Enclosure 8

GEH Document NEDO-33871, "Safety Analysis Report for Hope Creek Generating Station Thermal Power Optimization," Revision 0, (Non-Proprietary Version)

HITACHI

GE Hitachi Nuclear Energy

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SAFETY ANALYSIS REPORT FOR HOPE CREEK GENERATING STATION THERMAL POWER OPTIMIZATION

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The design, engineering, and other information contained in this document are furnished for the purposes of supporting: a license amendment request by Public Service Enterprise Group (PSEG), for a thermal power uprate at Hope Creek Generating Station to 3,902 MWt in proceedings before the U.S. Nuclear Regulatory Commission. The only undertakings of GEH respecting information in this document are contained in the contract between GEH and PSEG, and nothing contained in this document shall be construed as changing the contract. The use of this information by anyone for any purpose other than that for which it is intended is not authorized; and with respect to any unauthorized use, GEH makes no representation or warranty, and assumes no liability as to the completeness, accuracy, or usefulness of the information contained in this document.

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ACRONYMS AND ABBREVIATIONS

Term	Definition
1RPT	One Recirculation Pump Trip
2RPT	Two Recirculation Pump Trip
ABSP	Automated Backup Stability Protection
AC	Alternating Current
ADS	Automatic Depressurization System
AL	Analytical Limit
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
AOO	Anticipated Operational Occurrence
AOR	Analysis of Record
AP	Annulus Pressurization
APRM	Average Power Range Monitor
ARI	Alternate Rod Insertion
ART	Adjusted Reference Temperature
ARTS	APRM, RBM, Technical Specifications
ASDC	Alternate Shutdown Cooling
ASME	American Society of Mechanical Engineers
ATWS	Anticipated Transient Without Scram
AV	Allowable Value
B&PV	Boiler and Pressure Vessel
BHP	Brake Horsepower
BOC	Beginning of Cycle
BOP	Balance-of-Plant
BSP	Backup Stability Protection
BWR	Boiling Water Reactor
BWROG	Boiling Water Reactor Owners' Group
BWRVIP	Boiling Water Reactor Vessel and Internals Project
CB&I	Chicago Bridge & Iron
CDA	Confirmation Density Algorithm
CF	Core Flow

Term	Definition
CFD	Condensate Filter Demineralizer
CFR	Code of Federal Regulations
CGCS	Combustible Gas Control System
CIV	Containment Isolation Valve
CLTP	Current Licensed Thermal Power
CLTR	NEDC-33004P-A, Constant Pressure Power Uprate
COLR	Core Operating Limits Report
CRD	Control Rod Drive
CRGT	Control Rod Guide Tube
CS	Core Spray
CSC	Containment Spray Cooling
CSS	Core Support Structure
CUF	Cumulative Usage Factor
DBA	Design Basis Accident
DC	Direct Current
DCP	Design Change Package
DMR	Discharge Monitoring Report
DPA	Displacements per Atom
DSN	Discharge Serial Number
DSS-CD	Detect and Suppress Solution – Confirmation Density
ECCS	Emergency Core Cooling System
EDG	Emergency Diesel Generator
EFPY	Effective Full Power Years
EHC	Electro-Hydraulic Control
ELTR1	NEDC-32424P-A, Generic Guidelines for General Electric Boiling Water Reactor Extended Power Uprate
ELTR2	NEDC-32523P-A, Generic Evaluations of General Electric Boiling Water Reactor Extended Power Uprate
EMA	Equivalent Margin Analysis
EOC	End-of-Cycle
EOL	End-of-License
EOP	Emergency Operating Procedure

Term	Definition
EPRI	Electric Power Research Institute
EPU	Extended Power Uprate
EQ	Environmental Qualification
FAC	Flow Accelerated Erosion/Corrosion
FF	Fluence Factor
FFWTR	Final Feedwater Temperature Reduction
FIV	Flow Induced Vibration
FOA	Forced Oil and Air
FPC	Fuel Pool Cooling
FRVS	Filtration Recirculation and Ventilation System
FW	Feedwater
FWTR	Feedwater Temperature Reduction
GDC	General Design Criteria
GE	General Electric Company
GEH	GE-Hitachi Nuclear Energy
GL	Generic Letter
GNF	Global Nuclear Fuel
HCGS	Hope Creek Generating Station
HDA	Heat Dissipation Area
HELB	High Energy Line Break
HEPA	High Efficiency Particulate Air
HP	High Pressure
HPCI	High Pressure Coolant Injection
HVAC	Heating, Ventilation and Air Conditioning
IASCC	Irradiation Assisted Stress Corrosion Cracking
IBOT	Instantaneous Break Opening Time
ICF	Increased Core Flow
ID	Inside Diameter
IPE	Individual Plant Examination
IRM	Intermediate Range Monitor
ISP	Integrated Surveillance Program

Term	Definition
JR	Jet Reaction
ksi	Kips Per Square Inch
kV	Kilovolt
LAR	License Amendment Request
LCO	Limiting Condition for Operation
LEFM	Leading Edge Flow Meter
LHGR	Linear Heat Generation Rate
LOCA	Loss-of-Coolant Accident
LOP	Loss of Offsite Power
LP	Low Pressure
LPCI	Low Pressure Coolant Injection
LPRM	Local Power Range Monitor
LPSP	Low Power Setpoint
LTP	Licensed Thermal Power
LTR	Licensing Topical Report
LTS	Long-Term Solution
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MBTU	Million BTU
MCC	Motor Control Center
MCPR	Minimum Critical Power Ratio
MELB	Moderate Energy Line Break
MELLLA	Maximum Extended Load Line Limit Analysis
MELLLA+	Maximum Extended Load Line Limit Analysis Plus
MeV	Million Electron Volts
MFLCPR	Maximum Fraction of Limiting Critical Power Ratio
MFLPD	Maximum Fraction of Limiting Power Density
MGD	Million Gallons Per Day
MIP	MCPR Importance Parameter
Mlbm	Millions of Pounds Mass
MOC	Middle of Cycle
MOP	Mechanical Overpower

Term	Definition
MOV	Motor-Operated Valve
MS	Main Steam
MSIV	Main Steam Isolation Valve
MSIVC	Main Steam Isolation Valve Closure
MSL	Main Steam Line
MSLB	Main Steam Line Break
MSLBA	Main Steam Line Break Accident
MVA	Megavolt Amps
MWe	Megawatt(s)-Electric
MWt	Megawatt(s)-Thermal
N/A	Not Applicable
NJDEP	New Jersey Department of Environmental Protection
NJPDES	New Jersey Department of Environmental Protection (NJDEP) National Pollutant Discharge Elimination System Permit
NPSH	Net Positive Suction Head
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
NTSP	Nominal Trip Setpoint
OFS	Orificed Fuel Support
OLMCPR	Operating Limit Minimum Critical Power Ratio
OLTP	Original Licensed Thermal Power
OOS	Out-of-Service
OPRM	Oscillation Power Range Monitor
PF	Power Factor
P/F	Power/Flow
P_B	Primary Bending Stress Intensity
PCS	Pressure Control System
PCT	Peak Clad Temperature
P_L	Primary Local Stress Intensity
P_M	Primary Membrane Stress Intensity
PRA	Probabilistic Risk Assessment

Term	Definition
PRNM	Power Range Neutron Monitoring
PSEG	Public Service Enterprise Group
psi	Pounds Per Square Inch
psia	Pounds Per Square Inch – Absolute
psid	Pounds Per Square Inch – Differential
psig	Pounds Per Square Inch – Gauge
P-T	Pressure-Temperature
PUSAR	Power Uprate Safety Analysis Report
RACS	Reactor Auxiliaries Cooling System
RAMA	Radiation Analysis Modeling Application
RBM	Rod Block Monitor
RCF	Rated Core Flow
RCIC	Reactor Core Isolation Cooling
RCPB	Reactor Coolant Pressure Boundary
RFP	Reactor Feedwater Pump
RFW	Reactor Feedwater
RFWT	Reduced Feedwater Temperature
RG	Regulatory Guide
RHR	Residual Heat Removal
RIPD	Reactor Internal Pressure Difference
RIS	Regulatory Issue Summary
RLA	Reload Licensing Analysis
RLB	Recirculation Line Break
RPT	Recirculation Pump Trip
RPV	Reactor Pressure Vessel
RRC	Reactor Recirculation
RRS	Reactor Recirculation System
RT_{NDT}	Reference Temperature of the Nil-Ductility Transition
RTP	Rated Thermal Power
RWCU	Reactor Water Cleanup
RWE	Rod Withdrawal Error

Term	Definition
RWM	Rod Worth Minimizer
SACS	Safety Auxiliaries Cooling System
S_{AD}	Amplitude Discriminator Setpoint
SAW	Submerged Arc Welding
SBO	Station Blackout
SC	Safety Communication
SCC	Stress Corrosion Cracking
scfm	Standard Cubic Feet per Minute
SDC	Shutdown Cooling
SE	Safety Evaluation
SER	Safety Evaluation Report
SFP	Spent Fuel Pool
SGTS	Standby Gas Treatment System
SJAE	Steam Jet Air Ejector
SL	Safety Limit
SLCS	Standby Liquid Control System
SLMCPR	Safety Limit Minimum Critical Power Ratio
SLO	Single Loop Operation
SMAW	Shielded Metal-Arc Welding
SPC	Suppression Pool Cooling
SR	Surveillance Requirement
SRLR	Supplemental Reload Licensing Report
SRM	Source Range Monitor
SRP	Standard Review Plan
SRV	Safety Relief Valve
SRVDL	Safety Relief Valve Discharge Line
SSWS	Station Service Water System
STP	Simulated Thermal Power
TACS	Turbine Auxiliaries Cooling System
TBCS	Turbine Bypass Control System
TBV	Turbine Bypass Valve

Term	Definition
TCV	Turbine Control Valve
TFSP	Turbine First-Stage Pressure
T_{FW}	Feedwater Temperature
T/G	Turbine-Generator
TIP	Traversing In-Core Probe
TLO	Two Loop Operation
TLTP	TPO Licensed Thermal Power
TLTR	NEDC-32938P-A, Thermal Power Optimization Licensing Topical Report
T-M	Thermal-Mechanical
TOP	Thermal Overpower
TPO	Thermal Power Optimization
TRC	Total Residual Chlorine
TS	Technical Specification(s)
TSAR	Thermal Power Optimization Safety Analysis Report
TSV	Turbine Stop Valve
UFSAR	Updated Final Safety Analysis Report
UHS	Ultimate Heat Sink
USE	Upper Shelf Energy
V&V	Verification and Validation
VTD	Vendor Technical Document
VWO	Valves Wide Open
Wd	Recirculation Drive Flow

EXECUTIVE SUMMARY

This report summarizes the results of all significant safety evaluations performed that justify increasing the licensed thermal power (LTP) at Hope Creek Generating Station (HCGS) to 3,902 megawatts-thermal (MWt). The requested license power level is approximately 1.6% above the current licensed thermal power (CLTP) level of 3,840 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-A, "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 analysis of accidents, transients, and special events. Therefore, because the safety analysis methods have been previously addressed, they are not addressed in this report. Also, event and analysis descriptions that are provided in other licensing documents or the updated final safety analysis report (UFSAR) are not repeated. This report summarizes the results of the safety evaluations needed to justify a license 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 (T/G). 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 a power level uncertainty is reduced to as low as 0.3%, thereby supporting the evaluation of a power level increase of up to 1.7%. A higher steam flow is achieved by increasing the reactor power along the current rod and core flow (CF) 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 (DBAs), and previous licensing evaluations were performed. This report demonstrates that HCGS can safely operate at a power level of 3,902 MWt.

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

- All safety aspects of the plant that are affected by a 1.6% increase in the thermal power level were evaluated, including the nuclear steam supply system (NSSS) and balance-of-plant (BOP) systems.
- Evaluations and reviews were based on licensing criteria, codes, and standards applicable to the plant at the time of the TSAR submittal.

- Evaluations and/or analyses were performed using NRC-approved or industry-accepted analysis methods for the UFSAR accidents, transients, and special events affected by TPO.
- 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).
- NSSS components and systems were reviewed to confirm that they continue to comply with the functional and regulatory requirements specified in the UFSAR and/or applicable reload license.
- Any modification to safety-related or non-safety-related equipment will be implemented in accordance with 10 Code of Federal Regulations (CFR) 50.59.
- All plant systems and components affected by an increased thermal power level were reviewed to ensure that there is no significant increase in challenges to the safety systems.
- A review was performed to assure that the increased thermal power level continues to comply with the existing plant environmental regulations.
- 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.
- A review of the UFSAR and approved design changes ensures adequate evaluation of the licensing basis for the effect of TPO through the date of that evaluation.

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 TPO power uprate of approximately 1.6% of the CLTP, consistent with the magnitude of the thermal power uncertainty reduction for HCGS. This will result in an increase in LTP from 3,840 MWt to 3,902 MWt.

This report follows the NRC-approved format and content for BWR TPO licensing reports documented in NEDC-32938P-A, "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 (SERs) provided in NEDC-32424P-A, "Generic Guidelines for General Electric Boiling Water Reactor Extended Power Uprate," (ELTR1) (Reference 2) and NEDC-32523P-A, "Generic Evaluations of General Electric Boiling Water Reactor Extended Power Uprate," (ELTR2) (Reference 3). Note that the HCGS extended power uprate (EPU) was based on NEDC-33004P-A, "Constant Pressure Power Uprate," (CLTR) (Reference 4), which involved no change in operating pressure.

Since their NRC approval, numerous EPU submittals have been based on these reports. The outline for the TSAR in TLTR Appendix A follows the same pattern as that used for the EPUs. All of 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 HCGS.

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 a power level uncertainty is reduced to as low as 0.3%, thereby supporting the evaluation of a power level increase of up to 1.7%. Several pressurized water reactor and BWR plants have already been authorized to increase their thermal power above the OLTP based on a reduction in the uncertainty in the determination of the power through improved feedwater (FW) flow rate measurements. When a previous uprate (other than a TPO) has been accomplished, the ≥ 102% safety analysis basis is reestablished above the uprated power level. Therefore, all GEH 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

HCGS was originally licensed at 3,293 MWt. HCGS was uprated to 3,339 MWt through the issuance of Amendment 131 to the the facility operating license (Reference 5). Subsequently, HCGS was further uprated to the CLTP level of 3,840 MWt through the issuance of Amendment 174 to the facility operating license (Reference 6). 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 licensed power level. 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)). Detailed descriptions of the basis for the TPO analyses are provided in the subsequent sections of this report.

Figure 1-1 illustrates the TPO power/flow (P/F) operating map for the analysis at 101.6% of CLTP for HCGS. The changes to the P/F 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 CF along the established maximum extended load line limit analysis (MELLLA) rod line. This strategy allows HCGS to maintain most of the existing available CF operational flexibility while assuring that low power-related issues (e.g., stability and ATWS instability) do not change because of the TPO uprate.

No increase in the previously licensed maximum CF limit is associated with the TPO uprate. Previously licensed performance improvement features are presented in Section 1.3.2.

With respect to absolute thermal power and flow, there is no change in the extent of the single loop operation (SLO) operating domain as a result of the TPO uprate. Therefore, the SLO operating domain is not provided. For HCGS, the maximum analyzed reactor core thermal power for SLO remains at the licensed limit.

The TPO uprate is accomplished with no increase in the nominal vessel dome pressure. This minimizes the effect of uprating on reactor thermal duty, and evaluations of environmental conditions, and minimizes changes to instrument setpoints related to system pressure. 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 as described in Section 10.4. The TPO uprate does not affect the pressure control function of the turbine bypass valves (TBVs).

This report also addresses continued applicability, at TPO RTP conditions, of the limitations and conditions described in the following NRC SERs:

- The NRC SER for GEH licensing topical report (LTR) NEDC-33173P-A, "Applicability of GE Methods to Expanded Operating Domains," referred to as the Methods LTR (Reference 7);
- The NRC SER for GEH LTR NEDC-33075P, "General Electric Boiling Water Reactor Detect and Suppress Solution – Confirmation Density," referred to as the DSS-CD LTR (Reference 8)

A complete listing of the required Methods LTR SER and detect and suppress solution – confirmation density (DSS-CD) LTR SER limitations and conditions is presented in Appendices A and B, respectively. The disposition of each applicable limitation and condition is addressed in these appendices. In many cases, information showing compliance to a limitation and condition from the HCGS power uprate safety analysis report (PUSAR, Reference 9) remains applicable at TPO RTP conditions. In such cases, references to the relevant sections of Reference 9 are provided.

1.2.2 Margins

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. NRC-approved or industry-accepted computer codes and calculation techniques are used in the safety analyses for the TPO uprate. A list of the NSSS computer codes used in the evaluations is provided in Table 1-1. Computer codes used in previous analyses (i.e., analyses at 102% of CLTP) are not listed. 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 identify 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 HCGS. This TSAR includes all of the evaluations for the plant-specific application. Many of the evaluations are supported by generic reference, some supported by rational considerations of the process differences, and some plant-specific analyses are provided.

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

2.0 Reactor Core and Fuel Performance

Overall heat balance and power-flow operating map information are 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); filtration, recirculation, and ventilation system (FRVS) (referred to as the standby gas treatment system (SGTS) in the TLTR); and other engineered safety features are evaluated for key events. The evaluations include the containment responses during limiting abnormal events, loss-of-coolant accidents (LOCAs), and safety relief valve (SRV) containment dynamic loads.

5.0 Instrumentation and Control

The instrumentation and control signal ranges and analytical limits (ALs) 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) 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

[[

]] The standard reload analyses consider the plant conditions for the cycle of interest.

10.0 Other Evaluations

High energy line break (HELB) and environmental qualification (EQ) evaluations are performed at bounding conditions for the TPO range to show the continued operability of plant equipment under TPO conditions. The individual plant examination (IPE) probabilistic risk assessment (PRA) will not be updated, because the change in plant risk from the subject power uprate is insignificant. This conclusion is supported by NRC Regulatory Issue Summary (RIS) 2002-03 (Reference 10).

1.2.4 Exceptions to the TLTR

All evaluations follow the protocol as approved by the NRC, with two exceptions.

One exception to the TLTR regarding the turbine stop valve (TSV) closure scram, turbine control valve (TCV) fast closure scram, and end-of-cycle recirculation pump trip (EOC-RPT) bypasses is discussed in Section 5.3.16.

A second exception to the TLTR regarding the thermal limits monitoring threshold is discussed in Section 2.4.2.

1.2.5 Concurrent Changes Unrelated to TPO

HCGS currently has a license amendment request (LAR) under review by the NRC for the upgrade of the power range neutron monitoring (PRNM) system (References 11 and 12). The PRNM LAR will be implemented prior to operation above the CLTP (3,840 MWt). The PRNM

LAR revises the average power range monitor (APRM) functions, trip setpoints and allowable values (AVs) for reactor protection and control rod block. The current value column of Table 5-1 reflects the revised PRNM values for the APRM functions.

On October 31, 2016, PSEG reported to the NRC that pressure-temperature (P-T) limits in the current HCGS technical specifications (TS) were negatively affected by the results of the HCGS 120° capsule which requires the P-T curves to be updated. In response to this issue, HCGS submitted a LAR on March 27, 2017 (Reference 13), to revise the P-T limit curves. The assessment provided in Section 3.2.1 was performed using the results of the 120° capsule at the TPO RTP.

1.3 TPO Plant Operating Conditions

1.3.1 Reactor Heat Balance

The typical heat balance diagram at the TPO condition is presented in Figure 1-2 (Reactor Heat Balance – TPO Power at 101.6% of CLTP, 100% CF).

The small changes in thermal-hydraulic parameters for the TPO are identified in Table 1-2. These parameters are generated for TPO by performing reactor heat balances that relate the reactor thermal-hydraulic parameters to the increased plant FW and steam flow conditions. Input from HCGS operation is considered to match expected TPO uprate conditions.

1.3.2 Reactor Performance Improvement Features

The following performance improvement and equipment out-of-service (OOS) features currently licensed at HCGS are acceptable at the TPO RTP level:

Performance Improvement Feature
MELLLA (97.1% of Rated Core Flow (RCF) at TPO RTP)
Increased Core Flow (ICF) (105.0% of rated)
Feedwater Heater(s) OOS, -60.0ºF
Feedwater Temperature Reduction (FWTR), -102.0ºF
Single Loop Operation
RPT OOS
1 SRV OOS
APRM, RBM, Technical Specifications (ARTS) Program

1.4 BASIS FOR TPO UPRATE

The safety analyses in this report are based on a total thermal power measurement uncertainty of 0.374%. This will bound the actual power level requested. The detailed basis value is provided in Enclosure 14 to the LAR, which addresses the improved FW flow measurement accuracy using the Cameron Leading Edge Flow Meter (LEFM) Check-Plus system.

1.5 SUMMARY AND CONCLUSIONS

This evaluation has investigated a TPO uprate to 101.6% of CLTP. The strategy for achieving higher power is to increase CF along the established MELLLA rod lines. The plant licensing challenges have been reviewed (Table 1-3) 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 for TPO Analyses

Task	Computer Code	Version or Revision	NRC Approved	Comments
Reactor Heat Balance	ISCOR	09	Y(1)	NEDE-24011P Rev. 0 SER
Reactor Core and Fuel Performance	ISCOR TGBLA PANAC	09 06 11	Y(1) Y(4) Y(4)	NEDE-24011P Rev. 0 SER NEDE-30130P-A NEDE-30130P-A
Thermal-Hydraulic Stability	ODYSY ISCOR PANAC TRACG	05 09 11 04	Y Y(1) Y(2) Y	NEDE-33213P-A NEDE-24011P Rev. 0 SER NEDE-30130-A NEDE-33147P-A Rev. 4
Piping Components Flow Induced Vibration (FIV)	SAP4G07	07	N(3)	NEDO-10909
Anticipated Transient Without Scram	ODYN STEMP PANACEA SHEX	10 04 11 05	Y (3) Y (2) Y (5)	NEDE-24154P-A Supplement 1, Vol. 4 NEDE-30130-P-A

* The application of these codes to the HCGS TPO analyses complies with the limitations, restrictions, and conditions specified in the approving NRC SER where applicable for each code.

Notes for Table 1-1:

(1) The ISCOR code is not approved by name. However, in the SER supporting approval of NEDE-24011P Revision 0 by the May 12, 1978 letter from D. G. Eisenhut (NRC) to R. Gridley (GE), the NRC finds the models and methods acceptable, and mentions the use of a digital computer code. The referenced digital computer code is ISCOR. The use of ISCOR to provide core thermal-hydraulic information in reactor internal pressure differences (RIPDs), transient, ATWS, stability, reactor core and fuel performance, and LOCA applications is consistent with the approved models and methods.

(2) The use of PANAC Version 11 was initiated following approval of Amendment 26 of GESTAR II by letter from S. A. Richards (NRC) to G. A. Watford (GE) Subject: "Amendment 26 to GE Licensing Topical Report NEDE-24011P-A, "GESTAR II" - Implementing Improved GE Steady-State Methods, (TAC No. MA6481)," November 10, 1999.

(3) Not a safety analysis code that requires NRC approval. The code application is reviewed and approved by GEH for "Level-2" application and is part of GEH's standard design process. Also, the application of this code has been used in previous power uprate submittals.

(4) The use of TGBLA Version 06 and PANAC Version 11 was initiated following approval of Amendment 26 of GESTAR II by letter from S. A. Richards (NRC) to G. A. Watford (GE) Subject: "Amendment 26 to GE Licensing Topical Report NEDE-24011P-A, "GESTAR II" - Implementing Improved GE Steady-State Methods, (TAC No. MA6481)," November 10, 1999.

(5) The application of the methodology in the SHEX code to the containment response is approved by the NRC in the letter to G. L. Sozzi (GE) from A. Thadani (NRC), "Use of the SHEX Computer Program and ANSI/ANS 5.1-1979 Decay Heat Source Term for Containment Long-Term Pressure and Temperature Analysis," July 13, 1993 (Reference 14).

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

Parameter	CLTP	TPO RTP (101.6% of CLTP)
Thermal Power (MWt) (Percent of Current Licensed Power)	3,840 100.0	3,902 101.6
Steam Flow (Mlbm/hr) (Percent of Current Rated)	16.770 100.0	17.086 101.9
FW Flow (Mlbm/hr) (Percent of Current Rated)	16.738 100.0	17.054 101.9
Dome Pressure (psia)	1,020	1,020
Dome Temperature (°F)	547.1	547.1
FW Temperature (°F)	431.6	433.5
Full Power Core Flow Range (Mlbm/hr) (Percent of Current Rated)	94.8 to 105.0 (94.8 to 105.0)	97.1 to 105.0 (97.1 to 105.0)

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

Key Licensing Criteria	Effect of 1.6% Thermal Power Increase	Explanation of Effect
LOCA challenges to fuel (10 CFR 50, Appendix K)	No increase in peak clad temperature (PCT), no change of maximum linear heat generation rate (LHGR) required.	Previous analysis accounted for 102% of licensed power, bounding TPO operation. No vessel pressure increase.
Change of operating limit MCPR (OLMCPR)	< 0.01 increase.	Minor increase (< 0.01) due to slightly higher power density and increased minimum critical power ratio (MCPR) safety limit (SL) (slightly flatter radial power distribution).
Challenges to reactor pressure vessel (RPV) overpressure	No increase in peak pressure.	No increase because the previous analysis accounted for ≥ 102% overpower, bounding TPO operation.
Primary containment pressure during a LOCA	No increase in peak containment pressure.	Previous analysis accounted for 102% overpower, bounding TPO operation. No vessel pressure increase. No increase in energy to the pool.
Suppression pool temperature during a LOCA	No increase in peak suppression pool temperature.	Previous analysis accounted for 102% overpower, bounding TPO operation. No vessel pressure increase. No increase in energy to the suppression pool.
Offsite radiation release, DBAs	No increase (remains within 10 CFR 50.67).	Previous analysis bounds TPO operation. No RPV pressure increase.
Onsite radiation dose, normal operation	Approximately 1.7% increase. Must remain within 10 CFR 20 limits.	Slightly higher inventory of radionuclides in steam/FW flow paths.
Heat discharge to environment	Less than 1°F temperature increase.	Small (1.6%) power increase.
Equipment qualification	Remains within current pressure, radiation, and temperature envelopes.	No change in harsh environment terms (TPO operating conditions bounded by previous analyses); minimal change in normal operating conditions.
Fracture toughness, 10 CFR 50, Appendix G	≤ 2°F increase in reference temperature of the nil-ductility transition (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-CF 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	No change. Remains within existing American Society of Mechanical Engineers (ASME) Code "Emergency" category stress limit.	Previous analysis accounted for ≥ 102% of licensed power, bounding TPO operation. No change to the ATWS peak vessel pressure.
Vessel and NSSS equipment design pressure	No change.	Comply with existing ASME Code stress limits for all categories.

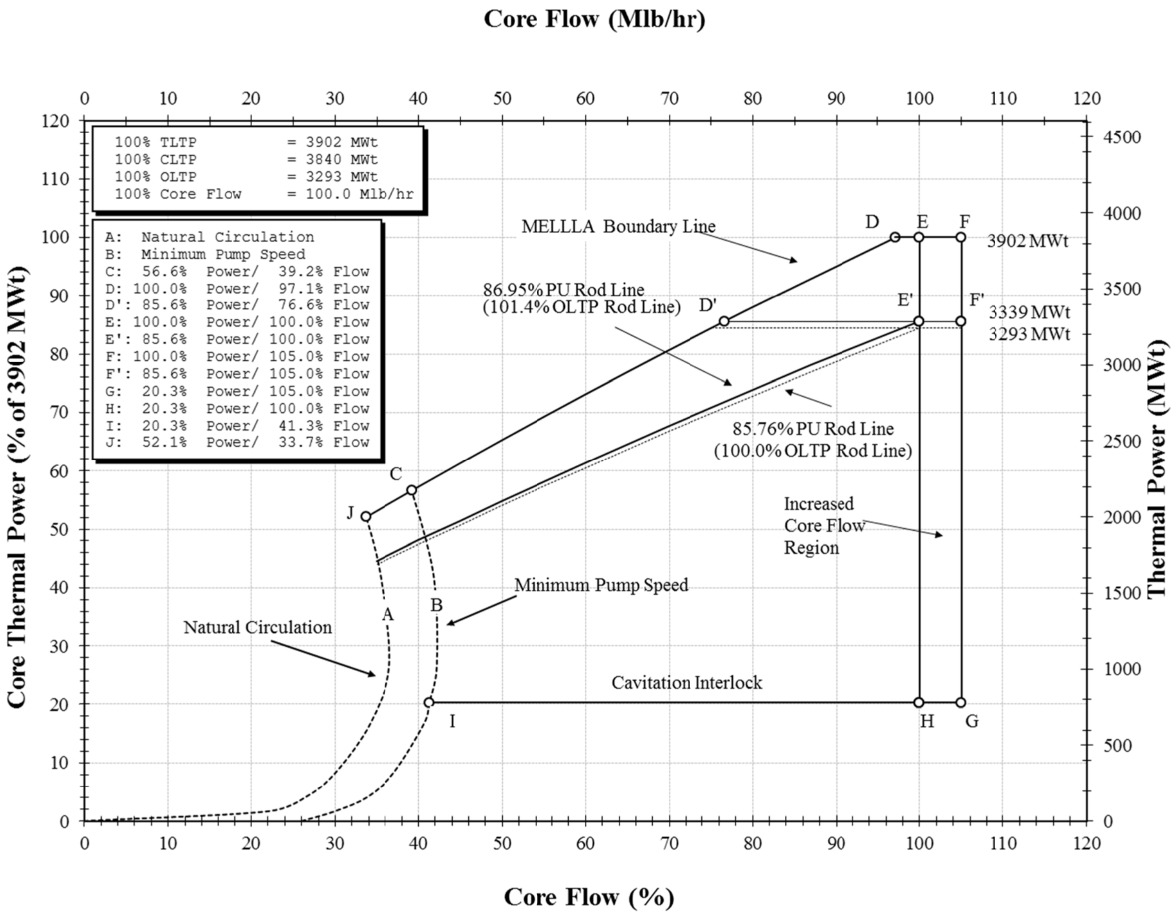
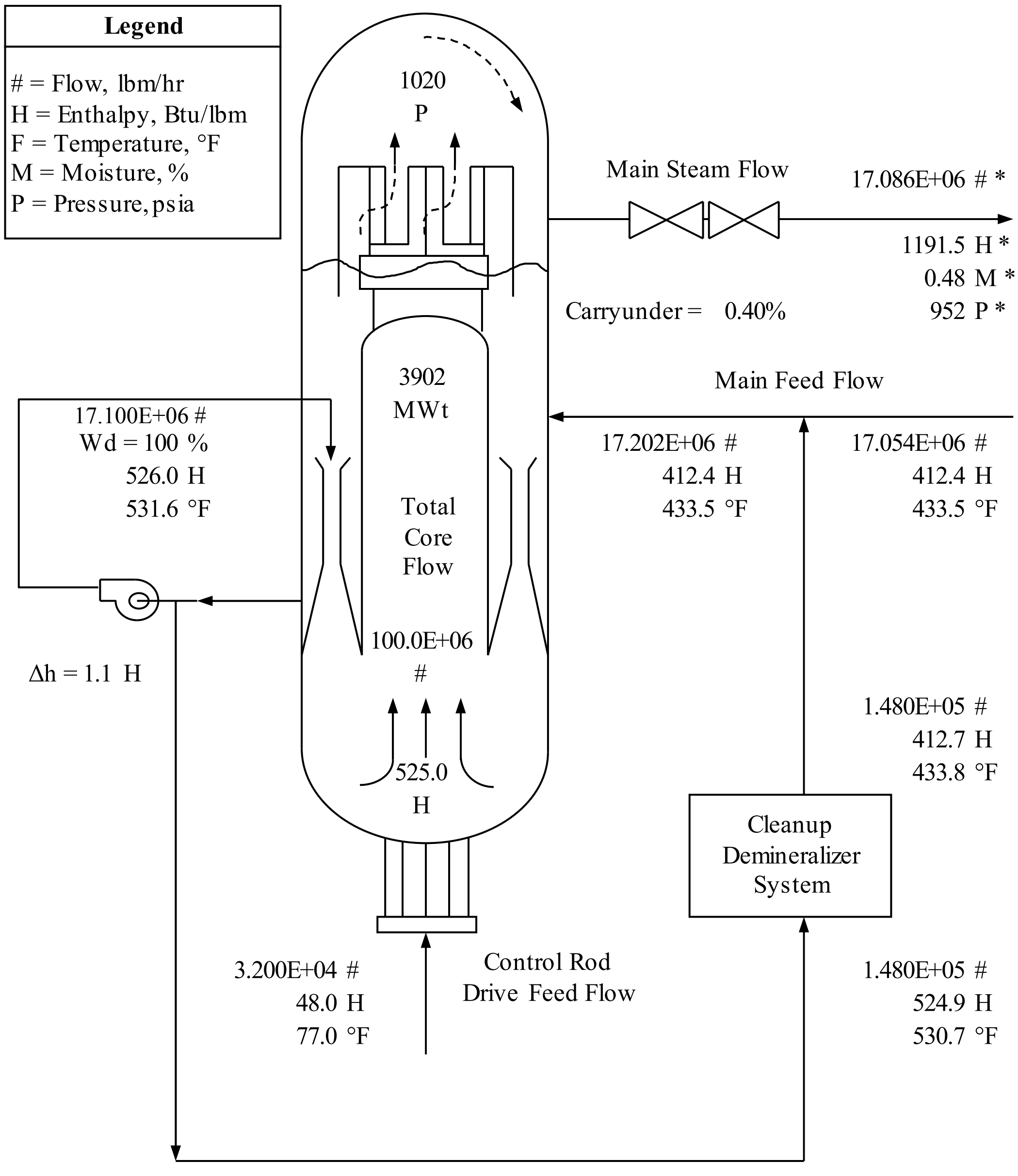


Figure 1-1 Power/Flow Map for TPO (101.6% of CLTP)



Core Thermal Power	3902.0
Pump Heating	10.7
Cleanup Losses	-4.9
Other System Losses	-2.6
Turbine Cycle Use	3905.2 MWt

Figure 1-2 Reactor Heat Balance – TPO Power (101.6% of CLTP), 100% CF

2.0 REACTOR CORE AND FUEL PERFORMANCE

This section addresses the evaluations that are applicable to the TPO uprate of 3,902 MWt.

