Exelon Generation

TS 5.6.5.d

January 23, 2018

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Peach Bottom Atomic Power Station, Units 2 and 3
Renewed Facility Operating License Nos. DPR-44 and DPR-56
NRC Docket Nos. 50-277 and 50-278

Subject: Issuance of the Core Operating Limits Reports

Reference: 1. Letter from U.S. NRC (R. B. Ennis) to Exelon (B. Hanson), "Peach Bottom Atomic Power Station, Units 2 and 3 – Issuance of Amendments Re: Measurement Uncertainty Recapture Power Update (CAC Nos. MF9289 and MF9290; EPID L-2017-LLS-0001)," dated November 15, 2017 (ADAMS Accession No. ML17286A013).

Enclosed are copies of the revised Core Operating Limits Reports (COLR) for Peach Bottom Atomic Power Station (PBAPS) Units 2 and 3. These reports incorporate the revised cycle specific parameters resulting from implementation of License Amendment Nos. 316 and 319, for Units 2 and 3 respectively, relating to PBAPS Measurement Uncertainty Recapture Uprate (Reference 1).

The revised COLRs are being submitted to the NRC as required by the PBAPS Technical Specifications (TS) Section 5.6.5.d.

If you have any questions concerning this letter, please contact Ms. Stephanie J. Hanson at (717) 456-3756.

Respectfully,

Patrick D. Navin
Site Vice President
Peach Bottom Atomic Power Station

CCN: 18-06

Enclosures:
1. Unit 2 Core Operating Limits Report for Reload 21, Cycle 22, Revision 12
2. Unit 3 Core Operating Limits Report for Reload 21, Cycle 22, Revision 13

cc: USNRC Region I, Regional Administrator, (without attachment)
USNRC Senior Resident Inspector, PBAPS (without attachment)
USNRC Project Manager – PBAPS (with attachment)
R. R. Janati, Pennsylvania Bureau of Radiation Protection (without attachment)
S. T. Gray, State of Maryland (without attachment)

ENCLOSURES

Unit 2 Core Operating Limits Report for Reload 21, Cycle 22, Revision 12
Unit 3 Core Operating Limits Report for Reload 21, Cycle 22, Revision 13

CORE OPERATING LIMITS REPORT FOR

PEACH BOTTOM ATOMIC POWER STATION UNIT 2

RELOAD 21, CYCLE 22

(This is a Complete Re-write)

Prepared By:	M. Doerzbacher Nuclear Fuels	Date: 11/16/17
Prepared By:	C. Burns Nuclear Fuels	Date: 11/17/2017
Reviewed By:	J. Cihak - Reactor Engineering	Date: 11/27/17
Reviewed By:	T. Bement - Engineering Safety Analysis	Date: 11/17/17
Independent Review By:	K. McCoskey - Nuclear Fuels	Date: 11/17/2017
Approved By:	A. Johnson - NF Sr. Manager	Date: 27NOV17
Station Qualified Reviewer:	J. Holley - SQR	Date: 11/30/17

Table of Contents

Revision History

Revision	Description
Revision 12	Revised for Rated Thermal Power of 4016 MWth
Revision 11	New Issue for Cycle 22

Note that no revision bars were used, as this is a complete re-write based on new licensing.

List of Tables

1.0 TERMS AND DEFINITIONS

ABSP	Automatic Backup Stability Protection
AFTO	Asymmetric Feedwater Temperature Operation
AFTO LFWH	Asymmetric Feedwater Temperature Operation Loss-of-Feedwater Heating
APRM	Average Power Range Monitor
ARTS	APRM and RBM Technical Specification Analysis
BASE	The "BASE" condition is defined by a group of individual operating conditions that are applicable to all Modes of Operation discussed in Section 11. The "BASE" condition includes the EOOS conditions provided in Table 11-2 as well as operation with FWHOOS/FFWTR.
BOC	Beginning Of Cycle
BSP	Backup Stability Protection
DSS-CD	Detect and Suppress Solution – Confirmation Density
DTSP	Rod Block Monitor Downscale Trip Setpoint
EOC	End of Cycle
EOOS	Equipment Out of Service. An analyzed option that assumes certain equipment to be non-operational
EOR	End of Rated. The cycle exposure at which reactor power is equal to 100% with recirculation system flow equal to 100%, all control rods fully withdrawn, all feedwater heating in service and equilibrium Xenon.
FFWTR	Final Feedwater Temperature Reduction
FWHOOS	Feedwater Heaters Out of Service
FWT	Feedwater Temperature
HFCL	High Flow Control Line
HTSP	Rod Block Monitor High Trip Setpoint
ICF	Increased Core Flow
ITSP	Rod Block Monitor Intermediate Trip Setpoint
LHGR	Linear Heat Generation Rate
LHGRFAC(F)	ARTS LHGR thermal limit flow dependent adjustments and multipliers
LHGRFAC(P)	ARTS LHGR thermal limit power dependent adjustments and multipliers
LTSP	Rod Block Monitor Low Trip Setpoint
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MCPR	Minimum Critical Power Ratio
MCPR(F)	ARTS MCPR thermal limit flow dependent adjustments and multipliers
MCPR(P)	ARTS MCPR thermal limit power dependent adjustments and multipliers
MELLLA	Maximum Extended Load Line Limit Analysis
MELLLA+	Maximum Extended Load Line Limit Analysis Plus
MSIVOOS	Main Steam Isolation Valve Out of Service
NCL	Natural Circulation Line
OLMCPR	Operating Limit Minimum Critical Power Ratio
PLUOOS	Power Load Unbalance Out of Service
PROOS	Pressure Regulator Out of Service
RBM	Rod Block Monitor
RDF	Rated Drive Flow
RPTOOS	Recirculation Pump Trip Out of Service
RTP	Rated Thermal Power
RWE	Rod Withdrawal Error
SLMCPR	Safety Limit Minimum Critical Power Ratio
SLO	Single Loop Operation
SRVOOS	Safety Relief Valve Out of Service
TBVOOS	Turbine Bypass Valve Out of Service
TBSOOS	Turbine Bypass System Out of Service
TCV/TSVOOS	Turbine Control Valve and/or Turbine Stop Valve Out of Service
TPO	Thermal Power Optimization, also known as Measurement Uncertainty Recapture

2.0 GENERAL INFORMATION

This report provides the following cycle-specific parameter limits for Peach Bottom Atomic Power Station Unit 2 CYCLE 22 (RELOAD 21):

- Maximum Average Planar Linear Heat Generation Rate (MAPLHGR)
- Single Loop Operation (SLO) MAPLHGR multipliers
- Operating Limit Minimum Critical Power Ratio (OLMCPR)
- ARTS MCPR thermal limit adjustments and multipliers
- SLO MCPR adjustment
- Linear Heat Generation Rate (LHGR)
- ARTS LHGR thermal limit multipliers
- SLO LHGR multipliers
- Rod Block Monitor (RBM) Allowable Values and MCPR Limits
- Turbine Bypass Valve Parameters
- EOC Recirculation Pump Trip (EOC-RPT) Parameters
- Stability Protection Setpoints
- Asymmetric Feedwater Temperature Operation (AFTO) thermal limit penalties

These values have been determined using NRC-approved methodology and are established such that all applicable limits of the plant safety analysis are met. SLO, FWHOOS operation, and FFWTR operation are not permitted in the MELLLA+ Region as controlled by station procedures. For the MELLLA+ Region, a specific definition of FWHOOS is provided in Facility Operating License (FOL) Section 2.C(16).

This report provides cycle-specific Operating Limit MCPR, LHGR, MAPLHGR thermal limits, and related information for the following conditions:

- All points in the operating region of the power/flow map including the MELLLA+ Region down to 85.2% of rated core flow during full power (4016 MWt) operation (Appendix A)
- Increased Core Flow (ICF), up to 110% of rated core flow
- End-of-Cycle Power Coastdown to a minimum power level of 40%
- Feedwater Heaters Out of Service (FWHOOS) up to 55° F temperature reduction
- Final Feedwater Temperature Reduction (FFWTR) between End-of-Rated (EOR) and End-of-Cycle (EOC) up to 90° F temperature reduction (4^{th} and 5^{th} stage FWHOOS)
- Asymmetric Feedwater Temperature Operation

ARTS provides for power- and flow-dependent thermal limit adjustments and multipliers that allow for a more reliable administration of the MCPR and LHGR thermal limits. The OLMCPR is determined by the cycle-specific reload analyses in Reference 2. Rated LHGR values are obtained from the bundle-specific thermal-mechanical analysis. Supporting documentation for the ARTS-based limits is provided in Reference 2. The off-rated limits assumed in the ECCS-LOCA analyses bound the cycle-specific limits calculated for MELLLA+ operation. The Allowable Values documented in Reference 5 for feedwater temperature as a function of thermal power for both FWHOOS and FFWTR are specified in the appropriate Peach Bottom procedures. The Peach Bottom Unit 2 Cycle 22 core is comprised entirely of GNF2 fuel.

