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Director
Nuclear Safety & Licensing

CNRO-2002-00055
RBG-46036

November 22, 2002

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

SUBJECT: River Bend Station, Unit 1
Docket No. 50-458
Revision to TSAR in Support of Appendix K Measurement Uncertainty Recovery Power Uprate Request
License Amendment Request (LAR) 2002-15

REFERENCE:
1. Entergy letter dated May 14, 2002, License Amendment Request 2002-15, "Appendix K Measurement Uncertainty Recovery – Power Uprate Request"
2. Entergy letter dated July 9, 2002, "Non-Proprietary TSAR in Support of Appendix K Measurement Uncertainty Recovery – Power Uprate Request (LAR 2002-15)"
3. General Electric letter dated November 1, 2002, "Request for Withholding Information from Public Disclosure River Bend Station, Unit 1 (TAC No. MB5094)"

Dear Sir or Madam:

Entergy Operations, Inc. (Entergy), in Reference 1, requested approval of changes to the River Bend Station, Unit 1 Operating License and Technical Specifications associated with an increase in the licensed power level. As a part of that original submittal, a Thermal Power Optimization Safety Analysis Report (TSAR), NEDC-33051P, was provided as Attachment 2. That document was noted to be a proprietary report; a non-proprietary version of the TSAR was submitted under Reference 2. These documents have been withdrawn by General Electric per the request of Reference 3.

Attached are a proprietary and a non-proprietary version of Revision 1 to the TSAR. This revision supersedes the documents transmitted in References 1 and 2. This revision is made to address NRC concerns with the proprietary information in Revision 0. The changes are similar in nature to those prepared for the Grand Gulf power uprate request recently approved in Amendment 156.

Attachment 1 includes information considered to be proprietary to General Electric. It is requested that the document in this attachment be withheld from public disclosure pursuant to 10CFR2.790. An affidavit signed by an officer of General Electric is provided in the front of the

A001

document. The address of General Electric is provided in the cover page of the report included in Attachment 1.

There are no new commitments made in this letter. Should you have any questions or comments concerning this request, please contact Jerry Burford at (601) 368-5755.

I declare under penalty of perjury that the foregoing is true and correct. Executed on November 22, 2002.

Sincerely,

JCR/FGB/bal
attachment:
1. NEDC-33051P, Revision 1 (proprietary)
2. NEDC-33051, Revision 1 (non-proprietary)

cc: Mr. P. D. Hinnenkamp (RBS)
Mr. E.W. Merschoff

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Attachment 2

CNRO-2002-00055

NEDC-33051, Revision 1 – non-proprietary

GE Nuclear Energy

175 Curtner Ave., San Jose, CA 95125

NEDO-33051
Revision 1
Class I
DRF-0000-0000-0017
October 2002

SAFETY ANALYSIS REPORT
FOR
RIVER BEND STATION
THERMAL POWER OPTIMIZATION

Prepared by: E. D. Schrull

Approved by: ____________________
Michael Dick, Project Manager
General Electric Company

Approved by: ____________________
Robert Lundholm, Project Manager
Entergy Operations, Inc.

IMPORTANT NOTICE REGARDING CONTENTS OF THIS REPORT

PLEASE READ CAREFULLY

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GLOSSARY OF TERMS

Term	Definition
AC	Alternating Current
ADS	Automatic Depressurization System
AL	Analytical Limit
ALARA	As Low As is 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
ASME	American Society Of Mechanical Engineers
ATWS	Anticipated Transient Without Scram
AV	Allowable Value
B&PV	Boiler and Pressure Vessel
BHP	Brake Horsepower
BOP	Balance Of Plant
BWR	Boiling Water Reactor
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
CRD	Control Rod Drive
CSC	Containment Spray Cooling
CSS	Core Support Structure
CUF	Cumulative Usage Factor
DBA	Design Basis Accident
DC	Direct Current
E1A	Stability Enhanced Option 1A
ECCS	Emergency Core Cooling System
EFPY	Effective Full Power Years
EHC	Electro-Hydraulic Control
ELTR1	NEDC-32424P-A
ELTR2	NEDC-32523P-A
EOL	End of Life
EOP	Emergency Operating Procedure
EPU	Extended Power Uprate
EQ	Environmental Qualification
FAC	Flow Accelerated Corrosion
FFWTR	Final Feedwater Temperature Reduction
FIV	Flow-Induced Vibration

Term	Definition
FPCCS	Fuel Pool Cooling And Cleanup System
FW	Feedwater
FWHOOS	Feedwater Heater(s) Out-Of-Service
GDC	General Design Criteria
GE	General Electric Company
GL	Generic Letter
HELB	High Energy Line Break
HEPA	High Efficiency Particulate Air
HPCI	High Pressure Coolant Injection
HPCS	High Pressure Core Spray
HPSP	High Power Setpoint
HVAC	Heating, Ventilation, And Air Conditioning
IASCC	Irradiation Assisted Stress Corrosion Cracking
ICF	Increased Core Flow
IEEE	Institute Of Electrical And Electronics Engineers
IPE	Individual Plant Examination
IRM	Intermediate Range Monitor
LCO	Limiting Conditions For Operation
LOCA	Loss-Of-Coolant-Accident
LPCI	Low Pressure Coolant Injection
LPCS	Low Pressure Core Spray
LPDES	Louisiana Pollutant Discharge Elimination System
LPRM	Local Power Range Monitor
LPSP	Low Power Setpoint
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MCC	Motor Control Center
MCPR	Minimum Critical Power Ratio
MCPRf	Flow Biased Minimum Critical Power Ratio
MELC	Moderate Energy Line Crack
MEOD	Maximum Extended Operating Domain
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
MSLB	Main Steam Line Break
MSLBA	Main Steam Line Break Accident
MSPLCS	Main Steam Positive Leakage Control System
MSR	Moisture Separator Reheater
MVA	Million Volt Amps
MWe	Megawatt-Electric

Term	Definition
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
P-T	Pressure-Temperature
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
RBS	River Bend Station
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
RPCCW	Reactor Plant Component Cooling Water
RPCS	Rod Pattern Control System
RPT	Recirculation Pump Trip
RPV	Reactor Pressure Vessel
RT_{NDT}	Reference Temperature Of Nil-Ductility Transition
RTP	Rated Thermal Power
RWCU	Reactor Water Cleanup
RWL	Rod Withdrawal Limiter
SAFER/GESTR-LOCA	A Computer Program, A Model For Analysis Of System Response To Loss-Of-Coolant Accident
SBO	Station Blackout
SBPCS	Steam Bypass Pressure Control System
SDC	Shutdown Cooling
SER	Safety Evaluation Report
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-Loop Operation

Term	Definition
SPC	Suppression Pool Cooling
SRM	Source Range Monitor
SRP	Standard Review Plan
SRV	Safety Relief Valve
SRVDL	Safety Relief Valve Discharge Line
SSW	Standby Service Water
TCV	Turbine Control Valve
TFSP	Turbine First Stage Pressure
T/G	Turbine-Generator
TIP	Traversing In-Core Probe
TLO	Two (Recirculation) Loop Operation
TLTR	NEDC-32938P, Thermal Power Optimization Licensing Topical Report
TPCCW	Turbine Plant Component Cooling Water
TPO	Thermal Power Optimization
TRM	Technical Requirements Manual
TSAR	Thermal Power Optimization Safety Analysis Report
TSV	Turbine Stop Valve
USAR	Updated Safety Analysis Report
UHS	Ultimate Heat Sink
USE	Upper Shelf Energy
VWO	Valves Wide Open

EXECUTIVE SUMMARY

This report summarizes the results of all significant safety evaluations performed that justify increasing the licensed thermal power at River Bend Station (RBS) to 3091 MWt. The requested license power level is 1.7% above the Current Licensed Thermal Power (CLTP) level of 3039 MWt.

This report follows the Nuclear Regulatory Commission (NRC)-approved 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 references the appropriate evaluation and establishes that the evaluation is applicable to the plant.

Only previously 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 Safety Analysis Report (USAR) are not repeated. 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 up to 1.5% of CLTP, which will produce up to an 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 0.3%, thereby allowing a power level increase at RBS of 1.7%. A 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 RBS can safely operate at a power level of 3091 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 methods for the USAR 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 USAR and/or applicable reload license.
6. No safety-related hardware changes are needed for TPO uprate beyond setpoint changes. Any non-safety-related plant modifications are developed in accordance with the plant design control procedures and 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. Current design control processes ensure that the effect of the power uprate has been appropriately considered.