Because HCGS currently uses Global Nuclear Fuel (GNF) fuel designs, the following limitations and conditions from the Methods LTR SER (Reference 7) are not applicable to the HCGS TSAR:

Methods LTR SER Limitations and Conditions:

- Limitation and Condition 9.13: APPLICATION OF 10 WEIGHT PERCENT GD
- Limitation and Condition 9.21: MIXED CORE METHOD 1
- Limitation and Condition 9.22: MIXED CORE METHOD 2

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 CF 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.

The range of void fraction, axial and radial power shape, and rod positions in the core change slightly as a result of the TPO uprate. In accordance with Methods LTR SER Limitation and Condition 9.17, the predicted bypass void fraction at the D-Level local power range monitor (LPRM) satisfies the [[ ]] design requirement for TPO conditions. The steady-state bypass voiding is demonstrated on the MELLLA upper boundary at a bounding high power level of 3,906 MWt in Table 2-1.

As required by Methods LTR SER Limitation and Condition 9.24, the following core design and fuel monitoring parameters are plotted as indicated in Table 2-2 and Figures 2-1 through 2-6 for each cycle exposure statepoint of the TPO core design. The parameters are compared to the historical experience base reported in the Methods LTR (Reference 7), the HCGS Cycle 20 reload licensing analysis (RLA) core design with GE14 fuel, the HCGS Cycle 21 RLA core design with the first reload of GNF2 fuel and residual GE14 fuel, the HCGS equilibrium GNF2 CLTP analyses at 3,840 MWt reactor thermal power level, and the HCGS equilibrium GNF2 TPO analyses at a bounding high power level of 3,906 MWt:

Table 2-2	Peak Nodal Exposures
Figure 2-1	Power of Peak Bundle versus Cycle Exposure
Figure 2-2	Coolant Flow for Peak Bundle versus Cycle Exposure
Figure 2-3	Exit Void Fraction for Peak Power Bundle versus Cycle Exposure
Figure 2-4	Maximum Channel Exit Void Fraction versus Cycle Exposure
Figure 2-5	Core Average Exit Void Fraction versus Cycle Exposure
Figure 2-6	Peak LHGR versus Cycle Exposure

Also, as required by Methods LTR SER Limitation and Condition 9.24, quarter core maps with mirror symmetry are plotted in Figure 2-7 through Figure 2-17 showing bundle power, bundle operating LHGR, and MCPR for beginning of cycle (BOC) (0 MWd/ST), middle of cycle (MOC) (6,500 MWd/ST), and end of full power (final feedwater temperature reduction (FFWTR)) (11,655 MWd/ST) conditions. The maximum fraction of limiting power density (MFLPD) occurs at 10,940 MWd/ST cycle exposure (Figure 2-13) and the largest maximum fraction of limiting critical power ratio (MFLCPR) occurs at 9,865 MWd/ST cycle exposure (Figure 2-17) for the HCGS TPO equilibrium core design. In Figure 2-7 through Figure 2-9, the bundle power is dimensionless. To obtain the bundle power in MWt, multiply each number by a factor of 5.11. This factor equals 3,906/764, where 3,906 MWt is the TPO bounding high power level and 764 is the total number of fuel bundles in the core.

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 TS SL, some thermal limits monitoring limiting condition for operation (LCO) thresholds, and some surveillance requirement (SR) thresholds are based on [[

]]
The historical 25% RTP value is a conservative basis, as described in the plant TS; [[

]] For HCGS, the historical 25% RTP value was already reduced to 24% of RTP (Reference 9). [[

]] Therefore, the SL percent RTP basis, some thermal limits monitoring LCOs, and SR percent RTP thresholds [[

]]

As required by Methods LTR SER Limitation and Condition 9.6, the GNF2 bundle R-factors generated for the TPO uprate are consistent with GNF standard design practices, which use an axial void profile shape with 60% average in-channel voids. This is consistent with lattice axial void conditions expected for the hot channel operating state as shown in Figure 2-18.

As required by Methods LTR SER Limitation and Condition 9.15, the nodal void reactivity biases applied in TRACG are applicable to the lattices representative of fuel loaded in the core.

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 SLMCPR is calculated for the first TPO fuel cycle and confirmed for each subsequent cycle. The historical uncertainty allowance and calculational methods are discussed in TLTR Section 5.7.2.1.

2.2.2 MCPR Operating Limit

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

]] 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 Maximum LHGR Operating Limits

The maximum average planar linear heat generation rate (MAPLHGR) and maximum LHGR limits are maintained as described in TLTR Section 5.7.2.2. No significant change results due to TPO operation. The LHGR limits are fuel dependent and are not affected by the TPO. The ECCS performance is addressed in Section 4.3.

2.2.4 Power-to-Flow Ratio

Methods LTR SER Limitation and Condition 9.3 requires that plant-specific EPU and expanded operating domain applications confirm that the core thermal power to CF ratio will not exceed 50 MWt/Mlbm/hr at any state point in the allowed operating domain. For plants that exceed the P/F value of 50 MWt/Mlbm/hr, the LAR will include a power distribution assessment to establish that axial and nodal power distribution uncertainties determined via neutronic methods have not increased.

The core thermal power to CF ratio at steady-state conditions along the MELLLA upper boundary is reported in Table 2-3. At Statepoint D (118.6% OLTP and 97.3% CF), the core P/F ratio is 40.14 MWt/Mlbm/hr, which does not exceed the core P/F ratio of 50 MWt/Mlbm/hr. Therefore, no power distribution assessment is required.

2.3 Reactivity Characteristics

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

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

2.4 THERMAL HYDRAULIC STABILITY

2.4.1 Detect and Suppress Solution – Confirmation Density

HCGS will operate under the requirements of the stability long-term solution (LTS) DSS-CD (Reference 15) consistent with the DSS-CD LTR (Reference 8), including any limitations and conditions in the applicable DSS-CD LTR SER (Reference 8). The DSS-CD stability solution has been shown to provide an early trip signal upon instability inception for both core wide and regional mode oscillations.

The DSS-CD solution monitors oscillation power range monitor (OPRM) signals to determine when a reactor scram is required. The OPRM signal is evaluated by the DSS-CD stability algorithms to determine when the signal is becoming sufficiently periodic and large to warrant a reactor scram to disrupt the oscillation (Reference 8).

[[

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The plant-specific application demonstrates that the analyses and evaluations supporting DSS-CD are applicable to the fuel loaded in the core and the new operating power. [[

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2.4.2 Thermal Limits Monitoring Threshold

For HCGS, the thermal limits monitoring threshold is 24.0% of CLTP. Due to operational considerations, HCGS will maintain the thermal limits monitoring threshold at 24.0% of TPO power. Maintaining the current thermal limits monitoring threshold for TPO is acceptable because of the large excess thermal margins that exist at the CLTP thermal limits monitoring threshold. Maintaining the current threshold in percent power only results in a threshold increase of 15 MWt, which is not significant.

Therefore, at TPO conditions, the thermal limits monitoring threshold for HCGS is 24.0% of TPO power.

2.4.3 Armed Region

The OPRM system may only cause a scram when plant operation is in the Armed Region. Per the DSS-CD LTR, the OPRM Armed Region is generically defined as the region on the P/F map at the thermal limits monitoring threshold at 25% OLTP and flow ≤ 70% rated recirculation drive flow (Reference 8). For a power-uprated plant, the thermal limits monitoring threshold may be scaled to a lower percent value. The rescaled thermal limits monitoring threshold becomes the new power boundary for the OPRM Armed Region boundary. For HCGS, at TPO conditions, the OPRM Armed Region power boundary remains at 24.0% of TPO power, consistent with Section 2.4.2.

The OPRM Armed Region for HCGS TPO is defined as the region on the P/F map with power ≥ 24.0% of TPO power and flow ≤ 70% rated recirculation drive flow. The OPRM Armed Region for HCGS is illustrated in Figure 2-19.

The minimum power level at which the OPRM should be confirmed operable is 19.0% TPO power. A 5% absolute power separation between the OPRM Armed Region power boundary and the power at which the OPRM system should be confirmed operable is deemed adequate for the DSS-CD application.

Therefore, the Armed Region is deemed acceptable for TPO operation.

2.4.4 Backup Stability Protection

Two backup stability protection (BSP) options are presented in this section and summarized in Reference 8 Section 7.5. Both options provide adequate protection for continued operation in the unlikely event the DSS-CD licensing basis algorithm cannot be demonstrated to provide its intended SLMCPR protection. The implementation of both options for HCGS is described in Reference 15.

The manual BSP regions are confirmed or established on a cycle-specific basis. Implementation of DSS-CD in accordance with the DSS-CD LTR (Reference 8) requires that HCGS confirm that the BSP approach is adequate as a part of the reload analysis. Because HCGS will implement the DSS-CD solution consistent with the requirements of the DSS-CD LTR, no further review of the BSP is required.

The automated backup stability protection (ABSP) setpoints [[ ]] are confirmed or established on a cycle-specific basis. Implementation of DSS-CD in accordance with the DSS-CD LTR (Reference 8) requires that HCGS confirm that the ABSP approach is adequate as a part of the reload analysis. Because HCGS will implement the DSS-CD solution consistent with the requirements of the DSS-CD LTR, no further review of the ABSP is required.

2.5 REACTIVITY CONTROL

The generic discussion in TLTR Section 5.6.3 and Appendix J.2.3.3 applies to HCGS. 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.

2.6 ADDITIONAL LIMITATIONS AND CONDITIONS RELATED TO REACTOR CORE AND FUEL PERFORMANCE

For that subset of limitations and conditions relating to reactor core and fuel design which did not fit conveniently into the organizational structure of the TLTR, the required information is presented here. The information is identified by the Methods LTR SER (Reference 7) limitation and condition to which it relates.

2.6.1 TGBLA/PANAC Version

As required by Methods LTR SER Limitation and Condition 9.1, in developing the HCGS equilibrium core, the latest versions of TGBLA and PANAC were used. Refer to Table 1-1 for the latest revisions to TGBLA and PANAC. Cycle-specific analyses will include the most recent TGBLA and PANAC versions.

2.6.2 LHGR and Exposure Qualification

Methods LTR SER Limitation and Condition 9.12 states that once the PRIME LTR and its application are approved, future license applications for EPU referencing LTR NEDC-33173P-A must utilize the PRIME thermal-mechanical (T-M) methods. The PRIME LTR was approved on January 22, 2010 (Reference 16) and implemented in GESTAR II in September 2010 (Reference 17). The HCGS TSAR is based on the GNF2 fuel product line, which has a PRIME T-M basis. PRIME fuel parameters are used in all analyses requiring fuel performance parameters.

The T-M evaluations performed in support of the HCGS TSAR are performed using the PRIME T-M methodology.

Table 2-1 Steady-State Bypass Voiding at Bounding High Power Level Conditions

State Point on Power/Flow Map [1]	Core Power (% of Rated)	Core Flow (% of Rated)	Hot Channel Void Fraction (%) in Bypass Region at Instrumentation D Level LPRM (ISCOR Node 21)	Hot Channel Void Fraction (%) in Bypass Region at Core Exit (ISCOR Node 24)
D	100.0	97.3	0.34	3.42
E	100.0	100.0	0.10	3.12
F	100.0	105.0	0.00	2.58

Note:

1. The domain Statepoints D, E, and F are identified on the HCGS P/F map shown in Figure 1-1 for the TPO bounding high power level conditions.

Table 2-2 Peak Nodal Exposures

Plant	Cycle	Peak Nodal Exposure (GWd/ST)
A	18	38.849
A	19	43.784
B	9	56.359
B	10	51.544
C	7	53.447
C	8	47.766
D	13	56.660
E	11	55.387
F	Equilibrium - 120% OLTP	51.174
HCGS RLA (GE14)	20	55.516
HCGS RLA (GNF2/GE14)	21	56.268
HCGS CLTP (GNF2)	Equilibrium – 116.6% OLTP	55.478
HCGS TPO (GNF2)	Equilibrium – 118.6% OLTP	54.523

Table 2-3 Core Power-to-Flow Ratio at Steady-State Bounding High Power Level Conditions

State Point on Power/Flow Map	Core Power MWt (% of rated)	Core Flow Mlbm/hr (% of rated)	Core Power-to-Flow Ratio (MWt/Mlbm/hr)
D	3906.0 (100.0)	97.3 (97.3)	40.14
E	3906.0 (100.0)	100.0 (100.0)	39.06
F	3906.0 (100.0)	105.0 (105.0)	37.20

Table 2-4 [[ ]]

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Notes:

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Table 2-5 [[ ]]

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Note:

[[ ]]

Table 2-6 [[ ]]

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Notes:

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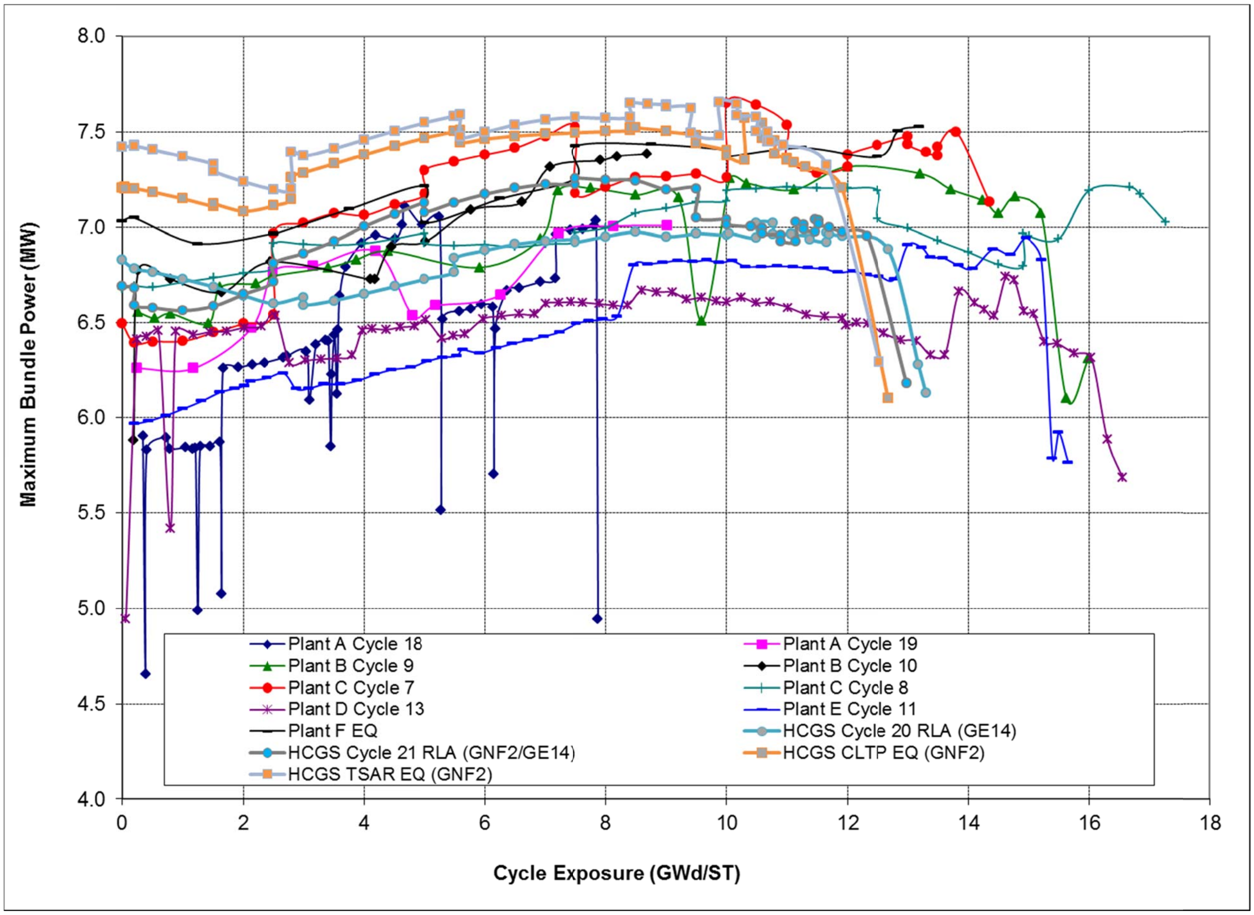