3.0 MAPLHGR LIMITS

3.1 Technical Specification

Section 3.2.1, 3.3.4.2, 3.4.1 and 3.7.6

3.2 Description

The limiting MAPLHGR value for the most limiting lattice of GNF2 fuel as a function of average planar exposure is given in Table 3-1. For single loop operation, a multiplier is used, which is shown in Table 3-2. The impact of AFTO on MAPLHGR is addressed in Section 10.0.

TABLE 3-1
MAPLHGR Versus Average Planar Exposure
(Reference 2)

Average Planar Exposure (GWD/ST)	MAPLHGR Limit (kW/ft)
0.0	13.78
17.52	13.78
60.78	7.50
63.50	6.69

TABLE 3-2
MAPLHGR Single Loop Operation (SLO) Multiplier
(Reference 2)

SLO Multiplier	0.73

4.0 MCPR LIMITS

4.1 Technical Specification

Section 2.1.1.2, 3.2.2, 3.3.4.2, 3.4.1 and 3.7.6

4.2 Description

The Operating Limit MCPR (OLMCPR) for GNF2 fuel is provided in Table 4-1. These values are determined by the cycle-specific fuel reload analyses in Reference 2. The values in Table 4-1 assume a 45 ms or greater delay between the time of the first TCV movement and the time of first TSV movement following a turbine trip, as analyzed in Appendix H of Reference 2. Control rod scram time verification is required as per Technical Specification 3.1.4, "Control Rod Scram Times". Tau (τ), a measure of scram time performance to notch position 36 throughout the cycle, is determined based on the cumulative scram time test results. The calculation of Tau shall be performed in accordance with site procedures. Linear interpolation shall be used to calculate the OLMCPR value if Tau is between 0.0 (Tau Option B) and 1.0 (Tau Option A). Table 4-1 is valid for a maximum FWT reduction of 90°F (Reference 2).

Separate OLMCPR values are presented in Table 4-1 for the conditions listed in Section 11.0. The impact of AFTO on MCPR is addressed in Section 10.0. For PR/PLUOOS + TBSOOS and PR/PLUOOS + RPTOOS conditions, the limits are listed in Section 10.0; these values are bounding for non-AFTO conditions.

The ARTS-based power-dependent MCPR limits are provided in Table 4-2. Table 4-2 is valid for a maximum temperature reduction of 90 °F for FFWTR operation (bounding for FWHOOS operation) (Reference 2). The flow-dependent MCPR limits are provided in Tables 4-3 and 4-4. Table 4-3 is valid for dual loop operating conditions with symmetric feedwater temperature operation, and Table 4-4 is valid for single loop operating conditions with symmetric feedwater temperature operation.

TABLE 4-1
Operating Limit Minimum Critical Power Ratio
(Reference 2)

EOOS Combination	SCRAM Time Option[1]	Cycle Exposure	
		< EOR - 4096 MWd/ST	≥ EOR – 4096 MWd/ST
BASE	B	1.38	1.42
	A	1.44	1.50
BASE SLO	B	1.42	1.44
	A	1.46	1.52
RPTOOS	B	1.41	1.44
	A	1.58	1.61
RPTOOS SLO	B	1.43	1.46
	A	1.60	1.63
PR/PLUOOS	B	1.38	1.42
	A	1.44	1.50
PR/PLUOOS SLO	B	1.42	1.44
	A	1.46	1.52
TBSOOS	B	1.42	1.47
	A	1.51	1.56
TBSOOS SLO	B	1.44	1.49
	A	1.53	1.58

(1) When Tau does not equal 0 or 1, use linear interpolation.

TABLE 4-2
Power Dependent MCPR(P) Limit Adjustments And Multipliers
(Symmetric Feedwater Heating)
(Reference 2)

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of rated)								
		0	22.6	<26.3	≥26.3	40	55	65	85	100
		Operating Limit MCPR			Operating Limit MCPR Multiplier, Kp					
Base	≤ 60	2.67	2.67	2.60	1.392	1.288	1.237	1.130	1.067	1.000
	> 60	2.99	2.99	2.83						
Base SLO	≤ 60	2.69	2.69	2.62	1.392	1.288	1.237	1.130	1.067	1.000
	> 60	3.01	3.01	2.85						
RPTOOS	≤ 60	2.67	2.67	2.60	1.392	1.288	1.237	1.130	1.067	1.000
	> 60	2.99	2.99	2.83						
RPTOOS SLO	≤ 60	2.69	2.69	2.62	1.392	1.288	1.237	1.130	1.067	1.000
	> 60	3.01	3.01	2.85						
PR/PLUOOS	≤ 60	2.67	2.67	2.60	1.392	1.288	1.237	1.210	1.147	1.000
	> 60	2.99	2.99	2.83						
PR/PLUOOS SLO	≤ 60	2.69	2.69	2.62	1.392	1.288	1.237	1.210	1.147	1.000
	> 60	3.01	3.01	2.85						
TBSOOS	≤ 60	3.64	3.64	3.25	1.399	1.323	1.237	1.155	1.079	1.000
	> 60	4.15	4.15	3.78						
TBSOOS SLO	≤ 60	3.66	3.66	3.27	1.399	1.323	1.237	1.155	1.079	1.000
	> 60	4.17	4.17	3.80						

TABLE 4-3
Flow Dependent MCPR Limits MCPR(F)
(Symmetric Feedwater Heating)
(Reference 2)

Core Flow (% rated)	MCPR(F) Limit
0.0	1.74
30.0	1.57
86.0	1.25
110.0	1.25

TABLE 4-4
SLO Flow Dependent MCPR Limits MCPR(F)
(Symmetric Feedwater Heating)
(Reference 2)

Core Flow (% rated)	MCPR(F) Limit
0.0	1.76
30.0	1.59
86.0	1.27
110.0	1.27

5.0 LHGR LIMITS

5.1 Technical Specification

Section 3.2.3, 3.3.4.2, 3.4.1 and 3.7.6

5.2 Description

The LHGR values for the GNF2 fuel type are provided in Tables 5-1 and 5-2. The ARTS-based LHGR power-dependent multipliers are provided in Table 5-3. Table 5-3 is valid for a maximum temperature reduction of 90° F for FFWTR operation (bounding for FWHOOS operation) (Reference 2). The flow-dependent multipliers are provided in Table 5-4 as a function of the number of recirculation loops in operation. The SLO LHGR multiplier is provided and accounted for in Table 5-4. The power- and flow-dependent LHGR multipliers were obtained from Reference 2. The impact of AFTO on LHGR is addressed in Section 10.0. For PR/PLUOOS + TBSOOS and PR/PLUOOS + RPTOOS conditions, the limits are listed in Section 10.0; these values are bounding for non-AFTO conditions. The power and flow dependent LHGR multipliers are sufficient to provide adequate protection for the off-rated conditions from an ECCS-LOCA analysis perspective.

TABLE 5-1
Linear Heat Generation Rate Limits – UO2 rods
(References 4 and 10)

Fuel Type	LHGR Limit
GNF2	See Appendix B of Reference 4

TABLE 5-2
Linear Heat Generation Rate Limits – Gad rods
(References 4 and 10)

Fuel Type	LHGR Limit
GNF2	See Appendix B of Reference 4

TABLE 5-3
Power Dependent LHGR Multiplier LHGRFAC(P)
(Symmetric Feedwater Heating)
(Reference 2)

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of rated)								
		0	22.6	<26.3	≥26.3	40	55	65	85	100
		LHGRFAC(P) Multiplier								
Base	≤ 60	0.508	0.508	0.522	0.620	0.696	0.751	0.817	0.930	1.000
	> 60	0.508	0.508	0.522						
Base SLO	≤ 60	0.508	0.508	0.522	0.620	0.696	0.751	0.817	0.930	1.000
	> 60	0.508	0.508	0.522						
RPTOOS	≤ 60	0.508	0.508	0.522	0.620	0.696	0.751	0.817	0.930	1.000
	> 60	0.508	0.508	0.522						
RPTOOS SLO	≤ 60	0.508	0.508	0.522	0.620	0.696	0.751	0.817	0.930	1.000
	> 60	0.508	0.508	0.522						
PR/PLUOOS	≤ 60	0.508	0.508	0.522	0.620	0.696	0.751	0.817	0.930	1.000
	> 60	0.508	0.508	0.522						
PR/PLUOOS SLO	≤ 60	0.508	0.508	0.522	0.620	0.696	0.751	0.817	0.930	1.000
	> 60	0.508	0.508	0.522						
TBSOOS	≤ 60	0.397	0.397	0.442	0.620	0.655	0.714	0.817	0.930	1.000
	> 60	0.397	0.397	0.417						
TBSOOS SLO	≤ 60	0.397	0.397	0.442	0.620	0.655	0.714	0.817	0.930	1.000
	> 60	0.397	0.397	0.417						