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 document addresses a Thermal Power Optimization (TPO) power uprate of 1.7% of the Current Licensed Thermal Power (CLTP), consistent with the magnitude of the thermal power uncertainty reduction for the River Bend Station (RBS). This report follows the Nuclear Regulatory Commission (NRC)-approved 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," (TLTR) (Reference 1). Power uprates in GE BWRs of up to 120% of Original Licensed Thermal Power (OLTP) 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 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 references the appropriate evaluation and establishes 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 0.3%, thereby allowing 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 OLTP level based on a reduction in the uncertainty in the determination of the power through improved feedwater (FW) flow rate and temperature 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

RBS was originally licensed at 2894 MWt and was uprated by 5% to the CLTP level of 3039 MWt. The current safety analysis basis assumes, where required, that the reactor had been operating continuously at a power level at least 1.02 times the CLTP level; many of the original safety analyses were performed at 105% steam flow (~104.2% of OLTP). The analyses performed at 102% of CLTP remain applicable at the TPO Rated Thermal Power (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 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 RBS. 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 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 controller 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. The NRC-approved computer codes were used subject to the restrictions / limitations imposed by the associated NRC Safety Evaluation Report (SER), where appropriate. 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 RBS. This TSAR includes all of the evaluations for the RBS 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.

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, Emergency Core Cooling System (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 standard reload analyses consider the plant conditions for the cycle of interest.

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 4). 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

- The analytical limit (AL) for the turbine-first-stage pressure signal that initiates the turbine/generator (T/G) trip scram and recirculation pump trip (RPT) at high power remains at the same value in terms of percent RTP. This is contrary to TLTR Section F.4.2.3, which states that the AL would remain the same in terms of absolute main turbine steam flow (lb/hr), and indicated as a pressure signal (psig). See TSAR Section 5.3.2 for further discussion.

1.2.5 Concurrent Changes Unrelated to TPO

None.

1.3 TPO PLANT OPERATING CONDITIONS

1.3.1 Reactor Heat Balance

The following typical heat balance diagram at the TPO condition is presented:

Figure 1-2 Reactor Heat Balance – TPO Power, 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 RBS 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 RBS are acceptable at the TPO thermal power:

Performance Improvement Feature
Increased Core Flow (ICF)
Maximum Extended Operating Domain (MEOD)

Performance Improvement Feature
7 Safety Relief Valves (SRVs) Out-of-Service
Single Loop Operation (SLO)
100°F Final Feedwater Temperature Reduction (FFWTR)
3% SRV Setpoint Tolerance
Feedwater Heater Out-of-Service (FWHOOS)

1.4 Basis for TPO Uprate

The uncertainty in measuring the RBS core thermal power has been evaluated for the LEFM√+™ system using bounding assumptions for the LEFM√+™ system. The RBS core power uncertainty (2σ) was calculated to be less than 11 MW using a Monte Carlo approach with over one million trials. As such, operation at the TPO power level of 3091 MWt will continue to ensure that 102% of CLTP (3100 MWt) is not exceeded at 95% probability and 95% confidence level. The uncertainties considered in this evaluation are identified in Table 1-4. The values used in the measurement uncertainty calculation will be confirmed by the initial calibration test results of the LEFM√+™ system.

These uncertainties consider the following:

- The accurate steam dome pressure instrumentation to be installed in RF11 to support the TPO uprate;
- The feedwater flow and temperature uncertainties developed for the RBS LEFM√+™ system using the methodologies in Reference 5;
- Bounding uncertainties for the minor contributors to the heat balance (e.g., control rod drive (CRD) flow rate, reactor water cleanup (RWCU) flow rate and temperature, and recirculation pump power); and
- Conservative bounding assumptions for CRD temperature, moisture carry-over, and system thermal losses.

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-P-A-10
Reactor Internal Pressure Differences	ISCOR	09	(1)	NEDC-32082P, Aug 1992 MFN-212-78, May 12, 1978 NEDE-32227, Oct. 1993

NOTE:

(1) The heat balance application of ISCOR is not considered to be NRC reviewed and approved. There is no special methodology used for the 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.

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

Parameter	Current Licensed Thermal Power	TPO Uprate Power
Thermal Power (MWt) (Percent Of Current Licensed Power)	3039 100	3091 101.7
Steam Flow (Mlb/hr) (Percent Of Current Rated)	13.198 100	13.424 101.7
FW Flow (Mlb/hr) (Percent Of Current Rated)	13.173 100	13.399 101.7
Dome Pressure (psia)	1070	1070
Dome Temperature (°F)	552 9	552.9
FW Temperature (°F)	425 6	425 6
Full Power Core Flow Range (Mlb/hr) (Percent Of Current Rated)	68.6 to 90.4 81 to 107	70 5 to 90.4 83.4 to 107

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 (MLHGR) required.	Previous analysis accounted for ≥ 102% of CLTP, bounding TPO operation with a bounding vessel pressure.
Change of Operating Limit Minimum Critical Power Ratio (OLMCPR)	< 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	~1°F temperature increase	Small % power increase.
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	< 20 psi increase, must stay within existing ASME Code "Emergency" category stress limit.	Slightly increased power relative to SRV capacity.
Vessel and NSSS equipment design pressure	No change	Comply with existing ASME Code stress limits of all categories.

Table 1-4 RBS Heat Balance Parameter Uncertainties

Parameter	Nominal Value	Uncertainty (2σ)
Steam Dome Pressure (psia)	1070	10.0
Feedwater System Flow (Mlb/hr)	13.3914	0 0388
Feedwater System Temperature (°F)	425.6	0.6
CRD Flow (Mlb/hr)	0 025	0.0012
CRD Temperature (°F)	77.0	0.0
RWCU Flow (Mlb/hr)	0.124	0.0018
RWCU Inlet Temperature (°F)	535.4	9.92
RWCU Outlet Temperature (°F)	439.1	9 92
Recirculation Pump A Power (MW/Pump)	4.6699	0 1412
Recirculation Pump B Power (MW/Pump)	4 6699	0 1412
Recirculation Pump Efficiency (%)	93.15	4 0
Moisture Carry-Over Fraction (%)	0.0	0.0
Thermal Losses (MW)	1.1	0 0
Saturated Steam Enthalpy (BTU/lbm)	n/a	0.10
Sub-cooled Liquid Enthalpy (BTU/lbm)	n/a	0.60

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

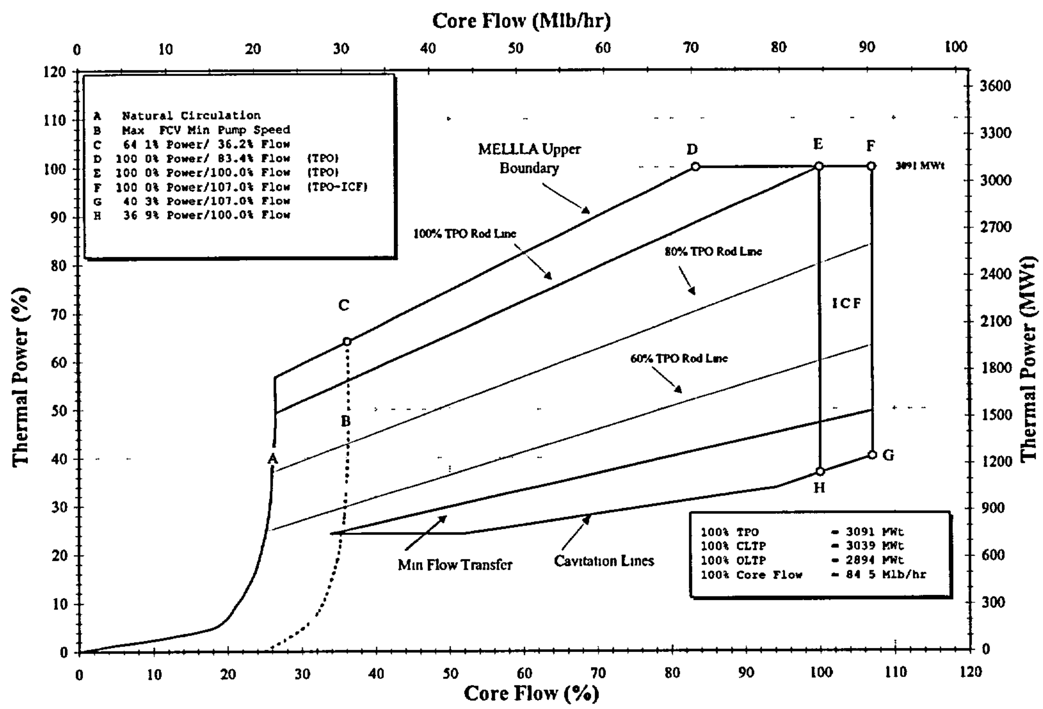
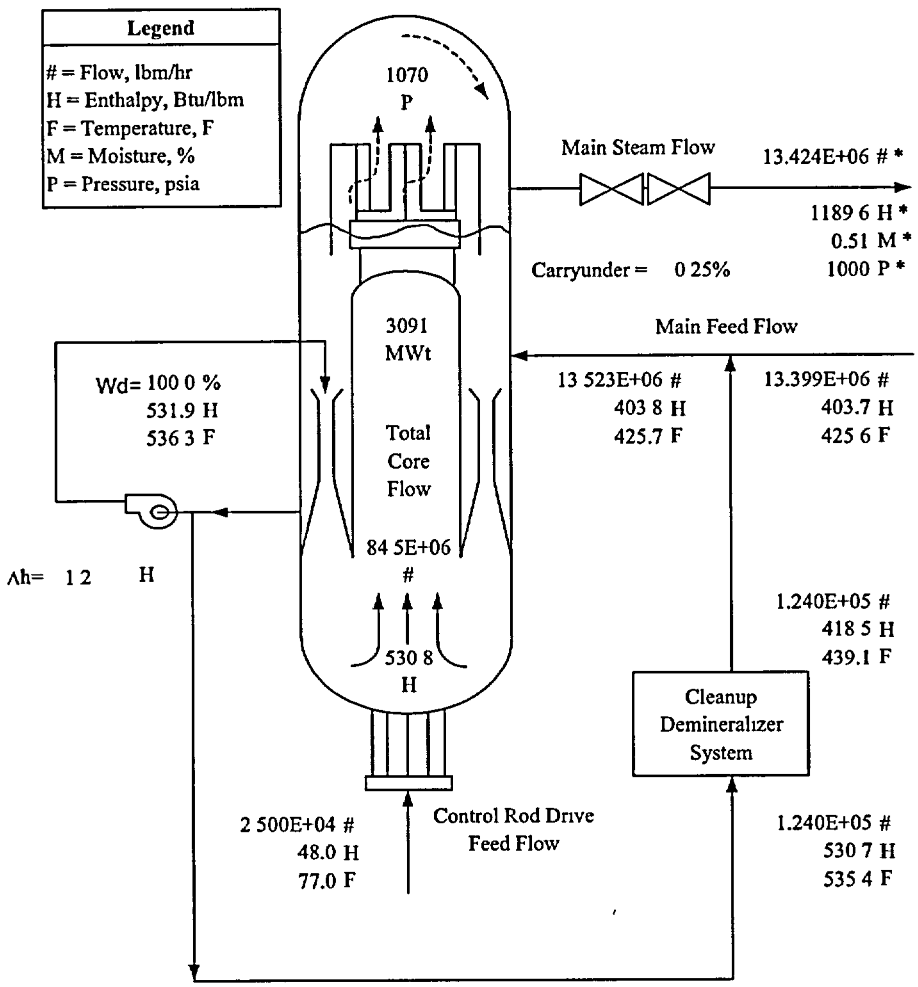