Figure 2-1 Power of Peak Bundle versus Cycle Exposure

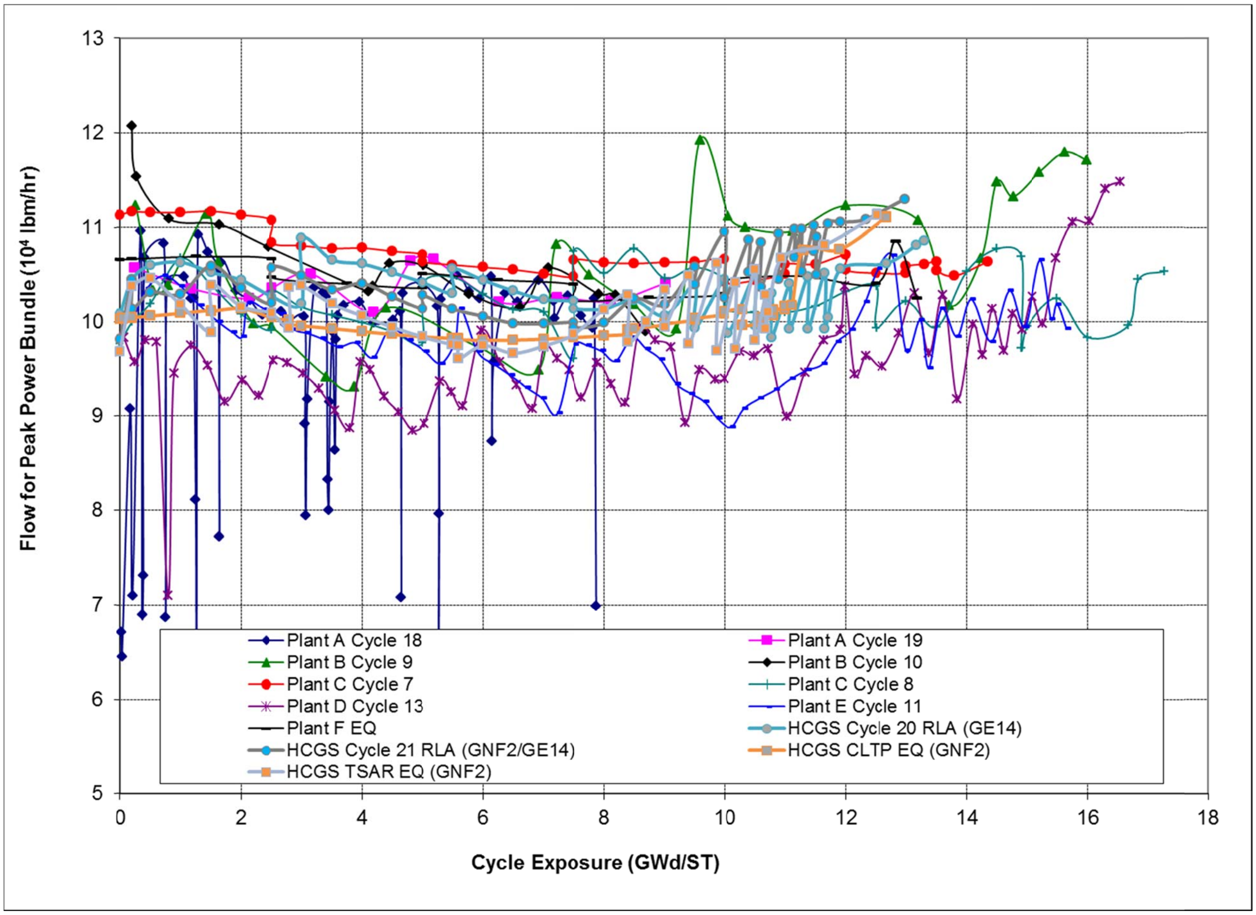


Figure 2-2 Coolant Flow for Peak Bundle versus Cycle Exposure

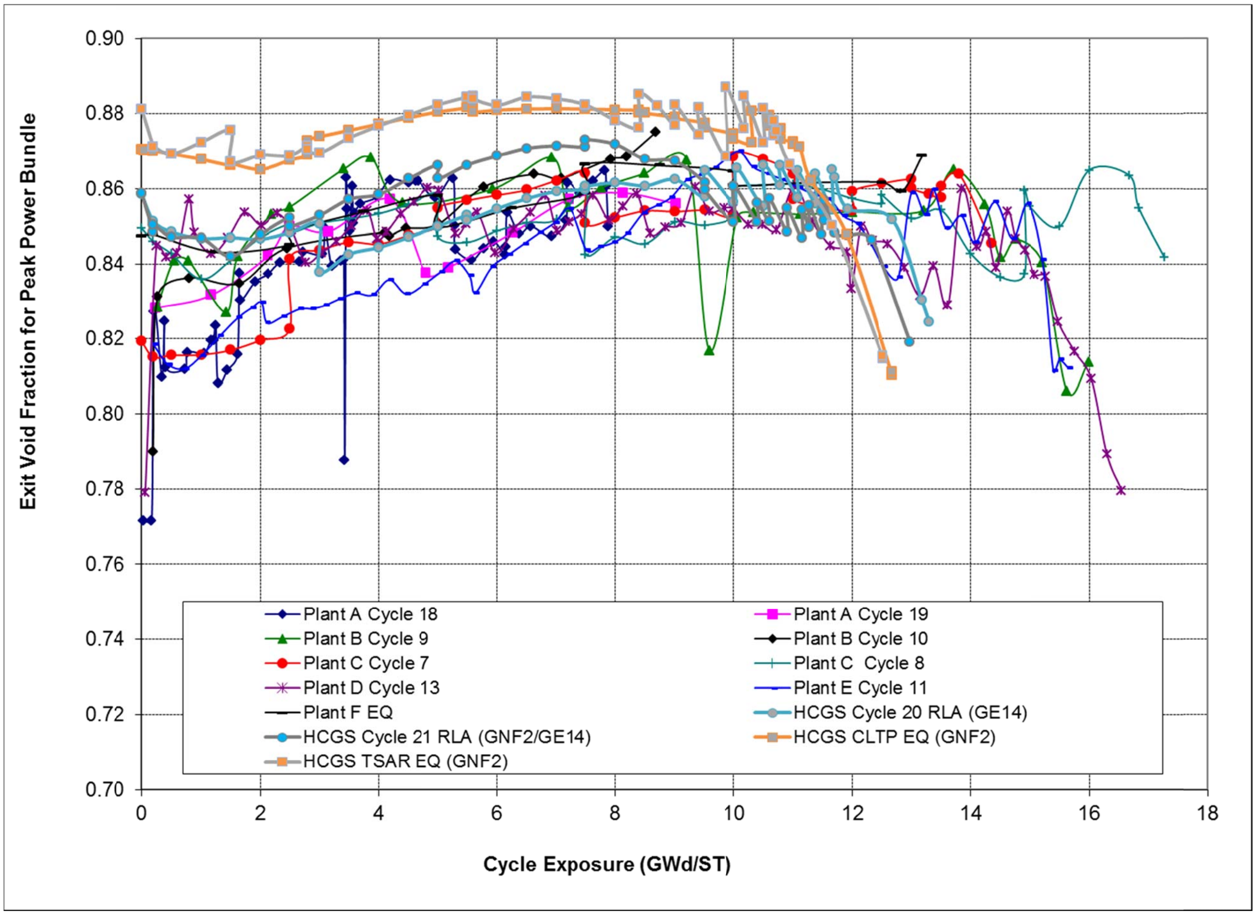


Figure 2-3 Exit Void Fraction for Peak Power Bundle versus Cycle Exposure

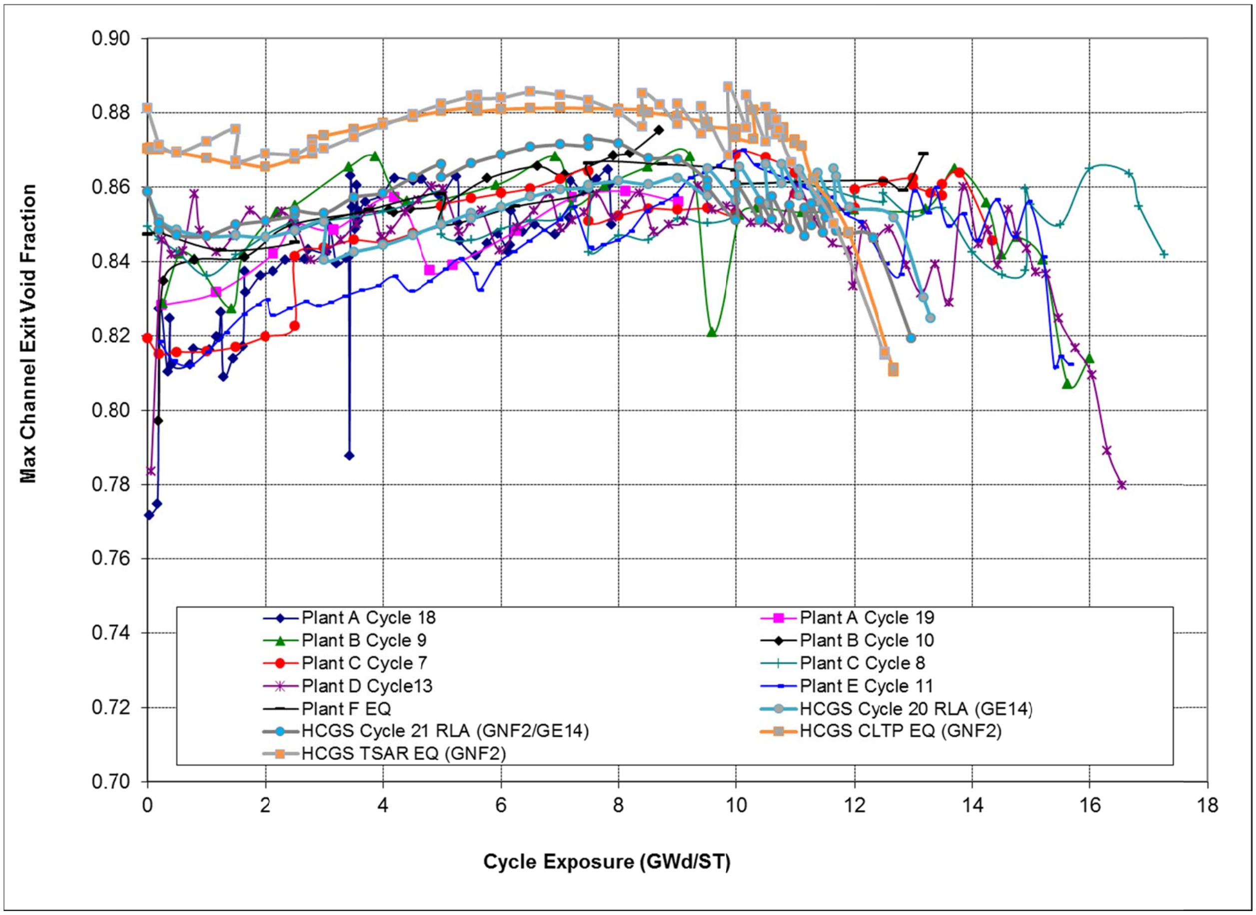


Figure 2-4 Maximum Channel Exit Void Fraction versus Cycle Exposure

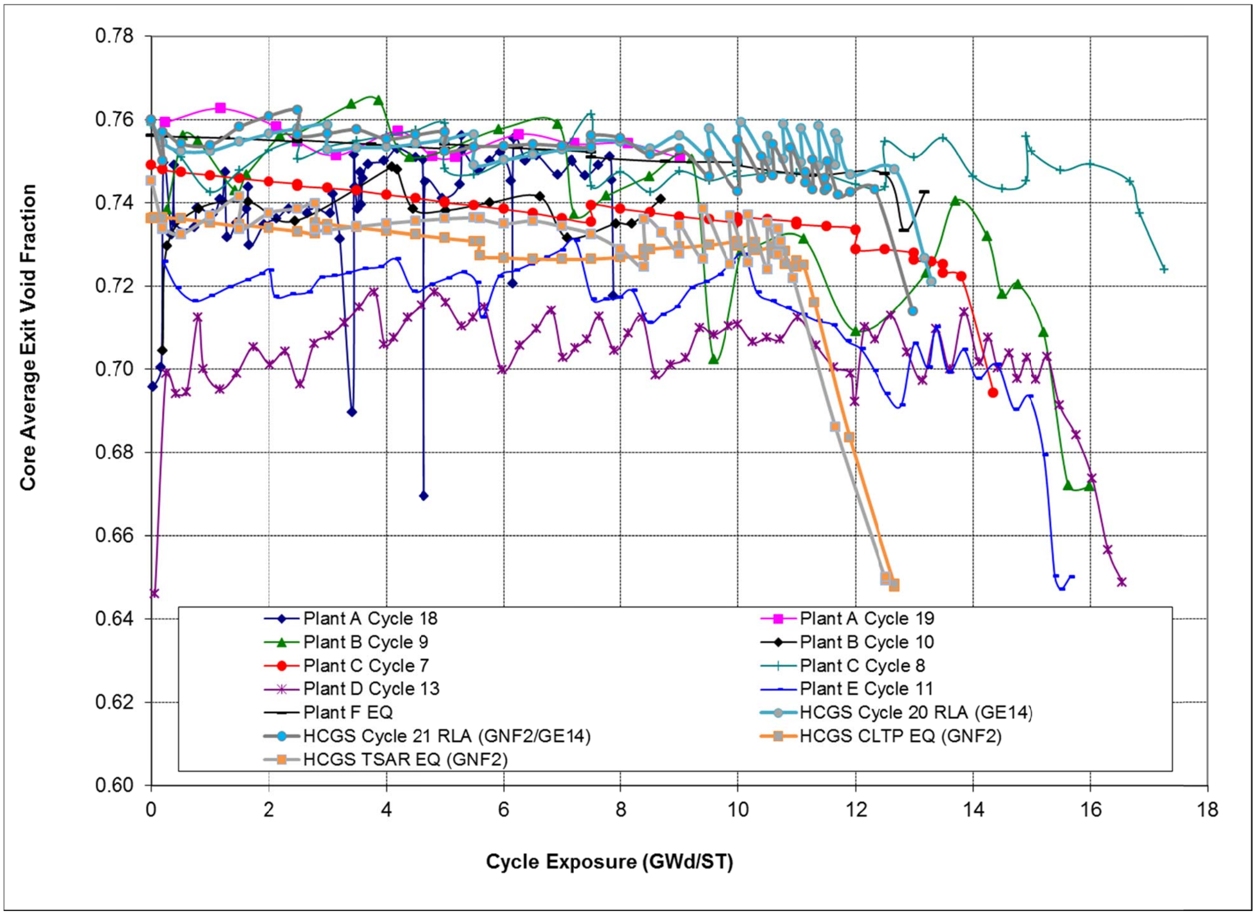


Figure 2-5 Core Average Exit Void Fraction versus Cycle Exposure

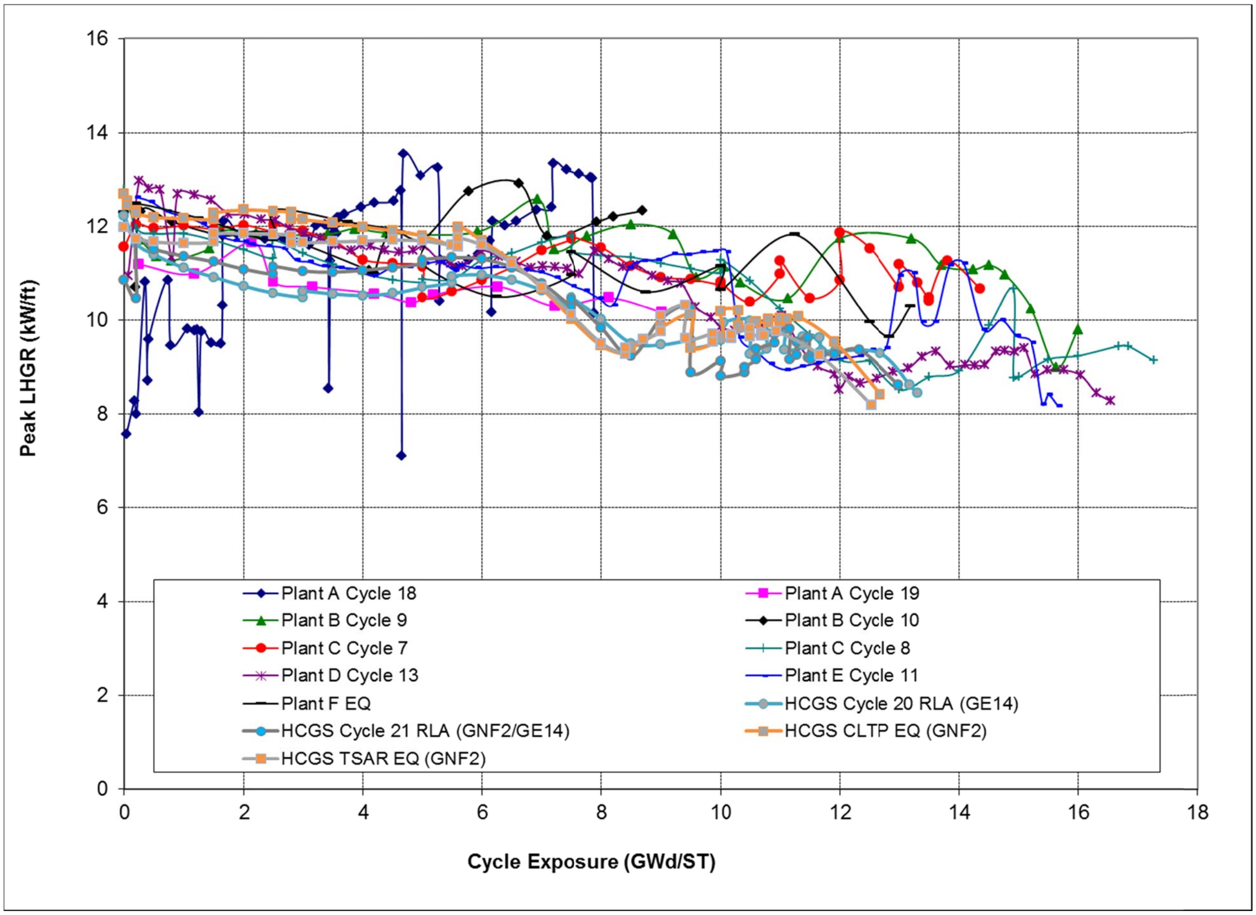


Figure 2-6 Peak LHGR versus Cycle Exposure

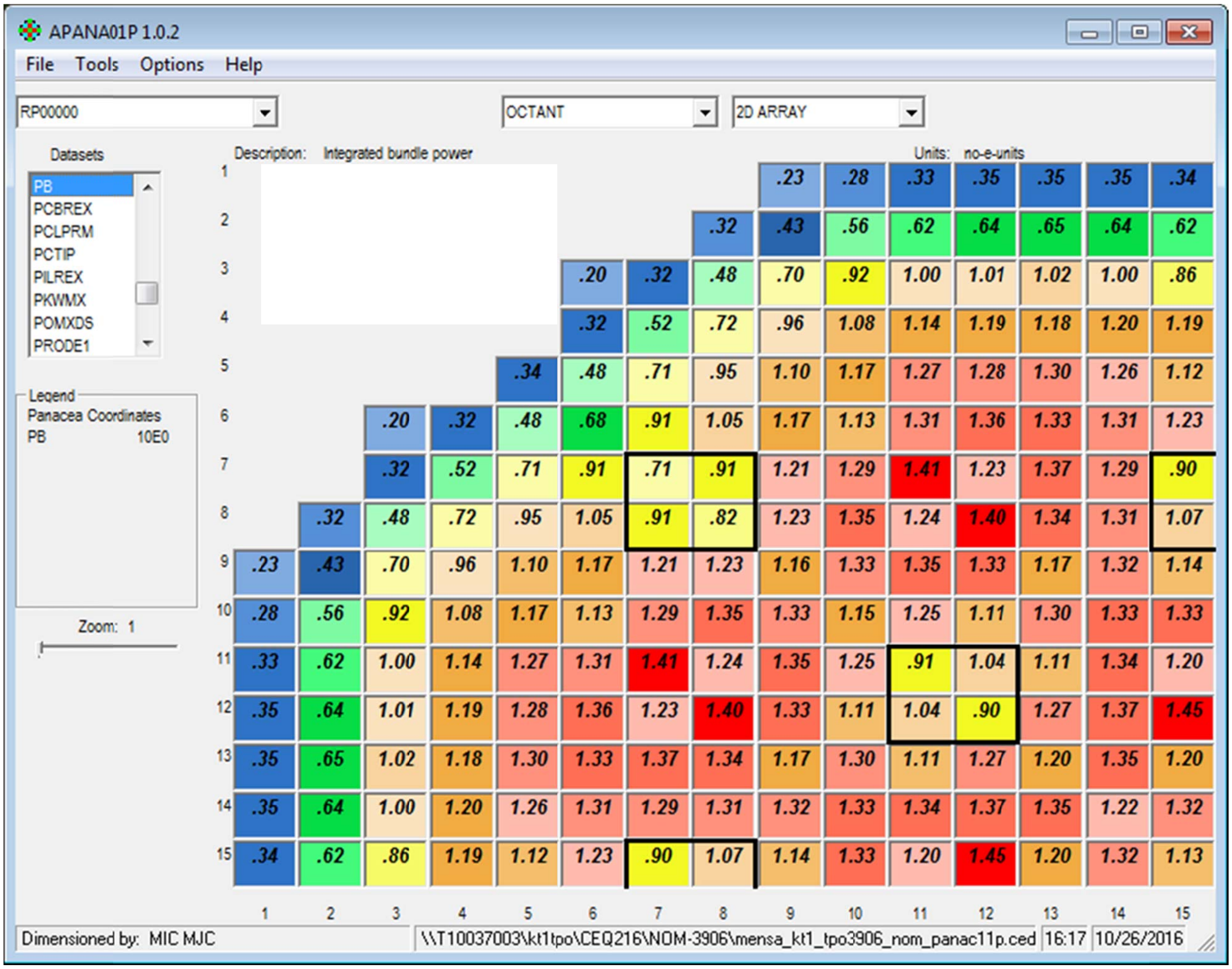
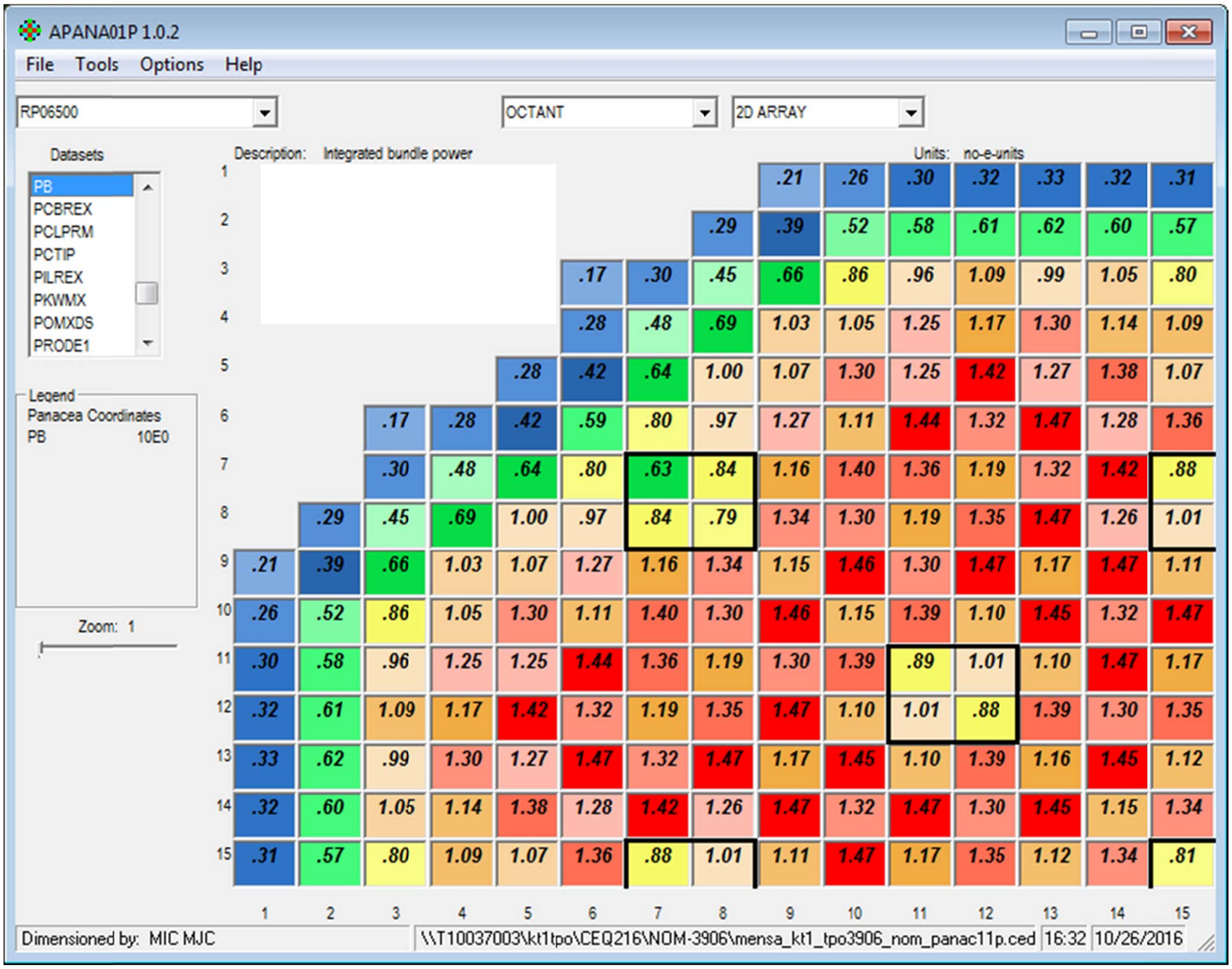
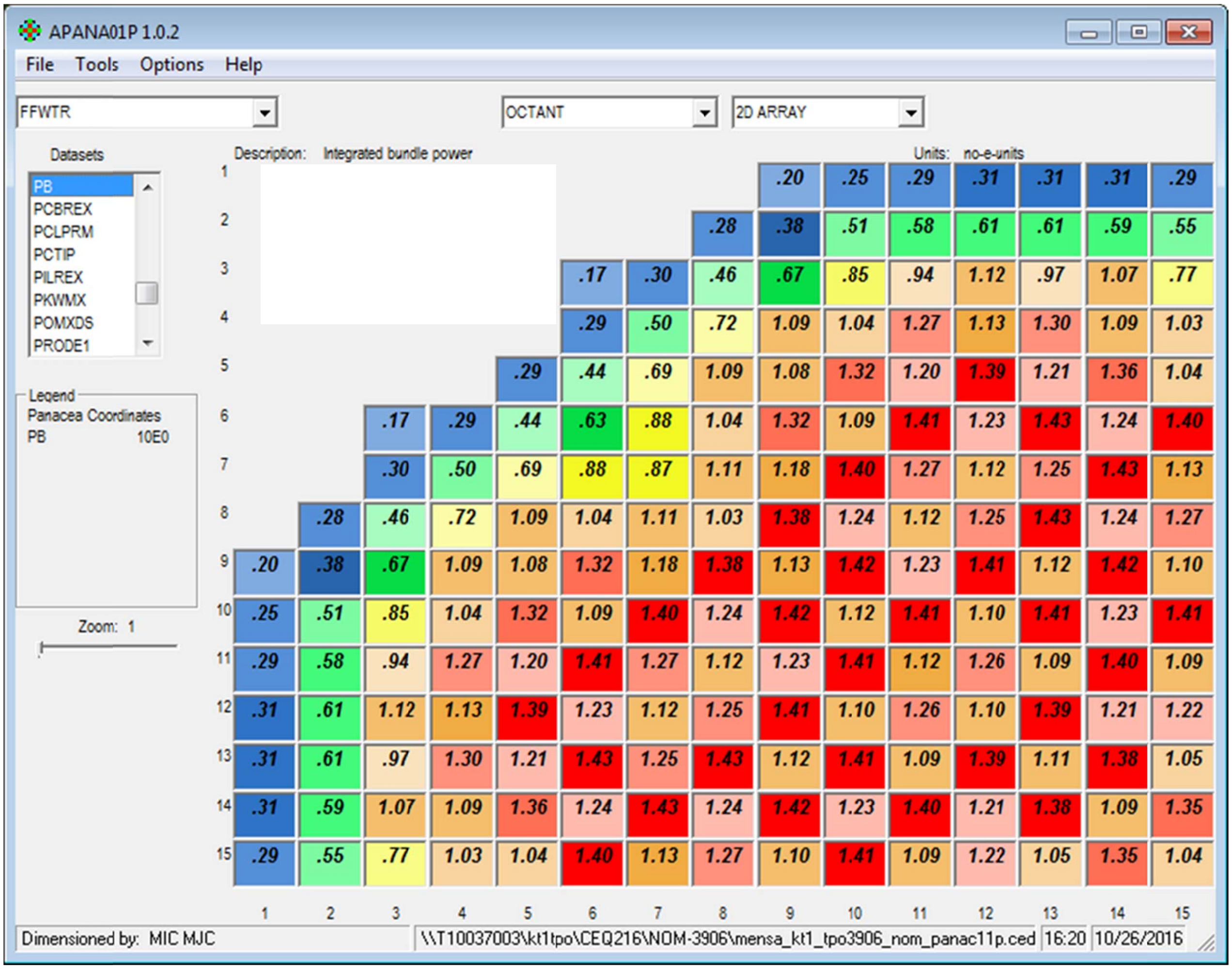


Figure 2-7 Dimensionless Bundle Power at BOC (0 MWd/ST)



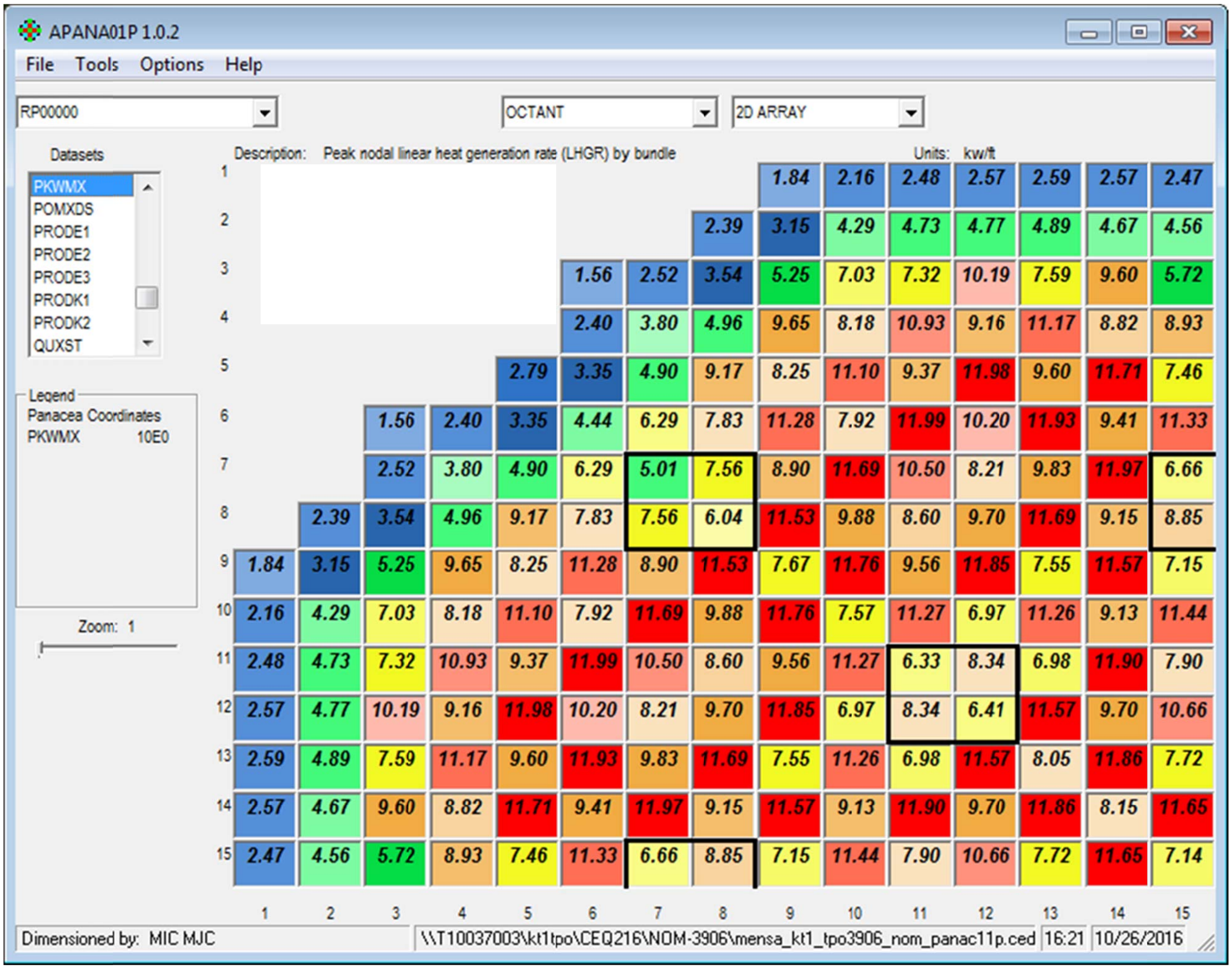
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1									.21	.26	.30	.32	.33	.32	.31
2								.29	.39	.52	.58	.61	.62	.60	.57
3						.17	.30	.45	.66	.86	.96	1.09	.99	1.05	.80
4						.28	.48	.69	1.03	1.05	1.25	1.17	1.30	1.14	1.09
5					.28	.42	.64	1.00	1.07	1.30	1.25	1.42	1.27	1.38	1.07
6			.17	.28	.42	.59	.80	.97	1.27	1.11	1.44	1.32	1.47	1.28	1.36
7			.30	.48	.64	.80	.63	.84	1.16	1.40	1.36	1.19	1.32	1.42	.88
8		.29	.45	.69	1.00	.97	.84	.79	1.34	1.30	1.19	1.35	1.47	1.26	1.01
9	.21	.39	.66	1.03	1.07	1.27	1.16	1.34	1.15	1.46	1.30	1.47	1.17	1.47	1.11
10	.26	.52	.86	1.05	1.30	1.11	1.40	1.30	1.46	1.15	1.39	1.10	1.45	1.32	1.47
11	.30	.58	.96	1.25	1.25	1.44	1.36	1.19	1.30	1.39	.89	1.01	1.10	1.47	1.17
12	.32	.61	1.09	1.17	1.42	1.32	1.19	1.35	1.47	1.10	1.01	.88	1.39	1.30	1.35
13	.33	.62	.99	1.30	1.27	1.47	1.32	1.47	1.17	1.45	1.10	1.39	1.16	1.45	1.12
14	.32	.60	1.05	1.14	1.38	1.28	1.42	1.26	1.47	1.32	1.47	1.30	1.45	1.15	1.34
15	.31	.57	.80	1.09	1.07	1.36	.88	1.01	1.11	1.47	1.17	1.35	1.12	1.34	.81

Figure 2-8 Dimensionless Bundle Power at MOC (6,500 MWd/ST)



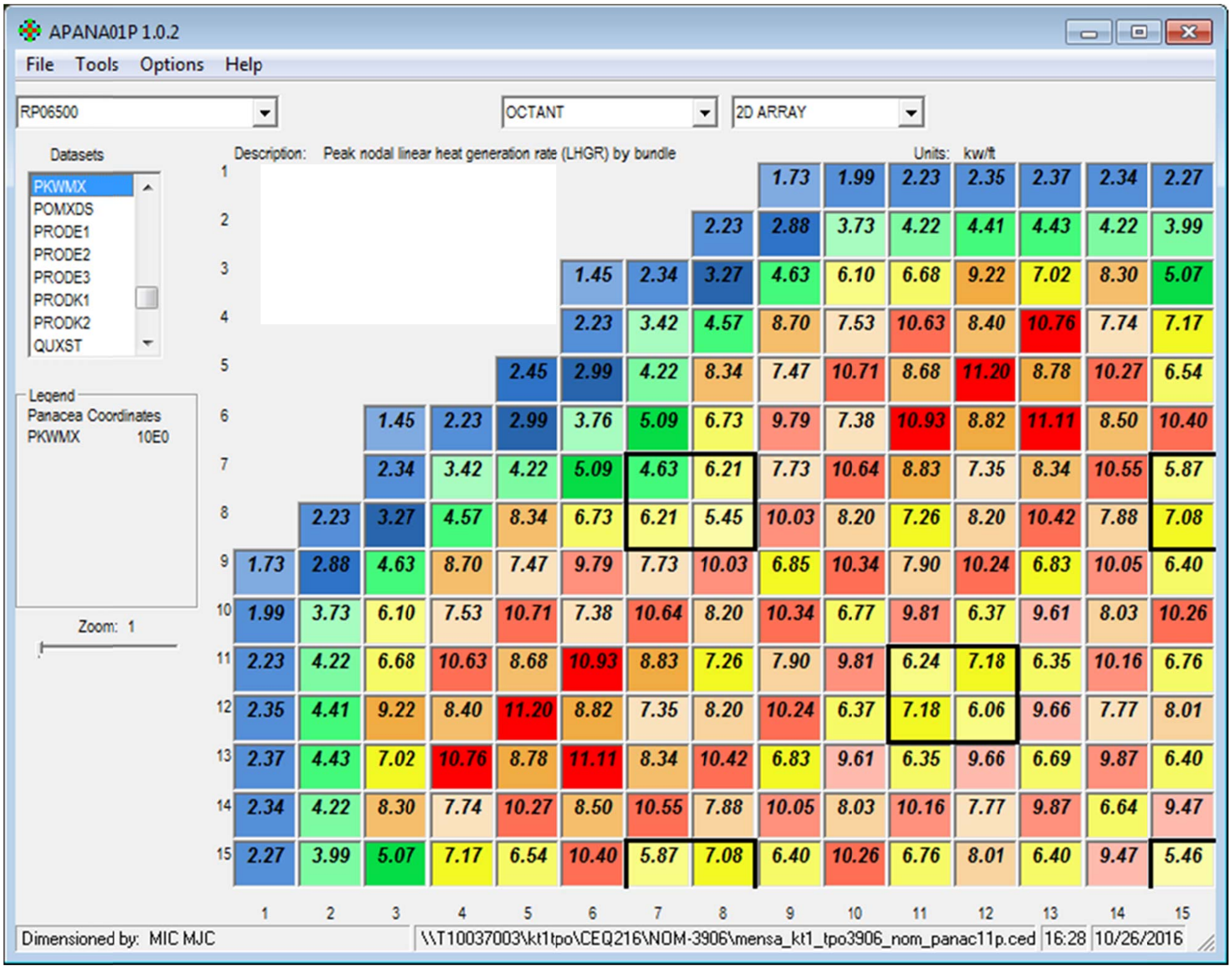
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1									.20	.25	.29	.31	.31	.31	.29
2								.28	.38	.51	.58	.61	.61	.59	.55
3						.17	.30	.46	.67	.85	.94	1.12	.97	1.07	.77
4						.29	.50	.72	1.09	1.04	1.27	1.13	1.30	1.09	1.03
5					.29	.44	.69	1.09	1.08	1.32	1.20	1.39	1.21	1.36	1.04
6			.17	.29	.44	.63	.88	1.04	1.32	1.09	1.41	1.23	1.43	1.24	1.40
7			.30	.50	.69	.88	.87	1.11	1.18	1.40	1.27	1.12	1.25	1.43	1.13
8		.28	.46	.72	1.09	1.04	1.11	1.03	1.38	1.24	1.12	1.25	1.43	1.24	1.27
9	.20	.38	.67	1.09	1.08	1.32	1.18	1.38	1.13	1.42	1.23	1.41	1.12	1.42	1.10
10	.25	.51	.85	1.04	1.32	1.09	1.40	1.24	1.42	1.12	1.41	1.10	1.41	1.23	1.41
11	.29	.58	.94	1.27	1.20	1.41	1.27	1.12	1.23	1.41	1.12	1.26	1.09	1.40	1.09
12	.31	.61	1.12	1.13	1.39	1.23	1.12	1.25	1.41	1.10	1.26	1.10	1.39	1.21	1.22
13	.31	.61	.97	1.30	1.21	1.43	1.25	1.43	1.12	1.41	1.09	1.39	1.11	1.38	1.05
14	.31	.59	1.07	1.09	1.36	1.24	1.43	1.24	1.42	1.23	1.40	1.21	1.38	1.09	1.35
15	.29	.55	.77	1.03	1.04	1.40	1.13	1.27	1.10	1.41	1.09	1.22	1.05	1.35	1.04

Figure 2-9 Dimensionless Bundle Power at EOC [FFWTR] (11,655 MWd/ST)



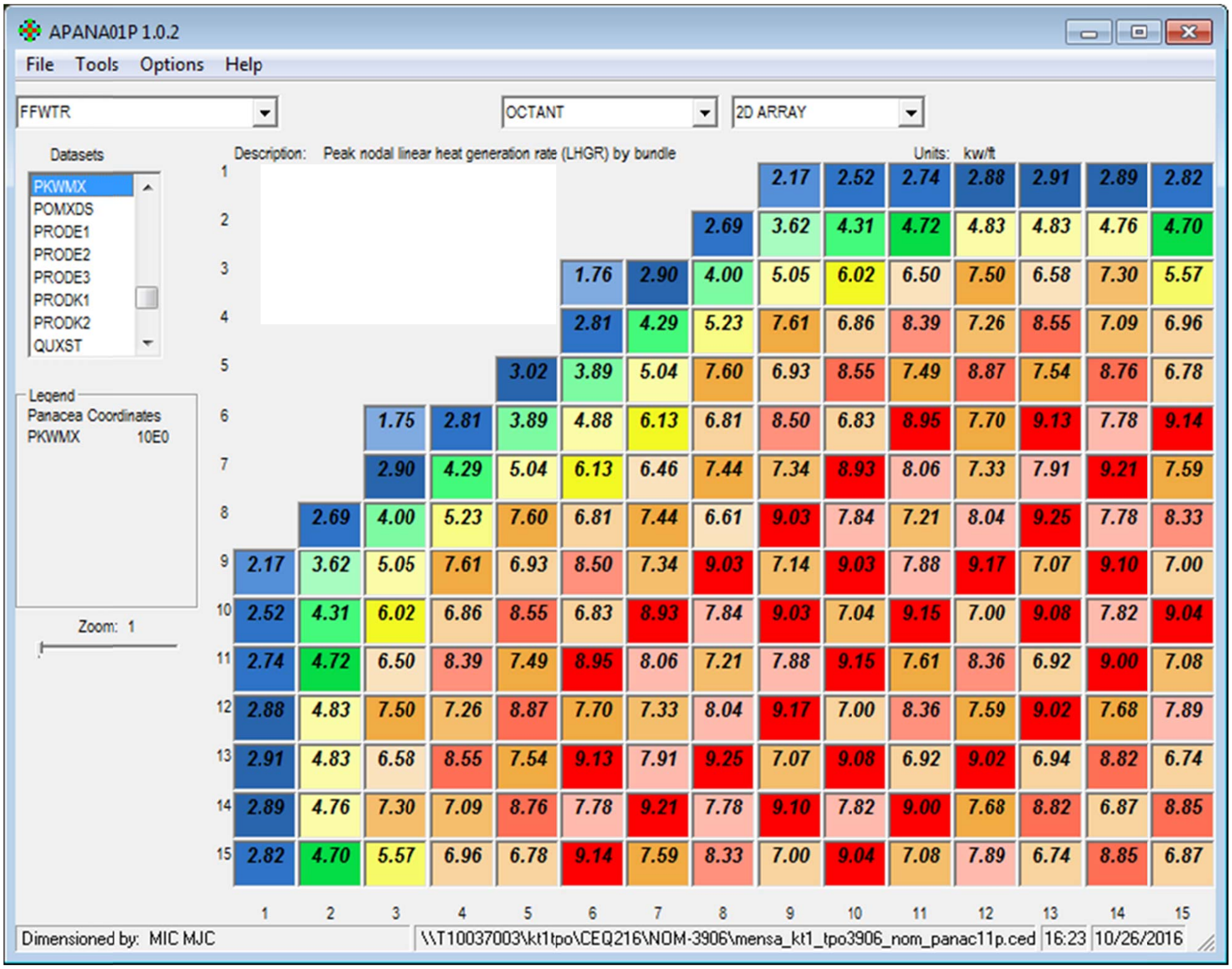
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1									1.84	2.16	2.48	2.57	2.59	2.57	2.47
2								2.39	3.15	4.29	4.73	4.77	4.89	4.67	4.56
3						1.56	2.52	3.54	5.25	7.03	7.32	10.19	7.59	9.60	5.72
4						2.40	3.80	4.96	9.65	8.18	10.93	9.16	11.17	8.82	8.93
5					2.79	3.35	4.90	9.17	8.25	11.10	9.37	11.98	9.60	11.71	7.46
6			1.56	2.40	3.35	4.44	6.29	7.83	11.28	7.92	11.99	10.20	11.93	9.41	11.33
7			2.52	3.80	4.90	6.29	5.01	7.56	8.90	11.69	10.50	8.21	9.83	11.97	6.66
8		2.39	3.54	4.96	9.17	7.83	7.56	6.04	11.53	9.88	8.60	9.70	11.69	9.15	8.85
9	1.84	3.15	5.25	9.65	8.25	11.28	8.90	11.53	7.67	11.76	9.56	11.85	7.55	11.57	7.15
10	2.16	4.29	7.03	8.18	11.10	7.92	11.69	9.88	11.76	7.57	11.27	6.97	11.26	9.13	11.44
11	2.48	4.73	7.32	10.93	9.37	11.99	10.50	8.60	9.56	11.27	6.33	8.34	6.98	11.90	7.90
12	2.57	4.77	10.19	9.16	11.98	10.20	8.21	9.70	11.85	6.97	8.34	6.41	11.57	9.70	10.66
13	2.59	4.89	7.59	11.17	9.60	11.93	9.83	11.69	7.55	11.26	6.98	11.57	8.05	11.86	7.72
14	2.57	4.67	9.60	8.82	11.71	9.41	11.97	9.15	11.57	9.13	11.90	9.70	11.86	8.15	11.65
15	2.47	4.56	5.72	8.93	7.46	11.33	6.66	8.85	7.15	11.44	7.90	10.66	7.72	11.65	7.14

Figure 2-10 Bundle Operating LHGR (kW/ft) at BOC (0 MWd/ST)



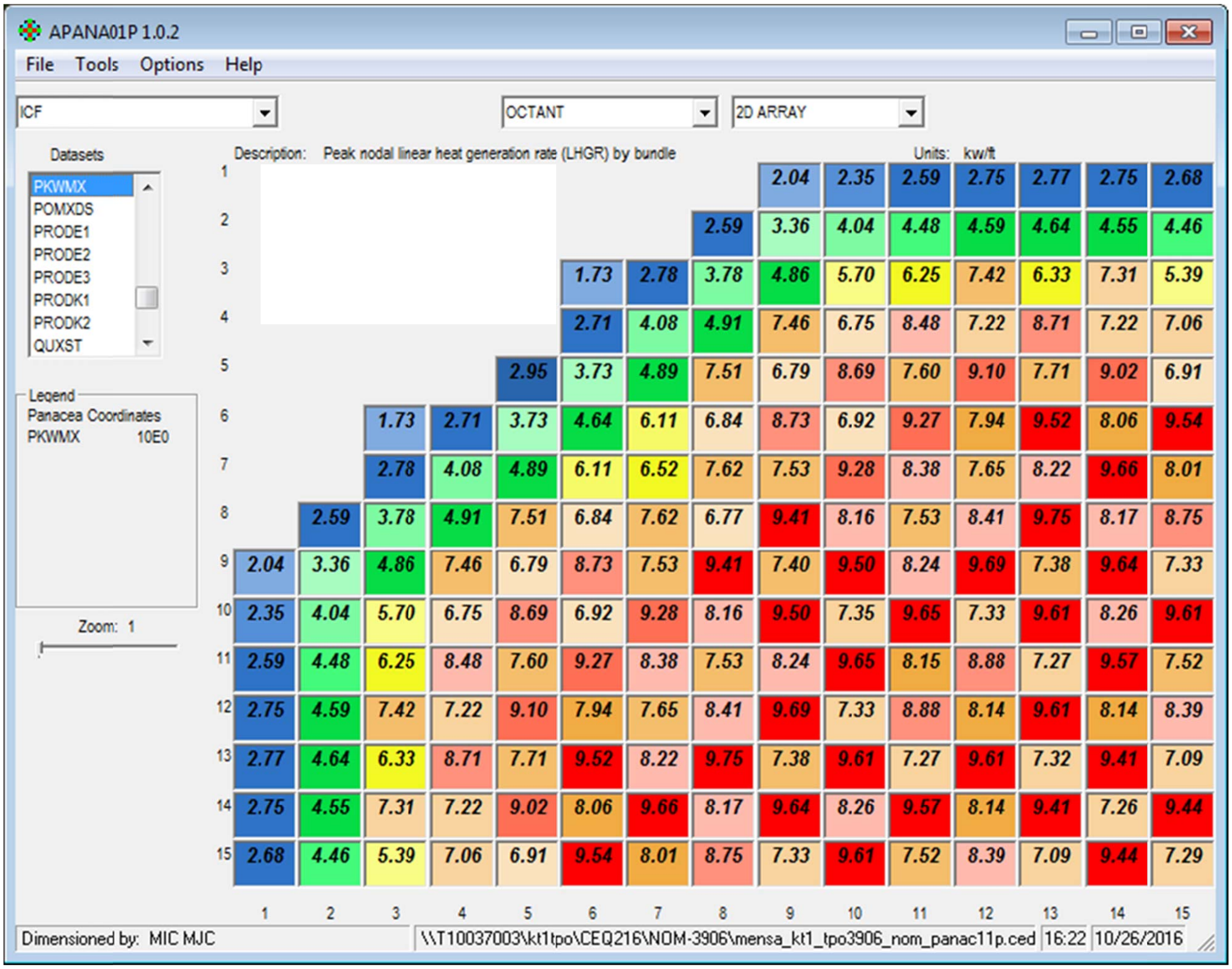
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1									1.73	1.99	2.23	2.35	2.37	2.34	2.27
2								2.23	2.88	3.73	4.22	4.41	4.43	4.22	3.99
3						1.45	2.34	3.27	4.63	6.10	6.68	9.22	7.02	8.30	5.07
4						2.23	3.42	4.57	8.70	7.53	10.63	8.40	10.76	7.74	7.17
5					2.45	2.99	4.22	8.34	7.47	10.71	8.68	11.20	8.78	10.27	6.54
6			1.45	2.23	2.99	3.76	5.09	6.73	9.79	7.38	10.93	8.82	11.11	8.50	10.40
7			2.34	3.42	4.22	5.09	4.63	6.21	7.73	10.64	8.83	7.35	8.34	10.55	5.87
8		2.23	3.27	4.57	8.34	6.73	6.21	5.45	10.03	8.20	7.26	8.20	10.42	7.88	7.08
9	1.73	2.88	4.63	8.70	7.47	9.79	7.73	10.03	6.85	10.34	7.90	10.24	6.83	10.05	6.40
10	1.99	3.73	6.10	7.53	10.71	7.38	10.64	8.20	10.34	6.77	9.81	6.37	9.61	8.03	10.26
11	2.23	4.22	6.68	10.63	8.68	10.93	8.83	7.26	7.90	9.81	6.24	7.18	6.35	10.16	6.76
12	2.35	4.41	9.22	8.40	11.20	8.82	7.35	8.20	10.24	6.37	7.18	6.06	9.66	7.77	8.01
13	2.37	4.43	7.02	10.76	8.78	11.11	8.34	10.42	6.83	9.61	6.35	9.66	6.69	9.87	6.40
14	2.34	4.22	8.30	7.74	10.27	8.50	10.55	7.88	10.05	8.03	10.16	7.77	9.87	6.64	9.47
15	2.27	3.99	5.07	7.17	6.54	10.40	5.87	7.08	6.40	10.26	6.76	8.01	6.40	9.47	5.46