TABLE 5-4
Flow Dependent LHGR Multiplier LHGRFAC(F)
(Symmetric Feedwater Heating)
(Reference 2)

EOOS Combination	Core Flow (% of rated)					
	0	30	33.6	70	80	110
	LHGRFAC(F) Multiplier					
Dual Loop	0.506	0.706	0.730	0.973	1.000	1.000
Single Loop	0.506	0.706	0.730	0.730	0.730	0.730

6.0 ROD BLOCK MONITOR SETPOINTS

6.1 Technical Specification

Section 3.3.2.1

6.2 Description

The RBM power-biased Allowable Values and MCPR Limits are provided in Table 6-1 with supporting documentation in References 2 and 8. These values correspond to the OLMCPR values provided in Table 4-1.

TABLE 6-1
Rod Block Monitor Setpoints
(References 2 and 8)

Power Level	Allowable Value[1]	MCPR Limit
LTSP	118.2%	< 1.83 [2] < 1.50 [3]
ITSP	113.4%	< 1.83 [2] < 1.50 [3]
HTSP	108.4%	< 1.83 [2] < 1.50 [3]
INOP	N/A	< 1.83 [2] < 1.50 [3]

(1) These setpoints (with RBM filter time constant between 0.1 seconds and 0.55 seconds) are based on a cycle-specific rated RWE MCPR limit which is less than or equal to the minimum cycle OLMCPR based on other events (see COLR References 2 and 8).
(2) This is the MCPR limit (given THERMAL POWER is ≥28.4% and < 90%) below which the RBM is required to be OPERABLE (see COLR Reference 2 and TS Table 3.3.2.1-1).
(3) This is the MCPR limit (given THERMAL POWER is ≥ 90%) below which the RBM is required to be OPERABLE (see COLR Reference 2 and TS Table 3.3.2.1-1).

7.0 TURBINE BYPASS VALVE PARAMETERS

7.1 Technical Specification

Section 3.7.6

7.2 Description

The operability requirements for the steam bypass system are governed by Technical Specification 3.7.6. If the requirements cannot be met, the appropriate power and flow dependent limits for Turbine Bypass System Out-of-Service (TBSOOS) must be used. Additionally, the OLMCPR for TBSOOS must be applied. Table 7-1 includes the Turbine Bypass Valve response time parameters. The minimum number of bypass valves to maintain system operability is provided in Table 7-2 per Reference 12.

TABLE 7-1
Turbine Bypass System Response Time
(Reference 12)

Maximum delay time before start of bypass valve opening following initial turbine inlet valve movement(1)	0.10 sec
Maximum time after initial turbine inlet valve movement(1) for bypass valve position to reach 80% of full flow (includes the above delay time)	0.30 sec

(1) First movement of any TSV or any TCV (whichever occurs first)

TABLE 7-2
Minimum Required Bypass Valves to Maintain System Operability
(Reference 12)

Reactor Power	No. of Valves in Service
$P \geq 22.6\%$	7

8.0 EOC RECIRCULATION PUMP TRIP (EOC-RPT) OPERABILITY

8.1 Technical Specification

Section 3.3.4.2

8.2 Description

The operability requirements for the EOC Recirculation Pump Trip are governed by Technical Specification 3.3.4.2. If the requirements cannot be met, the appropriate power and flow dependent limits for EOC Recirculation Pump Trip Out Of Service (RPTOOS) must be used. Additionally, the OLMCPR for RPTOOS must be applied. Table 8-1 includes the total RPT response time parameter.

TABLE 8-1
Recirculation Pump Trip Response Time
(Reference 12)

Total Recirculation Pump Trip Response Time *The time from when the turbine valves (turbine control valve or turbine stop valve) start to close until complete arc suppression of the EOC-RPT circuit breakers as described in Reference 7.*	0.175 sec

9.0 STABILITY PROTECTION

9.1 Technical Specification

Section 3.3.1.1, Table 3.3.1.1-1 Function 2.f

9.2 Description

Per Reference 2, the Cycle 22 DSS-CD S_{AD} Setpoint was confirmed to be 1.10 for DLO and SLO. The Automatic Backup Stability Protection (BSP) Setpoints are provided in Table 9-1. The Manual BSP Endpoints for Normal Feedwater Temperature and Reduced Feedwater Temperature are provided in Tables 9-2 and Table 9-3, respectively. Table 9-3 is intended for feedwater temperatures 10-90°F below nominal.

TABLE 9-1
Automatic BSP Setpoints for the Scram Region
(Reference 2)

Parameter	Symbol	Value
Slope of ABSP APRM flow-biased trip linear segment.	m_{Trip}	1.62
ABSP APRM flow-biased trip setpoint power intercept. Constant Power Line for Trip from zero Drive Flow to Flow Breakpoint value.	$P_{BSP\text{-}Trip}$	39.8 %RTP
ABSP APRM flow-biased trip setpoint drive flow intercept. Constant Flow Line for Trip.	$W_{BSP\text{-}Trip}$	46.7 %RDF
Flow Breakpoint value	$W_{BSP\text{-}Break}$	25.0 %RDF

TABLE 9-2[1]
Manual BSP Endpoints for Normal Feedwater Temperature
(Reference 2)

Endpoint	Power (%)	Flow (%)	Definition
A1	73.2	49.3	Scram Region Boundary, HFCL
B1	40.0	31.0	Scram Region Boundary, NCL
A2	63.5	50.0	Controlled Entry Region Boundary, HFCL
B2	27.6	30.1	Controlled Entry Region Boundary, NCL

Note: The BSP Boundary for Normal and Reduced Feedwater Temperature is defined by the MELLLA boundary line, per Reference 2.

TABLE 9-3[5]
Manual BSP Endpoints for Reduced Feedwater Temperature
(Reference 2)

Endpoint	Power (%)	Flow (%)	Definition
A1'	63.4	50.0	Scram Region Boundary, HFCL
B1'	33.8	30.6	Scram Region Boundary, NCL
A2'	65.0	52.0	Controlled Entry Region Boundary, HFCL
B2'	27.6	30.1	Controlled Entry Region Boundary, NCL

Note: The BSP Boundary for Normal and Reduced Feedwater Temperature is defined by the MELLLA boundary line, per Reference 2.

(1) Station may elect to place additional administrative margin on the endpoints provided in Table 9-2 and Table 9-3.

10.0 ASYMMETRIC FEEDWATER TEMPERATURE OPERATION (AFTO)

Asymmetric feedwater heating is the result of the specific configuration of the feedwater lines at Peach Bottom. A reduction in heating in either the 'A' or the 'C' heater strings will result in a temperature mismatch between the feedwater flows entering the opposite sides of the reactor vessel. This temperature mismatch may result in errors in the thermal limit values calculated by the core monitoring system. Thermal limit values for all conditions and events are impacted by these errors excluding SLO conditions. The station no longer requires SLO AFTO penalties due to a 3D MONICORE upgrade. AFTO is defined as operation in a feedwater heater/string configuration that results in a specified threshold difference as described in Reference 9. To simplify the implementation of the AFTO limits, only the maximum AFTO penalties indicated in Table 13 of Reference 9 will be implemented when the threshold asymmetry temperature is exceeded; this will minimize the number of AFTO thermal limit tables in the COLR and core monitoring system. There is no AFTO penalty for a FWT difference below 20°F, for a difference between 20 and 55°F there is a 4% LHGR/MAPLHGR penalty and a 3% MCPR penalty, and thermal limits are unanalyzed for a difference above 55°F.

10.1 LHGR LIMITS

The ARTS-based LHGR power-dependent multipliers for AFTO operation are provided in Table 10-1. The flow-dependent multipliers for AFTO in DLO are provided in Table 10-2. The power- and flow-dependent LHGR multipliers were obtained from Reference 2 and were adjusted with the appropriate penalties as per Reference 9. PR/PLUOOS + TBSOOS and PR/PLUOOS + RPTOOS values were obtained by taking the most limiting values of the two EOOS conditions (Reference 11). The maximum feedwater temperature difference allowed without a thermal limit penalty is 20°F. Once the temperature difference exceeds 20°F the maximum penalties from Reference 9 are applied to the thermal limits. Additionally, no LHGR penalties are required for AFTO while in SLO as previously discussed.