Figure 1-2 Reactor Heat Balance – TPO Power, 100% Core Flow



* Conditions at upstream side of TSV

Core Thermal Power	3091.0
Pump Heating	8 7
Cleanup Losses	-4 1
Other System Losses	-1 1
Turbine Cycle Use	3094.5 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 the same in terms of percent RTP, i.e., 23.8% RTP, for the TPO uprate.

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. RBS transitioned to Atrium–10 fuel during cycle 11 (one cycle prior to TPO implementation). NRC approved methods are used by the fuel vendor for reload licensing analysis.

2.2.2 MCPR Operating Limit

TLTR Appendix E shows that the changes in the OLMCPR for a TPO uprate
[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.

2.2.3 MAPLHGR and MLHGR Operating Limits

The Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) and MLHGR limits are maintained as described in TLTR Section 5.7.2.2. No significant change results due to TPO operation. The MLHGR 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 analysis.

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

RBS utilizes reactor stability Enhanced Option I-A (E1A). The E1A absolute high flow control line (which is used in the stability region boundary validation) does not change for the TPO uprate. Therefore, there is minimal effect on stability beyond the normal cycle-to-cycle core characteristic variations that are evaluated with the reload. TPO uprate does not significantly affect stability. Reload stability evaluations continue to ensure acceptable stability performance and protection for future cores operating at TPO uprate conditions.

2.5 REACTIVITY CONTROL

The generic discussion in TLTR Sections 5.6.3 and J.2.3.3 applies to RBS. 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. Previous analyses for the RBS 5% power uprate project were performed at 102% of CLTP.

The RBS reload transient analyses utilize Framatome's NRC-approved COTRANSA2 methodology, which applies a control rod velocity that is a function of the instantaneous steam dome pressure and control rod position. As such, the effect of any additional pressurization at the TPO uprate conditions is appropriately reflected in the modeled scram times.

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 along with other functions provide this protection. Evaluations and analyses for the CLTP have been performed at 102% of the 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 RBS TPO uprate. There are no changes in the SRV 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.

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) remains greater than 50 ft-lb for the design life of the vessel and maintains the margin requirements of 10 CFR 50, Appendix G. The minimum EOL USE for beltline materials is 67 ft-lb.
- The beltline material reference temperature of the nil-ductility transition (RT_{NDT}) remains below 200°F.
- The surface fluence increases for EOL (36 effective full power years (EFPYs)) due to TPO. The net effect in 1/4T fluence (32 EFPY) is negligible for TPO. Because 1/4T fluence contributes to the resulting adjusted reference temperature (ART), there is no change to ART or Shift for up to 32 EFPY. The Pressure-Temperature (P-T) curves currently licensed for River Bend for 32 EFPY account for a Shift value of 152°F. The Shift value calculated for TPO is unchanged up to 32 EFPY. Therefore, the current 32 EFPY P-T curves are valid with TPO. Due to an increased capacity factor, EOL EFPY is 36. Therefore, prior to operation beyond 32 EFPY, the P-T curves would

require revision to account for a Shift value of 156°F (a 4°F increase), which represents 36 EFPY.

- The 36 EFPY shift is slightly increased, and consequently, requires a change in the ART, which is the initial RT_{NDT} plus the Shift. These values are provided in Table 3-1.
- The reactor vessel material surveillance program consists of three capsules. The three capsules have been in the reactor vessel since plant startup. One of these capsules was removed after approximately 10.08 EFPY of operation; the second capsule is scheduled to be removed at 15 EFPY, and the third capsule is classified as "standby." The TPO has no effect on the existing surveillance 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 RBS 5% power uprate.

3.2.2.2 Normal and Upset Conditions

For the TPO uprate, the following Normal 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 RBS 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 RBS 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 5% power uprate Certified Stress Report applies to RBS 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 Emergency and Faulted evaluations of RIPD for TPO uprate are bounded by the current analyses performed at 102% of CLTP conditions.

3.3.2 Reactor Internals Structural Evaluation

Because there is no increase in nominal vessel pressure or operating temperature (except for a recirculation/core inlet flow temperature decrease of < 1°F), most of the pre-TPO design basis remains valid and very few additional analyses were required. [Redacted] loads, stresses, and cumulative (fatigue) usage factors (CUFs) are presented in Table 3-2. The evaluations supporting the TPO uprate were performed consistent with the design basis analysis of the components.

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. The flow-induced vibration (FIV) evaluation on the reactor internals for the RBS 5% uprate was performed at 102% of CLTP and 107% rated core flow. The conditions represented by the 5% uprate evaluation bound the conditions at TPO RTP. The 5% uprate evaluation was performed from vibration data recorded during startup testing of the Kuosheng-1 plant and during other tests at RBS. These expected vibration levels were 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 RTP is ~2% greater than CLTP	No change
Core Spray (CS) Line Low Pressure Coolant Injection (LPCI) Coupling Control Rod Guide Tube In-Core Guide Tubes	Core flow at TPO RTP is identical to CLTP	No Change
Fuel Channel	Steam flow at TPO RTP is ~2% greater than CLTP	No Change
Local Power Range Monitor (LPRM) / Intermediate Range Monitor (IRM) Guide Tubes	Core flow at TPO RTP is identical to CLTP No meaningful change in core flow distribution	No Change
Jet Pumps	Jet pump flow at TPO RTP is identical to CLTP	No Change
Jet Pump Sensing Lines	Vane passing frequency of recirculation pumps	No Change In Possibility of Resonance
FW Sparger	FW flow at TPO RTP is ~2% greater than CLTP	No change

The evaluation for the TPO uprate conditions indicates that vibrations of all safety-related reactor internal components are within the GE acceptance criteria. The 5% uprate evaluation 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 of the RPV internals remain within acceptable limits.

The safety-related Main Steam (MS) and FW piping have minor increases in flow rates and flow velocities resulting from the TPO uprate. The MS and FW piping experience minor increased vibration levels, approximately proportional to the square of the flow velocities and also in proportion to any increase in fluid density. The FW fluid density is not changed for TPO uprate conditions because there is no change in FW temperature. The MS and FW piping vibration is expected to increase by about 3.5%. Operating experience shows no evidence of vibration problems in MS and FW lines at CLTP operating conditions. Therefore, the MS and FW lines vibration remain within acceptable limits during TPO.

