representative or surrogate surveillance capsules that now represent each unit. Therefore, the 10 CFR 50, Appendix H surveillance capsule schedule for the ISP will govern. Implementation of TPO has no effect on the BWRVIP withdrawal schedule.

The maximum operating dome pressure for the TPO uprate is unchanged from current operation. Therefore, no change in the hydrostatic and leakage test pressures is required. The vessel is still in compliance with the regulatory requirements at TPO uprate conditions.

3.2.2 Reactor Vessel Structural Evaluation

The effect of the TPO uprate was evaluated to ensure that the RPV components comply with the existing structural requirements of the ASME B&PV Code.

3.2.2.1 Design Conditions

For the TPO uprate, the RPV design requirements are bounded by the design requirements specified in the RPV purchase documents that were modified and evaluated as acceptable for the PBAPS 5% power uprate.

3.2.2.2 Normal and Upset Conditions

For the TPO uprate, the following Normal and Upset operating conditions do not change: pressure, temperature in the saturated portion of the vessel, total core and recirculation flow, and static mechanical loads. The current basis for the PBAPS 5% power uprate bounds the transient conditions for TPO operation.

The component stress reports and design specification were reviewed and the current analysis is bounding with respect to the operating pressure and the temperature in the saturated portions of the vessel.

3.2.2.3 Emergency and Faulted Conditions

The TPO uprate does not change the Emergency and Faulted conditions for PBAPS because the previous evaluations were performed at ≥ 102% of CLTP. Therefore, the existing Emergency and Faulted stress analysis continues to meet the requirements of the ASME Code. The current assessment of the "original" Certified Stress Report applies to PBAPS for the TPO uprate.

3.3 REACTOR INTERNALS

The reactor internals include core support structure (CSS) and non-core support structure (non-CSS) components.

3.3.1 Reactor Internal Pressure Difference

The Reactor Internal Pressure Differences (RIPDs) are more strongly affected by the maximum licensed core flow rate than by the power level; the maximum flow rate is not changed for the TPO uprate. The effect due to the changes in loads for both Normal and Upset conditions is reported in Section 3.3.2. The Normal and Upset evaluations of RIPD for the TPO uprate are bounded by the current analyses that assumed an initial power level of 110% of OLTP (104.7% of CLTP). The Emergency and Faulted evaluations of RIPD for the TPO uprate are bounded by the current analyses that assumed an initial power level of 102% of 110% of OLTP (106.8% of CLTP).

Fuel bundle lift margins are only calculated for the Faulted conditions to demonstrate that fuel bundles would not be lifted under the worst-case conditions. Because the faulted evaluations are bounded by the CLTP analyses, the Fuel bundle lift margins are not calculated. As an older plant, the Peach Bottom licensing basis does not require the hydraulic lift forces to be combined with seismic loads. Thus, the hydraulic control rod guide tube (CRGT) lift forces were not calculated.

3.3.2 Reactor Internals Structural Evaluation

The reactor internal components were evaluated for structural integrity due to load changes associated with the TPO uprate. [Redacted] The evaluation considered the effect of TPO on pressure, temperature, weight, seismic, and flow loads, as applicable, and was performed consistent with the design bases for the components. The TPO loads were either bounded by the design basis values or the changes were insignificant. Therefore, the reactor internal components remain qualified for the TPO uprate.

3.3.3 Steam Separator and Dryer Performance

The steam separator and dryer performance evaluation is described in TLTR Section 5.5.1.6. As described in the TLTR, no additional evaluation of the steam separator and dryer performance is necessary [Redacted] the generic evaluation in the TLTR is applicable and no further evaluation is needed.

3.4 FLOW INDUCED VIBRATION

The process for the RPV internals vibration assessment is described in TLTR Section 5.5.1.3. An evaluation determined the effects of flow-induced vibration (FIV) on the reactor internals at TPO RTP and 110% rated core flow. The vibration levels for the TPO uprate conditions were estimated from vibration data recorded during startup testing of the NRC designated prototype plant (Browns Ferry Unit 1) and during other tests. These expected vibration levels are compared with established vibration acceptance limits. The following components were evaluated for the TPO uprate:

Component(s)	Process Parameter(s)	TPO Evaluation
Shroud Shroud Head and Separator Steam Dryer	Steam flow at TPO uprate power is ~2% greater than CLTP	Less than 10% increase in FIV
Jet Pumps	The increase in jet pump flow at TPO RTP is negligible	No change
Jet Pump Sensing Lines	Vane passing frequency of recirculation pumps	No change in possibility of resonance
FW Sparger	FW flow at TPO uprate power is ~2% greater than CLTP	Less than 10% increase in FIV

The calculations for the TPO uprate conditions indicate that vibrations of all safety-related reactor internal components are within the GE acceptance criteria. The analysis is conservative for the following reasons:

- The GE criteria of 10,000 psi peak stress intensity is much more conservative than the ASME allowable peak stress intensity of 13,600 psi for service cycles equal to 10^{11}.
- The modes are absolute summed.
- The maximum vibration amplitude in each mode is used in the absolute sum process, whereas in reality the vibration amplitude fluctuates.

Therefore, the flow-induced vibrations for the evaluated components remain within acceptable limits.

The safety-related Main Steam (MS) and FW piping have increased flow velocities of 1.8% resulting from the TPO uprate. The MS and FW piping experience increased vibration levels, approximately proportional to the square of the flow velocities and also in proportion to any increase in fluid density. Because PBAPS has already performed a 5% power uprate, further extrapolation of the original plant startup vibration data is not considered prudent. Therefore, a piping vibration startup test program, which meets the ASME code, will be performed. Vibration data for the MS and FW piping inside containment will be acquired using remote sensors, such as displacement probes, velocity sensors, and accelerometers.

The safety-related thermowells and sample probes in the MS, FW, and Recirculation piping systems have been evaluated analytically and are adequate for the TPO operating condition.

3.5 PIPING EVALUATION

3.5.1 Reactor Coolant Pressure Boundary Piping

The methods used for the piping and pipe support evaluations are described in TLTR Appendix K. These approaches are identical to those used in the evaluation of previous BWR power uprates of up to 20% power. The effect of the TPO uprate with no nominal vessel dome pressure increase is negligible for the reactor coolant pressure boundary (RCPB) portion of all piping except for portions of the FW lines, main steam lines, and piping connected to the MS lines. The following table summarizes the evaluation of the piping inside containment.

Component(s) / Concern	Process Parameter(s)	TPO Evaluation
Recirculation System Pipe Stresses Pipe Supports	Nominal dome pressure at TPO uprate power is identical to CLTP Recirculation flow at TPO uprate power is identical to CLTP Small increase in core pressure drop of < 1 psi Reactor recirculation fluid temperature decreases ~1°F	Current licensing basis envelops TPO conditions; therefore, piping system is acceptable for TPO.
MS and Attached Piping (Inside Containment) (e.g., SRV Discharge Line (SRVDL) piping up to first anchor, Reactor Core Isolation Cooling (RCIC) / High Pressure Coolant Injection (HPCI) piping (Steam Side), MS / Main Steam Isolation Valve (MSIV) drain lines, RPV head vent line piping located inside containment) Pipe Stresses Pipe Supports Erosion/Corrosion	Nominal dome pressure at TPO uprate power is identical to CLTP Steam flow at TPO uprate power is ~2% greater than CLTP No change in main steam line pressure or temperature	Current licensing basis envelops TPO conditions; therefore, piping system is acceptable for TPO. Minor increase in the potential for Erosion / Corrosion (Flow accelerated corrosion (FAC) concerns are covered by existing piping monitoring program).
FW Piping (Inside Containment) Pipe Stresses Pipe Supports Erosion/Corrosion	Nominal dome pressure at TPO uprate power is identical to CLTP FW flow at TPO uprate power is ~2% greater than CLTP Minor increase in FW line pressure < 2 psi Fluid temperature increases ~1°F	Current licensing basis envelops TPO conditions; therefore, piping system is acceptable for TPO. Minor increase in the potential for Erosion / Corrosion (FAC concerns are covered by existing piping monitoring program).

Component(s) / Concern	Process Parameter(s)	TPO Evaluation
Residual Heat Removal (RHR), RCIC piping, HPCI piping, Low Pressure Coolant Injection (LPCI) piping, CS piping, RWCU piping, and SLCS piping Pipe Stresses Pipe Supports Erosion/Corrosion	Nominal dome pressure at TPO uprate power is identical to CLTP Small increase in core pressure drop of < 1 psi Recirculation fluid temperature decreases ~1°F	Current licensing basis envelops TPO conditions; therefore, piping systems are acceptable for TPO. Minor increase in the potential for Erosion / Corrosion (FAC concerns are covered by existing piping monitoring program).

MS and Attached Piping Evaluation

The MS and attached piping system (inside containment) was evaluated for compliance with the USAS B31.1.0 code stress criteria, and for the effects of temperature, pressure, and flow on the piping stress and pipe supports (e.g., snubbers, hangers, and struts). The current licensing basis for the MS piping system (inside containment) analyzed for pressure, temperature, and flow, envelops the TPO operating pressure, temperature, and flow. Therefore, all safety aspects of the MS piping system (inside containment) are within current licensing basis evaluations.

Erosion/Corrosion

The carbon steel MS piping can be affected by FAC. FAC is affected by changes in fluid velocity, temperature and moisture content. PBAPS has an established program for monitoring pipe wall thinning in single and two-phase high energy carbon steel piping. The variation in velocity, temperature, and moisture content resulting from the uprate are minor changes to parameters affecting FAC.

No changes to piping inspection scope and frequency are required to ensure adequate margin for the changing process conditions. The continuing inspection program will take into consideration adjustments to predicted material loss rates used to project the need for maintenance/replacement prior to reaching minimum wall thickness requirements. The PBAPS program utilizes the CHECWORKS™ software. This program provides assurance that the TPO uprate has no adverse effect on high energy piping systems potentially susceptible to pipe wall thinning due to erosion/corrosion.

Feedwater Piping System Evaluation

The FW Piping System (inside containment) was evaluated for compliance with the ANSI B31.1 / ASME Section III Code stress criteria, and for the effects of temperature, pressure, and flow on the piping stress and pipe supports (e.g., snubbers, hangers, and struts). The current licensing basis for the FW piping system (inside containment) analyzed for pressure, temperature, and flow, envelops the TPO operating pressure, temperature, and flow. Therefore, all safety aspects of the FW piping system (inside containment) are within current licensing basis evaluations.

Erosion/Corrosion

The carbon steel FW piping can be affected by FAC. FAC in the FW piping is affected by changes in fluid velocity and temperature. PBAPS has an established program for monitoring pipe wall thinning in single and two-phase high energy carbon steel piping. The variation in velocity and temperature resulting from the TPO uprate are minor changes to parameters affecting FAC.

No changes to piping inspection scope and frequency are required to ensure adequate margin exists for the TPO process conditions. The continuing inspection program will take into consideration adjustments to predicted material loss rates used to project the need for maintenance/replacement prior to reaching minimum wall thickness requirements. The PBAPS program utilizes the CHECWORKS™ software. This program provides assurance that the TPO uprate has no adverse effect on high energy piping systems potentially susceptible to pipe wall thinning due to erosion/corrosion.

3.5.2 Balance-of-Plant Piping Evaluation

The BOP piping system includes all piping, pipe supports, and anchorage throughout the plant, except for the piping in the Reactor Recirculation System, the MS and attached piping system (inside containment), and FW piping system (inside containment), which are evaluated in Section 3.5.1.

The Design Basis Accident (DBA) LOCA dynamic loads including the pool swell loads, vent thrust loads, condensation oscillation (CO) loads and chugging loads were originally defined based on analyses at 102% CLTP. The structures attached to the containment, such as the piping systems, vent penetrations, and valves are based on these DBA LOCA hydrodynamic loads. For the TPO conditions, the DBA LOCA containment response loads do not change.

In addition, there are no changes in the SRV hydrodynamic loads. Because the SRV opening setpoint does not increase for the TPO uprate, the only parametric change specific to SRV loads is for the time between SRV actuations. The TPO uprate may result in a slight reduction in the time between the SRV actuations, which can affect the SRV discharge line water level at the time of the subsequent actuations. A higher water level at the time of a subsequent actuation would result in higher SRV loads. The SRV discharge line reflood height response is a function of discharge line vacuum breaker size and discharge line geometry. Because TPO uprate has no effect on the maximum reflood height, the original subsequent actuation SRV load definition is still bounding.

Pipe Stresses

The TPO uprate results in no change in the piping design pressure, and the piping temperature is either unchanged or is bounded by that used in the CLTP rerate evaluation which included a 2% power uncertainty in piping parameter determination. No piping, support, or equipment modifications are associated with the TPO uprate to change the dead weight, seismic, and hydrodynamic load contributions. There are no changes in the fluid transient loads, because the design attributes associated with the initiating events bound the TPO uprated condition. Additionally, there are no changes in pipe break loads that could affect piping analysis and no new postulated pipe break locations were identified.

Pipe stress can also be affected by variations in temperature gradients in Class I systems. However, according to the new BOP heat balance at 3517 MWt, the operating temperature in these systems does not change from the operating temperature at CLTP of 3458 MWt. In addition, there are no operational procedures or sequence changes that would affect thermal profiles. Therefore, because there are no negligible temperature changes, there is no change to pipe stress.

Therefore, the pipe stress evaluation is not affected by the TPO uprate because it is bounded by the previous evaluation.

Pipe Supports

Operation at TPO uprate conditions does not cause a piping reaction load change that affect support loads. There are also no room/ambient temperature changes that affect support loads and allowables. Therefore, support loads are not affected by the TPO uprate. Additionally, there are no changes in pipe break loads that could affect pipe support loads, and no new postulated pipe break locations were identified.