TABLE 10-1
AFTO Power Dependent LHGR Multiplier LHGRFAC(P) 20F < FWT DELTA ≤ 55F
(Asymmetric Feedwater Heating)
(References 2, 9 and 11)

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of rated)								
		0	22.6	<26.3	≥26.3	40	55	65	85	100
		LHGRFAC(P) Multiplier								
Base	≤ 60	0.488	0.488	0.501	0.595	0.668	0.721	0.784	0.893	0.960
	> 60	0.488	0.488	0.501						
RPTOOS	≤ 60	0.488	0.488	0.501	0.595	0.668	0.721	0.784	0.893	0.960
	> 60	0.488	0.488	0.501						
PR/PLUOOS	≤ 60	0.488	0.488	0.501	0.595	0.668	0.721	0.784	0.893	0.960
	> 60	0.488	0.488	0.501						
TBSOOS	≤ 60	0.381	0.381	0.424	0.595	0.629	0.685	0.784	0.893	0.960
	> 60	0.381	0.381	0.400						
PR/PLUOOS + TBSOOS	≤ 60	0.381	0.381	0.424	0.595	0.629	0.685	0.784	0.893	0.960
	> 60	0.381	0.381	0.400						
PR/PLUOOS + RPTOOS	≤ 60	0.488	0.488	0.501	0.595	0.668	0.721	0.784	0.893	0.960
	> 60	0.488	0.488	0.501						

TABLE 10-2
AFTO Flow Dependent LHGR Multiplier LHGRFAC(F) 20F < FWT DELTA ≤ 55F
(Asymmetric Feedwater Heating)
(References 2 and 9)

EOOS Combination	Core Flow (% of rated)					
	0	30	33.6	70	80	110
	LHGRFAC(F) Multiplier					
Dual Loop	0.486	0.678	0.701	0.934	0.960	0.960

10.2 MCPR LIMITS

The OLMCPRs during asymmetric feedwater temperature operation with a feedwater temperature difference greater than 20°F are provided in Table 10-3. The ARTS-based power-dependent MCPR limits for use during AFTO conditions are provided in Table 10-4. The flow-dependent MCPR limits for AFTO are provided in Table 10-5. The power- and flow-dependent OLMCPR curves were obtained from Reference 2 and were adjusted with a penalty for feedwater temperature difference greater than 20°F as per Reference 9. The values in Table 10-3 assume a 45 ms or greater delay between the time of the first TCV movement and the time of first TSV movement following a turbine trip. PR/PLUOOS + TBSOOS and PR/PLUOOS + RPTOOS values were obtained by taking the most limiting values of the two EOOS conditions (Reference 11). No MCPR penalties are required for asymmetric temperature differentials less than or equal to 20 °F.

TABLE 10-3
AFTO Operating Limit Minimum Critical Power Ratio 20F < FWT DELTA ≤ 55F
(Asymmetric Feedwater Heating)
(References 2, 9 and 11)

EOOS Combination	SCRAM Time Option[1]	Cycle Exposure	
		< EOR – 4096 MWd/ST	≥ EOR – 4096 MWd/ST
BASE	B	1.42	1.46
	A	1.48	1.55
RPTOOS	B	1.45	1.48
	A	1.63	1.66
PR/PLUOOS	B	1.42	1.46
	A	1.48	1.55
TBSOOS	B	1.46	1.51
	A	1.56	1.61
PR/PLUOOS + TBSOOS	B	1.46	1.51
	A	N/A	N/A
PR/PLUOOS + RPTOOS	B	1.45	1.48
	A	N/A	N/A

(1) When Tau does not equal 0 or 1, use linear interpolation.

TABLE 10-4
AFTO Power Dependent MCPR Limit Adjustments And Multipliers MCPR(P) 20F < FWT DELTA ≤ 55F
(Asymmetric Feedwater Heating)
(References 2, 9 and 11)

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of rated)								
		0	22.6	<26.3	≥26.3	40	55	65	85	100
		Operating Limit MCPR			Operating Limit MCPR Multiplier, Kp					
Base	≤ 60	2.75	2.75	2.68	1.392	1.288	1.237	1.130	1.067	1.000
	> 60	3.08	3.08	2.91						
RPTOOS	≤ 60	2.75	2.75	2.68	1.392	1.288	1.237	1.130	1.067	1.000
	> 60	3.08	3.08	2.91						
PR/PLUOOS	≤ 60	2.75	2.75	2.68	1.392	1.288	1.237	1.210	1.147	1.000
	> 60	3.08	3.08	2.91						
TBSOOS	≤ 60	3.75	3.75	3.35	1.399	1.323	1.237	1.155	1.079	1.000
	> 60	4.27	4.27	3.89						
PR/PLUOOS + TBSOOS	≤ 60	3.75	3.75	3.35	1.399	1.323	1.237	1.210	1.147	1.000
	> 60	4.27	4.27	3.89						
PR/PLUOOS + RPTOOS	≤ 60	2.75	2.75	2.68	1.392	1.288	1.237	1.210	1.147	1.000
	> 60	3.08	3.08	2.91						

TABLE 10-5
AFTO Flow Dependent MCPR Limits MCPR(F) 20F < FWT DELTA ≤ 55F
(Asymmetric Feedwater Heating)
(References 2 and 9)

Flow (% rated)	MCPR(F) Limit
0.0	1.79
30.0	1.62
86.0	1.29
110.0	1.29

10.3 MAPLHGR LIMITS

An appropriate penalty must be applied to MAPLHGR limits under asymmetric feedwater temperature operation (AFTO) for varying temperature differentials as per Reference 9. The reduction factor listed in Table 10-6 is the maximum penalty for the full range of analyzed FWT mismatches, bounding all smaller temperature deltas.

TABLE 10-6
AFTO MAPLHGR Reduction Factor
(Asymmetric Feedwater Heating)
(References 2 and 9)

AFTO Reduction Factor	
20F < FWT DELTA ≤ 55F	0.960

11.0 MODES OF OPERATION

The following conditions are supported by the Peach Bottom 2 Cycle 22 licensing analysis; operation in a condition (or conditions) is controlled by station procedures. If a combination of options is not listed, it is not supported. Table 11-1 provides allowed modes of operation with thermal limit sets in the COLR. Table 11-2 provides allowed modes of operation that do not contain explicit thermal limit sets in the COLR.

TABLE 11-1
Modes of Operation
(Reference 2)

EOOS Options	Supported Scram Speed Option	Supported Recirculation Loop Operation	Supported SFTO/AFTO
Base[1,2]	A or B	DLO or SLO[3]	SFTO or AFTO
TBSOOS	A or B	DLO or SLO[3]	SFTO or AFTO
RPTOOS	A or B	DLO or SLO[3]	SFTO or AFTO
PLUOOS	A or B	DLO or SLO[3]	SFTO or AFTO
PROOS	A or B	DLO or SLO[3]	SFTO or AFTO
PR/PLUOOS and TBSOOS	B	DLO	AFTO[4]
PR/PLUOOS and RPTOOS	B	DLO	AFTO[4]

TABLE 11-2
EOOS Options Included in 'Base' Conditions
(Reference 2)

Condition
TBVOOS
SRVOOS
MSIVOOS[5]
TCV/TSVOOS[5]

[1] The 'Base' condition includes the options listed in Table 11-2.
[2] The 'Base' condition includes operation with FWHOOS/FFWTR. Operation not permitted in the MELLLA+ Region for reduced FWT conditions as controlled by station procedures.
[3] Operation in SLO not permitted in the MELLLA+ Region as controlled by station procedures.
[4] AFTO limits bound SFTO limits.
[5] Permitted at power levels provided in the applicable station procedure.

12.0 METHODOLOGY

The analytical methods used in determining the core operating limits have been previously reviewed and approved by the NRC, specifically those described in the following document:

1. "General Electric Standard Application for Reactor Fuel", Global Nuclear Fuel Document No. NEDE-24011-P-A-25, August 2017 and U.S. Supplement NEDE-24011-P-A-25-US, August 2017.

13.0 REFERENCES

1. "Technical Specifications for Peach Bottom Atomic Power Station Unit 2", Exelon Document, Docket No. 50-277, License No. DPR-44.

2. Global Nuclear Fuel Document "Supplemental Reload Licensing Report for Peach Bottom Unit 2 Reload 21 Cycle 22 Mid-Cycle Thermal Power Optimization (TPO)", GNF Document No. 004N2488, Revision 0, October 2017.