The safety-related thermowells and sample probes in the MS, FW, and Recirculation piping systems are also 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, MS lines, and piping connected to the FW and 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 Recirculation fluid temperature decreases ~1°F	Current Licensing Basis envelopes TPO conditions; therefore, piping system is acceptable for TPO.
MS and Attached Piping Systems (Inside Containment) (e g., SRV Discharge Line (SRVDL) piping up to first anchor, Reactor Core Isolation Cooling (RCIC) piping (Steam Side), MS 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 MS line pressure and temperature	Current Licensing Basis envelopes 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 ~2°F	Current Licensing Basis envelopes 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)
RPV bottom head drain line, Residual Heat Removal (RHR), Low Pressure Core Spray (LPCS), High Pressure Core Spray (HPCS), RWCU, and SLCS piping Pipe Stresses Pipe Supports	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 envelopes TPO conditions; therefore, piping system is acceptable for TPO.

Main Steam and Attached Piping System Evaluation

The MS and attached piping system (inside containment) was evaluated for compliance with the ASME Code stress criteria, and for the effects of temperature, pressure and flow on the piping snubbers, hangers and struts. The current licensing basis for the MS piping system (inside containment) analyzed for pressure, temperature, and flow, envelopes 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. RBS 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 takes into consideration adjustments to predicted material loss rates used to project the need for maintenance/replacement prior to reaching minimum wall thickness requirements. 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 ASME Section III Code stress criteria, and for the effects of temperature, pressure and flow on the piping snubbers, hangers and struts. The current licensing basis for the FW piping system (Inside Containment) analyzed for pressure, temperature, and flow, envelopes the TPO operating pressure, temperature, and flow. Therefore, all safety aspects of the Feedwater 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. RBS 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 takes into consideration adjustments to predicted material loss rates used to project the need for maintenance/replacement prior to reaching minimum wall thickness requirements. 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

BOP piping systems remain acceptable for TPO uprate conditions. These piping systems continue to satisfy design basis requirements in accordance with applicable design basis criteria, when considering the temperature, pressure, and flow rate effects resulting from TPO. RBS piping and related support systems remain within allowable stress limits in accordance with ASME Section III and ANSI B31.1 codes, as appropriate. In addition, no piping or pipe support modifications are required due to the increased power level.

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. RBS 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 the RBS Flow Accelerated Corrosion Program. The RBS program utilizes the CHECWORKS™ software. The plant erosion/corrosion program currently monitors the affected systems. Continued monitoring of the systems provides confidence in the integrity of susceptible high energy piping systems. This action takes into consideration adjustments to predicted material loss rates used to project the need for maintenance/replacement prior to reaching minimum wall thickness requirements. This program provides assurance that the TPO has no adverse effect on high energy piping systems potentially susceptible to pipe wall thinning due to erosion/corrosion.

3.6 REACTOR RECIRCULATION SYSTEM

The Reactor Recirculation System evaluation process is described in TLTR Section 5.6.2. Previous analyses for the RBS 5% power uprate project were performed at 102% of CLTP. 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 increase in recirculation system vibration occurs from the TPO operating conditions.

During SLO, thermal power is currently limited to ≤ 79% of CLTP. To maintain the same absolute thermal power limit, the percent of RTP value is decreased by the ratio of the power increase (3039/3091) to 77.6% of the TPO RTP.

3.7 Main Steam Line Flow Restrictors

The generic evaluation provided in TLTR Appendix J is applicable to RBS. The requirements for the main steam line flow restrictors remain unchanged for TPO uprate conditions. Previous analyses for the RBS 5% power uprate project were performed at 102% of CLTP. Even though rated steam flow is slightly increased, no change in steam line break flow rate occurs because the operating pressure is unchanged. All safety and operational aspects of the main steam line flow restrictors are within previous evaluations.

3.8 Main Steam Isolation Valves

The generic evaluation provided in TLTR Appendix J is applicable to RBS. The requirements for the main steam isolation valves (MSIVs) remain unchanged for TPO uprate conditions. Previous analyses for the RBS 5% power uprate project were performed at 102% of CLTP. 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 RBS. Previous analyses for the RBS 5% power uprate project were performed at 102% of CLTP. 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 RBS.

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) Mode	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.	Containment Analyses have been performed at 102% of CLTP.
Shutdown Cooling (SDC) Mode	Removes sensible and decay heat from the reactor primary system during a normal reactor shutdown.	The slightly higher decay heat has negligible effect on the SDC mode, which has no safety function.

Operating Mode	Key Function	TPO Evaluation
Containment Spray Cooling (CSC) Mode	Not applicable	The CSC mode of RHR does not exist at RBS.
Steam Condensing Mode	Not applicable	The steam condensing mode of RHR has been permanently disabled.
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 RBS. Previous analyses for the RBS 5% power uprate project were performed at 102% of CLTP. 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 3-1 Adjusted Reference Temperatures for 36 EFPY

River Bend TPO **Beltline Plate and Weld ART Values for 36 EFPY**

Plate

Thickness = 5 41 inches

36 EFPY Peak I D. fluence = 9.0E+18 n/cm^2
36 EFPY Peak 1/4 T fluence = 6 5E+18 n/cm^2
36 EFPY Peak 1/4 T fluence = 6 5E+18 n/cm^2

Weld

Thickness = 5 41 inches

36 EFPY Peak I D fluence = 9.0E+18 n/cm^2
36 EFPY Peak 1/4 T fluence = 6 5E+18 n/cm^2
36 EFPY Peak 1/4 T fluence = 6 5E+18 n/cm^2

COMPONENT	HEAT OR HEAT/LOT	%Cu	%Ni	CF	Initial RTndt °F	1/4 T Fluence n/cm^2	36 EFPY Δ RTndt °F	σ_I	σ_Δ	Margin °F	36 EFPY Shift °F	36 EFPY ART °F
PLATES:												
Lower-Intermediate												
22-1-1	C-3054-1	0 09	0.70	58	-20	6 5E+18	51	0	17	34	85	65
22-1-2	C-3054-2	0 09	0 70	58	10	6 5E+18	51	0	17	34	85	95
22-1-3	C-3138-2	0 08	0 63	51	0	6.5E+18	45	0	17	34	79	79
WELDS:												
Vertical Welds BE,BF,BG												
E8018NM (3/16")	492L4871 / A421B27AF	0 03	0 98	41	-50	6.5E+18	36	0	18	36	72	22
E8018NM (5/32")	492L4871 / A421B27AE	0 04	0.95	54	-60	6 5E+18	47	0	24	47	95	35
Raco/NMM (Single Wire)	5P6756 / Linde 124 / 0342	0 084	0 938	113.6	-60	6 5E+18	100	0	28	56	156	96
Raco/NMM (Tandem Wire)	5P6756 / Linde 124 / 0342	0 084	0 938	113 6	-50	6.5E+18	100	0	28	56	156	106
Girth: None												

Table 3-2 Limiting Reactor Internal Components – Loads and Stresses

Component	Service Condition	Stress (or Load) Component	Units	CLTP	TPO	Limit
Shroud Flange at core plate	Upset	Pm	psi	13,888	14,124	14,300
Shroud at core plate wedge	Upset	Pm+Pb	psi	20,412	20,759	21,450
Shroud Support	Upset	Pm	psi	<16,740	<16,941	20,970
Shroud Support	Upset	Pm+Pb	psi	<18,241	<18,460	31,450
Shroud Support	Emergency	Pm	psi	<16,740	<16,941	20,970
Shroud Support	Emergency	Pm+Pb	psi	<18,144	<18,362	31,450
Shroud Support	Faulted	Pm+Pb	psi	<63,900	<64,667	69,900
Core Plate – Stiffener Beam	Upset	Buckling	psi	7,336	7,460	7,878
Core Plate – Perforated Top Plate	Upset	Pm + Pb	psi	16,429	16,708	21,450
Core Plate – Ligament in Top Plate	Upset	Pm	psi	8,051	8,187	14,300
Core Plate – Ligament in Top Plate	Upset	Pm+Pb	psi	16,429	16,708	21,450
Core Plate – Ligament	Upset	Pm	psi	8,051	8,187	14,300
Core Plate – Ligament	Upset	Pm+Pb	psi	16,429	16,708	21,450
Core Plate – Ligament	Emergency	Pm	psi	<7,816	<7,949	21,450
Core Plate – Ligament	Emergency	Pm+Pb	psi	<15,950	<16,221	32,175
Core Plate – Stiffener Beam	Fatigue	U	psi	0.6407	0.6946	1.0
CRD Guide Tube	Upset	Pm + Pb	psi	7,629	7,759	24,000
CRD Guide Tube	Emergency	Pm + Pb	psi	8,211	8,351	36,000
CRD Guide Tube	Faulted	Pm + Pb	psi	13,044	13,266	57,600
Orificed Fuel Support	Upset	Pm + Pb Horizontal Load	lbs	1,565	1,592	9,687

Component	Service Condition	Stress (or Load) Component	Units	CLTP	TPO	Limit
OrificedFuel Support	Upset	Pm + Pb Vertical Load	lbs	8,796	8,946	49,632
OrificedFuel Support	Faulted	Pm + Pb Horizontal Load	lbs	3,229	3,284	17,613
OrificedFuel Support	Faulted	Pm + Pb Vertical Load	lbs	16,618	16,901	90,240
Steam Dryer – Perforated Plate	Upset	Pm	psi	16,800	17,464	25,300
FW Sparger – Slotted Ring	Upset	Pm + Pb + Q	psi	70,710	73,750	76,500
FW Sparger– Slotted Ring	Emergency	Pm + Pb	psi	310	350	52,430
FW Sparger– Slotted Ring	Faulted	Pm + Pb	psi	1,520	1,560	83,880
Shroud Head Stud Stress	Upset	Pm	psi	18,181	18,235	23,300

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 previous containment evaluations are bounding for TPO uprate because they were performed at 102% of CLTP. The methodology and results of previous analyses have been reported in previous RBS licensing documentation and in the previous power uprate topical report (Reference 6). 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.