Figure 2-11 Bundle Operating LHGR (kW/ft) at MOC (6,500 MWd/ST)



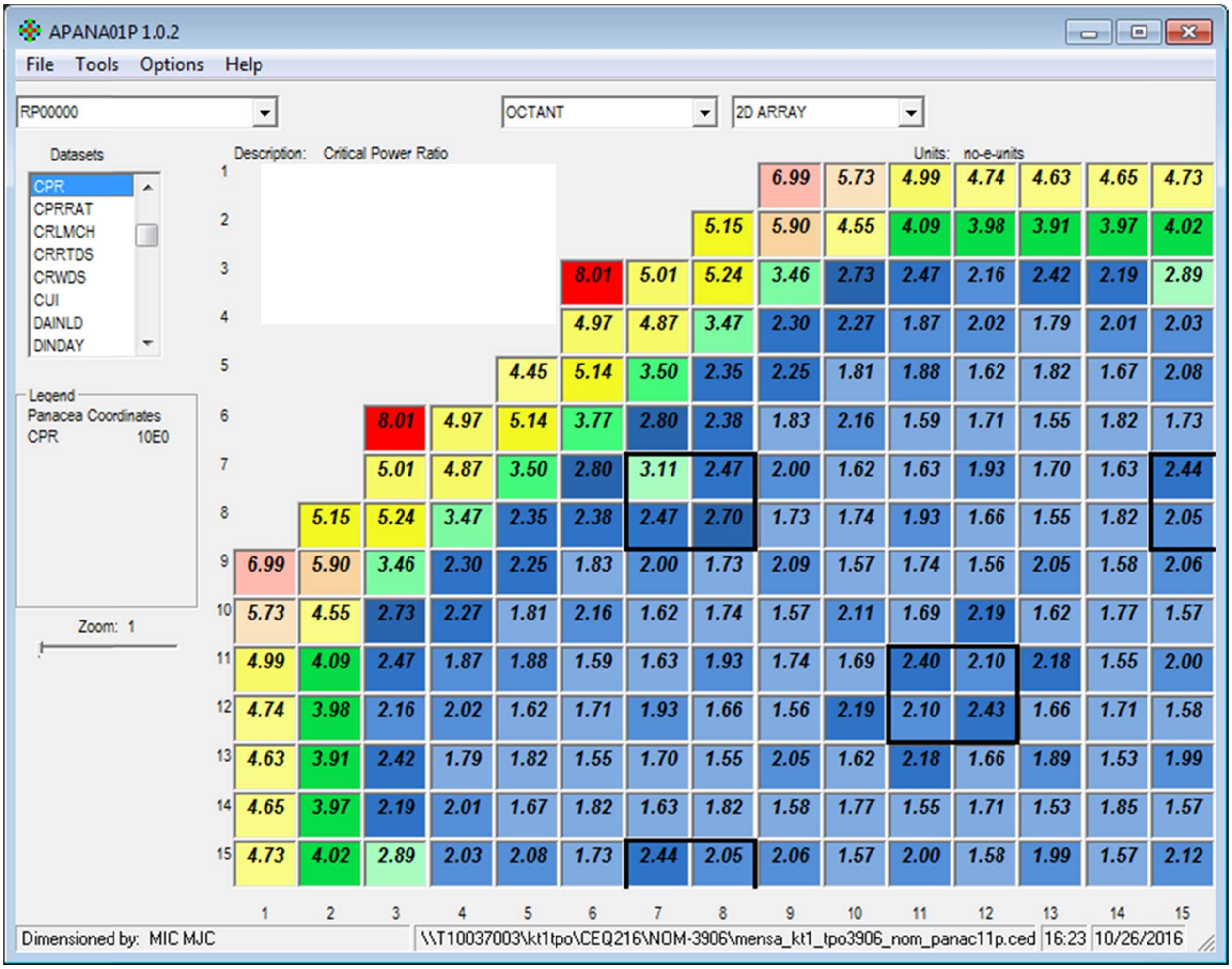
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1									2.17	2.52	2.74	2.88	2.91	2.89	2.82
2								2.69	3.62	4.31	4.72	4.83	4.83	4.76	4.70
3						1.76	2.90	4.00	5.05	6.02	6.50	7.50	6.58	7.30	5.57
4						2.81	4.29	5.23	7.61	6.86	8.39	7.26	8.55	7.09	6.96
5					3.02	3.89	5.04	7.60	6.93	8.55	7.49	8.87	7.54	8.76	6.78
6			1.75	2.81	3.89	4.88	6.13	6.81	8.50	6.83	8.95	7.70	9.13	7.78	9.14
7			2.90	4.29	5.04	6.13	6.46	7.44	7.34	8.93	8.06	7.33	7.91	9.21	7.59
8		2.69	4.00	5.23	7.60	6.81	7.44	6.61	9.03	7.84	7.21	8.04	9.25	7.78	8.33
9	2.17	3.62	5.05	7.61	6.93	8.50	7.34	9.03	7.14	9.03	7.88	9.17	7.07	9.10	7.00
10	2.52	4.31	6.02	6.86	8.55	6.83	8.93	7.84	9.03	7.04	9.15	7.00	9.08	7.82	9.04
11	2.74	4.72	6.50	8.39	7.49	8.95	8.06	7.21	7.88	9.15	7.61	8.36	6.92	9.00	7.08
12	2.88	4.83	7.50	7.26	8.87	7.70	7.33	8.04	9.17	7.00	8.36	7.59	9.02	7.68	7.89
13	2.91	4.83	6.58	8.55	7.54	9.13	7.91	9.25	7.07	9.08	6.92	9.02	6.94	8.82	6.74
14	2.89	4.76	7.30	7.09	8.76	7.78	9.21	7.78	9.10	7.82	9.00	7.68	8.82	6.87	8.85
15	2.82	4.70	5.57	6.96	6.78	9.14	7.59	8.33	7.00	9.04	7.08	7.89	6.74	8.85	6.87

Figure 2-12 Bundle Operating LHGR (kW/ft) at EOC [FFWTR] (11,655 MWd/ST)



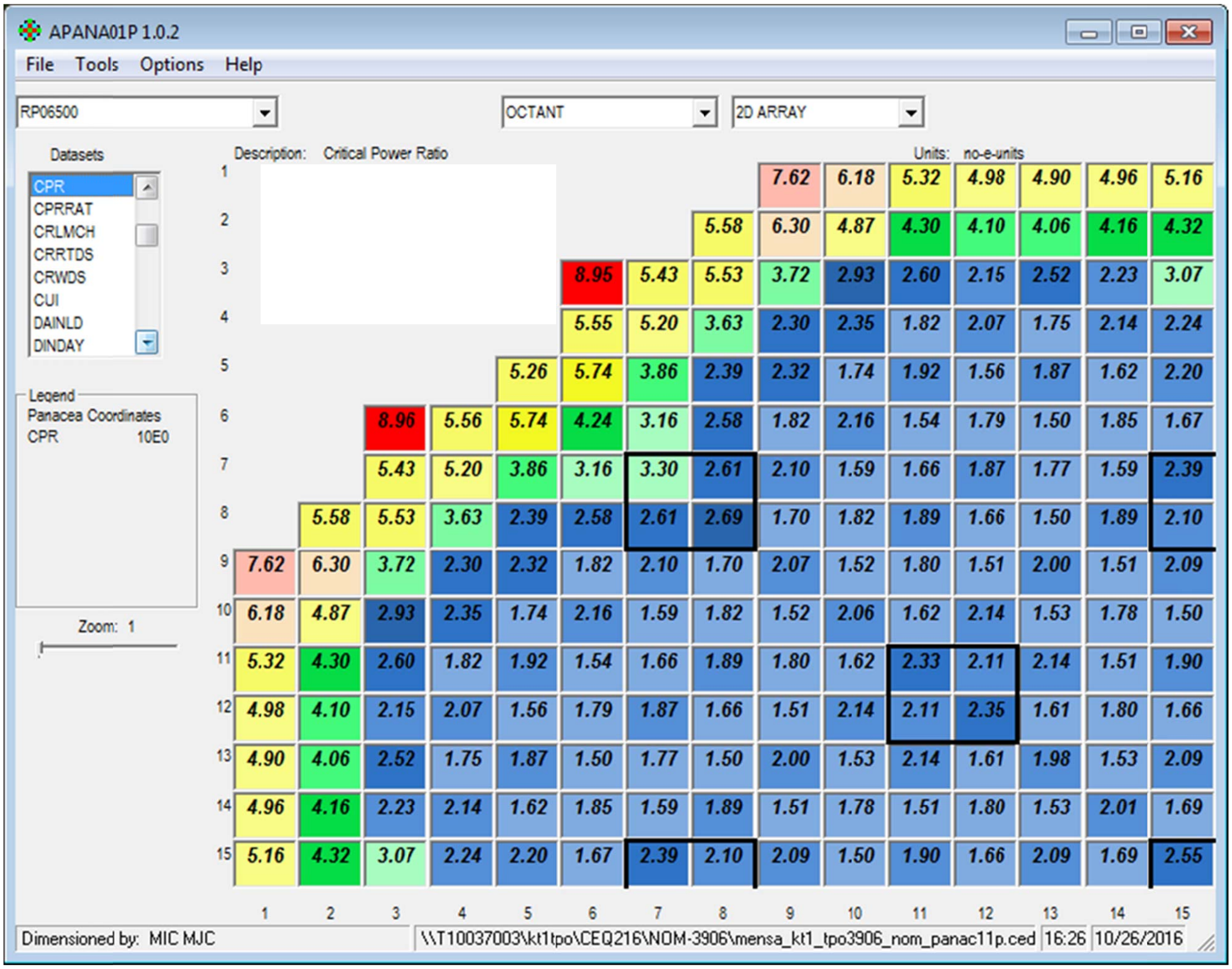
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1									2.04	2.35	2.59	2.75	2.77	2.75	2.68
2								2.59	3.36	4.04	4.48	4.59	4.64	4.55	4.46
3						1.73	2.78	3.78	4.86	5.70	6.25	7.42	6.33	7.31	5.39
4						2.71	4.08	4.91	7.46	6.75	8.48	7.22	8.71	7.22	7.06
5					2.95	3.73	4.89	7.51	6.79	8.69	7.60	9.10	7.71	9.02	6.91
6			1.73	2.71	3.73	4.64	6.11	6.84	8.73	6.92	9.27	7.94	9.52	8.06	9.54
7			2.78	4.08	4.89	6.11	6.52	7.62	7.53	9.28	8.38	7.65	8.22	9.66	8.01
8		2.59	3.78	4.91	7.51	6.84	7.62	6.77	9.41	8.16	7.53	8.41	9.75	8.17	8.75
9	2.04	3.36	4.86	7.46	6.79	8.73	7.53	9.41	7.40	9.50	8.24	9.69	7.38	9.64	7.33
10	2.35	4.04	5.70	6.75	8.69	6.92	9.28	8.16	9.50	7.35	9.65	7.33	9.61	8.26	9.61
11	2.59	4.48	6.25	8.48	7.60	9.27	8.38	7.53	8.24	9.65	8.15	8.88	7.27	9.57	7.52
12	2.75	4.59	7.42	7.22	9.10	7.94	7.65	8.41	9.69	7.33	8.88	8.14	9.61	8.14	8.39
13	2.77	4.64	6.33	8.71	7.71	9.52	8.22	9.75	7.38	9.61	7.27	9.61	7.32	9.41	7.09
14	2.75	4.55	7.31	7.22	9.02	8.06	9.66	8.17	9.64	8.26	9.57	8.14	9.41	7.26	9.44
15	2.68	4.46	5.39	7.06	6.91	9.54	8.01	8.75	7.33	9.61	7.52	8.39	7.09	9.44	7.29

Figure 2-13 Bundle Operating LHGR (kW/ft) at 10,940 MWd/ST [Peak MFLPD Point]



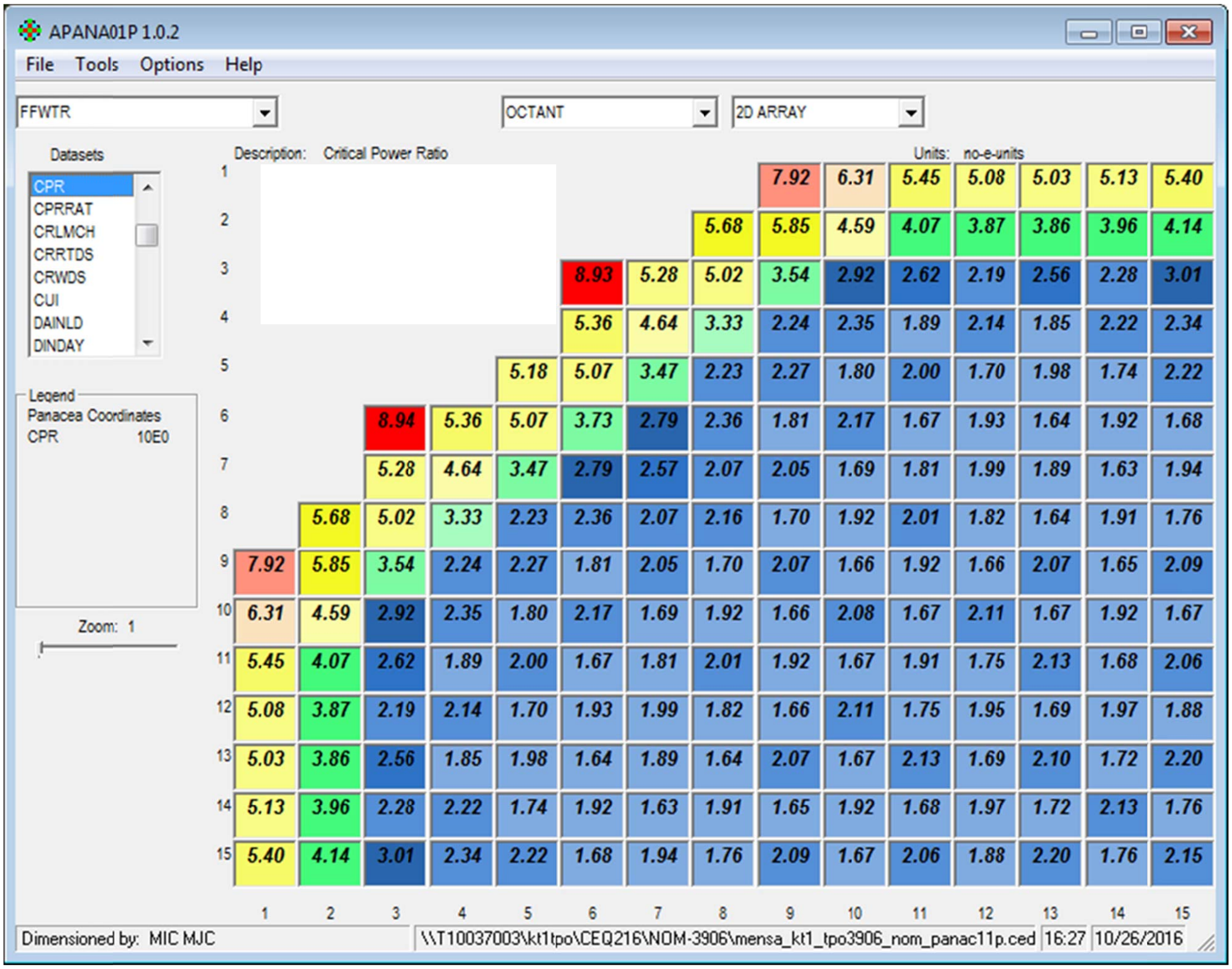
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1									6.99	5.73	4.99	4.74	4.63	4.65	4.73
2								5.15	5.90	4.55	4.09	3.98	3.91	3.97	4.02
3						8.01	5.01	5.24	3.46	2.73	2.47	2.16	2.42	2.19	2.89
4						4.97	4.87	3.47	2.30	2.27	1.87	2.02	1.79	2.01	2.03
5					4.45	5.14	3.50	2.35	2.25	1.81	1.88	1.62	1.82	1.67	2.08
6			8.01	4.97	5.14	3.77	2.80	2.38	1.83	2.16	1.59	1.71	1.55	1.82	1.73
7			5.01	4.87	3.50	2.80	3.11	2.47	2.00	1.62	1.63	1.93	1.70	1.63	2.44
8		5.15	5.24	3.47	2.35	2.38	2.47	2.70	1.73	1.74	1.93	1.66	1.55	1.82	2.05
9	6.99	5.90	3.46	2.30	2.25	1.83	2.00	1.73	2.09	1.57	1.74	1.56	2.05	1.58	2.06
10	5.73	4.55	2.73	2.27	1.81	2.16	1.62	1.74	1.57	2.11	1.69	2.19	1.62	1.77	1.57
11	4.99	4.09	2.47	1.87	1.88	1.59	1.63	1.93	1.74	1.69	2.40	2.10	2.18	1.55	2.00
12	4.74	3.98	2.16	2.02	1.62	1.71	1.93	1.66	1.56	2.19	2.10	2.43	1.66	1.71	1.58
13	4.63	3.91	2.42	1.79	1.82	1.55	1.70	1.55	2.05	1.62	2.18	1.66	1.89	1.53	1.99
14	4.65	3.97	2.19	2.01	1.67	1.82	1.63	1.82	1.58	1.77	1.55	1.71	1.53	1.85	1.57
15	4.73	4.02	2.89	2.03	2.08	1.73	2.44	2.05	2.06	1.57	2.00	1.58	1.99	1.57	2.12

Figure 2-14 Bundle Operating MCPR at BOC (0 MWd/ST)



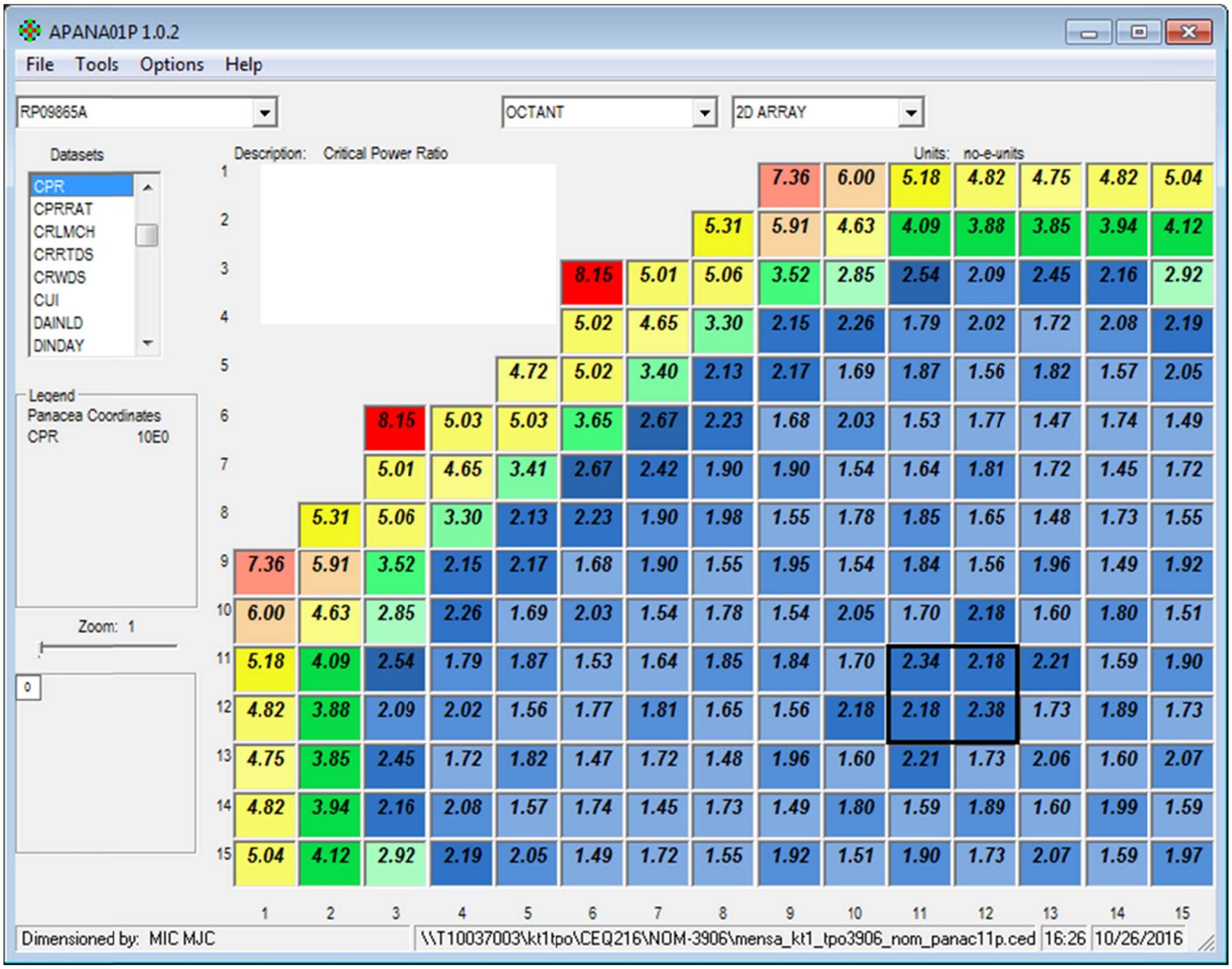
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1									7.62	6.18	5.32	4.98	4.90	4.96	5.16
2								5.58	6.30	4.87	4.30	4.10	4.06	4.16	4.32
3						8.95	5.43	5.53	3.72	2.93	2.60	2.15	2.52	2.23	3.07
4						5.55	5.20	3.63	2.30	2.35	1.82	2.07	1.75	2.14	2.24
5					5.26	5.74	3.86	2.39	2.32	1.74	1.92	1.56	1.87	1.62	2.20
6			8.96	5.56	5.74	4.24	3.16	2.58	1.82	2.16	1.54	1.79	1.50	1.85	1.67
7			5.43	5.20	3.86	3.16	3.30	2.61	2.10	1.59	1.66	1.87	1.77	1.59	2.39
8		5.58	5.53	3.63	2.39	2.58	2.61	2.69	1.70	1.82	1.89	1.66	1.50	1.89	2.10
9	7.62	6.30	3.72	2.30	2.32	1.82	2.10	1.70	2.07	1.52	1.80	1.51	2.00	1.51	2.09
10	6.18	4.87	2.93	2.35	1.74	2.16	1.59	1.82	1.52	2.06	1.62	2.14	1.53	1.78	1.50
11	5.32	4.30	2.60	1.82	1.92	1.54	1.66	1.89	1.80	1.62	2.33	2.11	2.14	1.51	1.90
12	4.98	4.10	2.15	2.07	1.56	1.79	1.87	1.66	1.51	2.14	2.11	2.35	1.61	1.80	1.66
13	4.90	4.06	2.52	1.75	1.87	1.50	1.77	1.50	2.00	1.53	2.14	1.61	1.98	1.53	2.09
14	4.96	4.16	2.23	2.14	1.62	1.85	1.59	1.89	1.51	1.78	1.51	1.80	1.53	2.01	1.69
15	5.16	4.32	3.07	2.24	2.20	1.67	2.39	2.10	2.09	1.50	1.90	1.66	2.09	1.69	2.55

Figure 2-15 Bundle Operating MCPR at MOC (6,500 MWd/ST)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1									7.92	6.31	5.45	5.08	5.03	5.13	5.40
2								5.68	5.85	4.59	4.07	3.87	3.86	3.96	4.14
3						8.93	5.28	5.02	3.54	2.92	2.62	2.19	2.56	2.28	3.01
4						5.36	4.64	3.33	2.24	2.35	1.89	2.14	1.85	2.22	2.34
5					5.18	5.07	3.47	2.23	2.27	1.80	2.00	1.70	1.98	1.74	2.22
6			8.94	5.36	5.07	3.73	2.79	2.36	1.81	2.17	1.67	1.93	1.64	1.92	1.68
7			5.28	4.64	3.47	2.79	2.57	2.07	2.05	1.69	1.81	1.99	1.89	1.63	1.94
8		5.68	5.02	3.33	2.23	2.36	2.07	2.16	1.70	1.92	2.01	1.82	1.64	1.91	1.76
9	7.92	5.85	3.54	2.24	2.27	1.81	2.05	1.70	2.07	1.66	1.92	1.66	2.07	1.65	2.09
10	6.31	4.59	2.92	2.35	1.80	2.17	1.69	1.92	1.66	2.08	1.67	2.11	1.67	1.92	1.67
11	5.45	4.07	2.62	1.89	2.00	1.67	1.81	2.01	1.92	1.67	1.91	1.75	2.13	1.68	2.06
12	5.08	3.87	2.19	2.14	1.70	1.93	1.99	1.82	1.66	2.11	1.75	1.95	1.69	1.97	1.88
13	5.03	3.86	2.56	1.85	1.98	1.64	1.89	1.64	2.07	1.67	2.13	1.69	2.10	1.72	2.20
14	5.13	3.96	2.28	2.22	1.74	1.92	1.63	1.91	1.65	1.92	1.68	1.97	1.72	2.13	1.76
15	5.40	4.14	3.01	2.34	2.22	1.68	1.94	1.76	2.09	1.67	2.06	1.88	2.20	1.76	2.15

Figure 2-16 Bundle Operating MCPR at EOC [FFWTR] (11,655 MWd/ST)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1									7.36	6.00	5.18	4.82	4.75	4.82	5.04
2								5.31	5.91	4.63	4.09	3.88	3.85	3.94	4.12
3						8.15	5.01	5.06	3.52	2.85	2.54	2.09	2.45	2.16	2.92
4						5.02	4.65	3.30	2.15	2.26	1.79	2.02	1.72	2.08	2.19
5					4.72	5.02	3.40	2.13	2.17	1.69	1.87	1.56	1.82	1.57	2.05
6			8.15	5.03	5.03	3.65	2.67	2.23	1.68	2.03	1.53	1.77	1.47	1.74	1.49
7			5.01	4.65	3.41	2.67	2.42	1.90	1.90	1.54	1.64	1.81	1.72	1.45	1.72
8		5.31	5.06	3.30	2.13	2.23	1.90	1.98	1.55	1.78	1.85	1.65	1.48	1.73	1.55
9	7.36	5.91	3.52	2.15	2.17	1.68	1.90	1.55	1.95	1.54	1.84	1.56	1.96	1.49	1.92
10	6.00	4.63	2.85	2.26	1.69	2.03	1.54	1.78	1.54	2.05	1.70	2.18	1.60	1.80	1.51
11	5.18	4.09	2.54	1.79	1.87	1.53	1.64	1.85	1.84	1.70	2.34	2.18	2.21	1.59	1.90
12	4.82	3.88	2.09	2.02	1.56	1.77	1.81	1.65	1.56	2.18	2.18	2.38	1.73	1.89	1.73
13	4.75	3.85	2.45	1.72	1.82	1.47	1.72	1.48	1.96	1.60	2.21	1.73	2.06	1.60	2.07
14	4.82	3.94	2.16	2.08	1.57	1.74	1.45	1.73	1.49	1.80	1.59	1.89	1.60	1.99	1.59
15	5.04	4.12	2.92	2.19	2.05	1.49	1.72	1.55	1.92	1.51	1.90	1.73	2.07	1.59	1.97

Figure 2-17 Bundle Operating MCPR at 9,865 MWd/ST [Peak MFLCPR Point]

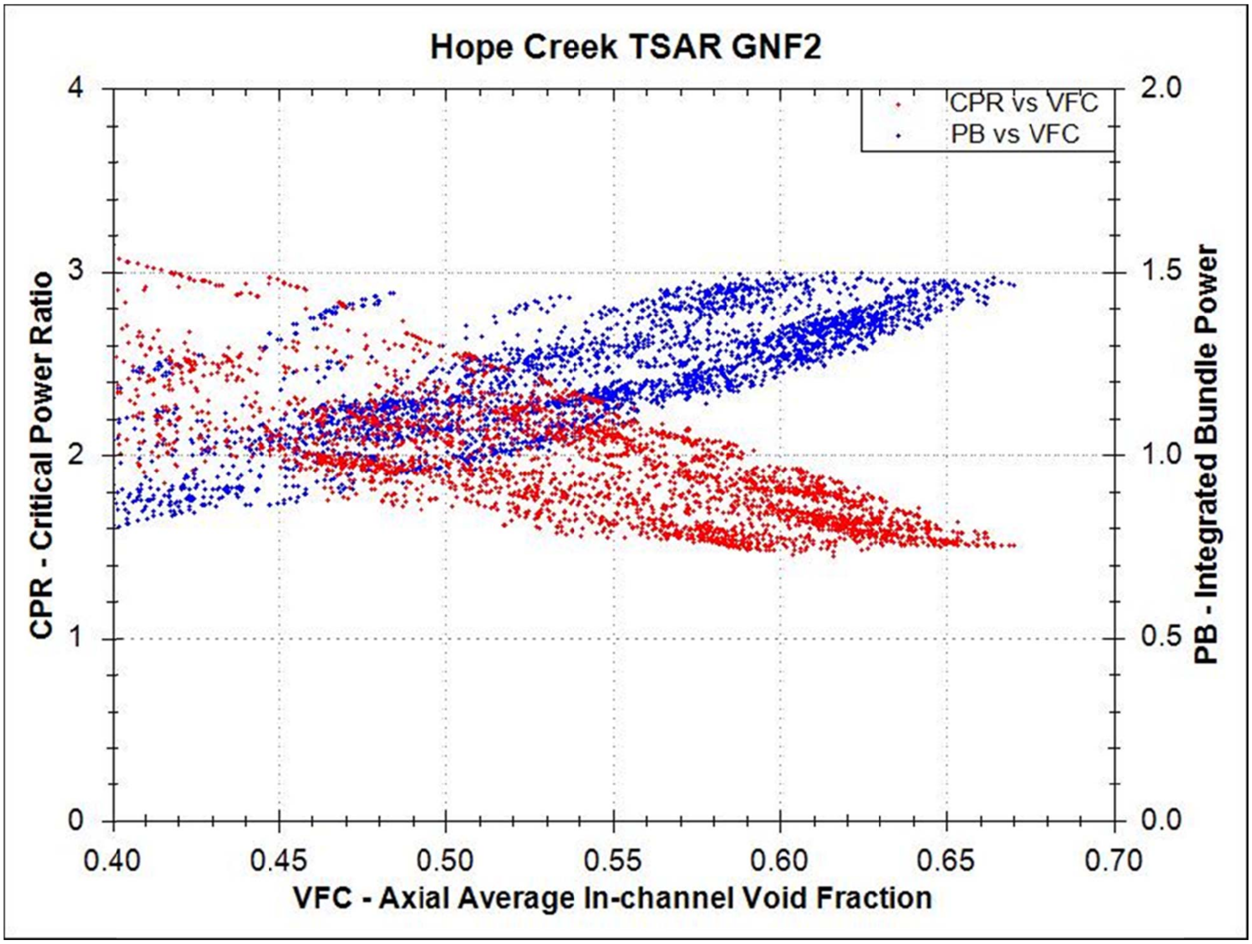


Figure 2-18 Bundle Average Void Fraction versus Critical Power and Bundle Power

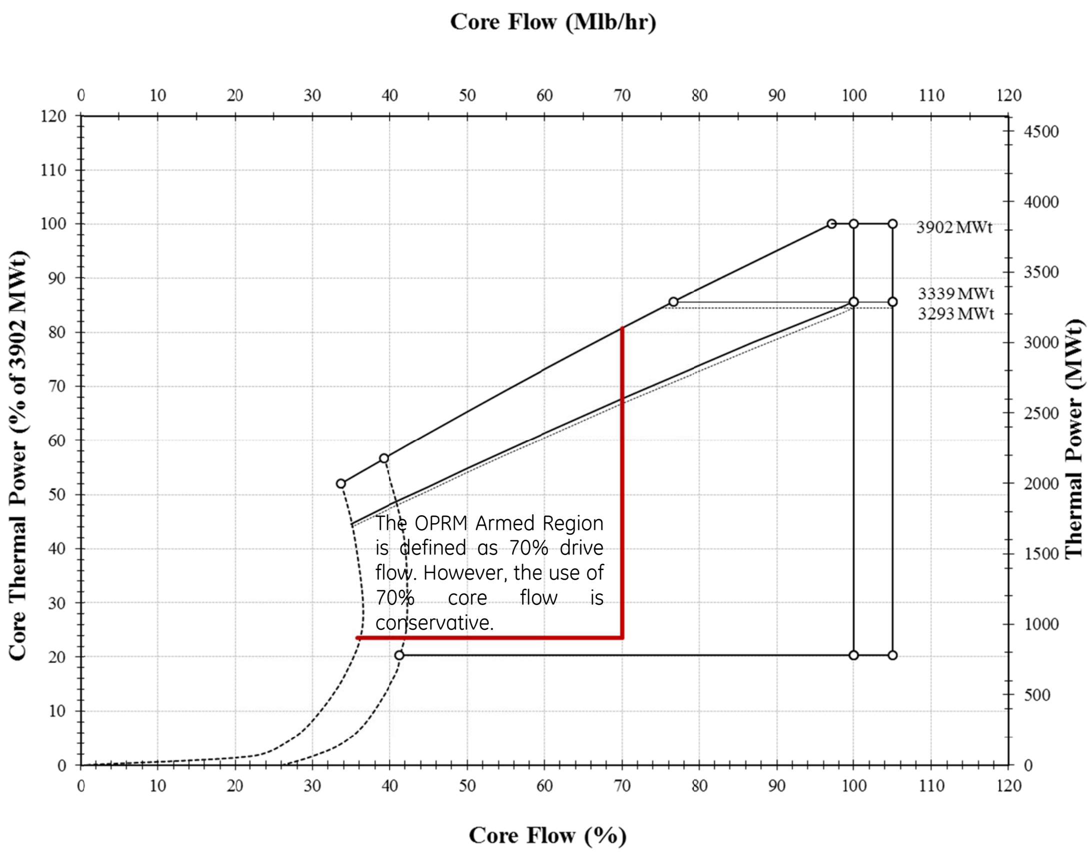


Figure 2-19 Illustration of OPRM Armed Region

3.0 REACTOR COOLANT AND CONNECTED SYSTEMS

3.1 NUCLEAR SYSTEM PRESSURE RELIEF / OVERPRESSURE PROTECTION

The pressure relief system prevents over-pressurization of the nuclear system during abnormal operational transients. The SRVs, along with other functions, provide this protection. Evaluations and analyses for the CLTP have been performed at 3,952 MWt, which is greater than 102% of CLTP, to demonstrate that the reactor vessel conformed to ASME Boiler and Pressure Vessel (B&PV) Code and plant TS requirements. There is no increase in nominal operating pressure for the HCGS TPO uprate. There are no changes in the SRV setpoints or valve OOS 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

The TLTR, Section 5.5.1.5, describes the RPV fracture toughness evaluation process. RPV embrittlement is caused by neutron exposure of the wall adjacent to the core including the regions above and below the core that experience fluence ≥ 1.0E+17 n/cm^2. This region is defined as the "beltline" region. Operation at TPO conditions results in a higher neutron flux, which increases the integrated fluence over the period of plant life. HCGS is evaluated for a fluence that bounds the required value for operation at TPO conditions.