3. Global Nuclear Fuel Document "General Electric Standard Application for Reactor Fuel", NEDE-24011-P-A-25, August 2017 and U.S. Supplement NEDE-24011-P-A-25-US, August 2017.

4. Global Nuclear Fuel Document NEDC-33270P Rev. 6, "GNF2 Advantage Generic Compliance with NEDE-24011-P-A (GESTAR II)," March 2016.

5. General Electric Hitachi Document 001N2494-R0, "Peach Bottom EPU Evaluation of Feedwater Temperature vs. Reactor Power for Feedwater Temperature Conditions of Nominal Rated, FWHOOS (Nominal -55°F) and FFWTR (Nominal -90°F)", July 2014. This document is searchable in Exelon EDMS under document number "PEAM-EPU-1" Rev. 0A.

6. General Electric Hitachi Document NEDO-33873, "Safety Analysis Report for Peach Bottom Atomic Power Station, Units 2 and 3, Thermal Power Optimization", Revision 0, February 2017.

7. PECO Calculation PE-0173, "Determination of Total Time Required to Initiate the Trip Signal to the EOC-RPT Circuit Breakers Trip Coils and to Complete the Recirculation Pump Trip", Rev. 1 dated 12/22/98.

8. Exelon Calculation PE-0251, Revision 4, "Provide Allowable Values (AV) and Nominal Trip Setpoints (NTSP) for Various Setpoint Functions of the NUMAC PRNM System" dated 7/31/17.

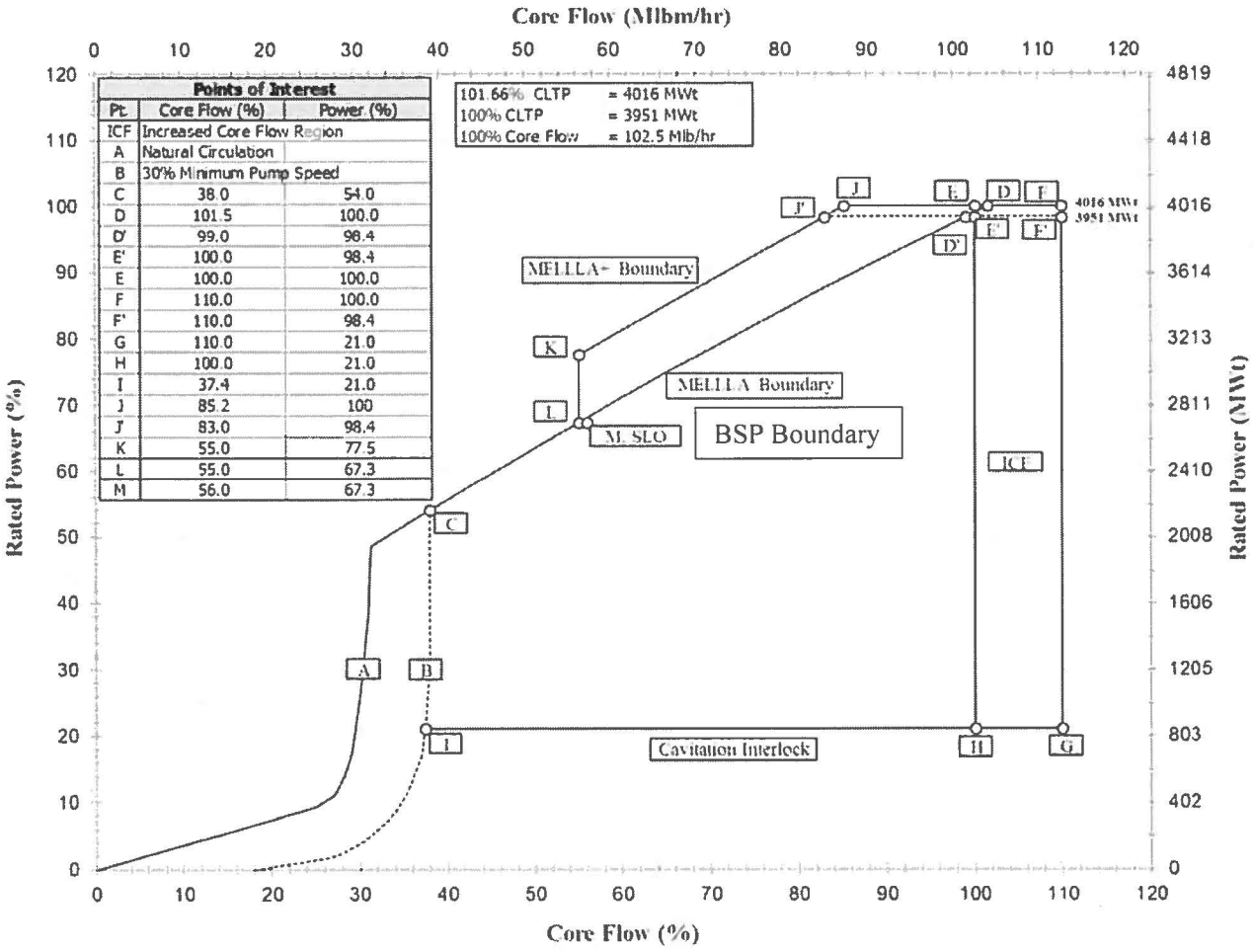
9. General Electric Hitachi Document 001N6733-R2, "Final Evaluation Report Exelon Nuclear Generating Company LLC, Peach Bottom Units 2 & 3, TPO with EPU/MELLLA+ PCR E03: Asymmetric Feedwater Temperature Operation for TPO with EPU/MELLLA+", Revision 2, September 2017. This document is searchable in Exelon EDMS under document number "PEAM-MUR-PCR-E03" Rev. 0.

10. Global Nuclear Fuel Document 002N6786, "Fuel Bundle Information Report for Peach Bottom Unit 2 Reload 21 Cycle 22", Revision 0, September 2016.

11. Global Nuclear Fuel Document 0000-0135-9000-R2, "Peach Bottom Atomic Power Station Units 2 and 3 TRACG Implementation for Reload Licensing Transient Analysis", dated June 2017.

12. Exelon TODI ENSAF ID# ES1700008, Rev. 0, "Final Resolved OPL-3 Parameters for Peach Bottom Unit 2 Cycle 22 TPO", 5/30/2017.

APPENDIX A
POWER/FLOW OPERATING MAP FOR MELLLA+ with TPO
(Reference 6)



CORE OPERATING LIMITS REPORT FOR

PEACH BOTTOM ATOMIC POWER STATION UNIT 3

RELOAD 21, CYCLE 22

Prepared By: _____ Date: 11/1/2017
Chad Burns Nuclear Fuels

Reviewed By: _____ Date: 11/10/2017
Matthew Miller Reactor Engineering

Reviewed By: _____ Date: 11/2/17
Travis Bement Engineering Safety Analysis

Independent Review By: _____ Date: 11/8/17
Tamara Stathes Nuclear Fuels

Approved By: _____ Date: 13NOV17
Armando Johnson NF Senior Manager

SQR By: _____ Date: 11/13/17
Jeff Holley Station Qualified Reviewer

Table of Contents

Revision History

Revision	Description
Revision 13	Update of Cycle 22 COLR to allow for implementation of Thermal Power Optimization/Measurement Uncertainty Recapture (TPO/MUR) to 4016 MW_t
Revision 12	New issue for Cycle 22