Therefore, the pipe support evaluation is not affected by the TPO uprate, because it is bounded by the previous evaluation.

Small-Bore Piping and Support

Small-bore piping and support are not affected by the TPO uprate, because the small-bore piping and support program has been conservatively performed and encompasses the TPO uprate condition. In addition, there is a negligible change in allowable stress because there is no change in pipe temperature or in ambient (room) temperature. However, small-bore piping may be affected by large-bore piping to which they are attached. Because there are no changes in the large-bore piping loads or movements, there are no changes in the small-bore attachment loads.

Therefore, small-bore piping and support program is not affected by the TPO uprate, because it are bounded by the previous evaluation.

Erosion/Corrosion

The integrity of high energy piping systems is assured by proper design in accordance with the applicable codes and standards. Piping thickness of carbon steel components can be affected by FAC. PBAPS has an established program for monitoring pipe wall thinning in single phase and two-phase high-energy carbon steel piping. Erosion/corrosion rates may be influenced by changes in fluid velocity, temperature, and moisture content.

Operation at the TPO RTP results in some changes to parameters affecting FAC in those systems associated with the turbine cycle (e.g., condensate, FW, MS). The evaluation of and inspection for FAC in BOP systems is addressed by compliance with NRC Generic Letter (GL) 89-08, "Erosion/Corrosion in Piping." The plant erosion/corrosion program currently monitors the affected systems. The PBAPS program utilizes the CHECWORKS™ software. Continued monitoring of the systems provides confidence in the integrity of susceptible high energy piping systems.

3.6 REACTOR RECIRCULATION SYSTEM

The Reactor Recirculation System evaluation process is described in TLTR Section 5.6.2. The TPO uprate has a minor effect on the recirculation system and its components. The TPO uprate does not require an increase in the maximum core flow. No significant reduction of the maximum flow capability occurs due to the TPO uprate because of the small increase in core pressure drop (< 1 psi). An evaluation has confirmed that no significant increase in recirculation system vibration occurs from the TPO operating conditions. The effect on pump NPSH at TPO conditions is negligible.

3.7 MAIN STEAM LINE FLOW RESTRICTORS

The generic evaluation provided in TLTR Appendix J is applicable to PBAPS. The requirements for the main steam line (MSL) flow restrictors remain unchanged for TPO uprate conditions. No change in steam line break flow rate occurs because the operating pressure is unchanged. All safety and operational aspects of the MSL flow restrictors are within previous evaluations.

3.8 MAIN STEAM ISOLATION VALVES

The generic evaluation provided in TLTR Appendix J is applicable to PBAPS. The requirements for the MSIVs remain unchanged for TPO uprate conditions. All safety and operational aspects of the MSIVs are within previous evaluations.

3.9 REACTOR CORE ISOLATION COOLING

The RCIC system provides inventory makeup to the reactor vessel when the vessel is isolated from the normal high pressure makeup systems. The generic evaluation provided in TLTR Section 5.6.7 is applicable to PBAPS. The TPO uprate does not affect the RCIC system operation, initiation, or capability requirements.

3.10 RESIDUAL HEAT REMOVAL SYSTEM

The RHR system is designed to restore and maintain the coolant inventory in the reactor vessel and to remove sensible and decay heat from the primary system and containment following reactor shutdown for both normal and post accident conditions. The RHR system is designed to function in several operating modes. The generic evaluation provided in TLTR Sections 5.6.4 and J.2.3.13 is applicable to PBAPS.

The following table summarizes the effect of the TPO on the design basis of the RHR system.

Operating Mode	Key Function	TPO Evaluation
LPCI Mode	Core Cooling	See Section 4.2.4
Suppression Pool Cooling (SPC) and Containment Spray Cooling (CSC) Modes	Normal SPC function is to maintain pool temperature below the limit. For Abnormal events or accidents, the SPC mode maintains the long-term pool temperature below the design limit The CSC mode sprays water into the containment to reduce post-accident containment pressure and temperature.	Containment analyses were performed at ≥ 102% CLTP.
Shutdown Cooling (SDC) Mode	Removes sensible and decay heat from the reactor primary system during a normal reactor shutdown	SDC analyses were performed at ≥ 102% of CLTP.
Fuel Pool Cooling Assist	Supplemental fuel pool cooling in the event that the fuel pool heat load exceeds the heat removal capability of the Fuel Pool Cooling system.	See Section 6.3.1

The ability of the RHR system to perform required safety functions is demonstrated with analyses based on ≥ 102% of CLTP. Therefore, all safety aspects of the RHR system are within previous evaluations. The requirements for the RHR system remain unchanged for TPO uprate conditions.

3.11 REACTOR WATER CLEANUP SYSTEM

The generic evaluation of the RWCU system provided in TLTR Sections 5.6.6 and J.2.3.4 is applicable to PBAPS. The performance requirements of the RWCU system are negligibly affected by TPO uprate. There is no significant effect on operating temperature and pressure conditions in the high-pressure portion of the system. Steady power level changes for much larger power uprates have shown no effect on reactor water chemistry and the performance of the RWCU system. Power transients are the primary source of challenge to the system, so safety and operational aspects of water chemistry performance are not affected by the TPO.

Table 3-1a Adjusted Reference Temperatures for PBAPS Unit 2 for 32 EFPY

Plates

Thickness in inches = 6 13

Ratio Peak/ Location = 1 00

32 EFPY Peak I D fluence = 1.3E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 9 3E+17 n/cm^2
32 EFPY Peak 1/4 T fluence = 9 3E+17 n/cm^2

Welds

Thickness in inches= 6 13

Ratio Peak/ Location = 1.00

32 EFPY Peak I D fluence = 1 3E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 9 3E+17 n/cm^2
32 EFPY Peak 1/4 T fluence = 9 3E+17 n/cm^2

COMPONENT	HEAT OR HEAT/LOT	%Cu	%Ni	CF	Initial RTndt °F	1/4 T Fluence n/cm^2	32 EFPY Δ RTndt °F	σ_I	σ_Δ	Margin °F	32 EFPY Shift °F	32 EFPY ART °F
PLATES:												
Lower Shell												
Mark 57	C2791-2	0 12	0 52	81	-8	7 6E+17	30	0	15	30	59	51
Mark 57	C2761-1	0 11	0 54	73	-14	7 6E+17	27	0	13	27	53	39
Mark 57	C2873-2	0 12	0 57	82	-20	7 6E+17	30	0	15	30	60	40
Lower-Intermediate Shell												
Mark 58	C2894-2	0 13	0 42	86	-20	9 3E+17	35	0	17	34	69	49
Mark 58	C2873-1	0.12	0 57	82	-6	9 3E+17	33	0	16	33	66	60
Mark 58	C2761-2	0.11	0 54	73	-20	9 3E+17	29	0	15	29	59	39
WELDS:												
Vertical Welds												
Lower Shell												
B1, B2, B3	37C065	0 182	0 181	94 5	-45	7 6E+17	34	16	17	48	82	37
Lower-Intermediate Shell												
C1, C2, C3	37C065	0 182	0 181	94 5	-45	9 3E+17	38	16	19	50	88	43
Girth												
BC	S-3986 Linde 124 Lot 3876	0 06	0 97	82	-32	7 6E+17	30	0	15	30	60	28

Table 3-1b Adjusted Reference Temperatures for PBAPS Unit 2 for 54 EFPY

Plates

Thickness in inches = 6 13

Ratio Peak/ Location = 1.00

54 EFPY Peak I D fluence = 2 3E+18 n/cm^2
54 EFPY Peak 1/4 T fluence = 1 6E+18 n/cm^2
54 EFPY Peak 1/4 T fluence = 1 6E+18 n/cm^2

Welds

Thickness in inches= 6 13

Ratio Peak/ Location = 1 00

54 EFPY Peak I D. fluence = 2 3E+18 n/cm^2
54 EFPY Peak 1/4 T fluence = 1 6E+18 n/cm^2
54 EFPY Peak 1/4 T fluence = 1 6E+18 n/cm^2

COMPONENT	HEAT OR HEAT/LOT	%Cu	%Ni	CF	Initial RTndt °F	1/4 T Fluence n/cm^2	54 EFPY Δ RTndt °F	σ_I	σ_Δ	Margin °F	54 EFPY Shift °F	54 EFPY ART °F
PLATES:												
Lower Shell												
Mark 57	C2791-2	0.12	0 52	81	-8	1 3E+18	38	0	17	34	72	64
Mark 57	C2761-1	0 11	0 54	73	-14	1 3E+18	34	0	17	34	68	54
Mark 57	C2873-2	0.12	0 57	82	-20	1 3E+18	39	0	17	34	73	53
Lower-Intermediate Shell												
Mark 58	C2894-2	0 13	0 42	86	-20	1 6E+18	44	0	17	34	78	58
Mark 58	C2873-1	0 12	0 57	82	-6	1.6E+18	42	0	17	34	76	70
Mark 58	C2761-2	0 11	0 54	73	-20	1 6E+18	37	0	17	34	71	51
WELDS:												
Vertical Welds												
Lower Shell												
B1, B2, B3	37C065	0 182	0 181	94 5	-45	1.3E+18	44	16	22	55	100	55
Lower-Intermediate Shell												
C1, C2, C3	37C065	0 182	0 181	94.5	-45	1 6E+18	49	16	24	59	107	62
Girth												
BC	S-3986 Linde 124 Lot 3876	0 06	0 97	82	-32	1 3E+18	39	0	19	39	77	45

Table 3-2a Adjusted Reference Temperatures for PBAPS Unit 3 for 32 EFPY

Plates

Thickness in inches = 6 13

Ratio Peak/ Location = 1 00

32 EFPY Peak I D fluence = 1 3E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 9 3E+17 n/cm^2
32 EFPY Peak 1/4 T fluence = 9 3E+17 n/cm^2

Welds

Thickness in inches= 6 13

Ratio Peak/ Location = 1 00

32 EFPY Peak I D fluence = 1 3E+18 n/cm^2
32 EFPY Peak 1/4 T fluence = 9 3E+17 n/cm^2
32 EFPY Peak 1/4 T fluence = 9 3E+17 n/cm^2

COMPONENT	HEAT OR HEAT/LOT	%Cu	%Ni	CF	Initial RTndt °F	1/4 T Fluence n/cm^2	32 EFPY Δ RTndt °F	σ_I	σ_Δ	Margin °F	32 EFPY Shift °F	32 EFPY ART °F
PLATES:												
Lower Shell												
6-146-1	C4689-2	0 12	0 56	82	-10	5 9E+17	26	0	13	26	53	43
6-146-3	C4684-2	0 13	0 58	90	-20	5 9E+17	29	0	15	29	58	38
6-146-7	C4627-1	0 12	0 57	82	-20	5 9E+17	26	0	13	26	53	33
Lower-Intermediate Shell												
6-139-10	C2773-2	0 15	0 49	104	10	9 3E+17	42	0	17	34	76	86
6-139-11	C2775-1	0 13	0 46	87	10	9 3E+17	35	0	17	34	69	79
6-139-12	C3103-1	0 14	0 60	100	10	9 3E+17	40	0	17	34	74	84
Intermediate												
6-146-5	C4608-1	0 12	0 55	82	10	5 9E+17	26	0	13	26	53	63
6-146-4	C4689-1	0 12	0 56	82	10	5 9E+17	26	0	13	26	53	63
6-146-2	C4654-1	0 11	0 55	74	10	5 9E+17	24	0	12	24	47	57
WELDS:												
Vertical Welds												
Lower Shell												
D1, D2, D3	37C065	0 182	0 181	94 5	-45	5 9E+17	30	16	15	45	75	30
Lower-Intermediate Shell												
E1, E2, E3	37C065	0 182	0 181	94 5	-45	9 3E+17	38	16	19	50	88	43
Intermediate												
F1, F2, F3	37C065	0 182	0 181	94 5	-45	5 9E+17	30	16	15	45	75	30
Girth												
Lower to Lower-Intermediate												
DE	3P4000 Linde 124 Lot 3932	0 02	0 96	27	-50	5 9E+17	9	0	4	9	17	-33
Lower-Intermediate to Intermediate												
EF	1P4217 Linde 124 Lot 3929	0 102	0 942	137	-50	5 9E+17	44	0	22	44	88	38

Table 3-2b Adjusted Reference Temperatures for PBAPS Unit 3 for 54 EFPY

Plates

Thickness in inches = 6 13

Ratio Peak/ Location = 1 00

54 EFPY Peak I D fluence = 2 3E+18 n/cm^2
54 EFPY Peak 1/4 T fluence = 1 6E+18 n/cm^2
54 EFPY Peak 1/4 T fluence = 1 6E+18 n/cm^2

Welds

Thickness in inches= 6 13

Ratio Peak/ Location = 1 00

54 EFPY Peak I D fluence = 2 3E+18 n/cm^2
54 EFPY Peak 1/4 T fluence = 1 6E+18 n/cm^2
54 EFPY Peak 1/4 T fluence = 1 6E+18 n/cm^2

COMPONENT	HEAT OR HEAT/LOT	%Cu	%Ni	CF	Initial RTndt °F	1/4 T Fluence n/cm^2	54 EFPY Δ RTndt °F	σ_I	σ_Δ	Margin °F	54 EFPY Shift °F	54 EFPY ART °F
PLATES.												
Lower Shell												
6-146-1	C4689-2	0 12	0 56	82	-10	1 0E+18	34	0	17	34	68	58
6-146-3	C4684-2	0 13	0 58	90	-20	1 0E+18	38	0	17	34	72	52
6-146-7	C4627-1	0 12	0 57	82	-20	1 0E+18	34	0	17	34	68	48
Lower-Intermediate Shell												
6-139-10	C2773-2	0 15	0 49	104	10	1 6E+18	53	0	17	34	87	97
6-139-11	C2775-1	0 13	0 46	87	10	1 6E+18	45	0	17	34	79	89
6-139-12	C3103-1	0 14	0 60	100	10	1 6E+18	51	0	17	34	85	95
Intermediate												
6-146-5	C4608-1	0.12	0 55	82	10	1 0E+18	34	0	17	34	68	78
6-146-4	C4689-1	0 12	0 56	82	10	1 0E+18	34	0	17	34	68	78
6-146-2	C4654-1	0 11	0 55	74	10	1 0E+18	31	0	15	31	61	71
WELDS:												
Vertical Welds												
Lower Shell												
D1, D2, D3	37C065	0 182	0 181	94 5	-45	1 0E+18	40	16	20	51	91	46
Lower-Intermediate Shell												
E1, E2, E3	37C065	0 182	0 181	94 5	-45	1 6E+18	49	16	24	59	107	62
Intermediate												
F1, F2, F3	37C065	0 182	0 181	94 5	-45	1 0E+18	40	16	20	51	91	46
Girth												
Lower to Lower-Intermediate												
DE	3P4000 Linde 124 Lot 3932	0 02	0 96	27	-50	1 0E+18	11	0	6	11	23	-27
Lower-Intermediate to Intermediate												
EF	1P4217 Linde 124 Lot 3929	0 11	0 96	147	-50	1 0E+18	62	0	28	56	118	68

4.0 ENGINEERED SAFETY FEATURES

4.1 CONTAINMENT SYSTEM PERFORMANCE

TLTR Appendix G presents the methods, approach, and scope for the TPO uprate containment evaluation for LOCA. The current containment evaluations were performed at 102% of CLTP. The methodology and results of the current analyses have been reported in previous PBAPS licensing documentation. Although the nominal operating conditions change slightly because of the TPO uprate, the required initial conditions for containment analysis inputs remain the same as previously documented.