The neutron fluence for TPO is calculated using three-dimensional neutron transport theory (radiation analysis modeling application (RAMA)). The neutron transport methodology is consistent with RG 1.190. A bounding peak fluence of 1.15E+18 n/cm^2 at 1/4T is used to evaluate the vessel against the requirements of 10 CFR 50, Appendix G (Reference 18). The results of these evaluations indicate that:

(a) The upper shelf energy (USE) will remain > 50 ft-lb for the design life of the vessel or maintain the margin requirements of 10 CFR 50, Appendix G as defined in RG 1.99 (Reference 19). All of the HCGS RPV materials have unirradiated USE data, and an equivalent margin analysis (EMA) was performed to determine the effect of surveillance data on USE reductions for the corresponding plate and weld heats. These values are provided in Tables 3-1, 3-2 and 3-3 for HCGS.

(b) The beltline material RT_{NDT} remains below the 200°F screening criteria as defined in Reference 19. These values are provided in Table 3-4 for HCGS.

(c) The surveillance program consists of three capsule holders containing six capsules each located at the 30, 120 and 300 degree azimuthal locations in HCGS. Flux wires from the 30 degree capsule were removed at the end of Cycle 1 (1 EFPY) and at the end of Cycle 5 (6.0 EFPY) and tested. Flux wires were removed from the 120 degree capsule after Cycle 19 (24.1 EFPY) and tested. HCGS is a participant in the integrated surveillance program (ISP) currently administrated by EPRI and is designated as a host plant; one additional capsule is scheduled to be removed and tested under the ISP in about 2036. TPO has no effect on the existing surveillance schedule.

(d) Beltline material USE value calculations were updated by incorporating the results of updated fluence values on end-of-license (EOL) USE values. The fluence projections used in the present calculation assume a 1.6% power uprate for all future cycles due to TPO. New P-T curves were prepared using the methods documented in the Boiling Water Reactor Owners' Group (BWROG) LTR, "Pressure Temperature Limits Report Methodology for Boiling Water Reactors" (Reference 20).

(e) The 56 EFPY beltline axial and circumferential weld material RT_{NDT} remains bounded by the requirements of Boiling Water Reactor Vessel and Internals Project (BWRVIP)-05 as defined in References 21 and 22. This comparison is provided in Tables 3-5 and 3-6 for axial and circumferential welds, respectively.

The maximum normal operating dome pressure for TPO is unchanged from that for CLTP operation. Therefore, the hydrostatic and leakage test pressures and associated temperatures are acceptable for TPO. Because the vessel is still in compliance with regulatory requirements as demonstrated above, operation with TPO does not have an adverse effect (not exceeding regulatory requirements) on the reactor vessel fracture toughness.

3.2.2 Reactor Vessel Structural Evaluation

The stress reconciliation for CLTP, considering a 60-year plant license, was [[

]] the actual operating TPO power level of 3,902 MWt.

The TLTR (Reference 1) provides a generic disposition for [[

]]

The following table provides the justification for confirming the TLTR disposition:

Topic	TLTR Generic Parameter(s) or Requirement(s)	Justification / CLTP vs. TPO Comparison
[[		]]

[[

]]

High and low pressure seal leak detection nozzles were not considered to be pressure boundary components at the time that the OLTP evaluation was performed and have not been evaluated for TPO, as they are not part of the pressure boundary region.

The effect of TPO was evaluated to ensure that the reactor vessel components continue to comply with the existing structural requirements of the ASME B&PV Code. For the components under consideration, the 1968 Edition with addenda to and including the Winter 1969 Addenda was used as the governing code. However, if a component's design has been modified, the governing code for that component was the code used in the stress analysis of the modified component. There are no components that [[ ]] and were modified since the original construction.

Typically, new stresses are determined by scaling the "original" stresses based on the TPO conditions (pressure, temperature, and flow). The bounding analyses were performed for the design, normal and upset, and emergency and faulted conditions. If there is an increase in annulus pressurization (AP), jet reaction (JR), pipe restraint or fuel lift loads, the changes are considered in the analysis of the components affected for normal, upset, emergency and faulted conditions.

3.2.2.1 Design Conditions

Because there are no changes in the design conditions due to TPO, the design stresses are unchanged and the Code requirements are met.

3.2.2.2 Normal and Upset Conditions

The reactor coolant temperature and flows at TPO conditions are unchanged from those at current rated conditions, because the 116.6% OLTP power uprate evaluations were performed at conditions [[ ]] that bound the change in operating conditions from CLTP to TPO. The evaluation type is mainly reconciliation of the stresses and usage factors to reflect TPO conditions. Calculations for TPO were not required as TPO is bounded by the evaluated EPU conditions. The HCGS analysis results for TPO show that all components meet their ASME Code requirements and no further analysis is required.

3.2.2.3 Emergency and Faulted Conditions

The stresses due to emergency and faulted conditions are based on loads such as peak dome pressure, which are unchanged for TPO. Therefore, the ASME Code requirements are met for all RPV components under emergency and faulted conditions.

As part of the TPO evaluation scope, GEH safety communications (SCs) were also considered in the reactor vessel stress evaluations, and SC 12-20 (Reference 24) and SC 13-08 (Reference 25) were determined to be applicable to HCGS. Thus, the shroud support to RPV connection region stress evaluation was reconciled to consider [[ ]] acoustic loads. As shown in Table 3-7, the shroud support (attachment to RPV) component was shown to be within the allowable limits and demonstrated to be structurally qualified for operation at TPO conditions when reconciled to incorporate GEH SC 12-20 (Reference 24) and SC 13-08 (Reference 25) concerns.

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 RIPDs are affected more by the maximum licensed CF rate than by the power level. The maximum licensed CF rate is not changed for the TPO uprate. RIPDs for the TPO uprate are bounded by the current analysis that conservatively assumed an initial power level 3,952 MWt (120% of OLTP and 105% CF) for normal conditions and 4,031 MWt (122.4% of OLTP and 105% CF) for upset, emergency, and faulted conditions. As stated in Section 3.3.2, the RIPD loads at TPO are bounded by the design basis values.

Fuel bundle lift margins and control rod guide tube (CRGT) lift forces are calculated at the faulted condition to demonstrate that fuel bundles would not lift under the worst conditions. The current analysis conservatively assumed 4,031 MWt (122.4% of OLTP and 105% CF), which bounds TPO. The effect due to the changes in minimum fuel lift margins and maximum CRGT lift forces is reported in Section 3.3.2. As stated in Section 3.3.2, these lift margins and lift forces at TPO are bounded by the design basis values.

Acoustic and flow-induced loads on jet pump, core shroud and shroud support due to a recirculation line break (RLB) are bounded by the current analyses that are calculated based on SC 12-20 (Reference 24).

3.3.2 Reactor Internals Structural Evaluation

The RPV internals consist of the CSS components and non-CSS components. The RPV internals are not ASME Code components; however, the requirements of the ASME Code are used as guidelines in their design/analysis. The evaluations/stress reconciliation in support of the TPO was performed consistent with the design basis analysis of the components. The reactor internal components evaluated are:

CSS Components

- Shroud
- Shroud Support
- Core Plate
- Top Guide
- Control Rod Drive and Control Rod Drive Housing
- Control Rod Guide Tube
- Orificed Fuel Support (OFS)

Non-CSS Components

- Fuel Channel
- Steam Dryer
- FW Sparger
- Jet Pump
- Core Spray (CS) Line and Sparger
- Access Hole Cover
- Shroud Head and Steam Separator Assembly
- Low Pressure Coolant Injection Coupling
- Core Differential Pressure and Standby Liquid Control Line

The original configurations of the RPV internals are considered in the TPO evaluation unless a component has undergone permanent structural modifications, in which case, the modified configuration is used as the basis for the evaluation (e.g., jet pumps).

The loads considered in the evaluation of the RPV internals include RIPDs, dead weight, seismic, AP/JR, acoustic and flow induced loads due to RLB, fuel lift, hydraulic flow and thermal loads.

RPV design pressure remains unchanged. RIPD loads are bounded by the design basis values. Seismic loads remain unchanged for TPO. AP/JR loads remain unchanged. Acoustic loads due to RLB remain unchanged for TPO, but increase due to GEH SCs. Flow induced loads due to RLB remain unchanged for TPO. The increase in hydraulic flow and thermal load is insignificant. Dead weights remain unchanged for TPO. Fuel lift loads remain unchanged for TPO.

GEH SC 12-20 (Reference 24), SC 14-02 (Reference 26), and SC 14-03 (Reference 27) were evaluated and resulted in an acoustic load increase for some RPV internals. The stresses of the RPV internals that were affected by the SCs were reconciled for the increase of the acoustic load to show that adequate stress margins still exist and the stresses remain within the allowable limits. All the RPV internals were shown to be within the allowable limits. The limiting stresses of all RPV internal components are summarized in Table 3-8. Therefore, the RPV internal components are demonstrated to be structurally qualified for operation at TPO conditions.

3.3.3 Steam Separator and Dryer Performance

For HCGS, the TPO performance of the steam dryer/separator was evaluated. The results of the evaluation demonstrated that the steam dryer/separator performance remains acceptable (i.e., moisture content ≤ 0.30 wt. %) at TPO conditions. TPO results in an increase in the amount of saturated steam generated in the reactor core. For constant CF, this results in an increase in the separator inlet quality, an increase in the steam dryer face velocity, and a decrease in the water level inside the dryer skirt. These factors, in addition to the radial power distribution, affect the steam dryer/separator performance. However, the net effect of these changes does not result in exceeding the acceptable moisture content of ≤ 0.30 wt. % leaving the steam dryer. In addition, the changes in separator and dryer performance do not result in unacceptable water levels inside the dryer skirt.

3.4 FLOW INDUCED VIBRATION

The process for the reactor vessel internals vibration assessment is described in TLTR Section 5.5.1.3. An evaluation determined the effects of FIV on the reactor internals at 105% RCF and TPO RTP of 101.7% of CLTP. The vibration levels for the TPO conditions were estimated from measured vibration data during startup tests on HCGS and the NRC designated prototype plant (Browns Ferry Unit 1), as well as other plants. The 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
FW Sparger	FW flow at TPO RTP is approximately 2% greater than CLTP.	Slight increase (< 4%) in FIV. Extrapolation of measured data shows stresses are within limits.
Jet Pumps	The increase in jet pump flow at TPO is negligible based on no change in CF and a minor increase in core differential pressure (< 0.1 psi).	Slight increase (< 2%) in FIV. Extrapolation of measured data shows stresses are within limits.
Jet Pump Sensing Lines	Resonance at vane passing frequency	No resonance at vane passing frequency range due to TPO.
Shroud	Flow at TPO RTP is approximately 2% greater than CLTP.	Slight increase (< 4%) in FIV. The maximum stresses are well within limits.
Shroud Head and Separator	Steam flow at TPO RTP is approximately 2% greater than CLTP.	Slight increase (< 4%) in FIV. Extrapolation of measured data shows stresses are within limits.
CRGT and In-Core Guide Tubes	CF at TPO is unchanged from CLTP.	No change.

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

- The GEH criteria of 10,000 psi peak stress intensity are more conservative than the ASME allowable peak stress intensity of 13,600 psi for service cycles $\geq 10^{11}$.
- Conservatively, the peak responses of the applicable modes are absolute summed.
- The maximum vibration stress amplitude of each mode is used in the absolute sum process, whereas in reality the maximum vibration amplitudes are unlikely to occur at the same time.

Therefore, it is concluded that the FIVs for all evaluated components remain within acceptable limits.

The safety-related main steam (MS) and FW piping has minor increased flow rates and flow velocities resulting from the TPO uprate.

The piping components were evaluated in accordance with ASME Code N-1300 (Reference 28) FIV analysis guidelines. The resonance separation rule in ASME Appendix N Subparagraph N-1324.1(d) of Reference 28 was used to determine if adequate separation exists between the vortex shedding frequencies and the natural frequencies of the piping components.

The safety-related portions of the MS and FW piping experience increased vibration levels, approximately proportional to the increase in the square of the flow velocities and also in proportion to any increase in fluid density. The MS and FW piping vibration is expected to increase by about 13% from 3,723 MWt, the power level at which the CLTP vibration data was obtained, to the TPO bounding high power level of 3,906 MWt. A MS and FW piping FIV test program, after the implementation of the power uprate to 3,723 MWt, showed that vibration levels were within acceptance criteria and operating experience shows that there are no existing vibration problems in MS and FW piping at CLTP operating conditions. The measurements from the FIV test program were extrapolated to the TPO bounding high power level of 3,906 MWt, and all projected vibrations are within their acceptance limits. Therefore, the MS and FW piping vibration will remain within acceptable limits during TPO. Analytical evaluations have shown that the safety-related piping components and thermowells in the MS, FW and recirculation piping systems are structurally adequate for TPO operating conditions.

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 RTP is identical to CLTP. Recirculation flow at TPO RTP is identical to CLTP. Small change in core pressure drop. Small change in recirculation fluid temperature.	Negligible change in pipe stress Negligible effect on pipe supports

Component(s) / Concern	Process Parameter(s)	TPO Evaluation
MS and Attached Piping (Inside Containment) (e.g., SRV discharge line (SRVDL) piping up to first anchor, reactor core isolation cooling (RCIC) MS drain lines, RPV head vent line piping located inside containment) Pipe Stresses Pipe Supports Flow Accelerated Erosion/Corrosion (FAC)	Nominal dome pressure at TPO RTP is identical to CLTP. Steam flow at TPO RTP is ~ 2% greater than CLTP. Minor decrease in main steam line (MSL) pressure < 3 psi.	Plant specific evaluation performed Minor change in pipe stress Minor effect on pipe supports Minor increase in the potential for FAC (FAC concerns are covered by existing piping monitoring program)
FW and Attached Piping (Inside Containment) Pipe Stresses Pipe Supports FAC	Nominal dome pressure at TPO RTP is identical to CLTP. FW flow at TPO RTP is ~2% greater than CLTP. Minor change in FW line pressure. Small increase in FW temperature of < 2°F.	Plant specific evaluation performed Negligible change in pipe stress Negligible effect on pipe supports Minor increase in the potential for FAC (FAC concerns are covered by existing piping monitoring program)

Component(s) / Concern	Process Parameter(s)	TPO Evaluation
RPV Bottom Head Drain Line, RCIC Piping, High Pressure Coolant Injection (HPCI) Piping, Low Pressure Coolant Injection (LPCI) Piping, CS Piping, SLCS Piping, and Reactor Water Cleanup (RWCU) Piping Pipe Stresses Pipe Supports	Nominal dome pressure at TPO RTP is identical to CLTP. Small change in core pressure drop. Small change in recirculation fluid temperature.	Negligible change in pipe stress Negligible effect on pipe supports
FAC		Minor increase in the potential for FAC (FAC concerns are covered by existing piping monitoring program)

For the MS and FW lines, supports, and connected lines, the methodologies as described in TLTR Section 5.5.2 and Appendix K were used to determine the percent increases in applicable ASME Code stresses, displacements, cumulative usage factors (CUFs), and pipe interface component loads (including supports) as a function of percentage increase in pressure (where applicable), temperature, and flow due to TPO conditions. The percentage increases were applied to the highest calculated stresses, displacements, and the CUF at applicable piping system node points to conservatively determine the maximum TPO calculated stresses, displacements and usage factors. This approach is conservative because the TPO does not affect weight and all building filtered loads (i.e., seismic loads are not affected by the TPO). The factors were also applied to nozzle load, support loads, penetration loads, valves, pumps, heat exchangers and anchors so that these components could be evaluated for acceptability, where required. No new computer codes were used or new assumptions introduced for this evaluation.

MS and Attached Piping System Evaluation

The MS piping system (inside containment) was evaluated for compliance with the ASME code stress criteria and for the effects of thermal displacements on the piping snubbers, hangers, and struts. Piping interfaces with RPV nozzles, penetrations, flanges and valves were also evaluated.

Pipe Stresses

The evaluation shows that the increase in flow associated with the TPO uprate does not result in load limits being exceeded for the MS piping system or for the RPV nozzles. The original design analyses have sufficient design margin between calculated stresses and ASME Code allowable limits to justify operation at the TPO uprate conditions. The temperature of the MS piping (inside containment) is unchanged for the TPO.

The design adequacy evaluation results show that the requirements of American National Standards Institute (ANSI) USAS B31.1, B31.7 Power Piping and ASME Section III Subsection ND (as applicable) requirements are satisfied for the evaluated piping systems. Therefore, the TPO does not have an adverse effect on the MS piping design.

Pipe Supports

The MS piping was evaluated for the effects of transient loading on the piping snubbers, hangers, struts, and pipe whip restraints. A review of the increases in MS flow associated with the TPO uprate indicates that piping load changes do not result in any load limit being exceeded at the TPO uprate conditions.

Erosion / Corrosion

The carbon steel MS piping can be affected by FAC. FAC is affected by changes in fluid velocity, temperature and moisture content. HCGS has an established FAC monitoring 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 TPO uprate are minor changes to parameters affecting FAC. The FAC monitoring program includes the use of a predictive method to calculate wall thinning of components susceptible to FAC. For TPO, the evaluation of predicted wall thinning of the MS and attached piping indicates minimal effect.

No changes to piping inspection scope and frequency are required prior to TPO implementation to ensure adequate margin for the changing process conditions. The continuing inspection program will take into consideration adjustments to predicted material loss rates used to project the need for maintenance/replacement prior to reaching minimum wall thickness requirements. This program provides assurance that any adverse effect from TPO on high energy piping systems potentially susceptible to pipe wall thinning due to FAC is monitored and addressed.

FW 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 thermal expansion displacements on the piping snubbers, hangers, and struts. Piping interfaces with RPV nozzles, penetrations, and valves were also evaluated.

Pipe Stresses

A review of the small increases in temperature, pressure, and flow associated with the TPO uprate indicates that piping load changes do not result in load limits being exceeded for the FW piping system or for RPV nozzles. The original design analyses have sufficient design margin between calculated stresses and ASME Code allowable limits to justify operation at the TPO uprate conditions.

The design adequacy evaluation shows that the requirements of ANSI (USAS) B31.1, B31.7 Power Piping, and ASME Section III Subsection ND-3600 requirements remain satisfied. Therefore, the TPO does not have an adverse effect on the FW piping design.

Pipe Supports

The TPO does not affect the FW piping snubbers, hangers, struts, and pipe whip restraints. A review of the increase in FW temperature and flow associated with the TPO uprate indicates that piping load changes do not result in any load limit being exceeded at the TPO uprate conditions.

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. HCGS 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. The FAC monitoring program includes the use of a predictive method to calculate wall thinning of components susceptible to FAC. For TPO, the evaluation of predicted wall thinning of the FW piping system indicates minimal effect.

No changes to piping inspection scope and frequency are required prior to TPO implementation to ensure adequate margin exists for the TPO process conditions. The continuing inspection program will take into consideration adjustments to predicted material loss rates used to project the need for maintenance/replacement prior to reaching minimum wall thickness requirements. This program provides assurance that any adverse effect from TPO on high energy piping systems potentially susceptible to pipe wall thinning due to FAC is monitored and addressed.

3.5.2 Balance-of-Plant Piping Evaluation

This section addresses the adequacy of the BOP piping design (outside of the RCPB) for operation at the TPO conditions.

The piping systems evaluated are as follows:

(1) MS (outside containment) including equalization header, turbine bypass piping, and crossover piping
(2) Reactor FW (RFW) (outside containment)
(3) RCIC
(4) HPCI
(5) RWCU
(6) Reactor Auxiliaries Cooling System (RACS)
(7) Residual Heat Removal (RHR)
(8) Safety Auxiliaries Cooling System (SACS)
(9) Turbine Auxiliaries Cooling System (TACS)
(10) Torus Attached Piping

The following piping systems were previously evaluated at 3,952 MWt and bound TPO operating conditions; therefore the piping systems are acceptable for TPO.

(3) RCIC
(4) HPCI
(5) RWCU
(6) Reactor Auxiliaries Cooling System (RACS)
(7) Residual Heat Removal (RHR)
(8) Safety Auxiliaries Cooling System (SACS)
(9) Turbine Auxiliaries Cooling System (TACS)
(10) Torus Attached Piping

The following piping system has operating pressures less than design pressures and temperature increases less than or equal to 2°F due to the power increases anticipated for TPO; however, the piping stresses have a minimal increase and remain acceptable for TPO.

(2) Reactor FW (RFW) (outside containment)

For the MS system, the flow from CLTP to TPO has increased slightly; however, the temperature remains unchanged.

All piping systems analyzed have temperature increases equal or less than 10% of available margin between the design and operating temperature; however, the piping stresses have a minimal increase and remain acceptable for TPO.

Pipe Supports

For those piping systems that have no change in operating conditions between CLTP and TPO, all the pipe support loads remain unchanged.

For those piping systems that have operating temperatures less than 150°F, temperature increases of less than or equal to 2°F, or temperature increases less than or equal to 10% of available margin due to the power increases anticipated for TPO, pipe support loads will experience a small increase in the thermal load. However, when considering the combination with other loads that are not affected by the TPO uprate (e.g., deadweight), the combined support load increase is minimal and remains acceptable.

Therefore, all supports, branch piping and equipment are acceptable for TPO.

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. HCGS has an established program for monitoring pipe wall thinning in single phase and two-phase high energy carbon steel piping. FAC rates may be influenced by changes in fluid velocity, temperature, and moisture content. The FAC monitoring program includes the use of a predictive method to calculate wall thinning of components susceptible to FAC. For TPO, the evaluation of predicted wall thinning of the BOP piping indicates minimal effect.

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 Generic Letter (GL) 89-08 (Reference 29). The plant FAC program currently monitors the affected systems. Continued monitoring of the systems provides confidence in the integrity of susceptible high energy piping systems. Appropriate changes to piping inspection frequency will be implemented to ensure adequate margin exists for those systems with changing process conditions. 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 any adverse effect from TPO on high energy piping systems potentially susceptible to pipe wall thinning due to FAC is monitored and addressed.

3.6 Reactor Recirculation System

The reactor recirculation system (RRS) evaluation process is described in TLTR Section 5.6.2. The TPO uprate has a minor effect on the RRS and its components. The TPO uprate does not require an increase in the maximum CF. 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). The effect on pump net positive suction head (NPSH) at TPO conditions is negligible. An evaluation has confirmed that no significant increase in RRS vibration occurs from the TPO operating conditions.

The cavitation protection interlock for the recirculation pumps and jet pumps is expressed in terms of FW flow. This interlock is based on sub-cooling and thus is a function of absolute FW flow rate and FW temperature at less than full thermal power operating conditions. Therefore, the interlock is not changed by TPO.

3.7 Main Steam Line Flow Restrictors

The generic evaluation provided in TLTR Appendix J.2.3.7 is applicable to HCGS. The requirements for the MSL flow restrictors remain unchanged for TPO uprate conditions. No change in steam line break flow rate occurs because the operating pressure is unchanged. All safety and operational aspects of the MSL flow restrictors are within previous evaluations.

3.8 Main Steam Isolation Valves

The generic evaluation provided in TLTR Appendix J.2.3.7 is applicable to HCGS. The requirements for the main steam isolation valves (MSIVs) remain unchanged for TPO uprate conditions. All safety and operational aspects of the MSIVs are within previous evaluations.

3.9 Reactor Core Isolation Cooling

The RCIC system provides inventory makeup to the reactor vessel when the vessel is isolated from the normal high pressure makeup systems. The generic evaluation provided in TLTR Section 5.6.7 is applicable to HCGS. 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 Section 5.6.4 and Appendices J.2.3.1 and J.2.3.13 are applicable to HCGS.

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 4.2.3.
Suppression Pool Cooling (SPC) and Containment Spray Cooling (CSC) Modes	Normal SPC function is to maintain pool temperature below the limit. For abnormal events or accidents, the SPC mode maintains the long-term pool temperature below the design limit. The CSC mode sprays water into the containment to reduce post-accident containment pressure and temperature.	Containment analyses have been performed at 102% of CLTP or greater.
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 a negligible effect on the SDC mode, which has no safety function.
Steam Condensing Mode	Decay heat removal	HCGS does not have a steam condensing mode of RHR.
Fuel Pool Cooling (FPC) Assist	Supports maintaining the spent fuel pool (SFP) water temperature below the design limit for full core offload.	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 or greater. 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 HCGS. 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. RWCU flow is not changed for TPO conditions. 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 that result in crud bursts causing high intermediate loading on the system capacity 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 HCGS Upper Shelf Energy 60-Year License (56 EFPY)

	Description	Heat/Lot Number	Flux Type	%Cu [1]	Unirradiated Transverse USE [2] (ft-lbs)	1/4T Fluence [1] (n/cm^2)	% Drop in USE	1/4T USE [3] (ft-lbs)	Requires EMA
Plates	Intermediate Shell (3)	5K3025/1	--	0.15	75	3.97E+17	11.3	66.5	NO
	Intermediate Shell (3)	5K2608/1	--	0.09	75	3.97E+17	8.8	68.4	NO
	Intermediate Shell (3)	5K2698/1	--	0.10	75	3.97E+17	8.8	68.4	NO
	Lower Intermediate Shell (4)	5K2963/1	--	0.07	102	1.15E+18	11.4	90.4	NO
	Lower Intermediate Shell (4)	5K2530/1	--	0.08	86	1.15E+18	11.4	76.2	NO
	Lower Intermediate Shell (4)	5K3238/1	--	0.09	76	1.15E+18	11.4	67.4	NO
	Lower Shell (5)	5K3230/1	--	0.07	121	8.10E+17	10.5	108.3	NO
	Lower Shell (5)	6C35/1	--	0.09	101	8.10E+17	10.5	95.8	NO
	Lower Shell (5)	6C45/1	--	0.08	97	8.10E+17	10.5	86.8	NO
Welds	Vertical W13	510-01205	SMAW [4]	0.09	92.5	3.92E+17	10.9	82.5	NO
	Vertical W13	D53040/1125-02205	SAW [4]	0.08	135	3.92E+17	10.4	120.9	NO
	Vertical W14	510-01205	SMAW	0.09	92.5	1.01E+18	13.5	80.0	NO
	Vertical W14	D53040/1125-02205	SAW	0.08	135	1.01E+18	13.0	117.5	NO
	Vertical W15	510-01205	SMAW	0.09	92.5	7.04E+17	12.4	81.0	NO
	Vertical W15	D53040/1125-02205	SAW	0.08	135	7.04E+17	11.9	118.9	NO
	Girth W6 (Shell 3-4)	519-01205	SMAW	0.01	109	3.97E+17	8.8	99.4	NO
	Girth W6 (Shell 3-4)	504-01205	SMAW	0.01	125	3.97E+17	8.8	114.0	NO
	Girth W6 (Shell 3-4)	510-01205	SMAW	0.09	92.5	3.97E+17	10.9	82.4	NO
	Girth W6 (Shell 3-4)	D53040/1810-02205	SAW	0.08	95	3.97E+17	10.4	85.1	NO
	Girth W6 (Shell 3-4)	D55733/1810-02205	SAW	0.10	68	3.97E+17	11.3	60.3	NO
	Girth W7 (Shell 4-5)	510-01205	SMAW	0.09	92.5	8.10E+17	12.9	80.6	NO
	Girth W7 (Shell 4-5)	D53040/1125-02205	SAW	0.08	95	8.10E+17	12.3	83.3	NO
Nozzles	LPCI (N17; A-D)	19468/1	--	0.12	79	1.40E+17	7.7	72.9	NO
	LPCI (N17; A-D)	10024/1	--	0.14	70	1.40E+17	8.5	64.1	NO
Nozzle Welds	LPCI Nozzle W179	001-01205	SMAW	0.02	109	3.65E+17	8.7	99.5	NO
	LPCI Nozzle W179	519-01205	SMAW	0.01	109	3.65E+17	8.7	99.5	NO
	LPCI Nozzle W179	504-01205	SMAW	0.01	125	3.65E+17	8.7	114.2	NO

Notes for Table 3-1:

1. Cu content and 1/4T fluence values are obtained from Table 3-4.
2. Unirradiated USE values are obtained from Table 5A-19 of the UFSAR (Reference 30). Transverse plate values are conservatively estimated as described in the UFSAR. Unirradiated USE values for all welds are not true USE but are conservatively determined from Charpy energy from tests performed at 10°F.
3. The EOL 1/4T USE is calculated by the following formula: $USE_{Unirradiated}$ x ((100 – %DropUSE) / 100).
4. SMAW = Shielded Metal-Arc Welding; SAW = Submerged Arc Welding.