List of Tables

1.0 Terms and Definitions

ABSP	Automatic Backup Stability Protection
AFTO	Asymmetric Feedwater Temperature Operation
AFTO LFWH	Asymmetric Feedwater Temperature Operation Loss-of-Feedwater Heating
APRM	Average Power Range Monitor
ARTS	APRM and RBM Technical Specification Analysis
BASE	The "BASE" condition is defined by a group of individual operating conditions that are applicable to all Modes of Operation discussed in Section 11. The "BASE" condition includes the EOOS conditions provided in Table 11-2 as well as operation with FWHOOS/FFWTR.
BOC	Beginning Of Cycle
BSP	Backup Stability Protection
DSS-CD	Detect and Suppress Solution – Confirmation Density
DTSP	Rod Block Monitor Downscale Trip Setpoint
EOC	End of Cycle
EOOS	Equipment Out of Service. An analyzed option that assumes certain equipment to be non-operational.
EOR	End of Rated. The cycle exposure at which reactor power is equal to 100% with recirculation system flow equal to 100%. all control rods fully withdrawn, all feedwater heating in service and equilibrium Xenon.
FFWTR	Final Feedwater Temperature Reduction
FWHOOS	Feedwater Heaters Out of Service
FWT	Feedwater Temperature
HFCL	High Flow Control Line
HTSP	Rod Block Monitor High Trip Setpoint
ICF	Increased Core Flow
ITSP	Rod Block Monitor Intermediate Trip Setpoint
LHGR	Linear Heat Generation Rate
LHGRFAC(F)	ARTS LHGR thermal limit flow dependent adjustments and multipliers
LHGRFAC(P)	ARTS LHGR thermal limit power dependent adjustments and multipliers
LTSP	Rod Block Monitor Low Trip Setpoint
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MCPR	Minimum Critical Power Ratio
MCPR(F)	ARTS MCPR thermal limit flow dependent adjustments and multipliers
MCPR(P)	ARTS MCPR thermal limit power dependent adjustments and multipliers
MELLLA	Maximum Extended Load Line Limit Analysis
MELLLA+	Maximum Extended Load Line Limit Analysis Plus
MSIVOOS	Main Steam Isolation Valve Out of Service
NCL	Natural Circulation Line
OLMCPR	Operating Limit Minimum Critical Power Ratio
PLUOOS	Power Load Unbalance Out of Service
PROOS	Pressure Regulator Out of Service
RBM	Rod Block Monitor
RDF	Rated Drive Flow
RPTOOS	Recirculation Pump Trip Out of Service
RTP	Rated Thermal Power
RWE	Rod Withdrawal Error
SLMCPR	Safety Limit Minimum Critical Power Ratio
SLO	Single Loop Operation
TBSOOS	Turbine Bypass System Out of Service
TCV/TSVOOS	Turbine Control Valve and/or Turbine Stop Valve Out of Service

2.0 General Information

This report provides the following cycle-specific parameter limits for Peach Bottom Atomic Power Station Unit 3 CYCLE 22 (RELOAD 21):

- Maximum Average Planar Linear Heat Generation Rate (MAPLHGR)
- Single Loop Operation (SLO) MAPLHGR multipliers
- Operating Limit Minimum Critical Power Ratio (OLMCPR)
- ARTS MCPR thermal limit adjustments and multipliers
- SLO MCPR adjustment
- Linear Heat Generation Rate (LHGR)
- ARTS LHGR thermal limit multipliers
- SLO LHGR multipliers
- Rod Block Monitor (RBM) allowable values and MCPR limits
- Turbine Bypass Valve parameters
- EOC Recirculation Pump Trip (EOC-RPT) parameters
- Stability Protection Setpoints
- Asymmetric Feedwater Temperature Operation (AFTO) thermal limits

These values have been determined using NRC-approved methodology and are established such that all applicable limits of the plant safety analysis are met. SLO, FWHOOS operation, and FFWTR operation are not permitted in the MELLLA+ Region as controlled by station procedures. For the MELLLA+ Region, a specific definition of FWHOOS is provided in Facility Operating License (FOL) Section 2.C(16).

This report provides cycle-specific Operating Limit MCPR, LHGR, MAPLHGR thermal limits, and related information for the following conditions:

- All points in the operating region of the power/flow map including MELLLA+ Region down to 85.2% of rated core flow during full power (4016 MWt) operation (Appendix A)
- Increased Core Flow (ICF), up to 110% of rated core flow
- End-of-Cycle Power Coastdown to a minimum power level of 40%
- Feedwater Heaters Out of Service (FWHOOS) to 55° F temperature reduction
- Final Feedwater Temperature Reduction (FFWTR) between End-of-Rated (EOR) and End-of-Cycle (EOC) to 90° F temperature reduction (4^{th} and 5^{th} stage FWHOOS)
- Asymmetric Feedwater Temperature Operation

ARTS provides for power and flow-dependent thermal limit adjustments and multipliers that allow for a more reliable administration of the MCPR and LHGR thermal limits. The OLMCPR is determined by the cycle-specific reload analyses in Reference 2. Rated LHGR values are obtained from the bundle-specific thermal-mechanical analysis. Supporting documentation for the ARTS-based limits is provided in Reference 2. The off-rated limits assumed in the ECCS-LOCA analyses bound the cycle-specific limits calculated for MELLLA+ operation. The Allowable Values documented in Reference 5 for feedwater temperature as a function of thermal power for both FWHOOS and FFWTR are specified in the appropriate Peach Bottom procedures. The Peach Bottom Unit 3 Cycle 22 core is comprised entirely of GNF2 fuel.

3.0 MAPLHGR LIMITS

3.1 Technical Specification

Section 3.2.1, 3.3.4.2, 3.4.1 and 3.7.6

3.2 Description

The MAPLHGR limits (kW/ft) obtained from the emergency core cooling system (ECCS) analysis are provided in Table 3-1. The MAPLHGR limits comprise a given fuel type as a function of average planar exposure. All MAPLHGR values for GNF2 as a function of axial location and average planar exposure shall be less than or equal to the applicable MAPLHGR limits for GNF2 fuel and lattice type. These MAPLHGR limits are specified in Reference 2 and the process computer databank. The SLO MAPLHGR multiplier is provided in Table 3-2 per Reference 2 and must be applied to the Table 3-1 limits when operating in SLO. The impact of AFTO on MAPLHGR is addressed in Section 10.0.

TABLE 3-1
MAPLHGR Versus Average Planar Exposure
(Reference 2)

Average Planar Exposure (GWd/ST)	MAPLHGR Limit (kW/ft)
0.0	13.78
17.52	13.78
60.78	7.50
63.50	6.69

TABLE 3-2
MAPLHGR Single Loop Operation (SLO) Multiplier
(Reference 2)

SLO Multiplier	0.73

4.0 MCPR LIMITS

4.1 Technical Specification

Section 2.1.1.2, 3.2.2, 3.3.4.2, 3.4.1 and 3.7.6

4.2 Description

The Operating Limit MCPR (OLMCPR) for GNF2 fuel is provided in Tables 4-1 and 4-2. These values are determined by the cycle-specific fuel reload analyses in Reference 2. Control rod scram time verification is required as per Technical Specification 3.1.4, "Control Rod Scram Times". Tau (τ), a measure of scram time performance to notch position 36 throughout the cycle, is determined based on the cumulative scram time test results. The calculation of Tau shall be performed in accordance with site procedures. Linear interpolation shall be used to calculate the OLMCPR value if Tau is between 0.0 (Tau Option B) and 1.0 (Tau Option A). Table 4-1 is valid for a maximum FWT reduction of 90°F.

The ARTS-based power-dependent MCPR limits are provided in Table 4-2. Table 4-2 is valid for a maximum temperature reduction of 90 °F for FFWTR operation (bounding for FWHOOS operation). The flow-dependent MCPR limits are provided in Tables 4-3 and 4-4. Table 4-3 is valid for dual loop operating conditions with symmetric feedwater temperature operation and Table 4-4 is valid for single loop operating conditions with symmetric feedwater temperature operation. The impact of AFTO on MCPR is addressed in Section 10.0. For PR/PLUOOS + TBSOOS and PR/PLUOOS + RPTOOS conditions, the limits are listed in Section 10.0, these values are bounding for non-AFTO conditions.

TABLE 4-1
Operating Limit Minimum Critical Power Ratio
(Reference 2)

EOOS Combination	SCRAM Time Option[1]	Cycle Exposure	
		< EOR – 3915 MWd/ST	≥ EOR – 3915 MWd/ST
BASE	B	1.40	1.42
	B*[3]	1.38	1.41
	A	1.48	1.50
BASE SLO[2]	B	1.43	1.45
	A	1.51	1.53
RPTOOS	B	1.43	1.45
	A	1.60	1.62
RPTOOS SLO[2]	B	1.46	1.48
	A	1.63	1.65
PR/PLUOOS	B	1.40	1.42
	A	1.48	1.50
PR/PLUOOS SLO[2]	B	1.43	1.45
	A	1.51	1.53
TBSOOS	B	1.44	1.47
	A	1.53	1.56
TBSOOS SLO[2]	B	1.47	1.50
	A	1.56	1.59

(1) When Tau does not equal 0 or 1, use linear interpolation.
(2) For single-loop operation, the MCPR operating limit is 0.03 higher than the two-loop value (Reference 2).
(3) Limit is only applicable if it is confirmed that a 45ms or greater delay exists between the time of the first TCV movement and the time of first TSV movement following a turbine trip; this may be selected per applicable station procedures.