Containment system performance for SRV actuation was also evaluated. Because the SRV opening setpoint does not increase for the TPO uprate, the only parametric change specific to SRV loads is for the time between SRV actuations. The TPO uprate may result in a slight reduction in the time between the SRV actuations, which can affect the SRV discharge line water level at the time of the subsequent actuations. A higher water level at the time of a subsequent actuation would result in higher SRV loads. The SRV discharge line reflood height response is a function of discharge line vacuum breaker size and discharge line geometry. Because TPO uprate has no effect on the maximum reflood height, the original subsequent actuation SRV load definition is still bounding.

The following table summarizes the effect of the TPO uprate on various aspects of the containment system performance.

Topic	Key Parameters	TPO Effect
Short Term Pressure and Temperature Response		Current Analysis Based on 102% of CLTP
Gas Temperature	Break Flow and Energy	
Pressure	Break Flow and Energy	
Long-Term Suppression Pool Temperature Response		
Bulk Pool	Decay Heat	
Local Temperature with SRV Discharge	Decay Heat	
Containment Dynamic Loads		
Loss-of-Coolant Accident Loads	Break Flow and Energy	
Safety-Relief Valve Loads	Decay Heat	
Subcompartment Pressurization	Break Flow and Energy	
Containment Isolation	Break Flow and Energy	The ability of containment isolation valves and operators to perform their required functions is not affected because the evaluations have been performed at 102% of CLTP.

4.1.1 Valve Programs

The motor-operated valve (MOV) requirements in the UFSAR were reviewed, and no changes to the functional requirements of the GL 89-10 MOVs are identified as a result of operating at the TPO RTP. The previous MOV program analyses were based on 102% of CLTP. The evaluation considered the effect of increased system pressures and flow rates on the capability of the MOVs to perform their safety function. Evaluation of safety-related MOVs was based on system pressures and flow rates that bound those corresponding to the TPO uprate except on four occasions. These exceptions are located in portions of the Feedwater, Condensate, Extraction Steam, and Main-Steam-to-Reactor Feed Pump Turbines. A review of the safety-related MOVs reveals that there are no safety-related MOVs affected in these piping runs. Therefore, the TPO uprate has no effect on the MOV Program at PBAPS.

In addition to the GL 89-10 program, the air-operated valve (AOV) program at PBAPS was reviewed. The AOV program is based on 102% of CLTP. Therefore, the TPO uprate does not affect the AOV program at PBAPS.

Based on these evaluations, the GL 89-10 MOV program and the AOV program at PBAPS are not affected by the TPO uprate. Therefore, MOVs and AOVs remain capable of performing their design basis functions.

4.1.2 Generic Letter 95-07 Program

The commitments relating to the GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," have been reviewed and no changes are identified as a result of operating at the TPO RTP level. Because the previous analyses were based on 102% of CLTP, there is no change in the environmental conditions at which the valves are required to operate. The process parameters for these systems do not change as a result of the TPO uprate. Therefore, the valves remain capable of performing their design basis function.

4.1.3 Generic Letter 96-06

The PBAPS response to GL 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," was reviewed for the TPO uprate. The containment design temperatures and pressures in the current GL 96-06 evaluation are not exceeded under post-accident conditions for the TPO uprate. The TPO uprate does not alter the sequencing of equipment, and does not increase the cooling water flow rate. Therefore, the PBAPS response to GL 96-06 remains valid under TPO uprate conditions.

4.2 EMERGENCY CORE COOLING SYSTEMS

4.2.1 High Pressure Coolant Injection

The HPCI system is a turbine driven system designed to pump water into the reactor vessel over a wide range of operating pressures. For the TPO uprate, there is no change to the normal reactor operating pressure or the SRV setpoints. The primary purpose of the HPCI is to maintain reactor vessel coolant inventory in the event of a small break LOCA that does not immediately depressurize the reactor vessel. The generic evaluation of the HPCI system provided in TLTR Section 5.6.7 is applicable to PBAPS. The ability of the HPCI system to perform required safety functions is demonstrated with previous analyses based on ≥ 102% of CLTP. Therefore, all safety aspects of the HPCI system are within previous evaluations and the requirements are unchanged for TPO uprate conditions.

4.2.2 High Pressure Core Spray

Not applicable to PBAPS.

4.2.3 Core Spray and Low Pressure Core Spray

The Low Pressure Core Spray (LPCS) system is not applicable to PBAPS.

The Core Spray (CS) system sprays water into the reactor vessel after it is depressurized. The primary purpose of the CS system is to provide reactor vessel coolant makeup during a large break LOCA or any small break LOCA after the reactor vessel has depressurized. It also provides spray cooling for long-term core cooling in the event of a LOCA. The generic evaluation of the CS system provided in TLTR Section 5.6.10 is applicable to PBAPS. The ability of the CS system to perform required safety functions is demonstrated with previous analyses based on ≥ 102% of CLTP. Therefore, all safety aspects of the CS system are within previous evaluations and the requirements are unchanged for TPO uprate conditions.

4.2.4 Low Pressure Coolant Injection

The LPCI mode of the RHR system is automatically initiated in the event of a LOCA. The primary purpose of the LPCI mode is to provide reactor vessel coolant makeup during a large break LOCA or any small break LOCA after the reactor vessel has depressurized. The generic evaluation of the LPCI mode provided in TLTR Section 5.6.10 is applicable to PBAPS. The ability of the RHR system to perform required safety functions required by the LPCI mode is demonstrated with previous analyses based on ≥ 102% of CLTP. Therefore, all safety aspects of the RHR system LPCI mode are within previous evaluations and the requirements are unchanged for TPO uprate conditions.

4.2.5 Automatic Depressurization System

The ADS uses SRVs to reduce the reactor pressure following a small break LOCA when it is assumed that the high pressure systems have failed. This allows the CS and LPCI to inject coolant into the reactor vessel. The ADS initiation logic and valve control is not affected by the TPO uprate. The generic evaluation of the ADS provided in TLTR Section 5.6.8 is applicable to PBAPS. The ability of the ADS system to perform required safety functions is demonstrated with previous analyses based on 102% of CLTP. Therefore, all safety aspects of the ADS are within previous evaluations and the requirements are unchanged for TPO uprate conditions.

4.2.6 ECCS Net Positive Suction Head

The current PBAPS design basis includes analysis of net positive suction head (NPSH) requirements for ECCS pumps following LOCA, ATWS, Station Blackout (SBO), and Appendix R events. For the LOCA and Appendix R events, there is no change in the available NPSH for systems using suppression pool water because previous NPSH analyses for these events were based on ≥ 102% of CLTP. SBO was analyzed at 100% of CLTP using a bounding peak suppression pool temperature of 180.0°F, which also bounds the maximum SBO pool temperature at the TPO power level. For the ATWS event, the current limiting NPSH margin is 7.4 feet based on a peak suppression pool temperature of 188.0°F. [Redacted] The reduction in available NPSH for this temperature increase would be less than 0.5 feet. Therefore, for the TPO ATWS event there would be adequate available NPSH for systems using suppression pool water. No change in current containment overpressure credit is required for operation at TPO RTP.

4.3 Emergency Core Cooling System Performance

The ECCS is designed to provide protection against postulated LOCAs caused by ruptures in the primary system piping. The current 10 CFR 50, Appendix K LOCA analysis for PBAPS has been performed at ≥ 102% of CLTP. [Redacted]

The limiting Upper Bound PCT does not change because the analysis was performed at ≥ 102% of CLTP, which bounds the TPO uprate

4.4 Main Control Room Atmosphere Control System

The Main Control Room atmosphere is not affected by the TPO uprate. Habitability following a postulated accident from TPO uprated conditions is unchanged because the Main Control Room Atmosphere Control System had previously been evaluated for accident conditions from 102% of CLTP. Therefore, the system remains capable of performing its safety function for the TPO uprate.

4.5 Standby Gas Treatment System

The Standby Gas Treatment System (SGTS) minimizes the offsite and control room dose rates during venting and purging of the containment atmosphere under abnormal conditions. The current capacity of the SGTS was selected to maintain the secondary containment at a slightly negative pressure during such conditions. This capability is not changed by TPO uprate conditions. The SGTS charcoal beds can accommodate DBA conditions from 102% of CLTP. The drawdown time is not affected by the TPO uprate because the Primary Containment post-LOCA temperature and pressure response are not affected by the TPO uprate. Therefore, the system remains capable of performing its safety function for the TPO uprate.

4.6 PRIMARY CONTAINMENT LEAK RATE TEST PROGRAM AND CONTAINMENT ISOLATION SYSTEM

The PBAPS design includes the Primary Containment Leak Rate Test (PCLRT) program and the Containment Isolation System. The PCLRT program is designed to enable leakage testing of the primary containment structure during non-operational conditions, i.e. systems tested not in-service. Therefore, system operation is not affected by the TPO uprate.

The PCLRT program is not affected, because the reactor operating parameters are not changed for the TPO uprate and the current containment response analyses have been performed at 102% of CLTP. Based on no change in the post accident short-term containment pressure and temperature, there is no revision necessary to the Appendix J testing methodology and/or acceptance test criteria.

The Containment Isolation System is not affected by TPO uprate. The system uses setpoints developed to ensure containment isolation based on postulated accidents as expressed in the UFSAR. These setpoints utilize a 2% uncertainty factor required by RG 1.49. Because the TPO uprate reduces the RG 1.49 uncertainty from 2% to 0.3%, the previous analysis remains bounding.

4.7 POST-LOCA COMBUSTIBLE GAS CONTROL SYSTEM

The Combustible Gas Control System (CGCS) maintains the post-LOCA concentration of oxygen or hydrogen in the containment atmosphere below the flammability limit. The generic evaluation of the CGCS provided in TLTR Section J.2.3.10 is applicable to PBAPS. The metal available for reaction is unchanged by the TPO uprate and the hydrogen production due to radiolytic decomposition is unchanged because the system was previously evaluated for accident conditions from 102% CLTP. Therefore, the current evaluation is valid for the TPO uprate.

5.0 INSTRUMENTATION AND CONTROL

5.1 NSSS MONITORING AND CONTROL

The instruments and controls that directly interact with or control the reactor are usually considered within the NSSS. The NSSS process variables and instrument setpoints that could be affected by the TPO uprate were evaluated.

5.1.1 Neutron Monitoring System

5.1.1.1 Average Power Range Monitors and Wide Range Neutron Monitors

The Average Power Range Monitors (APRMs) are re-calibrated to indicate 100% at the TPO RTP level of 3514 MWt. The APRM high flux scram and the upper limit of the rod block setpoints, expressed in units of percent of licensed power, are not changed. The flow-biased APRM trips, expressed in units of absolute thermal power (i.e., MWt), remain the same. Thus, the MCPR reduction or MLHGR ratio to the limiting value is unchanged for potential transient increases of power from the operating limit to the APRM rod block alarm or flow-referenced scram trip. This approach for the PBAPS TPO uprate follows the guidelines of TLTR Section 5.6.1 and Appendix F, which is consistent with the practice approved for GE BWR uprates in ELTR1 (Reference 2).

For the TPO uprate, no adjustment is needed to ensure the Wide Range Neutron Monitors (WRNMs) have adequate overlap with the APRMs. However, normal plant surveillance procedures may be used to adjust the WRNMs overlap with the APRMs. The WRNM channels short reactor period trip is unchanged for the TPO uprate.

5.1.1.2 Local Power Range Monitors and Traversing Incore Probes

At the TPO RTP level, the flux at some Local Power Range Monitors (LPRMs) increases. However, the small change in the power level is not a significant factor to the neutronic service life of the LPRM detectors and radiation level of the traversing incore probes (TIPs). It does not change the number of cycles in the lifetime of any of the detectors. The LPRM accuracy at the increased flux is within specified limits, and the LPRMs are designed as replaceable components. The TIPs are stored in shielded rooms and a small increase in radiation levels can be accommodated by the radiation protection program for normal plant operation.