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	
Alternate Shutdown Cooling Transient Event			
Containment Isolation			The ability of containment isolation valves and operators to perform their required functions are not affected because the evaluations have been performed at 102% of CLTP.

4.1.1 Generic Letter 89-10 Program

The motor-operated valve (MOV) requirements in the Updated Safety Analysis Report (USAR) were reviewed, and no changes to the functional requirements of the Generic Letter (GL) 89-10 MOVs are identified as a result of operating at the TPO RTP. Because the previous analyses were based on 102% of CLTP, there are no increases in the pressure or temperature at which

MOVs are required to operate. Therefore, the GL 89-10 MOVs remain capable of performing their design basis function.

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 RBS response to GL 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," remains applicable for the TPO uprate conditions. The containment design temperatures and pressures in the current GL 96-06 evaluation are not exceeded under post-accident conditions for the TPO uprate. Therefore, the RBS 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 High Pressure Coolant Injection (HPCI) system is not applicable to RBS.

4.2.2 High Pressure Core Spray

The HPCS system is a motor driven high pressure injection system designed to pump water into the reactor vessel over a wide range of operating pressures. The primary purpose of the HPCS 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 HPCS system provided in TLTR Section 5.6.7 is applicable to RBS. The ability of the HPCS system to perform required safety functions is demonstrated with previous analyses based on 102% of CLTP. Therefore, all safety aspects of the HPCS system are within previous evaluations and the requirements are unchanged for TPO uprate conditions.

4.2.3 Core Spray or Low Pressure Core Spray

The CS system is not applicable to RBS.

The LPCS system sprays water into the reactor vessel after it is depressurized. The primary purpose of the LPCS mode 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

LPCS system provided in TLTR Section 5.6.10 is applicable to RBS. The ability of the LPCS system to perform required safety functions is demonstrated with previous analyses based on 102% of CLTP. Therefore, all safety aspects of the LPCS 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 RBS. The ability of the RHR system to perform 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 Automatic Depressurization System (ADS) uses safety/relief valves to reduce the reactor pressure following a small break LOCA when it is assumed that the high pressure systems have failed. This allows the LPCS 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 RBS. 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 most limiting case for net positive suction head (NPSH) typically occurs at the peak long-term suppression pool temperature. The generic evaluation of the containment provided in TLTR Appendix G is applicable to RBS. Because previous containment analyses were based on 102% of CLTP, there is no change in the available NPSH for systems using suppression pool water. Therefore, the TPO does not affect compliance to the ECCS pump NPSH requirements.

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 analyses for RBS, for both the SAFER/GESTR LOCA methodology (GE-supplied resident fuel) and the Framatome methodology (Framatome-supplied resident fuel), have been performed at 102% of CLTP.

As described in TLTR Appendix D and the GE response to an NRC Request for Additional Information (RAI) on the TLTR (Reference 8), fuel analyzed using SAFER/GESTR-LOCA

[Redacted] For RBS, the SAFER/GESTR-LOCA analysis is applicable only to the GE-supplied resident fuel. The pre-TPO SAFER/GESTR LOCA analysis for GE-supplied fuel at RBS was performed at CLTP and [Redacted] Therefore, the pre-TPO SAFER/GESTR LOCA analysis for GE-supplied fuel bounds the 1.7% TPO uprate for RBS.

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 uprate 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 Design Basis Accident (DBA) conditions from 102% of CLTP. Therefore, the system remains capable of performing its safety function for the TPO uprate.

4.6 MAIN STEAM POSITIVE LEAKAGE CONTROL SYSTEM

The ability of Main Steam Positive Leakage Control System (MSPLCS) to perform its required functions under TPO uprate conditions is not affected because current evaluations have been performed at 102% of CLTP.

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 RBS. 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% of 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, Intermediate Range Monitors, and Source Range Monitors

The Average Power Range Monitors (APRMs) are re-calibrated to indicate 100% at the TPO RTP level of 3091 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 stability-related flow-biased APRM values are determined by the reload analysis. This approach for the RBS 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 IRMs have adequate overlap with the Source Range Monitors (SRMs) and APRMs. However, normal plant surveillance procedures may be used to adjust the IRMs overlap with the SRMs and APRMs. The IRM channels have sufficient margin to the upscale scram trip on the highest range when the APRM channels are reading near their downscale alarm trip because the change in APRM scaling is so small 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 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.

5.1.2 Rod Pattern Control System

The Rod Pattern Control System (RPCS) supports the operator by enforcing rod patterns until reactor power has reached appropriate levels. The RPCS Rod Withdrawal Limiter (RWL) prevents excessive control rod withdrawal after reactor power has reached an appropriate level. The power-dependent setpoints for the RWL 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 addressed 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 Pressure Control System (PCS) provides a fast and stable response to steam flow changes so that reactor pressure is controlled within allowable values. The PCS consists of two subsystems, the T/G Electronic-Hydraulic Control (EHC) system and the Steam Bypass Pressure Control System (SBPCS). The main T/G EHC system performs the speed/load control for the main T/G. The SBPCS performs the pressure control function.

Satisfactory reactor pressure control by the turbine pressure regulator and the turbine control valves (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)). RBS 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 T/G EHC and SBPCS 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 uprate power level.

PCS tests 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 control valves 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 ~2°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 ~2°F increase in FW temperature for the TPO uprate decreases leak detection trip avoidance margin. As described in Section F.4.2.8 of the TLTR, 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.

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 7) are used to generate the allowable values (AVs) and nominal trip setpoints (NTSPs) related to the AL changes shown in Table 5-1. 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 ALs that change based on results from the TPO evaluations and safety analyses. In general, if the AL does not change in units shown in the Technical Specifications, then no change in its associated plant AV and NTSP is required. 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 Reference 7.

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 TSV Closure Scram, TCV Fast Closure Scram, and Recirculation Pump Trip Bypasses

The Turbine Stop Valve (TSV) closure scram, TCV fast closure scram, and RPT bypasses allow these scrams and RPT to be bypassed, when reactor power is sufficiently low, such that the scram and RPT functions are not needed to mitigate a T/G trip. This reactor power bypass AL, indicated as a turbine first stage pressure (TFSP) signal, is used to determine the actual trip setpoint. The TFSP setpoint is chosen to allow operational margin so that the scrams and RPT can be avoided, by transferring steam to the turbine bypass system during T/G trips at low power.

The AL for the TFSP that activates the T/G trip scram and RPT at high power remains the same value in terms of percent RTP. This is contrary to TLTR Section F.4.2.3, which states that the AL would remain the same in terms of absolute main turbine steam flow (lb/hr), and indicated as a pressure signal (psig).

The reload analyses performed prior to TPO implementation will be based on the reactor power bypass AL for the TSV closure scram, TCV fast closure scram, and RPT remaining constant in percent of RTP. The new AL slightly increases with respect to absolute thermal power with a corresponding adjustment to the core operating limits. The maneuvering range for plant startup is maximized.

No modifications to the RBS turbine are made for the TPO uprate, so there is no change in the first-stage pressure/steam flow relationship from previous 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 TS AV of this function is expressed in terms of psid. Although the main steam flow increases by ~2%, the main steam line (MSL) flow element AL in ΔP is not changed for the TPO uprate. The corresponding AL in terms of steam flow is decreased to approximately 138% 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 is consistent with Section F.4.2.5 of the TLTR.

5.3.6 Fixed APRM Scram

The fixed APRM ALs, for both two (recirculation) loop (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 RBS. 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

As described in Section 2.4, RBS employs reactor stability solution E1A. The APRM flow-referenced trip and alarm for both TLO and SLO are credited in the E1A stability solution and are addressed on a cycle-specific basis based on the fuel and core design. The reload stability evaluations continue to determine the acceptability of the APRM flow-referenced trip and alarm values. There is no significant effect on the instrument errors or uncertainties from the TPO uprate.