TABLE 4-2
Power Dependent MCPR(P) Limit Adjustments and Multipliers
(Symmetric Feedwater Heating)
(Reference 2)

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of rated)								
		0	22.6	<26.3	≥26.3	40	55	65	85	100
		Operating Limit MCPR			Operating Limit MCPR Multiplier, Kp					
Base	≤ 60	2.67	2.67	2.60	1.392	1.288	1.237	1.130	1.067	1.000
	> 60	2.99	2.99	2.83						
Base SLO	≤ 60	2.70	2.70	2.63	1.392	1.288	1.237	1.130	1.067	1.000
	> 60	3.02	3.02	2.86						
RPTOOS	≤ 60	2.67	2.67	2.60	1.392	1.288	1.237	1.130	1.067	1.000
	> 60	2.99	2.99	2.83						
RPTOOS SLO	≤ 60	2.70	2.70	2.63	1.392	1.288	1.237	1.130	1.067	1.000
	> 60	3.02	3.02	2.86						
PR/PLUOOS	≤ 60	2.67	2.67	2.60	1.392	1.288	1.237	1.210	1.147	1.000
	> 60	2.99	2.99	2.83						
PR/PLUOOS SLO	≤ 60	2.70	2.70	2.63	1.392	1.288	1.237	1.210	1.147	1.000
	> 60	3.02	3.02	2.86						
TBSOOS	≤ 60	3.64	3.64	3.25	1.399	1.323	1.237	1.155	1.079	1.000
	> 60	4.15	4.15	3.78						
TBSOOS SLO	≤ 60	3.67	3.67	3.28	1.399	1.323	1.237	1.155	1.079	1.000
	> 60	4.18	4.18	3.81						

TABLE 4-3
Flow Dependent MCPR Limits MCPR(F)
(Symmetric Feedwater Heating)
(Reference 2)

Core Flow (% rated)	MCPR(F) Limit
0.0	1.74
30.0	1.57
86.0	1.25
110.0	1.25

TABLE 4-4
SLO Flow Dependent MCPR Limits MCPR(F)
(Symmetric Feedwater Heating)
(Reference 2)

Core Flow (% rated)	MCPR(F) Limit
0.0	1.77
30.0	1.60
86.0	1.28
110.0	1.28

5.0 LHGR LIMITS

5.1 Technical Specification

Section 3.2.3, 3.3.4.2, 3.4.1 and 3.7.6

5.2 Description

The LHGR values for GNF2 fuel type are provided in Tables 5-1 and 5-2. The ARTS-based LHGR power-dependent multipliers are provided in Table 5-3. Table 5-3 is valid for a maximum temperature reduction of 90° F for FFWTR operation (bounding for FWHOOS operation). The flow-dependent multipliers are provided in Table 5-4 as a function of the number of recirculation loops in operation. The power- and flow-dependent LHGR multipliers were obtained from Reference 2. The impact of AFTO on LHGR is addressed in Section 10. For PR/PLUOOS + TBSOOS and PR/PLUOOS + RPTOOS conditions, the limits are listed in Section 10; these values are bounding for non-AFTO conditions. The power and flow dependent LHGR multipliers are sufficient to provide adequate protection for the off-rated conditions from an ECCS-LOCA analysis perspective.

TABLE 5-1
Linear Heat Generation Rate Limits – UO2 rods
(References 4 and 11)

Fuel Type	LHGR Limit
GNF2	See Appendix B of Reference 4

TABLE 5-2
Linear Heat Generation Rate Limits – Gad rods
(References 4 and 11)

Fuel Type	LHGR Limit
GNF2	See Appendix B of Reference 4

TABLE 5-3
Power Dependent LHGR Multiplier LHGRFAC(P)
(Symmetric Feedwater Heating)
(Reference 2)

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of rated)								
		0	22.6	<26.3	≥26.3	40	55	65	85	100
		LHGRFAC(P) Multiplier								
Base	≤ 60	0.508	0.508	0.522	0.620	0.696	0.751	0.817	0.930	1.000
	> 60	0.508	0.508	0.522						
Base SLO	≤ 60	0.508	0.508	0.522	0.620	0.696	0.751	0.817	0.930	1.000
	> 60	0.508	0.508	0.522						
RPTOOS	≤ 60	0.508	0.508	0.522	0.620	0.696	0.751	0.817	0.930	1.000
	> 60	0.508	0.508	0.522						
RPTOOS SLO	≤ 60	0.508	0.508	0.522	0.620	0.696	0.751	0.817	0.930	1.000
	> 60	0.508	0.508	0.522						
PR/PLUOOS	≤ 60	0.508	0.508	0.522	0.620	0.696	0.751	0.817	0.930	1.000
	> 60	0.508	0.508	0.522						
PR/PLUOOS SLO	≤ 60	0.508	0.508	0.522	0.620	0.696	0.751	0.817	0.930	1.000
	> 60	0.508	0.508	0.522						
TBSOOS	≤ 60	0.397	0.397	0.442	0.620	0.655	0.714	0.817	0.930	1.000
	> 60	0.397	0.397	0.417						
TBSOOS SLO	≤ 60	0.397	0.397	0.442	0.620	0.655	0.714	0.817	0.930	1.000
	> 60	0.397	0.397	0.417						

TABLE 5-4
Flow Dependent LHGR Multiplier LHGRFAC(F)
(Symmetric Feedwater Heating)
(Reference 2)

EOOS Combination	Core Flow (% of rated)					
	0	30	33.6	70	80	110
	LHGRFAC(F) Multiplier					
Dual Loop	0.506	0.706	0.730	0.973	1.000	1.000
Single Loop	0.506	0.706	0.730	0.730	0.730	0.730

6.0 ROD BLOCK MONITOR SETPOINTS

6.1 Technical Specification

Section 3.3.2.1

6.2 Description

The RBM power-biased Allowable Values and MCPR Limits are provided in Table 6-1 with supporting documentation in References 2 and 9. The values correspond to the OLMCPR values provide in Table 4-1.

TABLE 6-1
Rod Block Monitor Setpoints
(References 2 and 9)

Power Level	Allowable Value(1)	MCPR Limit
LTSP	118.2%	< 1.83 (2) < 1.50 (3)
ITSP	113.4%	< 1.83 (2) < 1.50 (3)
HTSP	108.4%	< 1.83 (2) < 1.50 (3)
INOP	N/A	< 1.83 (2) < 1.50 (3)

(1) These setpoints (with RBM filter time constant between 0.1 seconds and 0.55 seconds) are based on a cycle-specific rated RWE MCPR limit which is less than or equal to the minimum cycle OLMCPR based on other events (see COLR References 2 and 9).

(2) This is the MCPR limit (given THERMAL POWER is $\geq$ 28.4% and < 90%) below which the RBM is required to be OPERABLE (see COLR Reference 2 and TS Table 3.3.2.1-1).

(3) This is the MCPR limit (given THERMAL POWER is $\geq$ 90%) below which the RBM is required to be OPERABLE (see COLR Reference 2 and TS Table 3.3.2.1-1).

7.0 TURBINE BYPASS VALVE PARAMETERS

7.1 Technical Specification

Section 3.7.6

7.2 Description

The operability requirements for the steam bypass system are governed by Technical Specification 3.7.6. If the requirements cannot be met, the appropriate power and flow dependent limits for Turbine Bypass System Out-of-Service (TBSOOS) must be used. Additionally, the OLMCPR for TBSOOS must be applied. Table 7-1 includes the Turbine Bypass Valve response time parameters. The minimum number of bypass valves to maintain system operability is provided in Table 7-2.

TABLE 7-1
Turbine Bypass System Response Time
(Reference 12)

Maximum delay time before start of bypass valve opening following initial turbine inlet valve movement(1)	0.10 sec
Maximum time after initial turbine inlet valve movement(1) for bypass valve position to reach 80% of full flow (includes the above delay time)	0.30 sec

(1) First movement of any TSV or any TCV (whichever occurs first)

TABLE 7-2
Minimum Required Bypass Valves To Maintain System Operability
(Reference 12)

Reactor Power	No. of Valves in Service
$P \geq 22.6\%$	7

8.0 EOC RECIRCULATION PUMP TRIP (EOC-RPT) OPERABILITY

8.1 Technical Specification

Section 3.3.4.2

8.2 Description

The operability requirements for the EOC Recirculation Pump Trip are governed by Technical Specification 3.3.4.2. If the requirements cannot be met, the appropriate power and flow dependent limits for EOC Recirculation Pump Trip Out Of Service (RPTOOS) must be used. Additionally, the OLMCPR for RPTOOS must be applied. Table 8-1 includes the total RPT response time parameter.