Table 3-2 HCGS EMA for Plate Heat No. 5K3238/1 for 56 EFPY

Equivalent Margin Analysis
Plant Applicability Verification Form
for HCGS
Including Power Uprate Conditions
60-Year License
(Cumulative Energy Provided in Fluence Report)
BWR/3-6 PLATE
(Heat 5K3238/1)

Surveillance Plate USE: 30° Capsule*

% Cu =	0.09	
Capsule Fluence =	1.64E+17	n/cm^2
Measured % Decrease =	13.8	(Charpy Curves)
RG 1.99 Predicted % Decrease =	6.8	(RG 1.99, Figure 2)

Surveillance Plate USE: 120° Capsule*

% Cu =	0.09	
Capsule Fluence =	6.27E+17	n/cm^2
Measured % Decrease =	< 0	(Charpy Curves)
RG 1.99 Predicted % Decrease =	9.3	(RG 1.99, Figure 2)

* Surveillance data are obtained from PSEG vendor technical document (VTD) Number 432903, Sheet 1, References 1, 4, and 5, corresponding to plate heat number K3238/1.

Lower-Intermediate Shell Plate (Heat 5K3238/1) USE:

% Cu =	0.09	
56 EFPY Peak ID Fluence =	1.65E+18	n/cm^2
56 EFPY 1/4T Fluence =	1.15E+18	n/cm^2
RG 1.99 Predicted % Decrease =	11.4	(RG 1.99, Figure 2)
Adjusted % Decrease =	22	(RG 1.99, Position 2.2)

Maximum = 22% ≤ 23.5%, so vessel plates are bounded by EMA.

Table 3-3 HCGS EMA for Weld Heat No. D53040 for 56 EFPY

Equivalent Margin Analysis
Plant Applicability Verification Form
for Hope Creek
Including Power Uprate Conditions
60-Year License
(Cumulative Energy Provided in Fluence Report)
BWR/2-6 PLATE
(Heat D53040)

Surveillance Weld USE: 30° Capsule*

% Cu =	0.07	
Capsule Fluence =	1.64E+17	n/cm^2
Measured % Decrease =	4.6	(Charpy Curves)
RG 1.99 Predicted % Decrease =	7.9	(RG 1.99, Figure 2)

Surveillance Weld USE: 120° Capsule*

% Cu =	0.07	
Capsule Fluence =	6.27E+17	n/cm2
Measured % Decrease =	3.3	(Charpy Curves)
RG 1.99 Predicted % Decrease =	10.9	(RG 1.99, Figure 2)

* Surveillance data are obtained from PSEG VTD Number 432903, Sheet 1 References 1, 4, and 5, corresponding to weld heat number D53040.

Vertical Welds W13/W14/W15 and Girth Welds W6/W7 (Heat D53040) USE:

% Cu =	0.08	
56 EFPY Peak ID Fluence =	1.44E+18	n/cm2
56 EFPY 1/4T Fluence =	1.01E+18	n/cm2
RG 1.99 Predicted % Decrease =	13.0	(RG 1.99, Figure 2)
Adjusted % Decrease =	7	(RG 1.99, Position 2.2)

Maximum = 13% ≤ 39%, so vessel welds are bounded by EMA.

Table 3-4 HCGS Adjusted Reference Temperatures 60-Year License (56 EFPY)

	Description	Heat/Lot Number	Flux Type	Initial RT_{NDT} (°F)	Chemistry (wt%)		Chemistry Factor, CF (°F)	Fluence at ID (n/cm^2)	Fluence at 1/4T (n/cm^2)	Fluence Factor, FF	Adjustments for 1/4T			
												Margin Terms		
					Cu	Ni					ΔRT_{NDT} (°F)	σ_Δ (°F)	σ_i (°F)	ART (°F)
Plates	Intermediate Shell (3)	5K3025/1	--	19	0.15	0.71	112.8	5.60E+17	3.97E+17	0.258	29.1	14.5	0.0	77.1
	Intermediate Shell (3)	5K2608/1	--	19	0.09	0.58	58.0	5.60E+17	3.97E+17	0.258	15.0	7.5	0.0	48.9
	Intermediate Shell (3)	5K2698/1	--	19	0.10	0.58	65.0	5.60E+17	3.97E+17	0.258	16.8	8.4	0.0	52.5
	Lower Intermediate Shell (4)	5K2963/1	--	-10	0.07	0.58	44.0	1.65E+18	1.15E+18	0.445	19.6	9.8	0.0	29.2
	Lower Intermediate Shell (4)	5K2530/1	--	19	0.08	0.56	51.0	1.65E+18	1.15E+18	0.445	22.7	11.4	0.0	64.4
	Lower Intermediate Shell (4)	5K3238/1	--	7	0.09	0.64	58.0	1.65E+18	1.15E+18	0.445	25.8	12.9	0.0	58.7
	Lower Shell (5)	5K3230/1	--	-10	0.07	0.56	44.0	1.16E+18	8.10E+17	0.376	16.5	8.3	0.0	23.1
	Lower Shell (5)	6C35/1	--	-11	0.09	0.54	58.0	1.16E+18	8.10E+17	0.376	21.8	10.9	0.0	32.6
	Lower Shell (5)	6C45/1	--	1	0.08	0.57	51.0	1.16E+18	8.10E+17	0.376	19.2	9.6	0.0	39.4
Welds	Vertical W13	510-01205	SMAW	-40	0.09	0.54	108.7	5.55E+17	3.92E+17	0.256	27.8	13.9	0.0	15.7
	Vertical W13	D53040/1125-02205	SAW	-30	0.08	0.63	110.1	5.55E+17	3.92E+17	0.256	28.2	14.1	0.0	26.4
	Vertical W14	510-01205	SMAW	-40	0.09	0.54	108.7	1.44E+18	1.01E+18	0.419	45.5	22.8	0.0	51.1
	Vertical W14	D53040/1125-02205	SAW	-30	0.08	0.63	110.1	1.44E+18	1.01E+18	0.419	46.1	23.1	0.0	62.3
	Vertical W15	510-01205	SMAW	-40	0.09	0.54	108.7	1.01E+18	7.04E+17	0.350	38.1	19.0	0.0	36.2
	Vertical W15	D53040/1125-02205	SAW	-30	0.08	0.63	110.1	1.01E+18	7.04E+17	0.350	38.6	19.3	0.0	47.2
	Girth W6 (Shell 3-4)	519-01205	SMAW	-49	0.01	0.53	20.0	5.60E+17	3.97E+17	0.258	5.2	2.6	0.0	-38.7
	Girth W6 (Shell 3-4)	504-01205	SMAW	-31	0.01	0.51	20.0	5.60E+17	3.97E+17	0.258	5.2	2.6	0.0	-20.7
	Girth W6 (Shell 3-4)	510-01205	SMAW	-40	0.09	0.54	108.7	5.60E+17	3.97E+17	0.258	28.0	14.0	0.0	16.1
	Girth W6 (Shell 3-4)	D53040/1810-02205	SAW	-49	0.08	0.63	110.1	5.60E+17	3.97E+17	0.258	28.4	14.2	0.0	7.8
	Girth W6 (Shell 3-4)	D55733/1810-02205	SAW	-40	0.10	0.68	126.4	5.60E+17	3.97E+17	0.258	32.6	16.3	0.0	25.2
	Girth W7 (Shell 4-5)	510-01205	SMAW	-40	0.09	0.54	108.7	1.16E+18	8.10E+17	0.376	40.9	20.4	0.0	41.8
	Girth W7 (Shell 4-5)	D53040/1125-02205	SAW	-30	0.08	0.63	110.1	1.16E+18	8.10E+17	0.376	41.4	20.7	0.0	52.8
Nozzles	LPCI (N17; A-D)	19468/1	--	-20	0.12	0.80	86.0	1.71E+17	1.40E+17	0.137	11.8	5.9	0.0	3.6
	LPCI (N17; A-D)	10024/1	--	-20	0.14	0.82	105.1	1.71E+17	1.40E+17	0.137	14.4	7.2	0.0	8.8
	Instrument (N16; A, D)	5K3025/1 (adj. plate)	--	19	0.15	0.71	112.8	3.37E+17	2.84E+17	0.213	24.0	12.0	0.0	67.0
	Instrument (N16; B, C)	5K2698/1 (adj. plate)	--	19	0.10	0.58	65.0	3.37E+17	2.84E+17	0.213	13.8	6.9	0.0	46.6
Nozzle Welds	LPCI Nozzle W179	001-01205	SMAW	-40	0.02	0.51	27.0	4.85E+17	3.65E+17	0.246	6.6	3.3	0.0	-26.7
	LPCI Nozzle W179	519-01205	SMAW	-49	0.01	0.53	20.0	4.85E+17	3.65E+17	0.246	4.9	2.5	0.0	-39.2
	LPCI Nozzle W179	504-01205	SMAW	-31	0.01	0.51	20.0	4.85E+17	3.65E+17	0.246	4.9	2.5	0.0	-21.2
ISP	Surveillance Plate	5K3238/1	--	7	0.09	0.64	[[	1.65E+18	1.15E+18	0.445	21.9	8.5	0.0	45.9
	Surveillance Weld	D53040	SAW	-30	0.07	0.57	]]	1.44E+18	1.01E+18	0.419	88.3	28.0	0.0	114.3

Reference: Structural Integrity Associates, Calculation Package File 1601009.301, Hope Creek P-T Curves, Table 3, Revision 1A, March 7, 2017.

Notes for Table 3-4:

1. The RPV beltline wall thickness of 6.102 inches is obtained from Table 5 of Reference 7 from PSEG VTD Number 432903, Sheet 1.
2. Fluence values 56 EFPY were obtained from Reference 19 (Tables 7-1 through 7-6). Fluence values for nozzles are reported for the 1/4T location along the nozzle extraction path, based on a plant-specific damage assessment (i.e., displacements per atom (DPA)) methodology.
3. Initial RT_{NDT} and chemistry data for as-fabricated RPV materials are obtained from Table 2 of Reference 7 from PSEG VTD Number 432903, Sheet 1.
4. A separate adjusted reference temperature (ART) calculation for plate heat 5K3238/1 is performed using the most recent ISP surveillance results. Best-estimate chemistry for the surveillance plate is obtained from Table 2-2 in Reference 3 from PSEG VTD Number 432903, Sheet 1, and the fitted chemistry factor is obtained from page 2-37 in Reference 4 from PSEG VTD Number 432903, Sheet 1. Because the data are credible, a reduced margin term ($\sigma_\Delta = 17/2 = 8.5°F$) is used for the surveillance plate according to RG 1.99, Regulatory Position 2.1 (Reference 1 from PSEG VTD Number 432903, Sheet 1).
5. A separate ART calculation for weld heat D53040 is performed using the most recent ISP surveillance results. Best-estimate chemistry for the surveillance weld is obtained from Table 2-3 in Reference 3 from PSEG VTD Number 432903, Sheet 1, and a fitted chemistry factor is obtained from page 2-38 in Reference 4 from PSEG VTD Number 432903, Sheet 1. The fitted chemistry factor is adjusted to account for differences in chemistry between the surveillance weld and vessel weld, according to Equation 3-5 in BWRVIP-135 Revision 3 (Reference 2 from PSEG VTD Number 432903, Sheet 1): CF_{adj} = (Table CF_{vessel}/Table CF_{surv})*CF_{fitted} = (110.1/93.5)*[[ ]] = [[ ]]. Because the adjusted surveillance chemistry factor is higher than the table chemistry factor, the adjusted surveillance chemistry factor must be used in the ART calculation. Scatter in the surveillance data exceeded credibility criteria, and a full margin term ($\sigma_\Delta = 28°F$) must be used in the ART calculation.
6. For N16 nozzles, the ART calculation shows the initial RT_{NDT} and chemistry factor corresponding to the adjacent plate, which bound those of the nozzle forging. The fluence corresponding to the nozzle location is used.

Table 3-5 HCGS 56 EFPY Effects of Irradiation on RPV Axial Weld Properties

Group	Chicago Bridge & Iron (CB&I) Vessel 64 EFPY [1]	HCGS Vessel 56 EFPY [3]
Copper Content, Cu (wt. %)	0.10	0.084
Nickel Content, Ni (wt. %)	1.08	0.626
Chemistry Factor (°F)	135.0	110.12
Fluence at Clad/Base Metal Interface (10^{19} n/cm^2)	1.38	0.144
Unirradiated Reference Temperature, $RT_{NDT(U)}$ (°F)	-30	-30
Shift in Reference Temperature, ΔRT_{NDT} (without margin) (°F)	147.1	46.1
Mean RT_{NDT} (°F) [2]	117.1	16.1

Notes:

1. Information reported in Table 2.6-5 of the SER for BWRVIP-05.
2. Mean RT_{NDT} was determined using the peak neutron fluence for the limiting weld.
3. The HCGS values are obtained from Table 3-2 for limiting axial weld W14 (SAW).

Table 3-6 HCGS 56 EFPY Effects of Irradiation on RPV Circumferential Weld Properties

Group	CB&I Vessel 64 EFPY [1]	HCGS Vessel 56 EFPY [3]
Copper Content, Cu (wt. %)	0.10	0.084
Nickel Content, Ni (wt. %)	1.08	0.626
Chemistry Factor (°F)	135.0	110.12
Fluence at Clad/Base Metal Interface (10^{19} n/cm^2)	1.38	0.116
Unirradiated Reference Temperature, $RT_{NDT(U)}$ (°F)	-30	-30
Shift in Reference Temperature, ΔRT_{NDT} (without margin) (°F)	147.1	41.4
Mean RT_{NDT} (°F) [2]	117.1	11.4

Notes:

1. Information reported in Table 2.6-5 of the SER for BWRVIP-05.
2. Mean RT_{NDT} was determined using the peak neutron fluence for the limiting weld.
3. The HCGS values are obtained from Table 3-2 for limiting axial weld W7 (SAW).

Table 3-7 CUF and Primary Stress Range of Limiting Components

	Primary Stress (ksi)			CUF [6]		
Component / Condition [1]	**Current AOR (New Loads) [2]**	**TPO (4,031 MWt)**	**Allowable (ASME Code Limit) [3]**	**Current AOR 60 Years (4,031 MWt) [5]**	**TPO 60 Years (4,031 MWt) [5]**	**Allowable (ASME Code Limit)**
Shroud Support / Faulted Condition [1] (Attachment to RPV Location)				0.465	0.465	1.0
P_M [4]	23.21	23.66	28.40			
P_L [4]	20.86	33.01	42.60			
$P_L + P_B$ [4]	24.46	34.93	42.60			

Notes:

1. The bounding stress values in the faulted condition for this component were revised due to a change in acoustic loads as a result of GEH SCs. The change was not due to implementation of TPO.
2. New loads stress intensity values.
3. Per the OLTP stress report, the ASME Code allowables are 28.40 ksi (S_y for SB168), 42.60 ksi (S_y for SA533, Gr. B, CL 1), and 42.6 ksi (S_y for SA533, Gr. B, CL 1) for P_M, P_L, and $P_L + P_B$, respectively. Note that per the OLTP stress report, the limiting location for P_M is different from that for P_L and $P_L + P_B$. Therefore, the material data corresponding to the limiting locations is applied for the determination of ASME Code allowables.
4. P_M = Primary Membrane Stress Intensity
   P_L = Primary Local Stress Intensity
   P_B = Primary Bending Stress Intensity
5. The analysis was conservatively evaluated for 102% (per RG 1.49) of original EPU (3,952 * 1.02 = 4,031 MWt).
6. No change in CUF calculation due to inclusion of revised acoustic loads.

Table 3-8 Governing Stress Results for RPV Internals

Item	Component	Service Level [1]	Stress/Load Category	Unit	CLTP Value	TPO Value [2]	Allowable [3]
1	Shroud	N/U	P_m	ksi	10.87	11.86	21.45
		F	$P_m + P_b$	ksi	14.07	19.98 [4]	42.90
2	Shroud Support	N/U	P_m	ksi	21.96	22.48	23.30
		N/U	$P_m + P_b$	ksi	22.66	23.20	35.00
		E/F	P_m	ksi	39.49	42.65 [4]	46.60
		E/F	$P_m + P_b$	ksi	41.62	59.10 [4]	69.90
3	Core Plate	N/U	Buckling	kip	1.65	1.80	2.03
		F	$P_m + P_b$	ksi	18.38	20.20	50.70
		F	Buckling	kip	1.91	2.10	4.07
4	Top Guide	N/U	Shear	ksi	10.46	11.51	12.20
		N/U	Buckling	kip	26.23	26.23	26.39
		F	$P_m + P_b$	ksi	27.55	30.30	50.70
		F	Buckling	kip	29.78	29.78	49.87
5	CRD & CRD Housing	Bounded by design basis values. The component is qualified for TPO.					
6	Control Rod Guide Tube	Bounded by design basis values. The component is qualified for TPO.					
7	Orificed Fuel Support	Bounded by design basis values. The component is qualified for TPO.					
8	Fuel Channel	Bounded by design basis values. The component is qualified for TPO.					
9	Steam Dryer	Bounded by design basis values. The component is qualified for TPO.					
10	FW Sparger	Bounded by design basis values. The component is qualified for TPO.					
11	Jet Pump	F	$P_m + P_b$	ksi	46.79	46.79 [4]	60.80
12	CS Line and Sparger	Bounded by design basis values. The component is qualified for TPO.					
13	Access Hole Cover	N/U	P_m	ksi	< 13.19	< 13.19	13.72
		N/U	$P_m + P_b$	ksi	13.19	13.19	20.58
		F	$P_m + P_b$	ksi	32.47	47.38 [4]	49.40
14	Shroud Head & Steam Separator Assembly	Bounded by design basis values. The component is qualified for TPO.					
15	LPCI Coupling	Bounded by design basis values. The component is qualified for TPO.					

Item	Component	Service Level [1]	Stress/Load Category	Unit	CLTP Value	TPO Value [2]	Allowable [3]
16	Core Differential Pressure and Standby Liquid Control Line	Bounded by design basis values. The component is qualified for TPO.					

Notes:

1. N - normal condition, U - upset condition, E - emergency condition and F - faulted condition.
2. Stresses/loads listed are for the limiting loading condition, with the least margin to allowable limits.
3. AVs are consistent with the original design basis.
4. Assumed acoustic loads are applied for the stress calculation.

4.0 ENGINEERED SAFETY FEATURES

4.1 CONTAINMENT SYSTEM PERFORMANCE

TLTR Appendix G presents the methods, approach, and scope for the TPO uprate containment evaluation for LOCA. The current containment evaluations were performed at 102% of CLTP. 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.

<table>
<tr><th>Topic</th><th>Key Parameters</th><th>TPO Effect</th></tr>
<tr><td>Short Term Pressure and Temperature Response</td><td></td><td rowspan="10">Current analysis based on 102% of CLTP or greater</td></tr>
<tr><td>Gas Temperature</td><td>Break Flow and Energy</td></tr>
<tr><td>Pressure</td><td>Break Flow and Energy</td></tr>
<tr><td>Long-Term Suppression Pool Temperature Response</td><td></td></tr>
<tr><td>Bulk Pool</td><td>Decay Heat</td></tr>
<tr><td>Local Temperature with SRV Discharge</td><td>Decay Heat</td></tr>
<tr><td>Containment Dynamic Loads</td><td></td></tr>
<tr><td>LOCA Loads</td><td>Break Flow and Energy</td></tr>
<tr><td>SRV Loads</td><td>Decay Heat</td></tr>
<tr><td>Sub-compartment Pressurization</td><td>Break Flow and Energy (Note 1)</td></tr>
<tr><td>Containment Isolation
Section 4.1.1 provides confirmation that motor-operated valves (MOVs) are capable of performing design basis functions at TPO conditions.</td><td></td><td>The ability of containment isolation valves (CIVs) and operators to perform their required functions is not affected because the evaluations were performed at 102% of CLTP or greater.</td></tr>
</table>

Note:

1. The HCGS current analysis of sub-compartment pressurization is based on the maximum break flow and energy of postulated pipe breaks between the RPV wall and the biological shield wall. In August 2010, these loads were reevaluated for HCGS and found to be within the plant design basis during FFWTR. As such, sub-compartment loads were evaluated after

issuance of GEH SC 09-01 (Reference 31), which discussed possible nonconservative assumptions in earlier BWR analyses. Because HCGS sub-compartment loads were evaluated by GEH after SC 09-01 issues were known and were performed at 102% of CLTP, the SC 09-01 issue is resolved for HCGS.

4.1.1 Generic Letter 89-10 Program

The MOV requirements in the UFSAR were reviewed, and no changes to the functional requirements of the GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," MOVs, were identified as a result of operating at the TPO RTP level. Because previous analyses were either based on 102% of CLTP or are consistent with the plant conditions expected to result from TPO, there are no increases in the pressure or temperature at which MOVs are required to operate with the exception of FW valves (slight temperature increase, but no field modifications required). Therefore, the GL 89-10 program remains unchanged following power uprate and the MOVs remain capable of performing their design basis functions.

4.1.2 Generic Letter 96-05

GL 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves," was reviewed and determined to have no effects related to this power uprate.

4.1.3 Generic Letter 95-07 Program

The evaluation performed in support of GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," has been reviewed and no changes are identified as a result of operating at the TPO RTP level. The criteria for susceptibility to pressure locking or thermal binding were reviewed and it was determined that the slight changes in operating or environmental conditions expected to result from the TPO uprate would have no effect on the functioning of power-operated gate valves within the scope of GL 95-07. Therefore, the GL 95-07 program remains unchanged following power uprate and the valves remain capable of performing their design basis functions.

4.1.4 Generic Letter 96-06

The HCGS response to GL 96-06, "Assurance of Equipment Operability and Containment Integrity during Design-Basis Accident Conditions," was reviewed for the TPO uprate. The containment design temperatures and pressures in the current GL 96-06 evaluation are not exceeded under post-accident conditions for the TPO uprate. Therefore, the HCGS response to GL 96-06 remains valid under TPO uprate conditions.

4.1.5 Containment Coatings

The nominal operating conditions change slightly and the required initial conditions for containment analysis inputs remain the same for TPO. The temperature and pressure do not increase significantly. The Service Level 1 coatings are qualified to 340°F, 70 psi and 1.1×10^6 rads. Therefore, the containment coatings continue to bound the DBA temperature, pressure, and radiation at TPO conditions.

4.2 EMERGENCY CORE COOLING SYSTEMS

4.2.1 High Pressure Coolant Injection

The HPCI system is a steam 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 HPCI system is to maintain reactor vessel coolant inventory in the event of a small break LOCA that does not immediately depressurize the reactor vessel. The generic evaluation of the HPCI system provided in TLTR Section 5.6.7 is applicable to HCGS. The ability of the HPCI system to perform required safety functions is demonstrated with previous analyses based on 102% of CLTP. Therefore, all safety aspects of the HPCI system are within previous evaluations and the requirements are unchanged for TPO uprate conditions.

4.2.2 Core Spray

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

4.2.3 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 small break LOCA after the RPV has been depressurized. The generic evaluation of the LPCI mode provided in TLTR Section 5.6.4 is applicable to HCGS. The ability of the RHR system to perform required safety functions required by the LPCI mode is demonstrated with previous analyses based on 102% of CLTP or greater. Therefore, all safety aspects of the RHR system LPCI mode are within previous evaluations, and the requirements are unchanged for the TPO uprate conditions.

4.2.4 Automatic Depressurization System

The automatic depressurization system (ADS) uses SRVs to reduce the reactor pressure following a small break LOCA when it is assumed that the high pressure systems have failed. This allows CS and LPCI to inject coolant into the RPV. 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 HCGS. The ability of the ADS 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 the TPO uprate conditions.

4.2.5 ECCS Net Positive Suction Head

The most limiting case for 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 HCGS. The CLTP containment analyses were based on 102% of CLTP and there is no change in the available NPSH for systems using suppression pool water. Therefore, the TPO uprate does not affect compliance with the ECCS pump NPSH requirements.

4.3 EMERGENCY CORE COOLING SYSTEM PERFORMANCE

The ECCS is designed to provide protection against a postulated LOCA caused by ruptures in the primary system piping. The current 10 CFR 50.46, or LOCA, analyses for HCGS have been performed at power levels assuming 102% of CLTP, consistent with Appendix K. Table 4-1 shows the licensing basis PCT results of the HCGS ECCS-LOCA analyses, including the PCT effect of any change to the acceptable evaluation models previously reported to the NRC. The ECCS-LOCA results for HCGS are in conformance with the licensing requirements of 10 CFR 50.46. Therefore, the pre-TPO LOCA analyses for HCGS bound the 1.6% TPO uprate for HCGS.

Reference 32 provides justification for the elimination of the 1,600°F upper bound PCT limit and generic justification that the licensing basis PCT will be conservative with respect to the upper bound PCT. The NRC SER for Reference 32 accepted this position, noting that because plant-specific upper bound PCT calculations have been performed for all plants, other means may be used to demonstrate compliance with the original SER requirements. These other means are acceptable provided there are no significant changes to a plant's configuration that would invalidate the existing upper bound PCT calculations.

References 33 and 34 provided justification for the elimination of the upper bound PCT limit for HCGS. For the TPO uprate, there are no changes to the plant configuration that would invalidate the HCGS LOCA evaluation for conformance with Reference 32. The pre-TPO LOCA analyses are concluded to bound the 1.6% TPO uprate for HCGS. References 33 and 34 also address the effect of power shapes on PCT for the MAPLHGR assumed for the evaluations.

4.4 MAIN CONTROL ROOM ATMOSPHERE CONTROL SYSTEM

The main control room atmosphere is not affected by the TPO uprate. Control room habitability following a postulated accident at TPO conditions is unchanged because the control room envelope/habitability systems have previously been evaluated for radiation release accident conditions at 102% of CLTP. Therefore, the system remains capable of performing its safety function at the TPO conditions.

4.5 FILTRATION, RECIRCULATION, AND VENTILATION SYSTEM (REFERRED TO AS SGTS IN THE TLTR)

The FRVS minimizes the offsite and control room dose rates during venting and purging of the containment atmosphere under abnormal conditions. The current capacity of the FRVS was selected to maintain the secondary containment at a slightly negative pressure during such conditions. This capability is not changed by the TPO uprate conditions. The FRVS can accommodate DBA conditions at 102% of CLTP. Therefore, the system remains capable of performing its safety function for the TPO uprate condition.

4.6 MAIN STEAM ISOLATION VALVE LEAKAGE CONTROL SYSTEM

HCGS does not have a MSIV leakage control system.

4.7 POST-LOCA CONTAINMENT ATMOSPHERE CONTROL SYSTEM

The HCGS combustible gas control system (CGCS) was designed to provide assurance that a combustible gas mixture would not be achieved post-LOCA using hydrogen recombiners. However, HCGS has incorporated the requirements of the revised 10 CFR 50.44 (68 FR 54123, dated September 16, 2003) which no longer defines a design basis post-LOCA hydrogen release. This consequently eliminates the requirements for hydrogen control systems to mitigate such releases. Those new requirements were adopted by HCGS through License Amendment Number 160, issued in August 2005 (Reference 35). As such, there is no further evaluation required for the TPO.

Table 4-1 HCGS ECCS-LOCA Analysis Results

Parameter	GE14	GNF2	Analysis Limit
Licensing Basis PCT [2]	1,485°F	1,610°F	< 2,200°F [1]
Maximum Local Oxidation	< 1.0%	< 1.0%	≤ 17% [1]
Core-Wide Metal-Water Reaction	< 0.1%	< 0.1%	≤ 1.0% [1]

Notes:

1. 10 CFR 50.46 ECCS-LOCA analysis acceptance criteria.
2. Where applicable, includes the effects of any change to or error discovered in the acceptable evaluation models previously reported to the NRC.

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 APRMs are re-calibrated to indicate 100% at the TPO RTP level of 3,902 MWt. The APRM neutron flux-upscale scram, APRM simulated thermal power (STP) upscale high flow clamped (scram) and STP upscale high flow clamp rod block setpoints, expressed in units of percent of licensed power, are not changed. The flow-biased APRM trips, expressed in units of absolute thermal power (i.e., MWt), remain the same. This approach for the HCGS 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 intermediate range monitors (IRMs) have adequate overlap with the source range monitors (SRMs) and APRMs. However, normal plant surveillance procedures may be used to adjust the IRM overlap with the 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 In-Core 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 in-core 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 chambers. The radiation protection program for normal plant operation can accommodate a small increase in radiation levels.

5.1.1.3 Rod Block Monitor

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

5.1.2 Rod Worth Minimizer

The rod worth minimizer (RWM) does not perform a safety-related function. The function of the RWM is to support the operator by enforcing rod patterns until reactor power has reached appropriate levels. The power-dependent setpoints for the RWM are discussed in Section 5.3.8.

5.2 BOP MONITORING AND CONTROL

Operation of the plant at the TPO RTP level has a 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 instrumentation with control functions has sufficient range/adjustment capability for use at the TPO uprate conditions. Safety-related BOP system setpoints are changing as discussed in Section 5.3.16 as a result of the TPO uprate. The plant-specific instrumentation and control design and operating conditions are bounded by those used in the evaluations contained in the TLTR.

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 AVs. The PCS consists of the pressure regulation system, TCV system, and TBV system. The main turbine speed/load control function is performed by the main T/G electro-hydraulic control (EHC) system. The TBV pressure control function is performed by the turbine bypass control system (TBCS).

Satisfactory reactor pressure control by the pressure regulator and the 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)). HCGS has demonstrated acceptable pressure control performance at current rated conditions and has approximately a 2% steam flow margin. To provide margin for pressure control required for the uprate, the HP turbine first stage nozzles and 2nd through 4th stage diaphragms are to be modified. Adjustments to the existing electronic controls will be required to compensate for changes in flow curves.

No modification is required for the TBVs. No modifications are required to controls or alarm annunciators provided in the main control room. The required adjustments are limited to tuning the control settings that may be required to operate optimally at the TPO uprate power level.

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

5.2.2 EHC Turbine Control System

The turbine EHC system was reviewed for the increase in core thermal power and associated ~2% increase in rated steam flow. The control system is expected to perform normally for TPO RTP operation. Normal operator controls are used in conjunction with the associated operating procedures. Confirmation testing will be performed during power ascension (Section 10.4).

5.2.3 Feedwater Control System

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

5.2.4 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 the leak detection trip avoidance margin. As described in TLTR Section F.4.2.8, the high steam tunnel temperature setpoint remains unchanged.

RWCU System Temperature Based Leak Detection

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

RCIC System Temperature Based Leak Detection

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

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 GEH setpoint methodologies (References 4 and 36*)* are used to generate the AVs and nominal trip setpoints (NTSPs) related to any AL change, as applicable. Each actual trip setting is established to preclude inadvertent initiation of the protective action, while assuring adequate allowances for instrument accuracy, calibration, drift, and applicable normal and accident design basis events.

Table 5-1 lists the ALs (or AVs if no ALs) that change based on results from the TPO evaluations and safety analyses. In general, if the AL does not change in the units shown in the TS, then no change in its associated plant AV and NTSP is required, as shown in the TS. 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 TPO 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 (Reference 1) Sections 5.8 and F.4 and on Section 5.3 of Reference 4.

5.3.1 High Pressure Scram

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

5.3.2 Hydraulic Pressure Scram

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

5.3.3 High Pressure Recirculation Pump Trip

The ATWS-RPT trips the pumps during plant transients with increases in reactor vessel dome pressure. The ATWS-RPT provides negative reactivity by reducing CF during the initial part of an ATWS. The evaluation in Section 9.3.1 demonstrates that the TS limit for the high pressure ATWS-RPT is acceptable for the TPO uprate.

5.3.4 Safety Relief Valve

Because there is no increase in reactor operating 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. For HCGS, although the MS flow increases approximately 2%, the MSL high flow isolation AL in terms of differential pressure is not changed for the TPO uprate. No new instrumentation is required. The corresponding AL in terms of percent of rated steam flow rate in each steam line is decreased as the result of higher absolute flow at TPO, as allowed by TLTR Section F.4.2.5. The TS AV does not change in differential pressure at the allowable steam flow.

Because of the large spurious trip margin, sufficient margin to the trip setpoint exists to allow for normal plant testing of the MSIVs. This is consistent with TLTR Section F.4.2.5.

5.3.6 Fixed APRM Scram

The fixed APRM ALs, 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 HCGS. The limiting transient that relies on the fixed APRM trip is the vessel overpressure transient (main steam isolation valve closure (MSIVC)) with indirect scram. This event has been analyzed assuming 102% of CLTP and is reanalyzed on a cycle-specific basis.

5.3.7 APRM Simulated Thermal Power – Upscale Flow Biased Scram

The flow-referenced APRM AVs, for both TLO and SLO, are unchanged in units of absolute core thermal power versus recirculation drive flow. Because the setpoints are expressed in percent of RTP, they decrease in proportion to the power uprate or CLTP RTP/TPO RTP. This is the same approach taken for generic BWR uprates described in ELTR1 (Reference 2). There is no significant effect on the instrument errors or uncertainties from the TPO uprate. Therefore, the NTSPs are established by directly incorporating the changes in the AVs.

5.3.8 Rod Worth Minimizer Low Power Setpoint

The RWM low power setpoint (LPSP) is used to enforce the rod patterns established for the control rod drop accident at low power levels. The TPO RWM LPSP AL has been scaled in terms of percent power to maintain the value in absolute power and is changed to 8.441% of RTP. The generic guidelines in TLTR Section F.4.2.9 are applicable to HCGS.

5.3.9 Rod Block Monitor

The TPO RBM LPSP AL is maintained the same in terms of percent power for TPO. The severity of the rod withdrawal error (RWE) during the power operation event is dependent upon the RBM rod block setpoint. [[

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5.3.10 Flow-Biased Rod Block Monitor

HCGS does not have a flow-biased RBM system.