5.3.8 Rod Pattern Controller Low and High Power Setpoints

The RPCS RWL Low Power Setpoint (LPSP) is used to enforce the rod pattern constraints established for the control rod drop accident at low power levels. The generic guidelines in Section F.4.2.9 of the TLTR are applicable to RBS. The RWL LPSP AL remains the same in terms of percent RTP.

The RPCS RWL High Power Setpoint (HPSP) AL is maintained the same in terms of percent power. This results in a slightly higher value of absolute power associated with the change in the limit on the number of control rod withdrawal notches prior to a rod block.

5.3.9 Low Steam Line Pressure MSIV Closure (RUN Mode)

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

5.3.10 Reactor Water Level Instruments

The generic discussion in TLTR Section F.4.2.10 is applicable to the RBS 1.7% TPO uprate. Use of the current ALs maintains acceptable safety system performance. The low reactor water level ALs for scram, high pressure injection and ADS/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 plant response following 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 following a single FW pump trip at TPO uprate conditions would remain the same relative to the remaining FW flow as exists at CLTP.

5.3.11 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.

5.3.12 Low Condenser Vacuum

In order to produce more electrical power, the amount of heat discharged to the main condenser increases slightly. The ability of the main condenser, circulating water, and normal heat sink to accommodate the increase in heat load due to TPO uprate is within the existing systems design capability. Therefore, implementation of TPO would not adversely affect any trip signals associated with low condenser vacuum (turbine trip / MSIV closure).

Table 5-1 Analytical Limits that Change due to TPO

Parameter	Current	TPO
Main Steam Line High Flow Isolation % rated steam flow	140	137.6

6.0 ELECTRICAL POWER AND AUXILIARY SYSTEMS

6.1 AC POWER

Plant electrical characteristics are given in Table 6-1.

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.

The existing grid stability analysis demonstrates conformance to General Design Criteria (GDC) 17 (10 CFR 50, Appendix A) and bounds TPO uprate conditions. 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 condensate and FW pumps. These pumps experience increased flow due to the TPO uprate conditions. Because these changes are small, the motor demand for each of these loads remains bounded by the existing design. Accordingly, there are negligible changes in the on-site distribution system design basis loads or voltages due to the TPO conditions. The system environmental design bases are unchanged. Operation at the TPO RTP level is achieved by utilizing existing equipment operating at or below the nameplate rating; therefore, under normal conditions, the electrical supply and distribution components (e.g., switchgear, motor control centers (MCCs), cables) are adequate.

Station loads under emergency operation and distribution conditions (emergency diesel generators) are based on BHP or running kW. The ECCS pumps use a conservatively high flow BHP. 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.

6.2 DC Power

The direct current (DC) loading requirements in the USAR 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. Operation at the TPO RTP level does not increase any loads or revise control logic. Therefore, there are no changes to the load, voltage drop or short circuit current values.

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 USAR requirements at the TPO conditions.

6.3.1 Fuel Pool Cooling

The Spent Fuel Pool (SFP) heat load increases slightly as a result of operation at the TPO RTP level. The TPO uprate does not affect the heat removal capability of the Fuel Pool Cooling and Cleanup System (FPCCS). The TPO heat load is within the design basis heat load for the FPCCS, and does not result in a delay in removing the RHR system from service (i.e., the outage day the FPCCS can maintain the upper containment fuel pool temperature such that the Fuel Pool Assist mode of the RHR system is not required).

The SFP cooling adequacy is determined by calculating the heat load generated by a full core discharge (200 fuel bundles are placed in the upper containment fuel pool and the remaining 424 fuel bundles are transferred to the SFP) plus remaining spaces filled with used fuel discharged at regular intervals. The analysis assumes 18-month fuel cycle lengths as the basis. The existing analyses and continuing compliance with the commitment to maintain the pool design limits (i.e., maximum temperature and corresponding heat removal capacity) by controlling the rate of the discharge (fuel offload) to the spent fuel pool confirm the capability of the FPCCS to maintain adequate fuel pool cooling for the TPO uprate.

The FPCCS heat exchangers are sufficient to remove the decay heat during normal refueling and under full core off-load conditions following operation at the TPO RTP. The RHR system in Fuel Pool Cooling Assist mode is available, if needed, to cool those bundles in the upper containment fuel pool.

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 SFP water quality is maintained by the 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 environmental permit requirements are adversely affected.

6.4.1 Service Water Systems

6.4.1.1 Safety-Related Loads

The safety-related Standby Service Water (SSW) system provides cooling water during and following a design basis accident. The safety-related performance of the SSW system during and following the most demanding design basis event (LOCA) does not change because the original LOCA analysis was based on 102% of CLTP (Section 4.3). Similarly, the containment response analysis in Section 4.1 is also based on 102% of CLTP. There is no change in the safety-related heat loads and the requirements are within the existing capacity of the RHR and associated SSW system.

6.4.1.2 Non-Safety-Related Loads

The major service water heat load increases from the TPO reflect an increase in main generator losses rejected to the stator water coolers and hydrogen coolers and the Turbine Plant Component Cooling Water (TPCCW) system. The thermal efficiency of the power generation cycle is not expected to change. Therefore, the increase in service water heat loads from these sources due to the TPO uprate operation is approximately proportional to the TPO (~1.7%). The design of these systems is adequate to handle the TPO uprate.

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 performance of the main condenser was evaluated for operation at the TPO RTP. The evaluation confirms that the condenser, circulating water system, and heat sink are adequate for TPO operation.

6.4.2.1 Discharge Limits

The RBS Louisiana Pollutant Discharge Elimination System (LPDES) Permit provides the effluent limitations and monitoring requirements for discharge wastewater at the site. The discharge limits on free available chlorine are 0.2 mg/l for the monthly average and 0.5 mg/l for the daily maximum. The discharge water temperature shall not exceed a monthly average of 105°F and a daily maximum of 110°F. Frequent monitoring of these parameters ensures that permit limits are not exceeded. The TPO uprate has minimal effect on the parameters, and no changes to LPDES permit requirements are needed.

6.4.3 Reactor Plant Component Cooling Water System

The heat loads on the Reactor Plant Component Cooling Water (RPCCW) system do not increase significantly due to TPO because they depend on either reactor vessel water temperature or flow rates in the systems cooled by the RPCCW. The change in reactor vessel water temperature is minimal and there is no change in nominal reactor operating pressure. The RPCCW system experiences a slight heat load increase in the Fuel Pool Coolers heat exchangers. However, the system has adequate design margin to remove the additional heat. Therefore, the RPCCW system is acceptable for the TPO uprate.

6.4.4 Turbine Plant Component Cooling Water System

The power-dependent heat loads on the TPCCW system increased by the TPO are those related to the operation of the bus duct cooler and exciter coolers. The remaining TPCCW heat loads are not strongly dependent upon reactor power and do not significantly increase. The TPCCW system has sufficient capacity to assure that adequate heat removal capability is available for TPO operation.

6.4.5 Ultimate Heat Sink

The ultimate heat sink (UHS) is the standby service water cooling tower which functions as both the supply and return for the SSW system. As a result of operation at the TPO RTP level, the post-LOCA UHS water temperature increases slightly, primarily due to higher reactor decay heat. This results in a higher UHS evaporation rate. However, the ability of the UHS to perform required safety functions is demonstrated with previous analyses based on 102% of CLTP. Therefore, all safety aspects of the UHS are within previous evaluations and the requirements are unchanged for TPO uprate conditions. The current Technical Specifications for UHS 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 sodium pentaborate solution into the vessel to achieve a subcritical condition. The generic evaluation presented in TLTR Sections 5.6.5 and L.3 is applicable to the RBS TPO uprate. Previous evaluations of the SLCS for the RBS 5% power uprate project were performed at 102% of CLTP. The TPO uprate of 1.7% power does not affect shutdown or injection capability of the SLCS. Because the shutdown margin is reload dependent, the SLCS shutdown margin is 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 (~2°F). The increased heat load is within the margin of the steam tunnel area coolers. In the drywell, the increase in heat load due to the FW process temperature is within the system capacity. In the turbine building, the maximum temperature increases in the FW heater bay and condenser areas are < 2°F due to the increase in the FW process temperatures. In the fuel building, the increase in heat load due to a slight SFP cooling process temperature increase is within the margin of the area coolers. 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

The RBS Appendix R fire event analyses assume an operating power level of 3100 MWt (102% of CLTP) at the start of the postulated fire event, which bounds the TPO uprate conditions. The TPO uprate does not cause an increase in peak vessel bottom pressure, maximum containment pressure, or maximum containment temperature. In addition, peak cladding temperature remains well below 1500°F. Therefore, the three criteria of TLTR Section L.4 are met and no additional analysis is required.

6.8 SYSTEMS NOT 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 RBS are confirmed to be consistent with the generic description provided in the TLTR.