5.1.1.3 Rod Block Monitor

The Rod Block Monitor (RBM) instrumentation is referenced to an APRM channel. Because the APRM has been rescaled, there is only a small effect on the RBM performance due to the LPRM performance at the higher average local flux. The RBM instrumentation is not significantly affected by TPO uprate conditions, and no change is needed.

5.1.2 Rod Worth Minimizer

The Rod Worth Minimizer (RWM) does not perform a safety-related function. The function of the RWM is to support the operator by enforcing rod patterns until reactor power has reached appropriate levels. The power-dependent setpoints for the RWM are included in Section 5.3.

5.2 BOP MONITORING AND CONTROL

Operation of the plant at the TPO RTP level has minimal effect on the BOP system instrumentation and control devices. The improved FW flow measurement, which is the basis for the reduction in power uncertainty, is provided in Section 1.4. All of the control systems and instrumentation have sufficient range/adjustment capability for use at the TPO uprate conditions. No safety-related BOP system setpoint changes are required as a result of the TPO uprate.

5.2.1 Pressure Control System

The PCS provides a fast and stable response to steam flow changes so that reactor pressure is controlled within a normal operating range. The PCS consists of the pressure regulation system, turbine control valve (TCV) system, and steam bypass valve system. The main turbine speed/load control function is performed by the main turbine-generator electro-hydraulic control (EHC) system. The steam bypass valve pressure control function is performed by the turbine bypass control system.

Satisfactory reactor pressure control by the pressure regulator and TCVs requires an adequate flow margin between the TPO RTP operating condition and the steam flow capability of the TCVs at their maximum stroke (i.e., valves wide open (VWO)). PBAPS has demonstrated acceptable pressure control performance at CLTP conditions and has in excess of the ~2% steam flow margin needed for the TPO uprate. The existing electronic controls, as designed for the CLTP conditions, are adequate and require no electronic component changes for the TPO uprate conditions.

No modification is required to the steam bypass valves. No modifications are required to the operator interface indications, controls, or alarm annunciators provided in the main control room. The required adjustments are limited to "tuning" of the control settings that may be required to operate optimally at the TPO RTP level.

PCS tests, consistent with the guidelines in TLTR Appendix L, will be performed during the power ascension phase (Section 10.4).

5.2.2 Feedwater Control System

An evaluation of the ability of the FW/level control system and FW turbine controls to maintain adequate water level control at the TPO uprate conditions has been performed. The ~2% increase in FW flow associated with TPO uprate is within the current control margin of these systems. No changes in the operating water level or water level trip setpoints are required for the

TPO uprate. Per the guidelines of TLTR Appendix L, the performance of the FW/level control systems will be recorded at 95% and 100% of CLTP and confirmed at the TPO RTP during power ascension. These checks will demonstrate acceptable operational capability and will utilize the methods and criteria described in the original startup testing of these systems.

5.2.3 Leak Detection System

The setpoints associated with leak detection have been evaluated with respect to the ~2% higher steam flow and ~1°F increase in FW temperature for the TPO uprate. Each of the systems, where leak detection potentially could be affected, is addressed below.

Main Steam Tunnel Temperature Based Leak Detection

The ~1°F increase in FW temperature for the TPO uprate decreases leak detection trip avoidance margin. As described in TLTR Section F.4.2.8, the high steam tunnel temperature setpoint remains unchanged.

RWCU System Temperature Based Leak Detection

There is no significant effect on RWCU system temperature or pressure due to the TPO uprate. Therefore, there is no effect on the RWCU temperature based leak detection.

RCIC System Temperature Based Leak Detection

The TPO uprate does not increase the nominal vessel dome pressure or temperature. Therefore, there is no change to the RCIC system temperature or pressure, and thus, the RCIC temperature based leak detection system is not affected.

HPCI System Temperature Based Leak Detection

The TPO uprate does not increase the nominal vessel dome pressure or temperature. Therefore, there is no change to the HPCI system temperature or pressure, and thus, the HPCI temperature based leak detection system is not affected.

RHR System Temperature Based Leak Detection

The TPO uprate does not increase the nominal vessel dome pressure or temperature. Therefore, there is no change to the RHR system temperature or pressure, and thus, the RHR temperature based leak detection system is not affected.

Non-Temperature Based Leak Detection

The non-temperature based leak detection systems are not affected by the TPO uprate.

5.3 TECHNICAL SPECIFICATION INSTRUMENT SETPOINTS

The determination of instrument setpoints is based on plant operating experience, conservative licensing analyses or limiting design/operating values. Standard GE setpoint methodologies (Reference 6) are used to generate the allowable values (AV) and nominal trip setpoints (NTSP) related to any analytical limit (AL) change, as applicable. Each actual trip setting is established to preclude inadvertent initiation of the protective action, while assuring adequate allowances for instrument accuracy, calibration, drift and applicable normal and accident design basis events.

Table 5-1 lists the analytical limits that change based on results from the TPO evaluations and safety analyses. In general, if the AL does not change in the units shown in the Technical Specifications, then no change in its associated plant AV and NTSP is required, as shown in the Technical Specifications. Changes in the setpoint margins due to changes in instrument accuracy and calibration errors caused by the change in environmental conditions around the instrument due to the TPO uprate are negligible. Maintaining constant nominal dome pressure for the uprate minimizes the potential effect on these instruments by maintaining the same fluid properties at the instruments. The setpoint evaluations are based on the guidelines in TLTR Sections 5.8 and F.4 and on Section 5.3 of the Reference 6.

5.3.1 High-Pressure Scram

The high-pressure scram terminates a pressure increase transient not terminated by direct or high flux scram. Because there is no increase in nominal reactor operating pressure with the TPO uprate, the scram AL on reactor high pressure is unchanged.

5.3.2 Hydraulic Pressure Scram and Recirculation Pump Trip

The AL for the turbine hydraulic pressure that initiates the T/G trip scram and EOC recirculation pump trip (RPT) at high power remains the same as for the CLTP. No modifications are being made to the turbine hydraulic control systems for TPO; actuation of these safety functions remains unchanged from the current operation.

5.3.3 High-Pressure Recirculation Pump Trip

The anticipated transient without scram recirculation pump trip (ATWS-RPT) trips the pumps during plant transients with increases in reactor vessel dome pressure. The ATWS-RPT provides negative reactivity by reducing core flow during the initial part of an ATWS. The evaluation in Section 9.3.1 demonstrates that the current high pressure ATWS-RPT AL is acceptable for the TPO uprate.

5.3.4 Safety Relief Valve

Because there is no increase in nominal vessel dome pressure, the SRV ALs are not changed.

5.3.5 Main Steam Line High Flow Isolation

The AV of this function is expressed in terms of psid. Although the main steam flow increases by ~2%, the MSL high steam flow AL in terms of differential pressure is not changed for the TPO uprate. The corresponding AL in terms of steam flow is decreased to approximately 137.5% of the TPO rated steam flow. Because of the large spurious trip margin, sufficient margin exists to allow for normal plant testing of the MSIVs and turbine stop and control valves. This approach is consistent with TLTR Section F.4.2.5.

5.3.6 Fixed APRM Scram

The fixed APRM ALs, for both two loop operation (TLO) and SLO, expressed in percent of RTP do not change for the TPO uprate. The generic evaluation and guidelines presented in TLTR Section F.4.2.2 are applicable to PBAPS. The limiting transient that relies on the fixed APRM trip is the MSIV closure transient with indirect scram. As described in TSAR Section 9.1, this event has been analyzed assuming 102% of CLTP and is reanalyzed on a cycle specific basis.

5.3.7 APRM Flow-Biased Scram

The flow-referenced APRM ALs, for both TLO and SLO, are unchanged in units of absolute core thermal power versus recirculation drive flow. Because the ALs are expressed in percent RTP, they decrease in proportion to the power uprate or CLTP RTP / TPO RTP. This is the same approach taken for generic BWR uprates described in ELTR1. There are no significant effects on the instrument errors or uncertainties from the TPO uprate. Therefore, the AV and NTSP are established by directly incorporating the change in the AL.

5.3.8 Rod Worth Minimizer Low Power Setpoint

The RWM Low Power Setpoint (LPSP) is used to enforce the rod patterns established for the control rod drop accident at low power levels. The generic guidelines in TLTR Section F.4.2.9 are applicable to PBAPS. The RWM LPSP AL for PBAPS is conservatively kept at the same value in terms of percent power.

5.3.9 Rod Block Monitor

The severity of rod withdrawal error during power operation event is dependent upon the RBM rod block setpoints. The power-dependent ALs are maintained at the same percent RTP. The cycle specific reload analysis is used to determine any changes in the rod block setpoint.

5.3.10 Main Steam Line High Radiation Scram/Isolation

The function of the MSL Radiation Monitoring System is to monitor gross releases of fission products from the fuel and, upon indication of a significant increase in MSL radiation level signifying fuel failure, to initiate a scram and MSIV closure. The current analysis of radiological consequences is based on 102% of CLTP, which bounds the TPO RTP. Therefore, the TPO uprate does not affect the MSL radiation monitor trip setpoint. No change in the Technical Specifications is required. This approach is consistent with TLTR Section F.4.2.8.

5.3.11 Low Steam Line Pressure MSIV Closure (RUN Mode)

The purpose of this function is to initiate MSIV closure on low steam line pressure when the reactor is in the RUN mode. This AL is not changed for the TPO as discussed in TLTR Section F.4.2.7.

5.3.12 Reactor Water Level Instruments

[Redacted] This generic disposition is also applicable to the PBAPS TPO uprate. Use of the current ALs maintains acceptable safety system performance. The low reactor water level ALs for scram, high pressure injection, and ECCS are not changed for the TPO uprate. The high water level ALs for trip of the main turbine, FW pumps, and reactor scram are also not changed for the TPO uprate.

Water level change during operational transients (e.g., trip of a recirculation pump, FW controller failure, loss of one FW pump) is slightly affected by the TPO uprate. The trip of one FW pump does not change significantly, because the maximum operating rod line is not being increased. Therefore, the final power level remains the same relative to the remaining FW flow.

5.3.13 Main Steam Line Tunnel High Temperature Isolations

As noted in Section 5.2.3 above, the high steam tunnel temperature AL remains unchanged for the TPO uprate.

5.3.14 Low Condenser Vacuum

In order to produce more electrical power, the amount of heat discharged to the main condenser increases slightly. This added heat load could slightly increase condenser backpressure, but the increase would be insignificant. The slight change in condenser vacuum after implementation of TPO would not adversely affect any trip signals associated with low condenser vacuum (turbine trip / MSIV closure).

5.3.15 TSV Closure Scram, TCV Fast Closure Scram, and EOC-RPT Bypasses

The Turbine Stop Valve (TSV) closure scram, TCV fast closure scram, and EOC-RPT bypasses allow this scram and EOC-RPT to be bypassed, when reactor power is sufficiently low, such that the scram and EOC-RPT functions are not needed to mitigate a T/G trip. This power level is the AL for determining the actual trip setpoint, which comes from the turbine first-stage pressure (TFSP).

Based on the guidelines in TLTR Section F.4.2.3, the TSV closure scram, TCV fast closure scram, and EOC-RPT bypass AL in percent RTP is reduced by the ratio of the power increase.

The new AL does not change with respect to absolute thermal power. Because the trip does not change in terms of absolute power, there is no effect on the transient response. The maneuvering range for plant startup is maximized.

Table 5-1 Analytical Limits that Change due to TPO

Parameter	Current	TPO
APRM Simulated Thermal Power Scram		
TLO Flow Biased (%RTP)	0.66 Wd + 67.2	0.65 Wd + 66.0
SLO Flow Biased (%RTP)	0.66 Wd + 67.2 – 0.66 ΔW	0.65 Wd + 66.0 – 0.65 ΔW
TFSP Bypass Permissive (%RTP)	30	29.5
Main Steam Line High Flow Isolation % rated steam flow	140	137.5

Where:

Wd = Recirculation drive flow in percent

ΔW = Difference between the TLO and SLO drive flow at the same core flow

6.0 ELECTRICAL POWER AND AUXILIARY SYSTEMS

6.1 AC POWER

Plant electrical characteristics are given in Table 6-1.

An evaluation of the station auxiliary electrical distribution system was performed to determine the adequacy of the systems/components used for both the plant loads and TPO uprate. The current analysis is based on 102% of CLTP, which bounds the TPO RTP.

Therefore, the performance of the Unit Auxiliary and Start-up transformers, 13.8KV, 4160V, and 480V auxiliary power systems, is not affected by the TPO uprate.

6.1.1 Off-Site Power

The review of the existing off-site electrical equipment concluded the following:

- The isolated phase bus duct is adequate for both rated voltage and low voltage current output.
- The main transformers and the associated switchyard components (rated for maximum transformer output) are adequate for the TPO uprate-related transformer output.

A grid stability analysis has been performed to demonstrate conformance to General Design Criteria 17 (10 CFR 50, Appendix A). GDC 17 addresses on-site and off-site electrical supply and distribution systems for safety-related components. There is no significant effect on grid stability or reliability. There are no modifications associated with the TPO uprate, which would increase electrical loads beyond those levels previously included or revise the logic of the distribution systems.