5.3.11 Main Steam Line High Radiation Isolation

The MSL normal radiation level increases approximately proportional to power. The setpoint is based on the normal operating background radiation level, and may be adjusted to provide the same level of protection at the TPO uprate conditions with no appreciable increase in spurious trip frequency. No change in the TS is required. This approach is consistent with TLTR Section F.4.2.8.

5.3.12 Low Steam Line Pressure MSIVC (RUN Mode)

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

5.3.13 Reactor Water Level Instruments

As described in TLTR Section F.4.2.10, the TPO uprate does not result in a significant increase in the possibility of a reactor scram, equipment trip, or ECCS actuation. Use of the current ALs maintains acceptable safety system performance. The low reactor water level TS setpoints for scram and ADS/ECCS are not changed for the TPO uprate. The high water level ALs for trip of the main turbine and the FW pumps are 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 not change relative to the remaining FW flow as exists at CLTP.

5.3.14 Main Steam Line Tunnel High Temperature Isolations

As noted in Section 5.2.4, the high steam tunnel temperature AL remains unchanged for the TPO uprate.

5.3.15 Low Condenser Vacuum

In order to produce more electrical power, the amount of heat discharged to the main condenser increases slightly. This added heat load may slightly increase condenser backpressure, but the increase would be insignificant (< 0.15 in. HgA). The slight change in condenser vacuum after implementation of TPO will not adversely affect any trip signals associated with low condenser vacuum (turbine trip / MSIVC).

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

The TSV closure scram, TCV fast closure scram, and EOC-RPT bypass signals allow these functions to be bypassed when reactor power is sufficiently low that the scram and EOC-RPT functions are not necessary in order to maintain adequate safety margins following a T/G trip. This bypass setpoint is specified in percent RTP and is automatically accomplished by pressure switches sensing turbine first-stage pressure (TFSP). The TFSP setpoint is chosen to allow operational margin so that scrams can be avoided by transferring steam to the turbine bypass system during T/G trips at low power.

The guidelines in TLTR Section F.4.2.3 state that the TSV closure scram, TCV fast closure scram, and EOC-RPT bypass setpoint will be kept the same in terms of absolute main turbine steam flow (lbm/hour), as indicated as a pressure signal (psig). This approach minimizes potential changes to the plant instrumentation, and maintains the same steam flow range of trip avoidance as previous operation (within the unchanged turbine steam bypass system). The basis for this approach, as stated in the TLTR, is as follows:

> No modifications to the main turbine are expected to be made for a TPO uprate, so there will be no change in the first-stage pressure/steam flow relationship from previous plant operation.

> The setpoint is chosen to allow operational margin so that scram may be avoided by transferring turbine steam to the turbine bypass system during T/G trips at low power. The transient events associated with operation just below this setpoint have been shown to be non-limiting from a safety viewpoint and are not usually specifically analyzed in the UFSAR or in current reloads because they generally have ample margin.

The HCGS high pressure turbine is being modified for the TPO uprate to maintain adequate flow margin on the TCVs. This modification changes the turbine first stage power/pressure relationship. Additionally, PSEG is maintaining the TSV closure scram and TCV fast closure scram bypass setpoint at 24% of RTP after implementation of TPO. Because the turbine modifications were not assumed in the TLTR, the basis for following the TLTR approach was re-evaluated.

The TSV closure scram bypass, TCV fast closure scram bypass, and EOC-RPT bypass AL in percent of RTP is unchanged; this is an exception to TLTR Sections 5.8 (Item 5) and F.4.2.3 (Reference 1). The new AL increases with respect to absolute thermal power and absolute main turbine steam flow from CLTP conditions, by maintaining it at 24% of RTP. Therefore, a plant-specific evaluation was performed.

The AL had been reduced previously during the EPU. Based on EPU calculations, the AL was reduced from 30% of RTP to 25.7% of RTP. The AL was then further reduced by 1.7% from 25.7% to the pre-TPO level of 24% to be consistent with the power level at which the TS thermal limits must be monitored. Rescaling the 25.7% for TPO results in an AL of 25.2% of RTP. This value is then conservatively reduced further by 1.2% of RTP to be consistent with the low power thermal limit threshold. This reduction is in the conservative direction, as the scram and EOC-RPT would be enforced to a lower RTP.

Based on this plant-specific evaluation, the bypass AL is not reduced as described in the TLTR and will remain at the current level of 24% of RTP. Although this will result in enabling these trip functions at a slightly higher thermal power under TPO, this is acceptable because the AL remains conservative.

Table 5-1 Analytical Limits and Allowable Values for Current and TPO Power Level

Parameter	Current	TPO	Justification
APRM Neutron Flux - Upscale Scram (% RTP), AL	121	No change	
APRM STP Scram [2]			(1)
STP – Upscale High Flow Clamped (Scram) (%RTP), AV	115.5	No change	
TLO STP – Upscale Flow Biased (Scram) (%RTP) [3], AV	$0.57W_d + 61.0$	$0.56W_d + 60.0$	(4)
SLO STP – Upscale Flow Biased (Scram) (%RTP) [3], AV	$0.57(W_d - 9) + 61.0$	$0.56(W_d – 9) + 60.0$	(4)
APRM STP Rod Block [2]			(1)
STP – Upscale High Flow Clamped (Rod Block) (%RTP), AV	111	No change	
TLO STP Upscale Rod Block (%RTP) [3], AV	$0.57W_d + 56.0$	$0.56W_d + 55.1$	(4)
SLO STP Upscale Rod Block (%RTP) [3], AV	$0.57(W_d - 9)+ 56.0$	$0.56(W_d – 9) + 55.1$	(4)
TSV Closure Scram Bypass, TCV Fast Closure Scram Bypass, and EOC-RPT Bypass - AL (%RTP)	24	No change	(4) (5) (6)
MSL High Flow Isolation – ALs: % rated steam flow psid	 140 176.2	 137.4 No change	(4) (5)
Rod Worth Minimizer LPSP – AL (%RTP)	8.576	8.441	(4) (5)

Notes:

1. HCGS does not have ALs for these setpoint functions.
2. No credit is taken in any safety analysis for flow biased setpoints.
3. W_d is % recirculation drive flow where 100% drive flow is that required to achieve 100% CF at 100% power.
4. These changes to the ALs and AVs are based upon the methodology approved by the NRC in Reference 1.
5. All limits scaled for an uprate of 1.6% thermal power.
6. Change remains conservative even though there is an exception to Reference 1.

6.0 ELECTRICAL POWER AND AUXILIARY SYSTEMS

6.1 AC POWER

The plant electrical characteristics at TPO uprated conditions are given in Table 6-1.

A detailed comparison of existing ratings with ratings at TPO conditions and the effect of the TPO uprate on the main generator, main transformers, station power transformers, and station service transformers are shown in Tables 6-2, 6-3, 6-4, and 6-5, respectively.

6.1.1 Off-Site Power

The main generator, main transformer and isolated phase bus nameplate ratings are listed in Table 6-1 and discussed below:

- Main Generator: The generator is a direct-driven 3-phase 60 Hz, 25,000 V, 1,800 rpm, hydrogen inner-cooled, synchronous generator rated for: 1,373.1 megavolt amps (MVA) at a 0.94 power factor (PF), with a 0.50 short circuit ratio at a nominal hydrogen pressure of 75 psig.
- Main Transformers: The 1,400.1 MVA main power transformer consists of three single-phase, 466.7 MVA 24 - GND Y / 288.7 kilovolt (kV), forced oil and air (FOA), 65°C rise, 60 Hz, oil-filled type, outdoor transformer.
- Isolated Phase Bus Duct: The isolated phase bus duct consists of a main bus and a delta bus. The isolated phase bus continuous current rating is based on a 105°C operating temperature (65°C rise above a 40°C ambient temperature) with forced air cooling for the main bus and the delta bus. The main bus is rated at 34,000 A with a momentary fault current rating of 468,000 A. The delta bus is rated at 19,500 A with a momentary fault current rating of 468,000 A. The voltage rating of the system is 25,000 V. The forced cooling is handled by an air handling unit with a design heat transfer capacity of 682,000 Btu/hr.

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

- The main generator will be operated within the existing generating capability curve for TPO uprate. The gross generator MWe output is on or within the existing generator reactive capability curve.
- The isolated phase bus duct is adequate for both rated voltage and low voltage current output. The isolated phase bus duct cooling system capacity is adequate for the expected heat rejection loads during the TPO uprate operation. Therefore, the isolated phase bus duct cooling system is adequate to support the TPO uprate.
- The main transformers and the associated switchyard components (rated for maximum generator output) are adequate for the TPO uprate-related transformer output. The items with the least margin are the disconnect switches which have 25.6% margin.

Operation of HCGS at the TPO level will not require modifications to the generator, bus duct, main transformer and the transmission components (disconnect switches, tubular bus and transmission lead) leading to the 500 kV switchyard to support operation at the nameplate output capacity of HCGS.

The current grid stability analysis bounds the increase in electrical output and demonstrates conformance to General Design Criteria (GDC) 17 (10 CFR 50, Appendix A). The analysis establishes grid voltage schedules, generator reactive power limits and reduced generation limits that are required under certain pre-event outages.

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 distribution system loads were reviewed under normal and emergency operating scenarios. In both cases, the 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 BHP. Therefore, there are negligible changes to the load, voltage drop or short circuit current values.

The only identifiable change in electrical load demand is associated with the condensate pumps. These pumps experience increased flow and a small change in horsepower duty due to the TPO uprate conditions. 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 (EDGs)) are based on operational requirements. The ECCS pump loading is based on station UFSAR design basis requirements. Emergency operation at the TPO RTP levels 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.

Because the duty cycle and duration for design basis EDG loads is based on analytical power levels of at least 102% of the CLTP, these will remain unchanged by TPO. Hence, the required reserve volume of emergency fuel oil is not changed. Therefore, useable emergency fuel oil reserves will be adequate to support TPO.

6.1.3 Emergency Diesel Generator

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

6.2 DC POWER

The direct current (DC) loading requirements documented in the UFSAR and station load calculations 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. These loads are used as inputs for the computation of load, voltage drop, and short circuit current values. 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.

The changes to the auxiliary power system as a result of the TPO uprate are small increases in the horsepower of the condensate pump and the reactor recirculation (RRC) pump motors. The DC system does not power the affected pumps; therefore, the DC is not affected by the increase in motor duty. The DC system supplies power for control and auxiliary systems of the main equipment.

There are no changes to the DC system loading resulting from TPO other than loads associated with the LEFM system.

The effect of the DC load change imposed by the LEFM modification has been evaluated using the methodology documented in the existing electrical design analysis calculations and has been found to be within the current acceptance criteria.

6.3 FUEL POOL

The following sections address FPC, crud and corrosion products in the fuel pool, radiation levels and structural adequacy of the fuel racks. The changes due to TPO are within the design limits of the system and its components. The FPC system meets the UFSAR requirements at the TPO conditions.

6.3.1 Fuel Pool Cooling

The SFP heat load remains within the capability of the FPC system as assured by cycle-specific calculations to verify heat load is less than or equal to that previously analyzed. The TPO uprate does not affect the heat removal capability of the FPC system supplemented with RHR assist mode, as shown in Table 6-6. The TPO heat load is within the design basis heat load for the FPC system supplemented with RHR assist mode.

The SFP cooling and makeup adequacy is maintained by controlling the timing of the discharge (fuel offload) to the SFP to ensure the capability of the FPC system to maintain adequate FPC for the TPO uprate.

The FPC system heat exchangers are sufficient to remove the decay heat during normal refueling. The equipment required is not affected by TPO.

For a full core off-load, the RHR system in FPC assist mode is available to maintain the SFP water temperature below the design limit.

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 FPC system.

6.3.3 Radiation Levels

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

6.3.4 Fuel Racks

There is no effect on the design of the fuel racks because the maximum allowable spent fuel temperature is not being increased.

6.4 WATER SYSTEMS

6.4.1 Cooling Water Systems

The HCGS cooling water systems include a non-safety related circulating water system to transfer the heat from the main condenser to a cooling tower and a once-though, safety-related station service water system (SSWS) to remove the heat from the closed loop SACS, the closed loop non-safety related RACS, and the closed loop non-safety TACS. The SSWS uses the Delaware River as the ultimate heat sink (UHS).

6.4.1.1 Safety-Related Loads

Station Service Water System

The safety-related SSWS is designed to provide a reliable supply of cooling water to the SACS during normal operation, normal shutdown, loss of offsite power (LOP) and following a LOCA. The SSWS also provides a reliable supply of cooling water to the RACS during normal operation and during LOP events without a LOCA.

The TPO effect is bounded by the LOCA analysis. The SSWS contains sufficient redundancy in pumps and heat exchangers to assure that adequate heat removal capability is available during all modes of operation at TPO conditions.

Safety Auxiliaries Cooling System

The SACS provides cooling for the following equipment and systems during and following the most demanding design basis event, the LOCA:

RHR heat exchangers

RHR pump seal and motor bearing coolers

Diesel generator coolers

Diesel generator room coolers

RHR pump room coolers

HPCI pump room coolers

RCIC pump room coolers

CS pump room coolers

FRVS coolers

Class 1E equipment chillers

Control room chillers

Containment instrument gas compressor

Post accident sampling station

SFP heat exchangers

The diesel generator loads, gas compressor loads, RHR pump seal loads, chillers, and FRVS loads remain unchanged for LOCA conditions at TPO conditions. The SACS cooling loads for the RHR heat exchanger and the ECCS room coolers are bounded by the LOCA analysis.

The SACS is used to supply flow to the TACS during normal operating conditions. The SACS to TACS flow path is isolated under LOP or LOCA conditions.

6.4.1.2 Reactor Auxiliaries Cooling System

The heat loads on the RACS remain bounded by the design heat load. The flow rates in the systems cooled by the RACS do not change due to TPO (e.g., recirculation and RWCU pumps cooling) and, therefore, are minimally affected by TPO. The operation of the remaining equipment cooled by the RACS (e.g., sample coolers and drain sump coolers) is not power-dependent and is not affected by TPO. The RACS contains sufficient redundancy in pumps and heat exchangers to assure that adequate heat removal capability is available during normal operation. Sufficient heat removal capacity is available to accommodate the RACS heat load at TPO conditions.

6.4.1.3 Turbine Auxiliaries Cooling System

The heat loads on the TACS which are power-dependent and are increased by TPO include those related to the operation of the generator stator coolers, iso-phase bus heat exchanger, the condenser compartment unit coolers and fans, and the Turbine Building chiller condensers and pump out unit coolers. Because the TACS flow to these components can be increased to compensate for the increased heat load, there is no increase in TACS operating temperature at TPO conditions.

6.4.2 Main Condenser/Circulating Water/Normal Heat Sink Performance

The main condenser, circulating water, and normal heat sink systems are designed to remove the heat rejected to the condenser and thereby maintain adequately low condenser pressure as recommended by the turbine vendor. TPO operation increases the heat rejected to the condenser and may reduce the difference between the operating pressure and the minimum condenser vacuum. The performance of the main condenser was evaluated for operation at the TPO conditions. The evaluation confirms that the condenser, circulating water system and normal heat sink are adequate for TPO operation.

6.4.2.1 Discharge Limits

The New Jersey Department of Environmental Protection (NJDEP) National Pollutant Discharge Elimination System Permit (NJPDES Permit Number NJ0025411) provides surface water discharge monitoring report (DMR) limits and monitoring requirements for effluents discharged to the Delaware River by HCGS. PSEG applied to the NJDEP for renewal of the NJPDES permit in December 2015. The current NJPDES permit for HCGS was issued by the NJDEP in March 2011 and remains in effect until NJDEP completes their application review and issues a renewed permit.

The environmental review previously conducted in support of EPU evaluated potential environmental effects of an increase in thermal power to 120% of the original license power (3,952 MWt). The TPO uprate is below the thermal power level previously evaluated, and as discussed below, will not result in any significant change in offsite effluents.

Except for stormwater runoff, all liquid effluent from HCGS is discharged through one surface water outfall which consists primarily of cooling tower blowdown (Discharge Serial Number (DSN) 461A). The prior evaluated effluent values, current discharge limits, reported discharge data, and expected change resulting from TPO at DSN 461A are summarized in Table 6-7.

Routine monitoring of these parameters assures that permit limits are not exceeded. Operation at the uprated condition will not require modification of these permit conditions. The performance of the cooling tower has been evaluated under updated conditions, and it is determined that tower outlet temperature (and, therefore, blowdown temperature) will have an insignificant increase.

The state thermal discharge limits, the current discharges, and bounding analysis discharges for the TPO uprate are shown in Table 6-7. This comparison demonstrates that the plant remains within the state discharge limits during operation at TPO conditions.

6.4.3 Ultimate Heat Sink

The UHS for HCGS is the Delaware River. The SSWS provides water from the UHS for equipment cooling throughout the plant. As a result of operation at the TPO RTP level, the post-LOCA heat load increases slightly, primarily due to higher reactor decay heat. 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 TS for UHS limits is adequate due to conservatism in the current 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. This system pumps a sodium pentaborate solution into the vessel to achieve a sub-critical condition. The generic evaluation presented in TLTR Section 5.6.5 (SLCS) and Appendix L.3 (ATWS Evaluation) is applicable to the HCGS TPO uprate. The TPO uprate does not affect shutdown or injection capability of the SLCS. Because the shutdown margin is reload dependent, the shutdown margin and the required reactor boron concentration are confirmed for each reload core.

The SLCS relief valve margin is adequate for the TPO uprate because the SLCS prior to the TPO uprate has a confirmed minimum relief valve margin of ≥ 141 psi (the margin was established to be 141 psi for a power level of 3,952 MWt, and therefore will be ≥ 141 psi for the TPO uprate).

The SLCS ATWS performance is evaluated in 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, Reactor Building, steam tunnel and primary containment (drywell).

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 temperature increases are expected to be very low due to the increase in the FW process temperatures. In the Reactor Building, the increase in heat load caused by the slightly higher FW process temperature 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 is no change in the physical plant configuration and the potential for minor changes to combustible loading as a result of the TPO uprate are addressed by controlled design change procedures.

The operator manual actions that are being used for compliance with 10 CFR 50, Appendix R were reviewed. No operator manual actions have been identified in areas where environmental conditions, such as heat, would challenge the operator. Because this uprate is being performed at a constant pressure and temperature, the normal temperature environments are not affected by TPO. Therefore, the operator manual actions required to mitigate the consequences of a fire are not affected.

A review was conducted of the Fire Protection Program as related to administrative controls, fire barriers, fire protection responsibilities of plant personnel and resources necessary for systems required to achieve and maintain safe-shutdown. The review looked at the effect of TPO uprate and how it would affect these areas. The TPO uprate will have no effect on fire protection administrative controls, fire barriers, fire protection responsibilities of plant personnel and resources necessary for systems required to achieve and maintain safe-shutdown.

A review was conducted of all repair activities that are credited to obtain and maintain cold shutdown. The HCGS Appendix R analysis demonstrates that the station can reach cold shutdown with significant margin to the 72-hour requirements in 10 CFR 50 Appendix R, Sections III.G.1.b and III.L. No "time-critical" repairs would be required to reach or maintain cold shutdown. The TPO and the additional decay heat removal would not affect the ability to reach and maintain cold shutdown within 72 hours.

Therefore, the fire protection systems and analyses are not affected by the TPO uprate.

6.7.1 10 CFR 50 Appendix R Fire Event

TLTR Section L.4 presents a generic evaluation of Appendix R events for an increase of 1.5% of CLTP. [[

]] The current analysis is based on 102% of CLTP, conservatively applying Appendix K power uncertainty as input. This establishes a bounding case for the clad temperature limit and the containment pressure limit. The plant-specific analysis shows there is an available margin of 902°F to the clad temperature limit and 50.9 psig to the containment pressure limit.

Therefore, the generic results are applicable and no further plant-specific Appendix R analysis is necessary for the TPO uprate.

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 HCGS are confirmed to be consistent with the generic description provided in the TLTR.

Table 6-1 TPO Plant Electrical Characteristics

Parameter	Value
Generator	
Generator Output (MWe)	1,287.281
Rated Voltage (kV)	25
Power Factor	0.94
Generator Output (MVA)	1,373.1
Current Output (Amps)	31,710
Isolated Phase Bus Duct Rating (Amps)	
Main Section	34,000
Delta Section	19,500
Main Transformers Rating (MVA)	1,400.1

Table 6-2 Main Generator Ratings Comparison

Power Level	Design	Maximum Nominal Unit	
	MVA @ 75 psig H_2	MWe @ 75 psig H_2	MVAR @ 75 psig H_2
Existing	1,373.1	1,287.281	477.819
Uprated [1]	1,373.1	1,287.281	477.819

Note:

1. Operation at the uprated condition is not expected to have any adverse effect on the operation of the main generator. Operation in this range is still within the operating boundaries specified in station design analysis and operating procedures. Existing HCGS operating procedures are in place to ensure the generator's design rating of 1,373.1 MVA is not exceeded.

Table 6-3 Main Transformer Ratings Comparison

Power Level	Design MVA at 65°C	MVA Loading
Existing	1,400.1	1,400.1
Uprated [1]	1,400.1	1,400.1

Note:

1. Operation at the uprated condition is not expected to have any effect on the operation of the main transformer.

Table 6-4 Station Power Transformer Comparison

<table>
<tr><th>Transformer [1]</th><th>Rated MVA at 65°C</th><th>Existing MVA Loading</th><th>TPO MVA Loading</th></tr>
<tr><td>500 GND Y-288.7 – 14.4 kV</td><td></td><td></td><td></td></tr>
<tr><td>T1</td><td>70</td><td rowspan="4" colspan="2">These transformers feed a ring bus that supplies the below 13.8 kV transformers. A single transformer is capable of supplying the entire station load.</td></tr>
<tr><td>T2</td><td>70</td></tr>
<tr><td>T3</td><td>70</td></tr>
<tr><td>T4</td><td>70</td></tr>
</table>

Note:

1. Operation at the uprated condition is not expected to have any effect on the operation of the station power transformers.

Table 6-5 Station Service Transformer Comparison

Transformer [1]	Rated MVA at 65°C	Existing MVA Loading	TPO MVA Loading
13.8-4.16 GND Y / 2.4 kV			
1AX501	32.5	11.218	11.218
1BX501	32.5	11.652	11.652
1CX501	32.5	4.236	4.236
1DX501	32.5	3.832	3.832
1AX503	21.95	7.671	7.671
1BX503	21.95	7.372	7.372
13.8-7.2 GND Y / 4.16 kV			
1AX502	28	12.729	12.729
1BX502	28	11.521	11.521
Total Station Load		70.231	70.231

Note:

1. Operation at the uprated condition is not expected to have any effect on the operation of the station service transformers.

Table 6-6 FPC System Parameters

Parameter	CLTP	TPO
Number of RHR/FPC trains	1 / 2	1 / 2
RHR heat exchanger flow rate, RHR/SACS	10,000 / 8,800 gpm	10,000 / 8,800 gpm
Fuel pool heat exchanger flow rate, SFP/SACS (one pump and one heat exchanger)	700 / 1,100 gpm	700 / 1,100 gpm
Design heat removal rate RHR heat exchanger in shutdown mode	40.6E+6 BTU/hr	40.6E+6 BTU/hr
Design heat removal rate SFP heat exchanger (one pump with one heat exchanger)	10.7E+6 BTU/hr	10.7E+6 BTU/hr
Fuel cycle (months)	18	18
Bulk pool temperature (Normal Operations)	≤ 135°F	≤ 135°F
Bulk pool temperature (During Refueling)	≤ 150°F	≤ 150°F

Table 6-7 Cooling Tower Blowdown Discharge Comparison (DSN 461A)

Parameter	EPU Environmental Report (2005)	NJPDES Permit Limits (2011)	Actual[1] (July 2011 – September 2015)	TPO
Flow, Effluent (MGD)				
Average	No Change	Report, No Limit	46.0	No Change
Maximum	No Change	Report, No Limit	91.7	No Change
Temperature, Effluent (°C), Daily Maximum	< 36.2	36.2	35.9	No Change
Heat Rate (MBTU/hr), Maximum (September - May)	No Change to Heat Dissipation Area (HDA) [2]	662	657	No Change
Heat Rate (MBTU/hr), Maximum (June - August)	No Change to HDA	534	326	No Change
pH, Effluent (Standard Unit)				
Minimum	No Change	6.0	7.4	No Change
Maximum	No Change	9.0	8.9	No Change
Chlorine Produced Oxidants (mg/L)				
Average	No Change	0.2	< 0.1[3]	No Change
Maximum	No Change	0.5	< 0.1	No Change
Carbon, Total Organic Net (mg/L)				
Average	No Change	Report, No Limit	0.51	No Change
Maximum	No Change	Report, No Limit	8.7	No Change

Notes:

1. Data from monthly DMRs submitted to NJDEP.
2. Thermal effluent limitations imposed in the NJPDES permit require that the net temperature increase of the Delaware River not be greater than 2.2°C from September to May and not greater than 0.8°C from June to August. These limitations apply outside a HDA no larger than 2,500 feet upstream or downstream or 1,500 feet outshore from the point where the effluent enters the river.
3. No measurable total residual chlorine (TRC) discharge. The chlorine analyzer detection limit is 0.1 mg/l.

7.0 POWER CONVERSION SYSTEMS

7.1 TURBINE-GENERATOR

The HCGS main T/G is being modified to provide more flow margin. The high pressure (HP) first stage inlet nozzle and 2nd stage through 4th stage diaphragms are to be modified. The modified configuration will provide excess capacity for TPO. 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 flow capability between the current analyzed and rated conditions is called the flow margin.

The low pressure (LP) turbine rotors and internal components were replaced in support of EPU. The components were designed for 3,960 MWt, which exceeds the TPO RTP. The LP rotors are GE monoblock rotors. The design of the monoblock rotors eliminates wheel keys and the failure modes associated with the LP rotor due to overspeed conditions.

The HCGS T/G has a flow margin of 2.4% at the rated throttle steam flow of 16,770,000 lb/hr at a throttle pressure of approximately 955 psia and rated electrical power output of approximately 1,291 MWe.

For the TPO uprate conditions of 3,902 MWt, the rated throttle steam flow is increased to approximately 17,086,000 lb/hr at a throttle pressure of approximately 952 psia. The evaluated increased throttle steam flow is approximately 101.9% of current rated steam flow. The evaluated increased throttle flow is due to the steam flow increase associated with operation at 101.6% CLTP conditions. The maximum uprated electrical output is bounded by the current generator curves at 1,320 MWe. Typical reactive power loading at the station is between 100 and 400 MVAR.

The moisture separators and cross around piping were evaluated for higher operating pressures and flows at TPO and were found to have suitable margin.

The increased loadings, pressure drops, thrusts, stresses, overspeed capability and other design considerations resulting from operation at TPO RTP conditions are bounded from previous analyses or have been evaluated in TPO Design Change Package (DCP) 80116312 for acceptability at the TPO uprate condition.

The LP rotors on the HCGS T/G set are monoblock rotor forgings. The missile analysis issued previously considering a stress corrosion cracking (SCC) failure mechanism of rotor wheels no longer applies because the rotors are monoblocks. In the monoblock rotor, the stress levels at the design point are conservative and the stress concentration associated with wheel keys no longer exists. If the unit trips, valves fail to operate and full flow steam remains; the maximum possible speed the rotors can attain is about 220% running speed, assuming that all steam path components on the rotor remain in place. This is the point at which the driving forces are countered by drag forces and can no longer accelerate the rotors. The rotor overspeed capability, with the assumption all buckets remain in place, is 225% for typical rotor strengths. Therefore, rotor missiles will not be generated. A complete failure of the control and safety systems is required for this to occur and is very unlikely. The probability of a control failure of this nature is approximately 1 x 10^{-8} per year. In conclusion, given the low stress levels of monoblock rotors and the elimination of the wheel SCC mechanism, the probability of generating rotor missiles is not present. The thermal power design value of 3,960 MWt for the LP rotors bounds the TPO rated conditions.

HCGS has a digital EHC system. The current overspeed trip settings will remain the same. Although the entrapped energy increases slightly for the TPO uprate conditions, the existing rotor design has sufficient margin to prevent damage to the system due to overspeed.

7.2 CONDENSER AND STEAM JET AIR EJECTORS

The main condenser capability was evaluated for performance at the TPO uprate conditions in Section 5.3.15. 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 core does not affect the steam jet air ejectors (SJAEs) because the design was based on flows greater than required flows at uprate conditions. Therefore, the condenser air removal system is not affected by the TPO uprate and the SJAEs are adequate for operation at the TPO conditions.

7.3 TURBINE STEAM BYPASS

The turbine steam bypass valves currently operate at a steam flow capacity of approximately 22.18% of the 100% rated flow at CLTP. The steam bypass capacity at the TPO RTP is approximately 21.75% of the 100% 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 condensate and FW 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 affect the plant availability and capability to operate reliably at the TPO uprate condition.

A review of the HCGS FW heaters, heater drain system, condensate demineralizers, and the pumps (condensate and FW) 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. A review of the HCGS heater drain system demonstrated that the components will be capable of supporting the slightly higher TPO uprate extraction flow rates.

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

- Ability to avoid suction pressure trip,
- Flow capacity, and

- Rated horsepower.

7.4.1 Normal Operation

The reactor feedwater pumps (RFPs) will provide FW at the required flow rate and with sufficient RPV interface pressure to support the TPO uprate. This is accomplished by slightly increasing the RFP speed to increase the FW flow rate while still providing sufficient pressure at the RPV interface. Adequate margin during steady-state conditions also exists between the calculated minimum pump suction pressure and the low suction pressure trip setpoints.

The condensate and FW system functions adequately following a single RFP trip in support of the NSSS to continue to operate without a reactor shutdown. Operation at the TPO condition continues to support this capability.

The existing FW design pressure requirements bound operating conditions with adequate margin. Piping design temperatures were reviewed and analyzed for increased temperatures when existing conditions were not bounding. The FW heaters are ASME Section VIII pressure vessels. The FW heaters were analyzed and will be re-rated as needed for the slightly higher FW heater temperatures for TPO uprate per DCP 80116312.

7.4.2 Transient Operation

To account for FW demand transients, the condensate and FW systems were evaluated to ensure that sufficient margin above the TPO uprated flow is available. 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 with low reactor water level, the RRS 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 P/F instability regions.

7.4.3 Condensate Filters and Condensate Deep Bed Demineralizers

The effect of the TPO uprate on the condensate filter demineralizer (CFD) system was reviewed. The system can accommodate (without bypass) TPO uprate conditions while operating with one CFD vessel removed from service (when backwash/resin change out is required).

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, discharge, or shipment.

Major sources of solid and liquid waste are from the CFD. The TPO uprate results in an approximate 2% increase in flow rate through the condensate system. This potentially results in a reduction in the average time between backwashes of the condensate pre-filters and replacement of the condensate demineralizer resin. This potential reduction of condensate demineralizer service time does not affect plant safety.

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 volume due to operation at the TPO uprate condition.

The total volume of processed waste is not expected to increase appreciably. The only significant increase in processed waste is due to the more frequent backwashes of the CFDs; no increase is expected from the RWCU and FPC. A review of plant operating effluent reports and the slight increase expected from the TPO uprate leads to the conclusion that the requirements of 10 CFR 20 and 10 CFR 50, Appendix I will continue to be met. Therefore, the TPO uprate does not adversely affect the processing of liquid or solid radwaste and there are no significant environmental effects.

8.2 GASEOUS WASTE MANAGEMENT

The gaseous waste systems collect, control, process, 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.

Non-condensable radioactive gas from the main condenser normally contains activation gases and fission product radioactive noble gas parents. These are the major sources of radioactive gas and are greater than all other sources combined. These non-condensable gases, along with non-radioactive air inleakage, are continuously removed from the main condensers by the SJAEs that discharge into the offgas system.

Building ventilation systems control airborne radioactive gases by using components 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 changes to the gaseous radwaste releases are proportional to the change in core power, and the total releases are a small fraction of the design basis releases.

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.

The offgas system was evaluated for 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 volume of waste gas processed by the recombiner and related components. The offgas system design basis radiolytic gas flow rate is 231 scfm. The actual radiolytic gas flow rate for the TPO uprate is less than 178 scfm (178 scfm is the previously calculated value for a power level of 3,952 MWt). The increase in H_2 and O_2 due to the TPO uprate remains well within the capacity of the system. 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, for TPO, the percent increase in the operating source terms is no greater than the percent increase in power. The source term increases due to the TPO uprate are bounded by the safety margins of the design basis sources.

The post-operation radiation sources in the core are primarily 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, which is used in shielding calculations for the core and for individual fuel bundles. This source term is defined in terms of million electron volts (MeV)/sec per watt of reactor thermal 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 primarily of nuclide activity inventories for fission products in the fuel. These are needed for post-accident and SFP evaluations, which are performed in compliance with regulatory guidance that applies different release and transport assumptions to different fission products. The core fission product inventories for these evaluations are based on an assumed fuel irradiation time, which develops “equilibrium” activities in the fuel (typically three years). Most radiologically significant fission products reach equilibrium within a 60-day period. The calculated inventories are approximately proportional to core thermal power. Consequently, for TPO, the inventories of those radionuclides, which reached or approached equilibrium, are expected to increase in proportion to the thermal power increase. The inventories of the very long-lived radionuclides, which did not approach equilibrium, are both power and exposure dependent. They are expected to increase proportionally with power if the fuel irradiation time remains within the current basis. Thus, the long-lived radionuclides are expected to increase proportionally to power. The radionuclide inventories are provided in terms of curies per megawatt of reactor thermal power at various times after shutdown.