Table 6-1 TPO Plant Electrical Characteristics

Parameter	Value
Guaranteed Generator Output (MWe)	1043.1
Rated Voltage (kV)	22
Guaranteed Generator Output (MVA)	1151.1
Current Output (kA)	30.209
Isolated Phase Bus Duct Rating	
Main Section (kA)	32
Branch Section (kA)	16
Main Transformers Rating (MVA)	1577

7.0 POWER CONVERSION SYSTEMS

RBS has previously uprated operation by 5% utilizing design margins in the power conversion system.

7.1 TURBINE-GENERATOR

The RBS main T/G is 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/G 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. The difference in the steam-passing capability between the current analyzed and rated conditions is called the flow margin.

The RBS turbine-generator has a flow margin of 6% at the rated throttle steam flow of 11,932,233 lb/hr at a throttle pressure of 987 psia and rated electrical power output of 1,043,125 kW at a power factor of 0.91.

For the TPO uprate RTP of 3091 MWt (~101.7% of CLTP), the rated throttle steam flow is increased to 12,629,593 lb/hr at a throttle pressure of 1000.5 psia. The increased throttle flow is approximately 105.8% of current rated. The increased throttle flow is due to the increased steam flow resulting from operation at TLTP conditions (~2%) and incorporates the current operating practice of throttling the moisture separator reheater (MSR) tube side steam supply (which results in an ~3.8% increase in turbine throttle flow) into the rated throttle flow. The uprated electrical output is 1,060,928 kW at a power factor of 0.922.

Steam specification calculations were performed to determine the TPO uprate turbine steam path conditions. These TPO uprate operating conditions are bounded by the previous analysis of the turbine and generator stationary and rotating components. Thus, the increased loadings, pressure drops, thrusts, stresses, overspeed capability, and other design considerations resulting from operation at TLTP conditions are within existing design limits and operation therefore is acceptable at the TPO uprate condition. In addition, valves, control systems, and other support systems were evaluated and TPO operating conditions are bounded by the existing analyses. The results of these evaluations show that no modifications are needed to support operation at the TPO uprate condition.

The existing rotor missile analysis was performed at conditions that bound the TPO uprate conditions and is based on the NRC approved methodology in NUREG-1048, which applies to units with GE monoblock rotors. Based on the calculated results of control system failure, which is on the order of 10^{-8} per year, the missile probability is acceptable.

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. Although the entrapped energy increases slightly for the TPO uprate conditions, no change in the overspeed trip settings is required because, as stated above, the existing analysis bounds the TPO uprate conditions.

7.2 Condenser And Steam Jet Air Ejectors

The main condenser capability was evaluated for performance at the TPO uprate conditions in Section 6.4.2. The design margin in the condenser heat removal capability can accommodate the additional heat rejected for operation at the TPO uprate 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 small increase in hydrogen and oxygen flows from the reactor does not affect the SJAE capacity because the design was based on operation at significantly greater than required flows. Therefore, the condenser air removal system is not affected by the TPO uprate and the mechanical vacuum pumps and SJAEs are adequate for operation at the TPO uprate conditions.

7.3 Turbine Steam Bypass

The SBPCS was originally designed for a steam flow capacity of 10% of the 100% rated flow. Because of the previous 5% power uprate at RBS (including a 30 psi reactor pressure increase), the steam bypass capacity was only slightly reduced in terms of rated flow. The steam bypass capacity at the TPO RTP remains $\geq$ 9.5% of the TPO RTP steam flow rate. The steam bypass system is 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 use a bypass capacity that is less than the actual capacity. Therefore, the turbine bypass capacity remains adequate for TPO operation because the actual capacity (unchanged) continues to bound the value used in the analyses.

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 condition.

A review of the RBS FW heaters, heater 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. The review also concluded that the FW control valves can maintain water level control at the TPO uprate conditions.

The performance evaluations were based on an assessment of the capability of the condensate and FW system equipment to remain within the design limitations of the following parameters:

- 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 2%. The condensate and FW systems were originally designed for 115.5% of original rated flow. Operation at the TPO RTP level does not significantly affect operating conditions of these systems. 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 flow 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.

7.4.2 Transient Operation

To account for FW demand transients, the condensate and FW system was evaluated to ensure that a minimum of 5% margin above the TPO uprated FW flow is available. This is the same criterion that was applied to the recently implemented 5% power uprate at RBS. 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 prevents a reactor low water level scram, and is 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) is bounded by the existing analyses. 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) do 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 backwash of the CD pre-filters and cleaning/replacement of CD resins. The TPO uprate results in ~2% increased flow rate through the CDs, resulting in a reduction in the average time between pre-filter backwashes and deep bed 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 condition.

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. 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. Therefore, the TPO uprate does not adversely affect the processing of liquid radwaste, and there are no significant environmental effects.

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 oxygen 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.

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 remain well within limits following implementation of the TPO uprate. There are no significant environmental effects due to the TPO uprate.

Radiolysis of water in the core region, which forms H_2 and O_2, increases linearly with core power, thus increasing the heat load on the recombiner and related components. The increases in H_2 and O_2 due to the TPO uprate remain well within the capacity of the system. The system radiological release rate is administratively controlled, and is not changed with operating power. Therefore, the TPO 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 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 CLTP accident source terms for RBS bound 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 are bounded by the existing design basis concentration.

8.4.2 Activated Corrosion 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. However, the TPO uprate corrosion product concentrations do not exceed the design basis concentrations. Therefore, no change is required in the design basis activated corrosion product concentrations for the TPO uprate.

8.4.3 Fission Products

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 the RBS design. The offgas rates for current operations are well below the original design basis. Therefore, the design basis release rates are adequate 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. Activity levels in the reactor water are approximately equal to current measured data, which are fractions of the design basis values. Therefore, the design basis values are unchanged.

8.5 RADIATION LEVELS

Normal operation radiation levels increase slightly for the TPO uprate. RBS 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 plant because it is offset by conservatism in the design, source terms, and analytical techniques.

Post-operation radiation levels in most areas of the plant 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 corrosion product crud is expected, as well as near some liquid radwaste equipment, the increase could be slightly higher. Regardless, individual worker exposures are 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.

The change in core activity inventory resulting from the TPO uprate (Section 8.3) increases post-accident radiation levels by no more than approximately the percentage increase in power level. The slight increase in the post-accident radiation levels has no significant effect on the plant or the habitability of the Technical Support Center or Emergency Operations Facility. A review of areas requiring post-accident occupancy (per NUREG-0737 Item II.B) concluded that access needed for accident mitigation is not significantly affected by the TPO uprate.

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 Requirements Manual (TRM) limits implement the guidelines of 10 CFR 50 Appendix I. A review of the normal radiological effluent doses shows that at CLTP, the annual doses are less than 2% of the doses allowed by TRM limits. The TPO uprate does not involve significant increases in the offsite dose from noble gases, airborne particulates, iodine, tritium or liquid effluents. In addition, radiation from shine is not a significant exposure pathway. 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 1.7% TPO uprate.

[Redacted] Also included are the analytical methods to be used and operating conditions to be assumed. 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 OLMCPR.

[Redacted]

The overpressure events and loss of FW transient are currently performed with the assumption of 2% overpower. Therefore, they are applicable and bounding for the TPO uprate.

The reload transient analysis includes the worst overpressure event, which is usually the closure of all MSIVs with high neutron flux scram.

The evaluations and conclusions of Appendix E are applicable to the RBS TPO uprate. Therefore, it is sufficient for the plant to perform the standard reload analyses at the first fuel cycle that implements the 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 core inventory increase, which is in proportion to the power increase.

Radiological consequences due to postulated DBA events, as documented in the USAR, have previously been evaluated and analyzed to show that NRC regulations are met for 102% of 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

RBS 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 RBS-specific 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 185°F.
5. Peak containment pressure less than 15 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 9) present a generic evaluation [Redacted] of an ATWS to a change in power typical of the TPO uprate. The evaluation is based on [Redacted] For a TPO uprate, if a plant has sufficient margin for the projected changes in peak parameters given in TLTR Section L.3.5 as augmented by Reference 9,

[Redacted]

The previous ATWS analysis, performed at 100% of CLTP, demonstrated a margin of 200 psi to the peak vessel bottom head pressure limit and a margin of 4.7°F to the pool temperature limit.

[Redacted]

Therefore, no RBS-specific ATWS analysis was performed for the TPO uprate.

9.3.2 Station Blackout

The RBS Station Blackout (SBO) evaluation has previously been performed assuming ≥ 102% of CLTP. Therefore, the postulated SBO scenarios for TPO operation are bounded by the current evaluations.