6.1.2 On-Site Power

The on-site power distribution system consists of transformers, numerous buses, and switchgear. Alternating current (AC) power to the distribution system is provided from the transmission system or from onsite diesel generators. The on-site power distribution system loads were reviewed under both normal and emergency operating scenarios. In both cases, loads are computed based primarily on equipment nameplate data or brake horsepower (BHP). These loads are used as inputs for the computation of load, voltage drop, and short circuit current values. Operation at the TPO RTP level is achieved in both normal and emergency conditions by operating equipment at or below the nameplate rating running kW or BHP. Therefore, there are negligible changes to the load, voltage drop or short circuit current values.

Station loads under normal operation/distribution conditions are computed based on equipment nameplate data with conservative demand factors applied. The only identifiable change in electrical load demand is associated with the condensate pumps. These pumps experience increased flow and pressure due to the TPO uprate conditions. The CLTP evaluation was based on 3528 MWt operation to account for a 2% power uncertainty.

Station loads under emergency operation and distribution conditions (emergency diesel generators) are based on equipment nameplate data, except for the ECCS pumps where a conservatively high flow BHP is used. Emergency operation at the TPO RTP level is achieved by utilizing existing equipment operating at or below the nameplate rating and within the calculated BHP for the stated pumps; therefore, under emergency conditions the electrical supply and distribution components are adequate.

No increase in flow or pressure is required of any AC-powered ECCS equipment for the TPO uprate. Therefore, the amount of power required to perform safety-related functions (pump and valve loads) does not increase, and the current emergency power system remains adequate. The systems have sufficient capacity to support all required loads for safe shutdown, to maintain a safe shutdown condition, and to operate the engineered safety feature equipment following postulated accidents.

6.1.3 Emergency Diesel Generator

There are no modifications associated with the TPO uprate that would increase the electrical loads associated with the engineered safeguard and selected non-safeguard systems or alter the Diesel Generator subsystems. Therefore, the performance of the emergency diesel generator (EDG) and the 4kV emergency system is not affected by the TPO uprate.

6.2 DC POWER

The direct current (DC) loading requirements in the UFSAR were reviewed, and no reactor power-dependent loads were identified. The DC power distribution system provides control and motive power for various systems and components. In both normal and emergency operating scenarios, loads are computed based on equipment nameplate data or BHP. These loads are used as inputs for the computation of load, voltage drop, and short circuit current values. Operation at the TPO RTP level is achieved in both normal and emergency conditions by operating equipment at or below the nameplate rating running KW or BHP. Therefore, there are no changes to the load, voltage drop or short circuit current values, and the performance of the 125/250VDC and 24/48VDC systems are not affected by the TPO uprate.

In addition, the class 1E 125 DC batteries power the actuation solenoids of the SRVs. The TPO uprate may lead to more SRV cycles in a total loss of offsite power (LOOP) scenario (station blackout). The load on each valve is < 150 mADC. This load on the batteries is considered insignificant when coupled with the load shedding actions by the control room operators to conserve battery capacity.

6.3 FUEL POOL

The following subsections address fuel pool cooling, crud and corrosion products in the fuel pool, radiation levels, and structural adequacy of the fuel racks. The overall conclusion is that the changes due to TPO are within the design limits of the systems and components, and the fuel pool cooling system meets the UFSAR requirements at the TPO conditions.

6.3.1 Fuel Pool Cooling

The Fuel Pool Cooling System was previously evaluated to 102% of CLTP and for a 24-month refueling cycle. The Fuel Pool Cooling System is capable of meeting its design requirement to maintain the Spent Fuel Pool outlet water temperature below the design temperature of 150°F for the normal heat load ($^1/_3$ core offload) with two cooling trains in operation.

6.3.2 Crud Activity and Corrosion Products

The crud activity and corrosion products associated with spent fuel can increase very slightly due to the TPO. The increase is insignificant and spent fuel pool (SFP) water quality is maintained by the Fuel Pool Cooling And Cleanup System (FPCCS).

6.3.3 Radiation Levels

The normal radiation levels around the SFP may increase slightly during fuel handling operations. This increase is acceptable and does not significantly increase the operational doses to personnel or equipment.

6.3.4 Fuel Racks

The fuel racks are designed for higher temperatures than are anticipated from the effects of the TPO uprate. There is no effect on the design of the fuel racks, because the original design SFP temperature is not exceeded.

6.4 WATER SYSTEMS

The safety-related and non-safety-related cooling water loads potentially affected by TPO are addressed in the following sections. The environmental effects of TPO are controlled such that none of the present limits (e.g., maximum allowed cooling water discharge temperature) are increased.

The auxiliary cooling systems: Safety-Related Service Water (SW), Emergency Cooling Water and Tower, Turbine Building Closed Cooling Water (TBCCW), Reactor Building Closed Cooling Water (RBCCW), and Chilled Water (CW) systems were analyzed for 102% of CLTP. Therefore, these systems are bounded by previous analyses and function as required under TPO uprate conditions.

6.4.1 Service Water Systems

6.4.1.1 Safety-Related Loads

The safety-related SW systems (i.e., the Emergency Service Water and High Pressure Service Water Systems) provide cooling water during and following a design basis accident. The performance of the safety-related SW systems during and following the most demanding design basis event, the LOCA, does not change because the original LOCA analysis was performed with 2% uncertainty applied to the CLTP (Section 4.2). Similarly, the containment response analysis in Section 4.1 is also based on a 2% uncertainty. There is no change in the safety-related heat loads and the requirements are within the existing capacity of the RHR and associated safety-related SW systems.

6.4.1.2 Nonsafety-Related Loads

The temperature of SW discharge results from the heat rejected to the SW system via closed cooling water systems and other auxiliary heat loads. The major SW heat load increases from the TPO reflect an increase in main generator losses rejected to the stator water coolers and hydrogen coolers and the TBCCW. The thermal efficiency of the power generation cycle is not expected to change. Therefore, the increase in SW heat loads from these sources due to the TPO uprate operation is approximately proportional to the TPO (~1.7%).

For normal operation, the maximum SW heat loads occur during peak summer months. A discharge temperature may be estimated assuming both realistic conditions and very conservative bounding conditions. The current plant and state limited discharge temperatures compared to TPO conditions are shown in Table 6-3. This comparison demonstrates that the SW system is adequate for the TPO conditions.

6.4.2 Main Condenser/Circulating Water/Normal Heat Sink Performance

The main condenser, circulating water, and normal heat sink systems are designed to remove the heat rejected to the condenser and thereby maintain adequately low condenser pressure as recommended by the turbine vendor. TPO operation increases the heat rejected to the condenser and may reduce the difference between the operating pressure and the required minimum condenser vacuum. The current evaluation of the performance of the main condenser was reviewed for operation at the TPO RTP. [EDS151]The results of this review concluded that the effect of the TPO uprate is acceptable because the current evaluation was based on the CLTP with 2% uncertainty, which envelops the design parameters at the TPO uprate conditions. Therefore, there is no change in the analysis.

6.4.2.1 Discharge Limits

The TPO uprate causes a slight increase in the discharge water temperature. The estimated increase in the temperature of the water being discharged to the environment would be ~1°F.

The effect of this small increase in discharge temperature was reviewed against the state thermal discharge limit.

The state thermal discharge limits are shown in Table 6-3. The station will monitor and report any adverse conditions on the discharge water temperature. The ability to maintain the plant within the current environmental permit will not be affected by the TPO uprate.

6.4.3 Chilled Water System

The CW system is a non-safety-related mechanical distribution system for PBAPS Units 2 and 3 that consists of the non-safety-related Drywell Chilled Water System (DCWS), and the non-safety-related Control Room Chilled Water System (CRCWS). The CW system has been evaluated for 102% of CLTP. Therefore, TPO uprate has no effect on the CW system.

6.4.4 Turbine Building Closed Cooling Water System

The power-dependent heat loads on the TBCCW system increased by the TPO are those related to the operation of the bus duct cooler and exciter coolers. The remaining TBCCW heat loads are not strongly dependent upon reactor power and do not significantly increase. The TBCCW system has sufficient capacity to assure that adequate heat removal capability is available for TPO operation. The TBCCW system has been evaluated for 102% of CLTP. Therefore, TPO uprate has no impact on the TBCCW system.

6.4.5 Emergency Heat Sink

A review was performed to evaluate the increased Emergency Heat Sink (EHS) heat load for the TPO. After a two-reactor shutdown, assuming the turbine condensers are not available as heat sinks, it is estimated that continued operation of the RHR in the shutdown cooling mode can cool the reactors to 212°F in approximately 12 hours and to 125°F in about 3 weeks. Based on continuous cooling tower operation at the rated flow condition, the total water consumed at the end of seven days is 3.4×10^6 gal at the CLTP. This represents a 6% margin on the Emergency Cooling Tower (ECT) reservoir. The TPO uprate reduces the margin to about 4% but is still adequate. Therefore, the current Technical Specifications for EHS limits are adequate due to conservatism in the original design.

6.5 STANDBY LIQUID CONTROL SYSTEM

The SLCS is designed to shut down the reactor from rated power conditions to cold shutdown in the postulated situation that all or some of the control rods cannot be inserted. It is a manually operated system that pumps a highly enriched sodium pentaborate solution into the vessel to achieve a subcritical condition. The generic evaluation presented in TLTR Sections 5.6.5 (SLCS) and L.3 (ATWS Evaluation) is applicable to the PBAPS TPO uprate. The TPO uprate does not affect the solution storage requirements, system injection capability, or the equivalent solution injection rate. Because the shutdown margin is reload dependent, the shutdown margin and the required reactor boron concentration are confirmed for each reload core.

The SLCS ATWS performance is evaluated in TSAR Section 9.3.1. The evaluation shows that the TPO has no adverse effect on the ability of the SLCS to mitigate an ATWS.

6.6 POWER DEPENDENT HEATING, VENTILATION AND AIR CONDITIONING

The Heating, Ventilation, and Air Conditioning (HVAC) systems that are potentially affected by the TPO uprate consist mainly of heating, cooling supply, exhaust, and recirculation units in the turbine building, containment building and the drywell, auxiliary building, fuel handling building, control building, and the radwaste building.

TPO results in a minor increase in the heat load caused by the slightly higher FW process temperature (< 1°F). However, the increased process temperature is still below the process temperature used in the HVAC analysis, which is based on 102% of CLTP. Other areas are unaffected by the TPO because the process temperatures and electrical heat loads remain constant.

Therefore, the power dependent HVAC systems are adequate to support the TPO uprate.

6.7 FIRE PROTECTION

Operation of the plant at the TPO RTP level does not affect the fire suppression or detection systems. There are no changes in physical plant configuration or combustible loading as a result of the TPO uprate. The safe shutdown systems and equipment used to achieve and maintain cold shutdown conditions do not change, and are adequate for the TPO uprate conditions. The operator actions required to mitigate the consequences of a fire are not affected. Therefore, the fire protection systems and analyses are not affected by the TPO uprate.

6.7.1 10 CFR 50 Appendix R Fire Event

TLTR Section L.4 presents a generic evaluation of Appendix R events for an increase of 1.5% CLTP. [Redacted] The current analysis based on CLTP has an available margin of 50°F to the clad temperature limit and 39 psi to the containment pressure limit. Therefore, the generic results are clearly applicable [Redacted]

6.8 OTHER SYSTEMS AFFECTED BY TPO UPRATE

Based on experience and previous NRC reviews, all systems that are significantly affected by TPO are addressed in this report. Other systems not addressed by this report are not significantly affected by TPO. The systems unaffected by TPO at PBAPS are confirmed to be consistent with the generic description provided in the TLTR.

Table 6-1 TPO Plant Electrical Characteristics

Parameter	Value
Design Generator Output (MWe)	1159
Rated Voltage (kV)	22
Power Factor	0.906
Design Generator Output (MVA)	1280
Current Output (kA)	33.6
Isolated Phase Bus Duct Rating (kA)	35.3
Main Transformers Rating (MVA)	1244

Table 6-2 Fuel Pool Cooling And Cleanup System Parameters

Parameter	Pre-TPO	TPO
System Component Design Temperature (°F)	150	150
System Component Design Pressure (psig)	150	150
Number of Fuel Pool Cooling Loops	3	3
Fuel Cycle (months)	24	24
Bulk Pool Temperature for a Full Core Off-load, Fuel Pool With Maximum Capacity, with Supplemental RHR Cooling (°F), if required	< 150	< 150

Table 6-3 Effluent Discharge Comparison

Parameter	State Limit	Current	TPO
Average Daily Discharge Temperature not to exceed (°F) / for more than days	Monitor / Report	Monitor / Report	Monitor / Report
Discharge Temperature not to exceed (°F) any given day	Monitor / Report	Monitor / Report	Monitor / Report
Chlorine mg/L (Maximum TRC)	0.2	0.2	0.2

7.0 POWER CONVERSION SYSTEMS

7.1 TURBINE-GENERATOR

The PBAPS main T/Gs are designed with a maximum flow-passing and generator capability in excess of rated conditions to ensure that the design rated output is achieved. The excess capacity ensures that the T/Gs can meet rated conditions for continuous operating capability with allowances for variations in flow coefficients from expected values, manufacturing tolerances, and other variables that may affect the flow-passing capability of the unit.

For the TPO RTP level, the rated throttle steam flow is increased to 14,386,500 lb/hr at a throttle pressure of 994 psia. The increased throttle flow is approximately 102% of current rated. The uprated electrical output is 1,195,401 kW at a power factor of 0.93.

Steam specification calculations were performed to determine the TPO uprate turbine steam path conditions. From the thermodynamic models, turbine and generator stationary and rotating components were evaluated for increased loadings, pressure drops, thrusts, stresses, overspeed capability, and other design considerations to assure that design limits are not exceeded and that operation remains acceptable at the TPO uprate condition. In addition, valves, control systems, and other support systems were evaluated. The results of these evaluations show that no modifications are needed to support operation at the TPO uprate condition.