The existing accident source term was evaluated with consideration of at least 2% overpower uncertainty. With operation at TPO conditions, the bounding set of power level assumptions remains the same as the previous analysis because of the reduced uncertainty.

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. However, the concentration in the steam remains nearly constant because the increase in activation production is balanced by the increase in steam flow. As a result, the activation products observed in the reactor water and steam increase in approximate proportion to the increase in thermal power.

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 activation rate in the reactor region increases with power, and the filter efficiency of the condensate demineralizers may decrease. The net result may be an increase in the activated corrosion product production. However, the TPO uprate corrosion product concentrations are not expected to exceed the design basis concentrations. Total TPO activated corrosion product activity levels in the reactor water remain less than the design basis activated corrosion product activity. 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 HCGS design. The total offgas rates for TPO uprate operations are bounded by the original design basis.

The fission product activity in the reactor water, like the activity in the steam, is the result of minute releases from the fuel rods. As is the case for the noble gases, there is no expectation that releases from the fuel increase due to the TPO uprate. Activity levels in the reactor water are expected to be 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. HCGS 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 approximately no more than the percentage increase in power level. In a few areas near the FPC 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 will be maintained within acceptable limits by the site as low as reasonably achievable (ALARA) program, which controls access to radiation areas. The HCGS radiation protection program procedural controls compensate for any minor increase in radiation levels due to the TPO uprate.

The change in core activity inventory resulting from the TPO uprate increases post-accident radiation levels by approximately no more than 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 on-site emergency response facilities. A review of areas requiring post-accident occupancy concluded that access needed for accident mitigation is not significantly affected by the TPO uprate.

Section 9.2 addresses the main control room doses for the worst-case accident.

8.6 NORMAL OPERATION OFF-SITE DOSES

The TS 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 a small fraction of the doses allowed by TS 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. Present offsite radiation levels are a negligible portion of background radiation. 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 AOOs for TPO uprate plants. [[

]] 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. [[

]] The OLMCPR changes for the 1.7% uprate may be slightly larger than shown in Table E-2, but the changes are expected to be within the normal cycle-to-cycle variation. 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 TLTR Appendix E are applicable to the HCGS 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.

9.1.1 Alternate Shutdown Cooling Evaluation

HCGS UFSAR Section 15.2.9.3 provides a qualitative evaluation of the alternate shutdown cooling (ASDC) mode of decay heat removal using only safety grade equipment. TPO conditions have no effect on this qualitative evaluation because none of the equipment is modified for or affected by TPO operation.

9.2 DESIGN BASIS ACCIDENTS

The radiological consequences of a DBA are increased with a larger 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 uprate power are generally expected to increase in proportion to the core inventory increase, which is approximately in proportion to the power increase.

Postulated DBA events have been evaluated and analyzed to show that NRC regulations are met for 2% above the CLTP. DBA events have either been previously analyzed at 102% of CLTP or are not dependent on core thermal power. The main steam line break accident (MSLBA) outside containment was evaluated using a 4 μCi/g dose equivalent I-131 limit on reactor coolant activity. The limit on reactor coolant activity is unchanged for the TPO uprate condition. 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

HCGS meets the following 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; and
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 HCGS-specific analysis at the CLTP demonstrates that the following ATWS acceptance criteria are met:

1. Peak vessel bottom pressure less than the ASME Service Level C limit of 1,500 psig;
2. PCT within the 10 CFR 50.46 limit of 2,200°F;
3. Peak clad oxidation within the requirements of 10 CFR 50.46;
4. Peak local suppression pool temperature less than 217.5°F; and
5. Peak containment pressure less than 62 psig.

The existing AOR for HCGS was performed at a power level of 3,952 MWt, which is 50 MWt greater than the TPO RTP. The associated results in Table 9-1 show margin to the acceptance criteria; therefore, no HCGS-specific ATWS analyses are performed for the TPO uprate.

9.3.2 Station Blackout

TLTR Appendix L.5 provides a generic evaluation of a potential loss of all AC power supplies based on previous plant response and coping capability analyses for typical power uprate projects. The previous power uprate evaluations have been performed according to the applicable bases for the plant (e.g., the bases, methods, and assumptions of RG 1.155 (Reference 37) and/or NUMARC 87-00 (Reference 38)). This evaluation is for confirmation of continued compliance to 10 CFR 50.63. It is recognized that this evaluation is dependent upon many plant-specific design and equipment parameters.

The following main considerations were evaluated:

- The adequacy of the condensate/reactor coolant inventory.
- The capacity of the Class 1E batteries.
- The station blackout (SBO) compressed nitrogen requirements.

- The ability to maintain containment integrity.
- The effect of loss of ventilation on rooms that contain equipment essential for plant response to an SBO event.

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

[[ ]] HCGS currently has margins of 21,768 gallons to the available condensate storage inventory and 7.4°F to the containment peak temperature limit. [[ ]] Therefore, no HCGS-specific SBO analysis is performed for the TPO uprate.

Table 9-1 ATWS Acceptance Criteria Results

Item	Parameter	Unit	TPO Value
1	Peak vessel bottom pressure	psig	1,416
2	Peak local suppression pool temperature	°F	215.6
3	Peak containment pressure	psig	9.7
4	PCT	°F	< 2,200
5	Clad oxidation	%	< 17

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 HELB mass and energy releases. These changes are insignificant in relation to the effect on line break calculations. 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 HELB analyses at HCGS have been previously evaluated, revised as necessary, and found to be acceptable at 3,952 MWt.

The HELB evaluation was performed for all systems evaluated in the UFSAR. At the TPO RTP, HELBs outside the drywell would result in an insignificant change in the sub-compartment pressure and temperature profiles. The affected building and cubicles that support safety-related functions are designed to withstand the resulting pressure and thermal loading following a HELB at the TPO RTP. A brief discussion of each break follows.

10.1.1 Steam Line Breaks

The critical parameter affecting the high energy steam line break analysis is the reactor vessel dome pressure. There is no increase in the steam flow calculated for a MSLBA. No change in the steam line break flow rate occurs because the flow restrictor and the operating pressure remain unchanged. The main steam line break (MSLB) is used to establish the peak pressure and the temperature environment in the MS tunnel. Design margins within the HELB analysis for a MSLB provide adequate margin to the limits in the steam tunnel.

10.1.2 Liquid Line Breaks

10.1.2.1 Feedwater Line Breaks

The TPO uprate increases the FW temperature by about 1.9°F and decreases enthalpy by 0.1 BTU/lbm, which results in an insignificant increase in the FW mass and energy release. As a result of the small increase in FW energy, the blowdown rate changes marginally, and the energy increases slightly. The MS tunnel HELB conditions are based on a MSLB in the tunnel; therefore, small changes in FW process parameters have no effect on the MS tunnel HELB conditions. Therefore, the original HELB analysis is bounding.

10.1.2.2 ECCS Line Breaks

ECCS lines are normally isolated from the reactor during normal operations; therefore, the previous HELB analysis for breaks outside primary containment is bounding for the TPO uprate condition.

10.1.2.3 RCIC System Line Breaks

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.

10.1.2.4 RWCU System Line Breaks

As a result of the small decreases in RWCU process temperatures and enthalpies, the blowdown rate and energy released decrease slightly; therefore, the original HELB analyses bound the TPO uprate conditions.

10.1.2.5 CRD System Line Breaks

The CRD system and supporting equipment operation are not affected by a TPO uprate; therefore, the CRD pipe rupture analysis is not affected by the TPO uprate.

10.1.2.6 Building Heating and Auxiliary Steam Line Breaks

Building heating and auxiliary steam lines are not connected to the reactor-turbine primary loop. Therefore, building heating and auxiliary steam lines are not affected.

10.1.2.7 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 bound the safe shutdown effects at the TPO uprate conditions. Existing pipe whip restraints, jet impingement shields, and their supporting structures are also adequate for the TPO uprate conditions.

10.1.2.8 Internal Flooding from HELB

None of the plant flooding zones contains a potential HELB location affected by the reactor operating conditions changed for the TPO uprate. The high energy line systems' operational modes, plant internal flooding analysis, and safe shutdown analysis evaluated for HELB are not affected by the TPO uprate.

10.2 MODERATE ENERGY LINE BREAK

The plant flooding zones containing a potential moderate energy line break (MELB) location are either unaffected or negligibly affected by the reactor operating conditions changed for the TPO uprate. The following systems contain potential MELB locations in plant flooding zones: condensate, SSWS, SACS, RACS, RHR, demineralized water, fire protection, CRD, RCIC, CS, FPC, SLCS, HPCI, and chilled water.

No new moderate energy lines are identified from the TPO uprate. Sources of moderate energy flooding and protection requirements for safe-shutdown equipment for a postulated MELB or equipment spray are either not dependent on power level or sources are negligibly affected with no change in protection requirements. Therefore, the plant internal flooding analysis is not affected.

10.3 ENVIRONMENTAL QUALIFICATION

Safety-related electrical components must be qualified for the environment in which they operate. The TPO 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. The resulting environmental conditions are bounded by the existing environmental parameters specified for use in the EQ program.

10.3.1 Electrical Equipment

The environmental conditions for safety-related electrical equipment were reviewed to ensure that the existing qualification for the normal and accident conditions expected in the area where the devices are located remain adequate.

No change is needed for the TPO uprate.

10.3.1.1 Inside Containment

EQ for safety-related electrical equipment located inside the containment is based on 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 at least 102% of CLTP. Normal temperatures may increase slightly near the FW and RRC lines and will be evaluated through Section A.3.1.2 of UFSAR Appendix A, which addresses the existing program that manages the aging (EQ) of electrical equipment. 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 steam tunnel, or other HELBs, whichever is limiting for each area. The existing HELB pressure and temperature profiles bound the TPO uprate conditions. The current plant environmental envelope for radiation is not exceeded by the changes resulting from the TPO uprate.

10.3.2 Mechanical Equipment With Non-Metallic Components

Operation at the TPO RTP level increases the normal process temperature very slightly in the FW and RRC piping. Mechanical equipment is excluded from the equipment qualification program.

10.3.3 Mechanical Component Design Qualification

The 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 or greater, the accident pressures, temperatures and radiation levels do not change. The mechanical design of equipment/components (e.g., valves, heat exchangers, pumps, and snubbers) in certain systems is affected by operation at the TPO RTP level because of the slightly increased temperature and sometimes flow rate. The revised operating conditions do not significantly affect the cumulative usage fatigue factors of mechanical components.

10.4 TESTING

The TPO uprate power ascension is based on the guidelines in TLTR Section L.2. Pre-operational tests are not needed because there are no significant changes to any plant systems or components that require such testing.

In preparation for operation at TPO uprate conditions, routine measurements of reactor and system pressures, flows, and selected major rotating equipment vibration 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 ≤ 95% of CLTP and held constant. The setpoint is adjusted so the reactor dome pressure is the same at TPO RTP as at 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 TCVs.

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 95% and 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 HCGS.

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

Because level and pressure changes can produce power excursions above the initial condition for these tests, the final tests will be performed at a power level with a margin to TPO RTP equal to the largest anticipated excursion. The magnitude of the anticipated excursions is based on those experienced in the same tests performed at 95% and 100% of CLTP projected to TPO RTP (and other available operating experience). The intention of this margin is to avoid exceeding the licensed power limit (NRC RIS 2007-21, Reference 39), while creating the largest practical power difference from CLTP to obtain responses that are representative of TPO power.

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

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10.5 OPERATOR TRAINING AND HUMAN FACTORS

No additional training (apart from normal training for plant changes) is required to operate the plant in the TPO uprate condition. For TPO uprate conditions, operator response to transient, accident, and special events is not affected. Operator actions for maintaining safe shutdown, core cooling, and containment cooling do not change for the TPO uprate. Minor changes to the P/F map and the flow-referenced setpoints will be communicated through normal operator training. Simulator changes and validation for the TPO uprate will be performed in accordance with established HCGS plant simulator certification testing procedures.

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 increases in steam and FW flow rate influence FAC. However, the sensitivity to the TPO uprate is small and various programs are currently implemented to monitor the aging of plant components, including EQ, FAC, and in-service inspection. EQ 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 HCGS, based on the BWRVIP, is sufficient to address the increase. The Maintenance Rule also provides oversight for the other mechanical and electrical components important to plant safety to guard against age-related degradation.

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

10.7 NRC AND INDUSTRY COMMUNICATIONS

NRC and industry communications are generically addressed in the TLTR, Section 10.8. Per the TLTR, it is not necessary to review prior dispositions of NRC and industry communications and no additional information is required in this area.

10.8 PLANT PROCEDURES AND PROGRAMS

Plant procedures and programs are in place to:

1. Monitor and maintain instrument calibration during normal plant operation to assure that instrument uncertainty is not greater than the uncertainty used to justify the TPO uprate;
2. Control the software and hardware configuration of the associated instrumentation;
3. Perform corrective actions, where required, to maintain instrument uncertainty within limits;
4. Report deficiencies of the associated instruments to the manufacturer; and
5. Receive and resolve the manufacturer's deficiency reports.

10.9 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 the TPO uprate will have a negligible effect or no effect on the operator action thresholds and on the EOPs in general.

10.10 INDIVIDUAL PLANT EXAMINATION

HCGS maintains and regularly updates a station PRA model. Use of the model is integrated with station operations and decision-making.

The HCGS IPE PRA model and analysis will not be specifically updated for TPO because the change in plant risk from the TPO uprate is insignificant because there is no change to plant operation, maintenance, or equipment design. This conclusion is supported by NRC RIS 2002-03 (Reference 10). In response to feedback received during the public workshop held on August 23, 2001, the NRC wrote, "The NRC has generically determined that measurement uncertainty recapture power uprates have an insignificant effect on plant risk. Therefore, no risk information is requested to support such applications." (Reference 10).

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38. Nuclear Management and Resources Council, Inc., "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," NUMARC 87-00, Revision 1, August 1991.
39. NRC RIS 2007-21, Revision 1, "Adherence to Licensed Power Limits," February 9, 2009.
40. GE Hitachi Nuclear Energy, "General Electric Boiling Water Reactor Maximum Extended Load Line Limit Analysis Plus," NEDC-33006P-A, Revision 3, June 2009.

41. GE Hitachi Nuclear Energy, "Migration to TRACG04 / PANAC11 from TRACG02 / PANAC10 for TRACG AOO and ATWS Overpressure Transients," NEDE-32906P, Supplement 3-A, Revision 1, April 2010.

42. Global Nuclear Fuel, "Supplemental Reload Licensing Report for Hope Creek Reload 20 Cycle 21," 002N6864, Revision 0, September 2016.

43. GE Hitachi Nuclear Energy, "General Electric Boiling Water Reactor Detect and Suppress Solution-Confirmation Density," NEDC-33075P-A, Revision 6, January 2008.

Appendix A – Limitations from Safety Evaluation for LTR NEDC-33173P

Disposition of additional limitations and conditions related to the SE for NEDC-33173P, "Applicability of GE Methods to Expanded Operating Domains"

There are 24 limitations and conditions listed in Section 9 of the Methods LTR SER (Reference 7). The table below lists each of the 24 limitations and conditions and identifies which section of the TSAR discusses compliance with each limitation and condition.

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
9.1	TGBLA/PANAC Version	The neutronic methods used to simulate the reactor core response and that feed into the downstream safety analyses supporting operation at EPU/MELLLA+ will apply TGBLA06/PANAC11 or later NRC-approved version of neutronic method.	Comply	Table 1-1 and Section 2.6.1
9.2	3D Monicore	For EPU/MELLLA+ applications, relying on TGBLA04/PANAC10 methods, the bundle RMS difference uncertainty will be established from plant-specific core-tracking data, based on TGBLA04/PANAC10. The use of plant-specific trendline based on the neutronic method employed will capture the actual bundle power uncertainty of the core monitoring system.	N/A	(1) (11)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
9.3	Power/Flow Ratio	Plant-specific EPU and expanded operating domain applications will confirm that the core thermal power to core flow ratio will not exceed 50 MWt/Mlbm/hr at any statepoint in the allowed operating domain. For plants that exceed the power-to-flow value of 50 MWt/Mlbm/hr, the application will provide power distribution assessment to establish that neutronic methods axial and nodal power distribution uncertainties have not increased.	Comply	Section 2.2.4 (2)
9.4	SLMCPR 1	Limitation has been removed according to Appendix I of this SE.	N/A	(3)
9.5	SLMCPR 2	This Limitation has been revised according to Appendix I of this SE. For operation at MELLLA+, including operation at the EPU power levels at the achievable core flow state-point, a 0.01 value shall be added to the cycle-specific SLMCPR value for power-to-flow ratios up to 42 MWt/Mlbm/hr, and a 0.02 value shall be added to the cycle-specific SLMCPR value for power-to-flow ratios above 42 MWt/Mlbm/hr.	N/A	(10)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
9.6	R-Factor	The plant specific R-factor calculation at a bundle level will be consistent with lattice axial void conditions expected for the hot channel operating state. The plant-specific EPU/MELLLA+ application will confirm that the R-factor calculation is consistent with the hot channel axial void conditions.	Comply	Section 2.2
9.7	ECCS-LOCA 1	For applications requesting implementation of EPU or expanded operating domains, including MELLLA+, the small and large break ECCS-LOCA analyses will include top-peaked and mid-peaked power shape in establishing the MAPLHGR and determining the PCT. This limitation is applicable to both the licensing bases PCT and the upper bound PCT. The plant-specific applications will report the limiting small and large break licensing basis and upper bound PCTs.	Comply	Section 4.3

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
9.8	ECCS-LOCA 2	The ECCS-LOCA will be performed for all statepoints in the upper boundary of the expanded operating domain, including the minimum core flow statepoints, the transition statepoint as defined in Reference 40 and the 55 percent core flow statepoint. The plant-specific application will report the limiting ECCS-LOCA results as well as the rated power and flow results. The SRLR will include both the limiting statepoint ECCS-LOCA results and the rated conditions ECCS-LOCA results.	N/A	(10)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
9.9	Transient LHGR 1	Plant-specific EPU and MELLLA+ applications will demonstrate and document that during normal operation and core-wide AOOs, the T-M acceptance criteria as specified in Amendment 22 to GESTAR II will be met. Specifically, during an AOO, the licensing application will demonstrate that the: (1) loss of fuel rod mechanical integrity will not occur due to fuel melting and (2) loss of fuel rod mechanical integrity will not occur due to pellet–cladding mechanical interaction. The plant-specific application will demonstrate that the T-M acceptance criteria are met for the both the UO_2 and the limiting GdO_2 *[sic]* rods.	Comply	(12)
9.10	Transient LHGR 2	Each EPU and MELLLA+ fuel reload will document the calculation results of the analyses demonstrating compliance to transient T-M acceptance criteria. The plant T-M response will be provided with the SRLR or Core Operating Limits Report (COLR), or it will be reported directly to the NRC as an attachment to the SRLR or COLR.	Comply	(12)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
9.11	Transient LHGR 3	To account for the impact of the void history bias, plant-specific EPU and MELLLA+ applications using either TRACG or ODYN will demonstrate an equivalent to 10 percent margin to the fuel centerline melt and the 1 percent cladding circumferential plastic strain acceptance criteria due to pellet-cladding mechanical interaction for all of limiting AOO transient events, including equipment out-of-service. Limiting transients in this case, refers to transients where the void reactivity coefficient plays a significant role (such as pressurization events). If the void history bias is incorporated into the transient model within the code, then the additional 10 percent margin to the fuel centerline melt and the 1 percent cladding circumferential plastic strain is no longer required.	Comply	(12)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
9.12	LHGR and Exposure Qualification	In MFN 06-481, GE committed to submit plenum fission gas and fuel exposure gamma scans as part of the revision to the T-M licensing process. The conclusions of the plenum fission gas and fuel exposure gamma scans of GE 10x10 fuel designs as operated will be submitted for NRC staff review and approval. This revision will be accomplished through Amendment to GESTAR II or in a T-M licensing LTR. PRIME (a newly developed T-M code) has been submitted to the NRC staff for review (Reference 16). Once the PRIME LTR and its application are approved, future license applications for EPU and MELLLA+ referencing LTR NEDC-33173P must utilize the PRIME T-M methods.	Comply	Section 2.6.2 (4)
9.13	Application of 10 Weight Percent Gd	Before applying 10 weight percent Gd to licensing applications, including EPU and expanded operating domain, the NRC staff needs to review and approve the T-M LTR demonstrating that the T-M acceptance criteria specified in GESTAR II and Amendment 22 to GESTAR II can be met for steady-state and transient conditions. Specifically, the T-M	N/A	(5)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
		application must demonstrate that the T-M acceptance criteria can be met for thermal overpower (TOP) and mechanical overpower (MOP) conditions that bounds the response of plants operating at EPU and expanded operating domains at the most limiting statepoints, considering the operating flexibilities (e.g., equipment out-of-service). Before the use of 10 weight percent Gd for modern fuel designs, NRC must review and approve TGBLA06 qualification submittal. Where a fuel design refers to a design with Gd-bearing rods adjacent to vanished or water rods, the submittal should include specific information regarding acceptance criteria for the qualification and address any downstream impacts in terms of the safety analysis. The 10 weight percent Gd qualifications submittal can supplement this report.		

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
9.14	Part 21 Evaluation of GESTR-M Fuel Temperature Calculation	Any conclusions drawn from the NRC staff evaluation of the GE's Part 21 report will be applicable to the GESTR-M T-M assessment of this SE for future license application. GE submitted the T-M Part 21 evaluation, which is currently under NRC staff review. Upon completion of its review, NRC staff will inform GE of its conclusions.	N/A	(6) (13)
9.15	Void Reactivity 1	The void reactivity coefficient bias and uncertainties in TRACG for EPU and MELLLA+ must be representative of the lattice designs of the fuel loaded in the core.	Comply	Section 2.2 (7)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
9.16	Void Reactivity 2	A supplement to TRACG /PANAC11 for AOO is under NRC staff review (Reference 41). TRACG internally models the response surface for the void coefficient biases and uncertainties for known dependencies due to the relative moderator density and exposure on nodal basis. Therefore, the void history bias determined through the methods review can be incorporated into the response surface “known” bias or through changes in lattice physics/core simulator methods for establishing the instantaneous cross-sections. Including the bias in the calculations negates the need for ensuring that plant-specific applications show sufficient margin. For application of TRACG to EPU and MELLLA+ applications, the TRACG methodology must incorporate the void history bias. The manner in which this void history bias is accounted for will be established by the NRC staff SE approving NEDE-32906P, Supplement 3, “Migration to TRACG04/PANAC11 from TRACG02/PANAC10,” May 2006 (Reference 41). This limitation applies until the new TRACG/PANAC methodology is approved by the NRC staff.	N/A	(14)

Limitation and Condition Number from NRC SER	**Limitation and Condition Title**	**Limitation and Condition Description**	**Disposition**	**Section of HCGS TSAR which Addresses the Limitation and Condition**
9.17	Steady-State 5 Percent Bypass Voiding	The instrumentation specification design bases limit the presence of bypass voiding to 5 percent (LRPM levels). Limiting the bypass voiding to less than 5 percent for long-term steady operation ensures that instrumentation is operated within the specification. For EPU and MELLLA+ operation, the bypass voiding will be evaluated on a cycle-specific basis to confirm that the void fraction remains below 5 percent at all LPRM levels when operating at steady-state conditions within the MELLLA+ upper boundary. The highest calculated bypass voiding at any LPRM level will be provided with the plant-specific SRLR.	Comply	Section 2.1 (2)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
9.18	Stability Setpoints Adjustment	The NRC staff concludes that the presence bypass voiding at the low-flow conditions where instabilities are likely can result in calibration errors of less than 5 percent for OPRM cells and less than 2 percent for APRM signals. These calibration errors must be accounted for while determining the setpoints for any detect and suppress long term methodology. The calibration values for the different long-term solutions are specified in the associated sections of this SE, discussing the stability methodology.	N/A	(9)
9.19	Void-Quality Correlation 1	For applications involving PANCEA/ODYN/ISCOR/TASC for operation at EPU and MELLLA+, an additional 0.01 will be added to the OLMCPR, until such time that GE expands the experimental database supporting the Findlay-Dix void-quality correlation to demonstrate the accuracy and performance of the void-quality correlation based on experimental data representative of the current fuel designs and operating conditions during steady-state, transient, and accident conditions.	Comply	(2)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
9.20	Void-Quality Correlation 2	The NRC staff is currently reviewing Supplement 3 to NEDE-32906P, "Migration to TRACG04/PANAC11 from TRACG02/PANAC10," dated May 2006 (Reference 41). The adequacy of the TRACG interfacial shear model qualification for application to EPU and MELLLA+ will be addressed under this review. Any conclusions specified in the NRC staff SE approving Supplement 3 to LTR NEDC-32906P (Reference 41) will be applicable as approved.	N/A	(14)
9.21	Mixed Core Method 1	Plants implementing EPU or MELLLA+ with mixed fuel vendor cores will provide plant-specific justification for extension of GE's analytical methods or codes. The content of the plant-specific application will cover the topics addressed in this SE as well as subjects relevant to application of GE's methods to legacy fuel. Alternatively, GE may supplement or revise LTR NEDC-33173P (Reference 7) for mixed core application.	N/A	(8)
9.22	Mixed Core	For any plant-specific applications of TGBLA06 with fuel type characteristics not covered in this	N/A	(8)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
	Method 2	review, GE needs to provide assessment data similar to that provided for the GEH/GNF fuels. The Interim Methods review is applicable to all GEH/GNF lattices up to GNF2. Fuel lattice designs, other than GEH/GNF lattices up to GNF2, with the following characteristics are not covered by this review: • square internal water channels water crosses • Gd rods simultaneously adjacent to water and vanished rods • 11x11 lattices • MOX fuel The acceptability of the modified epithermal slowing down models in TGBLA06 has not been demonstrated for application to these or other geometries for expanded operating domains. Significant changes in the Gd rod optical thickness will require an evaluation of the TGBLA06 radial flux and Gd depletion modeling before being applied. Increases in the lattice Gd loading that result in nodal reactivity biases beyond those previously established will require review before the GEH methods may be applied.		

<table>
<tr><th>Limitation and Condition Number from NRC SER</th><th>Limitation and Condition Title</th><th>Limitation and Condition Description</th><th>Disposition</th><th>Section of HCGS TSAR which Addresses the Limitation and Condition</th></tr>
<tr><td>9.23</td><td>MELLLA+ Eigenvalue Tracking</td><td>In the first plant-specific implementation of MELLLA+, the cycle-specific eigenvalue tracking data will be evaluated and submitted to NRC to establish the performance of nuclear methods under the operation in the new operating domain. The following data will be analyzed:
• Hot critical eigenvalue,
• Cold critical eigenvalue,
• Nodal power distribution (measured and calculated TIP comparison),
• Bundle power distribution (measured and calculated TIP comparison),
• Thermal margin,
• Core flow and pressure drop uncertainties, and
• The MCPR importance parameter (MIP) Criterion (e.g., determine if core and fuel design selected is expected to produce a plant response outside the prior experience base).
Provision of evaluation of the core-tracking data will provide the NRC staff with bases to establish if operation at the expanded operating domain</td><td>N/A</td><td>(15)</td></tr>
</table>

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
		indicates: (1) changes in the performance of nuclear methods outside the EPU experience base; (2) changes in the available thermal margins; (3) need for changes in the uncertainties and NRC-approved criterion used in the SLMCPR methodology; or (4) any anomaly that may require corrective actions.		
9.24	Plant-Specific Application	The plant-specific applications will provide prediction of key parameters for cycle exposures for operation at EPU (and MELLLA+ for MELLLA+ applications). The plant-specific prediction of these key parameters will be plotted against the EPU Reference Plant experience base and MELLLA+ operating experience, if available. For evaluation of the margins available in the fuel design limits, plant-specific applications will also provide quarter core map (assuming core symmetry) showing bundle power, bundle operating LHGR, and MCPR for BOC, MOC, and EOC. Because the minimum margins to specific limits may occur at exposures other than the traditional BOC, MOC, and EOC, the data will be provided at these exposures.	Comply	Section 2.1

Notes:

1. As shown in Table 1-1, the HCGS TSAR is based on TGBLA06/PANAC11, not TGBLA 04/PANAC10.
2. Correspondence concerning implementation of this limitation and condition is docketed: Letter from James F. Harrison (GEH) to NRC, "Implementation of Methods Limitations - NEDC-33173P," MFN 08-693, September 18, 2008 (Reference 7).
3. This limitation was removed as noted in Reference 7.
4. The PRIME LTR and its application (Reference 16) was approved on January 22, 2010 and implemented in GESTAR II in September 2010. The HCGS TSAR is based on the GNF2 fuel product line, which has a PRIME T-M basis. PRIME fuel parameters will be used in all analyses requiring fuel performance parameters.
5. HCGS uses GNF2 fuel, and as such does not seek to apply 10 wt% Gd to this licensing application.
6. This limitation and condition relates to GEH's treatment of the NRC staff review of the 10 CFR Part 21 report related to the GESTR-M T-M evaluation (pertains to non-ECCS-LOCA considerations). The HCGS TSAR is based on the GNF2 fuel product line, which has a PRIME T-M and fuel temperature basis included. Therefore, this limitation is no longer applicable.
7. The HCGS TSAR licensing basis uses TRACG for DSS-CD analyses. The void reactivity coefficients bias and uncertainties used in the latest version of TRACG are in accordance with Reference 41 and are applicable to the GNF2 lattice designs loaded in the core.
8. The HCGS TSAR is based on a GNF2 equilibrium core design. Therefore, the mixed core limitations are not applicable.
9. Not applicable to DSS-CD because the significant conservatisms in the current licensing methodology and associated MCPR margins are more than sufficient to compensate for the overall uncertainty in the OPRM instrumentation.
10. The HCGS TSAR is based on MELLLA conditions and does not include maximum extended load line limit analysis plus (MELLLA+) conditions. Therefore, this limitation is not applicable to HCGS.
11. HCGS utilizes the ACUMEN core monitoring system which was incorporated into GESTAR II in Revision 23 (Reference 17).
12. Fuel rod T-M performance will be evaluated as part of the RLAs performed for the cycle-specific core. Documentation of acceptable fuel rod T-M response will be included in the SRLR.
13. For ECCS-LOCA considerations, the conclusions of the Part 21 process have been incorporated into HCGS's ECCS-LOCA analysis bases as described in Section 16.1 of Reference 42.

14. TRACG AOO methodology is not applied at HCGS.

15. Correspondence concerning implementation of this limitation and condition is docketed in the letter from James F. Harrison (GEH) to NRC, "Clarification of Limitation and Condition 23 for NEDC-33173P, 'Applicability of GE Methods to Expanded Operating Domains'," MFN 15-066, August 26, 2015 (Reference 7).

Appendix B - Limitations from Safety Evaluation for LTR NEDC-33075P

Disposition of additional limitations and conditions related to the SE for NEDC-33075P, Revision 7, "General Electric Boiling Water Reactor Detect and Suppress Solution – Confirmation Density"

There are 4 limitations and conditions listed in Section 5 of the DSS-CD LTR Revision 7 SER. The table below lists each of the 4 limitations and conditions and identifies which section of the TSAR discusses compliance with each limitation and condition.

Limitation and Condition Number from NRC SER	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
5.1	The NRC staff previously reviewed and approved the implementation of DSS-CD using the approved GEH Option III hardware and software. The DSS-CD solution is not approved for use with non-GEH hardware. The hardware components required to implement DSS-CD are expected to be those currently used for the approved Option III. If the DSS-CD hardware implementation deviates from the approved Option III solution, a hardware review by the NRC staff will be required. Implementations on other Option III platforms will require plant-specific reviews.	Comply	(1)
5.2	The confirmation density algorithm (CDA) setpoint calculation formula and the adjustable parameters values are defined in NEDC-33075P, Revision 7 (Reference 8). Deviation from the stated values or calculation formulas is not allowed without NRC review. To this end, the subject TR, when approved and implemented by a licensed nuclear power plant, must be referenced in the plant TSs, so that these values become controlled and part of the licensing bases.	Comply	(2)

Limitation and Condition Number from NRC SER	Limitation and Condition Description	Disposition	Section of HCGS TSAR which Addresses the Limitation and Condition
5.3	The NRC staff previously concluded that the plant-specific settings for eight of the FIXED parameters and three of the ADJUSTABLE parameters, as stated in section 3.6.3 of the NRC staff's SE for NEDC-33075P, Revision 5 (Reference 43), are licensing basis values. The process by which these values will be controlled must be addressed by licensees.	Comply	(3)
5.4	If plants other than Brunswick Steam Electric Plant, Units 1 and 2, use the DSS-CD trip function, those plant licensees must ensure the DSS-CD trip function is applicable in their plant licensing bases, including the optional BSP trip function, if it is to be installed.	Comply	(4)

Notes:

1. The DSS-CD solution is implemented on GEH hardware that will be installed and is approved by the NRC for the Option III solution (Reference 15).
2. GESTAR II, which includes the subject topical report, is referenced in the HCGS TSs.
3. The values of the FIXED and ADJUSTABLE parameters are established by GEH and will be documented in a DSS-CD Settings Report.
4. Verification and validation (V&V) of the DSS-CD trip function code was performed for transportability considerations.