10.0 OTHER EVALUATIONS

10.1 HIGH ENERGY LINE BREAK

Because the TPO uprate system operating temperatures and pressures change only slightly, there is no significant change in High Energy Line Break (HELB) mass and energy releases. The FW lines, near the pump discharge, increase < 2°F and < 5 psi. The recirculation lines decrease < 1°F and increase < 1 psi due to the slightly higher core pressure drop. Vessel dome pressure and other portions of the RCPB remain at current operating pressure or lower. Therefore, the consequences of any postulated HELB would not significantly change. The postulated break locations remain the same because the piping configuration does not change due to the TPO uprate.

The evaluation of HELBs outside containment was performed for all systems evaluated in the USAR. The evaluation shows that the affected buildings and cubicles that support the safety-related function are designed to withstand the resulting pressure and thermal loading following an HELB.

The analyses of the pressure and temperature response to ruptures in high-energy systems were reviewed for the effect of operating at TPO conditions. The review indicated that the critical parameter affecting the high-energy steam line break analyses is the reactor vessel dome pressure. Each of the HELB analyses were performed assuming a reactor pressure that bounds the TPO reactor pressure of 1070 psia. The evaluations show that the affected building and cubicles that support safety-related functions are designed to withstand the resulting pressure and thermal loading following an HELB at the TPO RTP.

A brief discussion of each event follows.

10.1.1 Main Steam Line and Feedwater Line Breaks

The critical parameter affecting the high energy steam line break analysis is the RPV dome pressure. Because there is no pressure increase for the TPO, the steam line pressure decreases and there is a slight decrease in the main steam line break (MSLB) blowdown rate. The existing analysis is bounding for the TPO condition.

The FW system line break outside containment is bounded by the MSLB. However, FW system line break is the critical case for flooding considerations.

10.1.2 ECCS Line Breaks

The HPCS and other ECCS lines are normally isolated from the reactor vessel, and a failure of one of these lines would result in a non-limiting break inside the drywell, which would be bounded by other line breaks. Because these lines are normally isolated, the TPO uprate does not affect their line break analyses for breaks outside the drywell.

10.1.3 RCIC System Line Breaks

A steam line break in the RCIC pump/turbine room is potentially the limiting line break for the Auxiliary Building structural design and equipment qualification. Because there is no increase in the reactor dome pressure relative to the original analysis, the mass flow rate does not increase. Therefore, the previous HELB analysis is bounding for the TPO uprate conditions.

10.1.4 RWCU System Line Breaks

The RWCU system line breaks are the limiting breaks for the Containment and Auxiliary Building structural design and equipment qualification. The original analysis was performed with conservative model assumptions, which more than offset the insignificant effects of the TPO uprate on RWCU system temperature and pressure. Therefore, the original HELB analysis is bounding.

10.1.5 CRD System Line Breaks

The CRD pipe rupture analysis is not affected by the TPO uprate.

10.1.6 RHR Steam Condensing Line Break

The RHR steam condensing line break is a steam line break in the MCC area and is potentially a limiting line break for Auxiliary Building structural design and equipment qualification. Because there is no increase in the reactor dome pressure relative to the original analysis, the mass flow rate does not increase. Therefore, the previous HELB analysis is bounding for the TPO uprate conditions.

10.1.7 Pipe Whip and Jet Impingement

Because there is no change in the nominal vessel dome pressure, pipe whip and jet impingement loads do not significantly change. Existing calculations supporting the dispositions of potential targets of pipe whip and jet impingement from postulated HELBs have been reviewed and determined to be adequate for the safe shutdown effects in the TPO RTP conditions. Existing pipe whip restraints, jet impingement shields, and their supporting structures are also adequate for the TPO uprate conditions.

10.1.8 Internal Flooding from HELB

The effects of flooding due to a postulated HELB are not increased by the TPO uprate. Minor increases in pressure and temperature of high-energy lines remain below design values. In addition, operational modes for the systems that contain high-energy lines are not affected by the TPO uprate. The plant internal flooding analysis and safe shutdown analysis are not affected.

10.2 Moderate Energy Line Crack

A review of the moderate energy line crack (MELC) evaluations was performed for the TPO uprate to determine the effect of the TPO uprate. The review addressed the effect on structures, systems, and components resulting from sprays, flooding, and environmental effects (pressure, temperature, humidity, and radiation). The review concluded that there is no effect on the existing MELC evaluations as a result of operating at TPO conditions.

The following are the moderate energy systems: Condensate Makeup and Drawoff, Fire Protection, RPCCW, SSW, Makeup Water, Turbine Plant Sampling, Reactor Plant Sampling, Ventilation Chilled Water, HPCS, LPCS, RCIC, RHR, Radioactive Liquid Waste, Spent Fuel Pool Cooling and Cleanup, CRD, Fuel Transfer, Domestic Water, Control Building Chilled Water, and SLCS.

10.3 Environmental Qualification

Safety-related components must be qualified for the environment in which they operate. The TPO 1.7% increase in power level increases the radiation levels experienced by equipment during normal operation and accident conditions. Because the TPO uprate does not increase the nominal vessel dome pressure, there is a very small effect on pressure and temperature conditions experienced by equipment during normal operation and accident conditions.

Due to the existing margin between actual and design basis conditions and to existing margins in the ventilation systems, the existing normal operation temperature, pressure and relative humidity environmental conditions remain unchanged for the TPO uprate.

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 may increase slightly near the FW lines but remain less than design conditions due to existing margins between design and actual conditions and existing design margins in the ventilation systems. These temperatures are evaluated through the EQ temperature monitoring program, which tracks such information for equipment aging considerations. The current radiation levels under normal plant conditions 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 an MSLB 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 existing analyses that bound the TPO conditions.

10.3.2 Mechanical Equipment With Non-Metallic Components

Operation at the TPO RTP level may increase the normal process temperature very slightly in the FW piping. The slight increase in normal and accident radiation is bounded by the existing design values. The evaluation of the safety-related mechanical equipment with non-metallic components did not identify any equipment potentially affected by the TPO temperature and radiation conditions.

10.3.3 Mechanical Component Design Qualification

The 1.7% increase in power level increases the radiation levels experienced by equipment during normal operation. However, where the previous accident analyses have been based on 102% of CLTP, the accident pressures, temperatures and radiation levels do not change. The service conditions of equipment/components (valves, heat exchangers, pumps, snubbers, etc.) in certain systems are affected by operation at the TPO RTP level because of the slightly increased temperature and flow rate. However, the TPO operating conditions are bounded by existing design conditions as evaluated in the piping assessments in Section 3.5. The revised operating conditions do not significantly affect the CUFs of mechanical components.

The effects of increased fluid induced loads on safety-related components are described in Section 3.5. As stated in Section 3.5, the containment loads for the TPO uprate are bounded by previous analyses at 102% of CLTP. Increased nozzle loads and component support loads due to the revised operating conditions were evaluated in the piping assessments in Section 3.5. These increased loads are insignificant, and become negligible when combined with the dynamic loads. Therefore, the mechanical components and component supports are adequately designed for the TPO uprate conditions.

10.4 TESTING

The TPO uprate power 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 systems or components.

In preparation for operation at TPO uprated conditions, routine measurements of reactor and system pressures and flows are taken near 95% and 100% of CLTP, and at 100% of TPO RTP. The measurements will be taken along the same rod pattern line used for the increase to TPO RTP. 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 turbine pressure controller setpoint will be readjusted at $\leq$95% of CLTP and held constant. The setpoint is reduced so the reactor dome pressure is the same at TPO RTP as for the CLTP. Adjustment of the pressure setpoint before taking the baseline 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 and during power ascension to the TPO RTP at each steady-state heat balance point defined above. Fuel thermal margin will be projected to the TPO RTP point after the measurements taken at 100% of CLTP to show the estimated margin. The thermal margin will be confirmed by the measurements taken at full 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 and pressure setpoint step changes will be used. If necessary, adjustments will be made to the controllers and actuator elements.

The increase in power for the TPO uprate (1.7%) 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, Technical Specifications, 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 influence FAC. However, the sensitivity to a 1.7% 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 RBS, based on the Boiling Water Reactor Vessel and Internals Project (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 (EOPs) action thresholds are plant unique and will be addressed using standard procedure updating processes. It is expected that a TPO uprate of 1.7% will have a negligible or no effect on the operator action thresholds and to the EOPs in general.

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 NEDC-32523P-A, Supplement 1 Volume II, April 1999.

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

5 Caldon Engineering Report 157, "Supplement to Caldon Topical ER-80P: Basis for Power Uprates with an LEFM Check or LEFM CheckPlus," Revision 5 (Approved by NRC SER dated December 20, 2001).

6 GE Nuclear Energy, "Safety Analysis Report For River Bend 5% Power Uprate," NEDC-32778P, Class 3 (Proprietary), July 1999.

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

8 GE Nuclear Energy, "Partial Response to Request for Additional Information – GE Nuclear Energy Licensing Topical Report NEDC-32938P RAI#'s: 12-17 and 22-25," MFN 01-048, dated September 21, 2001.

9 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.