The current rotor missile analysis, based on the NRC-approved methodology in NUREG-1048, was performed at the VWO conditions, which do not change for the TPO uprate. Therefore, a new analysis does not need to be performed for the TPO uprate.

The overspeed calculation compares the entrapped steam energy contained within the turbine and the associated piping, after the stop valves trip, and the sensitivity of the rotor train for the capability of overspeeding. The entrapped energy increases slightly for the TPO uprate conditions, so changes in the overspeed trip settings are required. The overspeed trip settings will be increased to 109.1% minimum and 110.1% maximum for the TPO uprate.

7.2 CONDENSER AND STEAM JET AIR EJECTORS

The condenser capability was evaluated for performance at the TPO uprate conditions based on current circulating water system flow. The design margin in the condenser heat removal capability can accommodate the additional heat rejected for operation at the TPO uprate conditions. Operational conditions such as cleanliness, tube plugging, and circulating water temperature cause more significant variations in the condenser back pressure than the small additional TPO heat rejection. Condenser capability was previously evaluated for 102% of CLTP. Therefore, the condenser functions as required under TPO RTP conditions.

The design of the steam jet air ejectors (SJAEs) was based on the removal of non-condensable gases produced in the reactor and air leakage into the condenser for the VWO operating conditions. Air leakage into the condenser does not increase as a result of the TPO uprate. The expected air in-leakage flow rate at PBAPS does not increase with reactor power, because condenser vacuum would be maintained at current levels. The in-leakage flow rate is substantially dependent upon original plant and equipment design and routine maintenance. SJAE capability was previously evaluated for 102% of CLTP. Therefore, the SJAEs function as required under TPO RTP conditions.

7.3 Turbine Steam Bypass

The Steam Bypass Pressure Control System (SBPCS) was originally designed for a steam flow capacity of 25.6% of the 100% rated flow at CLTP. The steam bypass capacity at the TPO RTP is ~25.2% of the 100% TPO RTP steam flow rate. The steam bypass system is a normal operating system and non-safety-related. While the bypass capacity as a percent of rated steam flow is reduced, the actual steam bypass capacity is unchanged. The transient analyses that credit the turbine bypass system availability use the actual capacity. The TPO transient analysis (Section 9.1) results are acceptable. Therefore, the turbine bypass capacity is adequate for TPO operation. Further, bypass capability was previously evaluated for 102% of CLTP. Therefore, the SBPCS will function as required under TPO RTP conditions.

7.4 Feedwater And Condensate Systems

The FW and condensate systems are designed to provide FW at the temperature, pressure, quality, and flow rate required by the reactor. These systems are not safety-related; however, their performance may have an effect on plant availability and the capability to operate reliably at the TPO uprate conditions.

The FW and condensate systems, including pumps, piping, valves, and equipment have been previously evaluated to the 102% of CLTP heat balance conditions. The design parameters for the FW system at the TPO RTP are bounded by the evaluation basis. A bounding moisture separator efficiency of 100% for the TPO uprate analysis has been assumed. This increased moisture removal efficiency results in a slight shift in the overall heat balances. The comparison shows that, while there is no change in the design parameters, the service conditions at the TPO RTP exhibit some variations. While the flow rates and the service temperatures are still bounded by the conditions used in the evaluation, the operating pressure may be slightly higher than the current operating parameters. Nevertheless, the operating pressures are still significantly less than the design rating of the FW heaters, valves and piping.

Evaluations of the PBAPS FW heaters, heater vents and drains, condensate demineralizers, and pumps (FW and condensate) demonstrated that the components are capable of performing in the proper design range to provide the slightly higher TPO uprate FW flow rate at the desired temperature and pressure. These evaluations also concluded that the FW control valves and FW turbine controls can maintain water level control at the uprated conditions.

The evaluations considered the effect of the TPO uprate on the FW and condensate systems with respect to the following:

- Pump NPSH
- Ability to avoid suction pressure trip
- Flow capacity
- Bearing cooling capability
- Rated motor horsepower
- Full load motor amps
- Vibration

The FW system run-out and loss of FW heating events would see very small changes from the TPO uprate as shown by the experience with substantially larger power uprates.

7.4.1 Normal Operation

System operating flows for the TPO uprate increase approximately 1.8%. Operation at the TPO RTP level does not significantly affect operating conditions of these systems. The FW and Condensate systems were evaluated at 102% of CLTP and found to be acceptable. The design flow rate for the condensate pump is 10,870 gpm. At 3517 MWt, the pump operates at 9647 gpm, which is within the design margin at the TPO RTP.

Discharge pressure at the condensate pumps decreases due to the pump head characteristics at increased flows. Discharge pressure at the FW pumps compensates for the increase in FW friction losses due to higher flow. The FW turbine control valves automatically open, if required, to accomplish this function. During steady-state conditions, the condensate and FW systems have available NPSH for all of the pumps to operate without cavitation at the TPO uprate conditions. Adequate trip margin, during steady-state conditions, exists between the calculated minimum pump suction pressure and the minimum pump suction pressure based on required NPSH.

The existing FW design pressure and temperature requirements are adequate. The FW heaters and associated regulating valves were originally designed for greater than warranted flow conditions. The FW heaters are ASME Section VIII pressure vessels. The FW heaters were analyzed and verified to be acceptable for the slightly higher FW heater temperatures and pressures for the TPO uprate.

7.4.2 Transient Operation

To account for FW demand transients, the condensate and FW system was evaluated to ensure that an adequate margin above the TPO uprated FW flow is available. This is the same criteria that was applied to the original design. For system operation with all system pumps available, the predicted operating parameters were acceptable and within the component capabilities.

Following a single FW pump trip, the reactor recirculation system would runback recirculation flow, such that the steam production rate is within the flow capacity of the remaining FW pumps. The runback setting is set low enough to prevent a reactor low water level scram, and sufficient to maintain adequate margin to the potential power/flow instability regions.

7.4.3 Condensate Demineralizers

The effect of the TPO uprate on the condensate demineralizers (CDs) was reviewed. The flow rate throughout the Condensate system increases approximately 1.8% from the current rated flow but remains within the design flow rate. The CDs experience slightly higher loadings at the TPO RTP level which result in slightly reduced run times. However, the reduced run times are acceptable (refer to Section 8.0 for the effect on the radwaste systems). Because a spare unit is utilized when cleaning is required, reduced run times (more frequent cleaning) of polisher units does not affect CD capacity.

8.0 RADWASTE AND RADIATION SOURCES

8.1 LIQUID AND SOLID WASTE MANAGEMENT

The liquid radwaste system collects monitors, processes, stores, and returns processed radioactive waste to the plant for reuse or for discharge.

The single largest source of liquid and wet solid waste is from the backwash of the CD filters, and cleaning/replacement of CD resins. The TPO uprate results in a minor increased flow rate through the CDs, resulting in a reduction in the average time between filter backwashes and resin cleaning. The reduction of CD service time does not affect plant safety. The RWCU filter demineralizer may also require more frequent backwashes due to slightly higher levels of activation and fission products.

The floor drain collector subsystem and the waste collector subsystem both receive periodic inputs from a variety of sources. Neither subsystem experiences a significant increase in the total volume of liquid waste due to operation at the TPO uprate conditions.

The activated corrosion products in liquid wastes are expected to increase proportionally to the TPO uprate. The total volume of processed waste is not expected to increase appreciably because the only significant increase in processed waste is due to the more frequent backwashes of the CDs and RWCU filter demineralizers. The power level basis used in the current PBAPS analysis of the Liquid and Solid Waste Management Systems was 102% of CLTP, which bounds the TPO uprate. Therefore, the TPO uprate does not adversely affect the processing of liquid radwaste, and there are no significant environmental effects. A review of plant operating effluent reports and the slight increase expected from TPO uprate, concludes that the requirements of 10 CFR 20 and 10 CFR 50, Appendix I will be met.

8.2 GASEOUS WASTE MANAGEMENT

The gaseous waste systems collect, control, process, store and dispose of gaseous radioactive waste generated during normal operation and abnormal operational occurrences. The gaseous waste management systems include the offgas system and various building ventilation systems. The systems are designed to meet the requirements of 10 CFR 20 and 10 CFR 50, Appendix I.

The waste gases originating in the reactor coolant consist mainly of hydrogen and nitrogen with trace amounts of radioactive gases. The function of the offgas system is to collect and isolate these radioactive noble gases, airborne halogens, and particulates, and to reduce their activity through decay.

Building ventilation systems control airborne radioactive gases by using devices such as high efficiency particulate air (HEPA) and charcoal filters, and radiation monitors that activate isolation dampers or trip supply and exhaust fans, or by maintaining negative or positive air pressure to limit migration of gases. The activity of airborne effluents released through building vents does not increase significantly due to the TPO uprate because:

- The amount of fission products released into the coolant depends on the number and nature of the fuel rod defects and is not dependent on reactor power; and
- [Redacted]

The release limit is an administratively controlled variable and is not a function of core power. The gaseous effluents are well within limits at CLTP operation and will remain well within limits following implementation of the TPO uprate. There are no significant environmental effects due to the TPO uprate.

Core radiolytic gas, which forms H_2 and O_2, on the other hand, increase in direct proportion to the power level. However, the evaluation of the effect on the Condenser Air Removal / Off-Gas System for the previous 5% power uprate was based on 102% of CLTP. Therefore, the TPO uprate has no effect on the design and operation of the Condenser Air Removal / Off-Gas System. The system radiological release rate is administratively controlled, and is not changed with operating power. Therefore, power uprate does not affect the offgas system design or operation.

8.3 RADIATION SOURCES IN THE REACTOR CORE

TLTR Appendix H describes the methodology and assumptions for the evaluation of radiological effects for the TPO uprate.

During power operation, the radiation sources in the core are directly related to the fission rate. These sources include radiation from the fission process, accumulated fission products and neutron reactions as a secondary result of fission. Historically, these sources have been defined in terms of energy released per unit of reactor power. Therefore, the increase in the operating source terms is no greater than the increase in power. The source term increases due to the TPO uprate are bounded by the safety margins of the design basis sources.

The post-operation radiation sources in the core are the result of accumulated fission products. Two separate forms of post-operation source data are normally applied. The first is the core gamma-ray source used in shielding calculations for the core and for individual fuel bundles. This source term is defined in terms of MeV/sec per watt of reactor power (or equivalent) at various times after shutdown. Therefore, the total gamma energy source increases in proportion to reactor power.

The second set of post-operation source data consists of tabulated isotopic activity inventories for fission products in the fuel. These are needed for post-accident evaluations, which are performed in compliance with regulatory guidance that applies different release and transport assumptions to different fission products.

As described in TLTR Section H.3, the radioactive fission product inventory used for TPO uprate evaluations, accident events, or equipment qualification is based on the existing plant design basis. The previous analysis for PBAPS bounds the accident source terms for the TPO uprate because they were evaluated at ≥ 102% of CLTP.

8.4 RADIATION SOURCES IN REACTOR COOLANT

8.4.1 Coolant Activation Products

During reactor operation, the coolant passing through the core region becomes radioactive as a result of nuclear reactions. The coolant activation is the dominant source in the turbine building and in the lower regions of the drywell. Because these sources are produced by interactions in the core region, their rates of production are proportional to power. As a result, the activation products, observed in the reactor water and steam, increase in approximate proportion to the increase in thermal power. The activation products in the steam and coolant are bounded by the existing design basis concentration.

8.4.2 Activated Corrosion and Fission Products

The reactor coolant contains activated corrosion products from metallic materials entering the water and being activated in the reactor region. Under the TPO uprate conditions, the FW flow increases with power, the activation rate in the reactor region increases with power, and the filter efficiency of the condensate demineralizers may decrease as a result of the FW flow increase. The net result may be an increase in the activated corrosion product production.

Fission products in the reactor coolant are separable into the products in the steam and the products in the reactor water. The activity in the steam consists of noble gases released from the core plus carryover activity from the reactor water. The noble gases released during plant operation result from the escape of minute fractions of the fission products from the fuel rods. Noble gas release rates increase approximately with power level. This activity is the noble gas offgas that is included in PBAPS design. The offgas rates for TPO uprate operations are well below the original design basis. Therefore, the design basis release rates are used for the TPO uprate.

The fission product activity in the reactor water, like the activity in the steam, is the result of minute releases from the fuel rods and is expected to be higher than previous calculated data due to the TPO uprate.

Although the activated corrosion product and fission product activities are expected to increase approximately proportional to the TPO power increase, the sum of the total activated corrosion product activity and the total fission product activity due to the TPO uprate is expected to remain a fraction of the original design basis activity in the reactor water. Therefore, the activated corrosion product and fission product activities design bases in the reactor water are unchanged for the TPO uprate.

8.5 RADIATION LEVELS

Normal operation radiation levels increase slightly for the TPO uprate. PBAPS was designed with substantial conservatism for higher-than-expected radiation sources. Thus, the increase in radiation levels does not affect radiation zoning or shielding in the various areas of the plants because it is offset by conservatism in the design, source terms, and analytical techniques.

Post-operation radiation levels in most areas of the plants increase by no more than the percentage increase in power level. In a few areas near the SFP cooling system piping and the reactor water piping, where accumulation of activated corrosion product (crud) is expected, as well as near some liquid radwaste equipment, the increase could be slightly higher. Regardless, individual worker exposures will be maintained within acceptable limits by the site As Low As is Reasonably Achievable (ALARA) program, which controls access to radiation areas. Procedural controls compensate for increased radiation levels.

Accident doses, normal effluent releases and doses, vital area access doses, Technical Support Center doses, Emergency Operations Facility doses, control room habitability doses, post-accident sampling doses, equipment qualification doses, and plant shielding adequacy were all previously evaluated at 102% of CLTP. This evaluation bounds that for TPO uprate.

Section 9.2 addresses the Main Control Room doses for the worst case accident.

8.6 NORMAL OPERATION OFF-SITE DOSES

As discussed in Section 8.2, the normal operation gaseous activity levels remain essentially unchanged for the TPO uprate. The Technical Specification limits implement the guidelines of 10 CFR 50 Appendix I. A review of the normal radiological effluent doses shows normal effluent releases and doses, vital area access doses, control room habitability doses, equipment qualification doses, and plant shielding adequacy were all previously evaluated at 102% of CLTP. This evaluation bounds that for TPO uprate. Therefore, the normal offsite doses are not significantly affected by operation at the TPO RTP level and remain below the limits of 10 CFR 20 and 10 CFR 50, Appendix I.

9.0 REACTOR SAFETY PERFORMANCE EVALUATIONS

9.1 ANTICIPATED OPERATIONAL OCCURRENCES

TLTR Appendix E provides a generic evaluation of the AOO events for TPO uprate plants. [Redacted] The generic results are also applicable to the PBAPS TPO uprate. [Redacted] The AOO events are organized into two major groups: Fuel Thermal Margin Events, and Transient Overpressure Events.

TLTR Table E-2 illustrates the effect of a 1.5% power uprate on the Operating Limit Minimum Critical Power Ratio (OLMCPR). [Redacted] The overpressure and loss of feedwater flow events are currently performed at 102% of CLTP. Therefore, they are applicable and bounding for the TPO uprate.

The worst overpressure event, which is currently the closure of all MSIVs with high neutron flux scram will be analyzed for the first TPO reload (consistent with current reload analysis practice).

The evaluations and conclusions of Appendix E are applicable to the PBAPS TPO uprate. Therefore, it is sufficient for the plant to perform the standard reload analyses at the first fuel cycle that will implement TPO uprate.

9.2 DESIGN BASIS ACCIDENTS

The radiological consequences of a DBA are basically proportional to the quantity of radioactivity released to the environment. This quantity is a function of the fission products released from the core as well as the transport mechanisms from the core to the release point. The radiological releases at the TPO RTP are generally expected to increase in proportion to the power increase.

Radiological consequences due to postulated DBA events, as documented in the UFSAR, have previously been evaluated and analyzed to show that NRC regulations are met for 2% above the CLTP. Therefore, the radiological consequences associated with a postulated DBA from TPO uprate conditions are bounded by the previous analyses. The evaluation/analysis was based on the methodology, assumptions, and analytical techniques described in the RGs, the Standard Review Plan (SRP), where applicable, and in previous Safety Evaluations (SEs).

9.3 SPECIAL EVENTS

9.3.1 Anticipated Transient without Scram

PBAPS meets the ATWS mitigation equipment requirements defined in 10 CFR 50.62:

1. Installation of an Alternate Rod Insertion (ARI) system.
2. Boron injection equivalent to 86 gpm.

3. Installation of automatic RPT logic (i.e., ATWS-RPT).

There are no changes in the equipment for the TPO uprate. The performance characteristics of the equipment do not change because operating conditions (operating pressure, SRV setpoints, and maximum rod line) do not change.

The PBAPS analysis at the CLTP demonstrates that the following ATWS acceptance criteria are met:

1. Peak vessel bottom pressure less than ASME Service Level C limit of 1500 psig.
2. Peak clad temperature within the 10 CFR 50.46 limit of 2200°F.
3. Peak clad oxidation within the requirements of 10 CFR 50.46.
4. Peak suppression pool temperature less than 190°F.
5. Peak containment pressure less than containment design pressure of 56 psig.

TLTR Section 5.3.5, TLTR Appendix L, and the GE response to an NRC Request for Additional Information (RAI) on the TLTR (Reference 7) present a generic evaluation of the sensitivity of an ATWS to a change in power typical of the TPO uprate. [Redacted] PBAPS currently has a margin of 2°F to the pool temperature limit [Redacted] Therefore, a plant-specific ATWS analysis was performed for the TPO uprate using the methodology discussed in Section L.3 of ELTR1. The key inputs to the ATWS analysis are provided in Table 9-1.

The analyzed events have been shown to be the limiting events for ATWS calculations. The limiting case was a PRFO event, initiated at the beginning of cycle (BOC) conditions. As shown in Figure 9-1, the calculated peak vessel bottom pressure is 1492 psig for the TPO uprate. This result meets the above ATWS acceptance criteria. Therefore, the plant pressure response to an ATWS event at the TPO conditions is acceptable.

9.3.2 Station Blackout

The SBO event involves complete loss of on-site and off-site AC power systems. The power requirement is met by the on-site DC battery for a limited time, to support safety functions. Power from the Alternate AC (AAC) power source (Conowingo Hydroelectric Power Station) becomes available at the end of the first hour of the SBO event. The intent of this analysis was to show that the equipment supporting safety functions is qualified for the conditions imposed by the SBO event. The reactor thermal power is one of the important parameters for the SBO event mitigation analysis.

The SBO analysis is required, per 10 CFR 50.63, to demonstrate that all equipment necessary to support safety functions is qualified for a specific time duration (coping time).

TLTR Appendix L provides a generic evaluation of a potential loss of all alternating current power supplies based on previous plant response and coping capability analyses for typical power uprate projects. The previous power uprate evaluations have been performed according to the applicable bases for the plant (e.g., the bases, methods, and assumptions of RG 1.155 and/or

NUMARC 87-00). This evaluation is for confirmation of continued compliance to 10 CFR 50.63 Station Blackout. It is recognized that this evaluation is dependent upon many plant-specific design and equipment parameters.

Specifically, the following main considerations were evaluated:

- The adequacy of the condensate/reactor coolant inventory;
- The capacity of the Class 1E batteries;
- The SBO compressed Nitrogen requirements;
- The ability to maintain containment integrity; and
- The effect of loss of ventilation on rooms that contain equipment essential for plant response to an SBO event.

Applicable operator actions have previously been assumed consistent with the plant Emergency Procedure Guidelines. These are the currently accepted procedures for each plant and SBO analysis. For the TPO uprate, there is no significant change in the time available for the operator to perform these assumed actions.

[Redacted] The condensate water inventory is not credited as a makeup water source under the current SBO analysis. However, condensate storage tank (CST) water inventory is available for SBO coping.

PBAPS has also performed plant specific analysis for the SBO event. The existing SBO position and supporting calculations were reviewed for changes due to the increase in the reactor thermal power. The parameter changes important to equipment operability or affecting existing analyses were evaluated for the current SBO position. The inputs and assumptions, other than reactor thermal power, are not changed. All other assumptions and parameters are the same.

The following areas/items were reviewed for the effect of the TPO uprate:

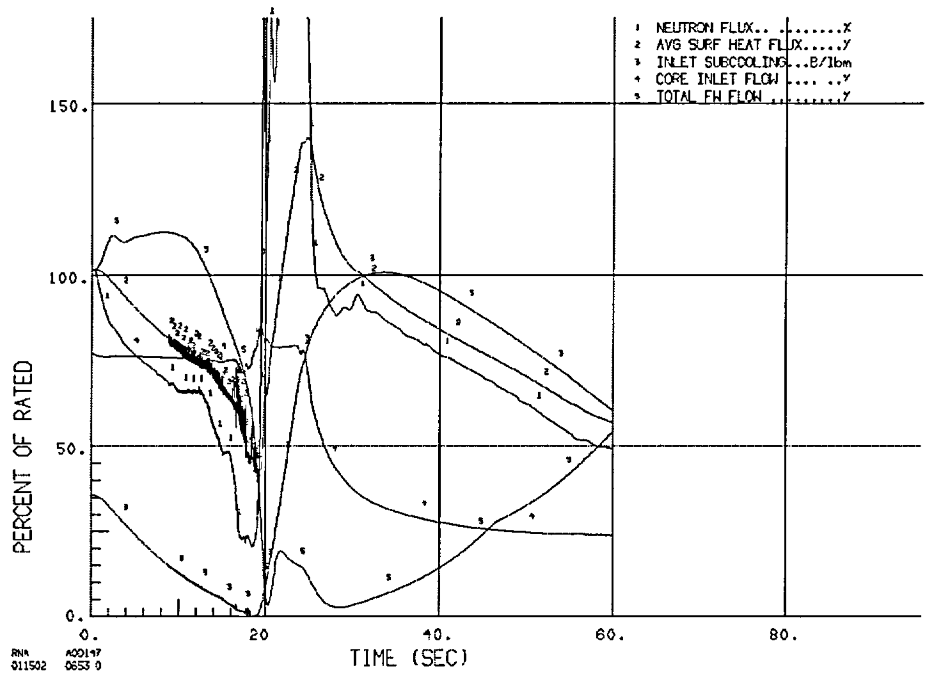
- Control Room, Cable Spreading Room, and "Other Areas"
- RCIC Room
- HPCI Room
- Containment (Drywell)
- Condensate Water Requirement
- Suppression Pool Temperature

The PBAPS specific analysis concluded that equipment operability during an SBO event and event mitigation capability under TPO conditions is not compromised.

Table 9-1 Key Inputs for ATWS Analysis

ATWS Input Variable	TPO Condition Value
Reactor power (MWt)	3517
Core Flow (% Rated)	82.94
Reactor dome pressure (psia)	1050
Total Relief Valve Capacity at 1080 psig (% NBR steam flow)	61.1
Total Safety Valve Capacity at 1080 psig (% NBR steam flow)	12.9
High pressure ATWS-RPT Technical Specification Limit (psig)	1106
Number of SRVs OOS	1

Figure 9-1 Limiting ATWS Event (PRFO at BOC)



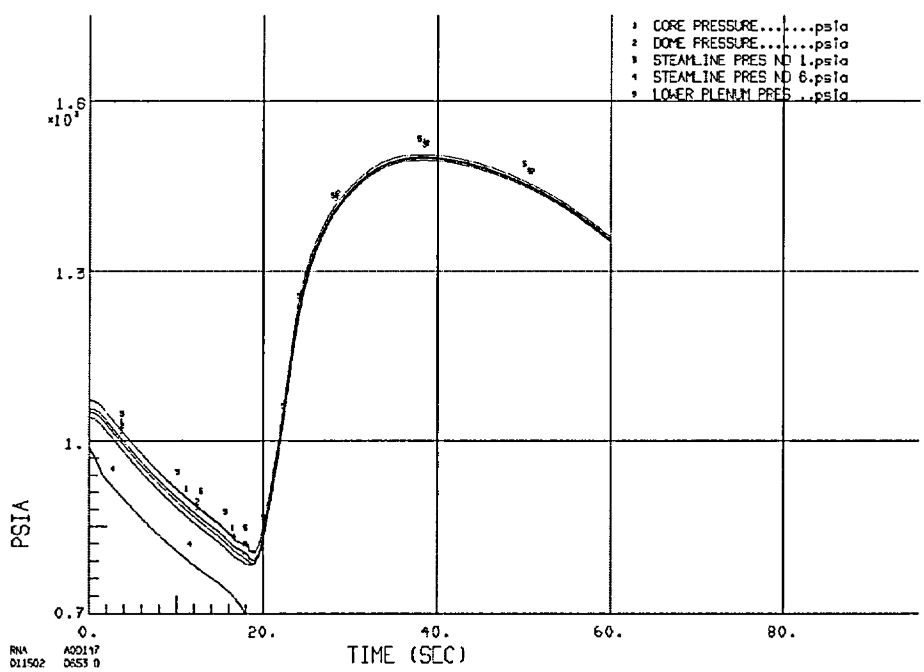
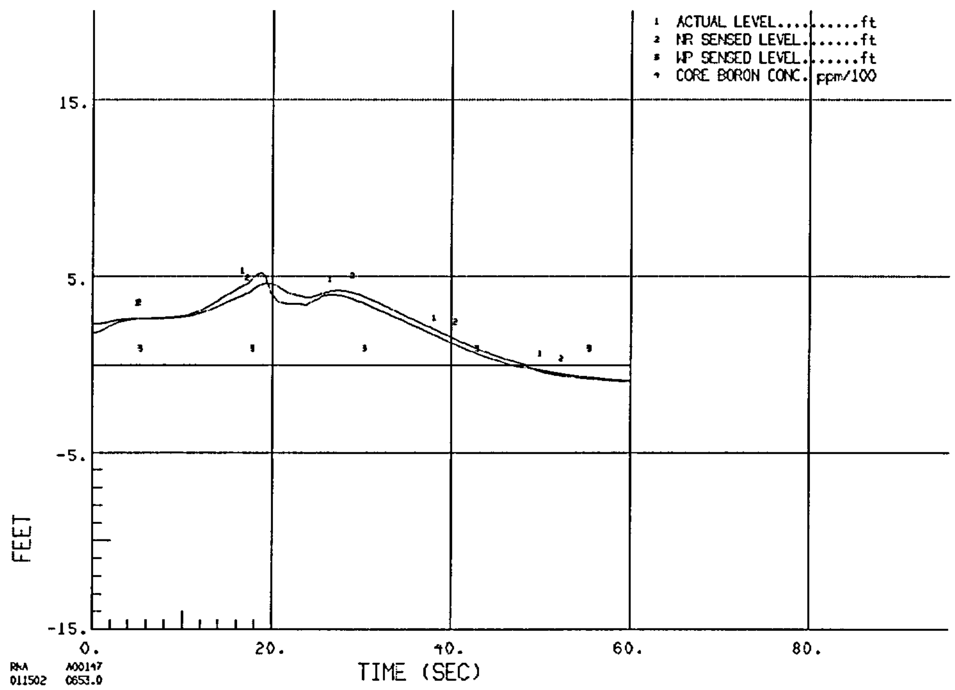
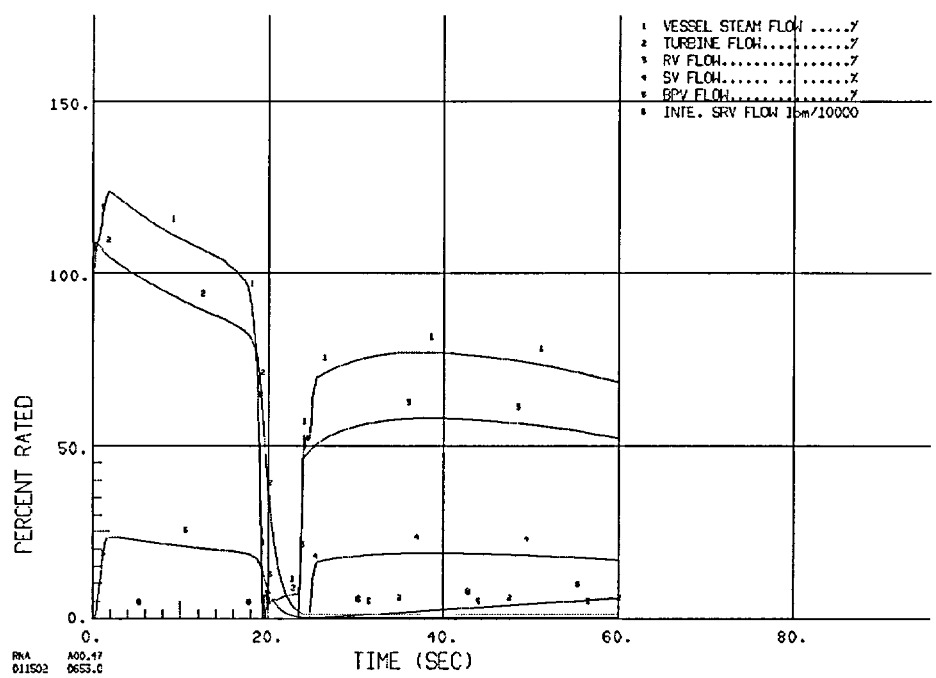


Figure 9-1 Limiting ATWS Event (PRFO at BOC) (Continued)





10.0 OTHER EVALUATIONS

10.1 HIGH ENERGY LINE BREAK

Four possible events initiated by high energy line breaks (HELBs) are considered. Any one of these events is a cause for concern because of the possibility that damage could be done to strúctures, systems, and components whose unimpaired operability is vital for the safe shutdown of the plant. Additional concerns include the impairment of containment integrity and the release of radioactive effluent that could cause offsite doses to exceed the limits of 10 CFR 100. The nature of the HELB determines which event or combination of events is of concern. The four possible events that can proceed from an HELB are the following: (1) HELB Pressurization Events, (2) Pipe Whip and Jet Impingement Events, (3) Flooding Events, and (4) Annulus Pressurization Events.

10.1.1 HELB Pressurization Events

The five HELBs important to HELB Pressurization Events had been evaluated for the previous 5% power uprate effort. Those five line breaks are as follows:

- Main Steam System line break
- HPCI line break
- RCIC System line break
- RWCU line break
- High Energy Sampling and Instrument Sensing line break

The evaluation was based on 102% of CLTP. The temperatures and pressures corresponding to that power level bound those based on the TPO uprate. Therefore, the TPO uprate does not affect HELB Pressurization Events caused by any of these line breaks. The remaining HELB, the FW System line break, is not important to HELB Pressurization Events.

10.1.2 Pipe Whip and Jet Impingement Events

Five of the six HELBs important to pipe whip and jet impingement had all been previously evaluated at temperatures and pressures that bound those based on the TPO uprate values. There is a minor increase (< 2 psi) in FW line pressure due to TPO. However, current analysis has a 3-psi margin, which was calculated based on a reactor pressure of 1053 psi. Therefore, Pipe Whip and Jet Impingement loads are not affected by the TPO uprate.

10.1.3 Flooding Events

Of the six types of HELBs, the one most responsible for flooding events is the FW System line break. The concern is the submersion of and subsequent damage to structures, systems, and components whose unimpaired operability is vital for the safe shutdown of the plant. However, the flooding rate is a function of FW System hardware, such items as pump and piping, and not reactor power. Therefore, the TPO uprate does not increase the rate and amount of flooding ensuing from a FW System line break.

10.1.4 Annulus Pressurization Events

The recirculation line break is the controlling line break for Annulus Pressurization Events, and reactor pressure is the controlling parameter. Because the RPV pressure during normal operation does not change for the TPO uprate, there is no effect on the Annulus Pressurization load.

10.2 MODERATE ENERGY LINE CRACK

Moderate-energy lines are lines that do not meet the definition of high-energy lines. For PBAPS, analysis for protection against Moderate Energy Line Crack (MELC) hazards is not required because the operating license was issued prior to July 1, 1975, per SRP 3.6.1. However, PBAPS addresses the SRP concern of MELC through various initiatives. For PBAPS, a moderate energy line is considered to be any line containing fluids, which have normal service temperature below 200°F or design pressure below 275 psig. The TPO uprate does not change the process conditions for these lines. Therefore, the plant internal flooding protection and safe shutdown consideration are not affected.

10.3 ENVIRONMENTAL QUALIFICATION

Safety-related components must be qualified for the environment in which they operate. The TPO uprate increase in power level increases the radiation levels experienced by equipment during normal operation and accident conditions. The EQ attributes have been evaluated for both normal plant operation and post-accident conditions (i.e., harsh environment conditions due to a LOCA or an HELB). Because the TPO uprate does not increase the reactor dome pressure, there is a very small effect on pressure and temperature conditions experienced by equipment during normal operation and accident conditions. In addition, the HVAC analysis was performed based on 102% of CLTP. Therefore, the results of that analysis are bounding, and currently applicable normal plant operation and harsh environment EQ temperatures and pressures are not affected by the TPO uprate. Following the occurrence of a LOCA or an HELB while operating at the CLTP level, the relative humidity in the Drywell (following a LOCA) or the relative humidity in the Containment (following an HELB) would be 100%. The 100% relative humidity conditions would prevail if either of these events were to occur while the plants are operating at the TPO RTP level. Therefore, the TPO uprate has no effect on the relative humidity to which safety-related electrical equipment in the Drywell and/or Containment would be exposed under harsh environment conditions. Equipment radiation doses, radiation dose rates, and doses to various plant areas were calculated based on 102% of CLTP, which bounds the TPO RTP level. Therefore, the resulting environmental conditions are bounded by the existing environmental parameters specified for use in the environmental qualification program.

10.3.1 Electrical Equipment

The safety-related electrical equipment was reviewed to ensure that the existing qualification for the normal and accident conditions expected in the area where the devices are located remain adequate. Conservatisms in accordance with IEEE 323 were originally applied to the environmental parameters, and no change is needed for the TPO uprate.

10.3.1.1 Inside Containment

Environmental qualification (EQ) for safety-related electrical equipment located inside the containment is based on Main Steam Line Break Accident (MSLBA) and/or DBA-LOCA conditions and their resultant temperature, pressure, humidity, and radiation consequences, and includes the environments expected to exist during normal plant operation. The current accident conditions for temperature and pressure are based on analyses initiated from ≥ 102% of CLTP. Normal temperatures are may increase slightly near the FW and reactor recirculation lines and will be evaluated through the EQ temperature monitoring program, which tracks such information for equipment aging considerations. The current radiation levels under normal plant conditions will also increase slightly. The current plant environmental envelope for radiation is not exceeded by the changes resulting from the TPO uprate.

10.3.1.2 Outside Containment

Accident temperature, pressure, and humidity environments used for qualification of equipment outside containment result from a main steam line break in the pipe tunnel, or other HELBs, whichever is limiting for each area. Some of the HELB pressure and temperature profiles increase by a small amount due to the TPO uprate conditions. However, there is adequate margin in the qualification envelopes to accommodate the small changes. Maximum accident radiation levels used for qualification of equipment outside containment are from a DBA-LOCA.

10.4 TESTING

The TPO uprate ascension is based on the guidelines from TLTR Section L.2. Pre-operational tests are not needed because no significant changes are required for any plant system or component.

In preparation for operation at TPO uprate conditions, baseline power ascension measurements will be taken near 95% and 100% of CLTP, consisting of routine measurements of reactor and system pressures, flows, and selected major rotating equipment vibration. These measurements will be retaken at 100% of TPO RTP. The baseline power ascension measurements will be taken along the same rod pattern line to set a consistent basis for evaluating changes. Core power from the APRMs is re-scaled to the TPO RTP before exceeding the CLTP and any necessary adjustments will be made to the APRM alarm and trip settings. The increase beyond CLTP to TPO RTP will be along a constant rod pattern line in one increment.

The turbine pressure controller setpoint will be established prior to taking the baseline power ascension data and held constant through the TPO power ascension. The setpoint is established so the reactor dome pressure is within Technical Specification limits at TPO RTP. A constant pressure setpoint for the baseline power ascension and TPO power ascension data establishes a consistent basis for measuring the performance of the reactor and the turbine control valves.

Demonstration of acceptable fuel thermal margin will be performed prior to the power ascension to the TPO RTP at the 100% CLTP steady-state heat balance point. Fuel thermal margin will be calculated for the TPO RTP point after the measurements taken at 100% of CLTP to project the estimated margin. The thermal margin will be confirmed by the measurements taken at TPO RTP conditions. The demonstration of core and fuel conditions will be performed with the methods currently used at the plant.

Performance of the pressure and FW/level control systems will be recorded at each steady-state point defined above. The checks will utilize the methods and criteria described in the original startup testing of these systems to demonstrate acceptable operational capability. Water level changes of ±3 inches and pressure setpoint step changes of ±3 psi will be used. If necessary, adjustments will be made to the controllers and actuator elements.

The increase in power for the TPO uprate is sufficiently small that large transient tests are not necessary. High power testing performed during initial startup demonstrated the adequacy of the safety and protection systems for such large transients. Operational occurrences have shown the unit response is clearly bounded by the safety analyses for these events. [Redacted]

10.5 Operator Training And Human Factors

No additional training (apart from normal training) is required to operate the plant in the TPO uprate condition. For TPO uprate conditions, operator response to transient, accident and special events are not affected. Operator actions for maintaining safe shutdown, core cooling, containment cooling, etc., do not change for the TPO uprate. Minor changes to the power/flow map, flow-referenced setpoint, and the like, will be communicated through normal operator training. Simulator changes and validation for the TPO uprate will be performed in accordance with ANSI/ANS 3.5-1985.

10.6 Plant Life

Two degradation mechanisms may be influenced by the TPO uprate: (1) Irradiation Assisted Stress Corrosion Cracking (IASCC) and (2) FAC. The increase in irradiation of the core internal components influences IASCC. The increase in steam and FW flow rate influences FAC. However, the sensitivity to the TPO uprate change is small and various programs are currently implemented to monitor the aging of plant components, including Equipment Qualification, FAC, and Inservice Inspection. Equipment qualification is addressed in Section 10.3, and FAC is addressed in Section 3.5. These programs address the degradation mechanisms and do not change for the TPO uprate. The core internals see a slight increase in fluence, but the inspection strategy used at PBAPS based on the BWRVIP is sufficient to address the increase. The Maintenance Rule also provides oversight for the other mechanical and electrical components, important to plant safety, to guard against age-related degradation.

The longevity of most equipment is not affected by the TPO uprate because there is no significant change in the operating conditions. No additional maintenance, inspection, testing, or surveillance procedures are required.

10.7 NRC AND INDUSTRY COMMUNICATIONS

NRC and industry communications are discussed in the TLTR Section B.4. Per the TLTR, a plant-specific review of NRC and industry communications is not needed for a TPO uprate.

10.8 EMERGENCY OPERATING PROCEDURES

The Emergency Operating Procedures (EOP) action thresholds are plant-specific and will be addressed using standard procedure updating processes. Following an evaluation of the effects of the TPO uprate on the operator action thresholds, the EOPs will be revised, as necessary.

11.0 REFERENCES

1 GE Nuclear Energy, "Generic Guidelines and Evaluations for General Electric Boiling Water Reactor Thermal Power Optimization," (TLTR), Licensing Topical Report NEDC-32938P, Class III (Proprietary), July 2000.

2 GE Nuclear Energy, "Generic Guidelines for General Electric Boiling Water Reactor Extended Power Uprate," (ELTR1), Licensing Topical Reports NEDC-32424P-A, Class III (Proprietary), February 1999; and NEDO-32424, Class I (Non-proprietary), April 1995.

3 GE Nuclear Energy, "Generic Evaluations of General Electric Boiling Water Reactor Extended Power Uprate," (ELTR2), Licensing Topical Reports NEDC-32523P-A, Class III (Proprietary), February 2000; NEDC-32523P-A, Supplement 1 Volume I, February 1999; and Supplement 1 Volume II, April 1999.

4 GE Nuclear Energy, "Power Rerate Safety Analysis Report for Peach Bottom 2 & 3," NEDC-32183P, Class III (Proprietary), May 1993.

5 NRC Regulatory Issue Summary 2002-03, "Guidance on the Content of Measurement Uncertainty Recapture Power Uprate Applications," dated January 31, 2002.

6 GE Nuclear Energy, "Constant Pressure Power Uprate," Licensing Topical Report NEDC-33004P, Revision 1, Class III (Proprietary), July 2001.

7 GE Nuclear Energy, "Final Response to Request for Additional Information – GE Nuclear Energy Licensing Topical Report NEDC-32938P RAI#'s 18 & 19," MFN 01-053, dated October 5, 2001.