TABLE 8-1
Recirculation Pump Trip Response Time
(Reference 12)

Total Recirculation Pump Trip Response Time *The time from when the turbine valves (turbine control valve or turbine stop valve) start to close until complete arc suppression of the EOC-RPT circuit breakers as described in Reference 7.*	0.175 sec

9.0 STABILITY PROTECTION

9.1 Technical Specification

Section 3.3.1.1, Table 3.3.1.1-1 Function 2.f

9.2 Description

Per Reference 2, the Cycle 22 DSS-CD S_{AD} Setpoint was confirmed to be 1.10 for DLO and SLO. The Automatic Backup Stability Protection (BSP) Setpoints are provided in Table 9-1. The Manual BSP Endpoints for Normal Feedwater Temperature and Reduced Feedwater Temperature are provided in Tables 9-2 and 9-3. Reduced FWT as stated in Table 9-3 is intended for feedwater temperatures 10-90°F below nominal.

TABLE 9-1
Automatic BSP Setpoints for the Scram Region
(Reference 2)

Parameter	Symbol	Value
Slope of ABSP APRM flow-biased trip linear segment.	m_{Trip}	1.37
ABSP APRM flow-biased trip setpoint power intercept. Constant Power Line for Trip from zero Drive Flow to Flow Breakpoint value.	$P_{BSP\text{-}Trip}$	39.3 %RTP
ABSP APRM flow-biased trip setpoint drive flow intercept. Constant Flow Line for Trip.	$W_{BSP\text{-}Trip}$	46.5 %RDF
Flow Breakpoint value	$W_{BSP\text{-}Break}$	20.0 %RDF

TABLE 9-2[1]
Manual BSP Endpoints for Normal Feedwater Temperature
(Reference 2)

Endpoint	Power (%)	Flow (%)	Definition
A1	73.1	49.2	Scram Region Boundary, HFCL
B1	40.0	31.0	Scram Region Boundary, NCL
A2	63.5	50.0	Controlled Entry Region Boundary, HFCL
B2	27.6	30.1	Controlled Entry Region Boundary, NCL

Note: The BSP Boundary for Normal and Reduced Feedwater Temperature is defined by the MELLLA boundary line, per Reference 2.

TABLE 9-3[1]
Manual BSP Endpoints for Reduced Feedwater Temperature
(Reference 2)

Endpoint	Power (%)	Flow (%)	Definition
A1	63.0	49.4	Scram Region Boundary, HFCL
B1	33.8	30.6	Scram Region Boundary, NCL
A2	65.3	52.4	Controlled Entry Region Boundary, HFCL
B2	27.6	30.1	Controlled Entry Region Boundary, NCL

Note: The BSP Boundary for Normal and Reduced Feedwater Temperature is defined by the MELLLA boundary line, per Reference 2.

(1) Station may elect to place additional administrative margin on the endpoints provided in Table 9-2 and Table 9-3.

10.0 ASYMMETRIC FEEDWATER TEMPERATURE OPERATION (AFTO)

Asymmetric feedwater heating is the result of the specific configuration of the feedwater lines at Peach Bottom. A reduction in heating in either the 'A' or the 'C' heater strings will result in a temperature mismatch between the feedwater flows entering the opposite sides of the reactor vessel. This temperature mismatch may result in errors in the thermal limit values calculated by the core monitoring system. Thermal limit values for all conditions and events are impacted by these errors excluding SLO conditions. The station no longer requires SLO AFTO penalties due to a 3D MONICORE upgrade. AFTO is defined as operation in a feedwater heater/string configuration that results in a specified threshold difference as described in Reference 10. To simplify the implementation of the AFTO limits, only the maximum AFTO penalties indicated in Table 13 of Ref. 10 will be implemented when the threshold asymmetry temperature is exceeded; this will minimize the number of AFTO thermal limit tables in the COLR and core monitoring system. There is no AFTO penalty for a FWT difference below 20°F, between 20 and 55°F difference there is a 4% LHGR/MAPLHGR penalty and a 3% MCPR penalty, and thermal limits are unanalyzed for a difference above 55°F.

LHGR LIMITS

The ARTS-based LHGR power-dependent multipliers for AFTO operation are provided in Table 10-1. The flow-dependent multipliers for AFTO in DLO are provided in Table 10-2. The power-and flow-dependent LHGR multipliers were obtained from Reference 2 and were adjusted with the appropriate penalties per Reference 10. PR/PLUOOS + TBSOOS and PR/PLUOOS + RPTOOS values were obtained by taking the most limiting values of the two EOOS conditions (Reference 8). The maximum feedwater temperature difference allowed without a thermal limit penalty is 20 °F.

TABLE 10-1
AFTO Power Dependent LHGR Multiplier LHGRFAC(P) 20°F < FWT DELTA ≤ 55°F
(Asymmetric Feedwater Heating)
(References 2, 8, and 10)

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of rated)								
		0	22.6	<26.3	≥26.3	40	55	65	85	100
		LHGRFAC(P) Multiplier								
Base	≤ 60	0.488	0.488	0.501	0.595	0.668	0.721	0.784	0.893	0.960
	> 60	0.488	0.488	0.501						
RPTOOS	≤ 60	0.488	0.488	0.501	0.595	0.668	0.721	0.784	0.893	0.960
	> 60	0.488	0.488	0.501						
PR/PLUOOS	≤ 60	0.488	0.488	0.501	0.595	0.668	0.721	0.784	0.893	0.960
	> 60	0.488	0.488	0.501						
TBSOOS	≤ 60	0.381	0.381	0.424	0.595	0.629	0.685	0.784	0.893	0.960
	> 60	0.381	0.381	0.400						
PR/PLUOOS + TBSOOS	≤ 60	0.381	0.381	0.424	0.595	0.629	0.685	0.784	0.893	0.960
	> 60	0.381	0.381	0.400						
PR/PLUOOS + RPTOOS	≤ 60	0.488	0.488	0.501	0.595	0.668	0.721	0.784	0.893	0.960
	> 60	0.488	0.488	0.501						

TABLE 10-2
AFTO Flow Dependent LHGR Multiplier LHGRFAC(F) 20°F < FWT DELTA ≤ 55°F
(Asymmetric Feedwater Heating)
(References 2 and 10)

EOOS Combination	Core Flow (% of rated)					
	0	30	33.6	70	80	110
	LHGRFAC(F) Multiplier					
Dual Loop	0.486	0.678	0.701	0.934	0.960	0.960

MCPR LIMITS

The OLMCPRs during asymmetric feedwater temperature operation with a feedwater temperature difference greater than 20°F are provided in Table 10-3. The ARTS-based power-dependent MCPR limits for use during AFTO conditions are provided in Table 10-4. The flow-dependent MCPR limits for AFTO are provided in Table 10-5. PR/PLUOOS + TBSOOS and PR/PLUOOS + RPTOOS values were obtained by taking the most limiting OLMCPR values of the two EOOS conditions (Reference 8). No MCPR penalties are required for asymmetric temperature differentials less than or equal to 20°F.

TABLE 10-3
AFTO Operating Limit Minimum Critical Power Ratio 20°F < FWT DELTA ≤ 55°F
(Asymmetric Feedwater Heating)
(References 2, 8, and 10)

EOOS Combination	SCRAM Time Option[1]	Cycle Exposure	
		< EOR – 3915 MWd/ST	≥ EOR – 3915 MWd/ST
BASE	B	1.44	1.46
	B*[2]	1.42	1.45
	A	1.52	1.55
RPTOOS	B	1.47	1.49
	A	1.65	1.67
PR/PLUOOS	B	1.44	1.46
	A	1.52	1.55
TBSOOS	B	1.48	1.51
	A	1.58	1.61
PR/PLUOOS + TBSOOS	B	1.48	1.51
	A	N/A	N/A
PR/PLUOOS + RPTOOS	B	1.47	1.49
	A	N/A	N/A

(1) When Tau does not equal 0 or 1, use linear interpolation.
(2) Limit is only applicable if it is confirmed that a 45ms or greater delay exists between the time of the first TCV movement and the time of first TSV movement following a turbine trip; this may be selected per applicable station procedures.

TABLE 10-4
AFTO Power Dependent MCPR Limit Adjustments And Multipliers MCPR(P) 20°F < FWT DELTA ≤ 55°F
(Asymmetric Feedwater Heating)
(References 2, 8, and 10)

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of rated)								
		0	22.6	<26.3	≥26.3	40	55	65	85	100
		Operating Limit MCPR			Operating Limit MCPR Multiplier, Kp					
Base	≤ 60	2.75	2.75	2.68	1.392	1.288	1.237	1.130	1.067	1.000
	> 60	3.08	3.08	2.91						
RPTOOS	≤ 60	2.75	2.75	2.68	1.392	1.288	1.237	1.130	1.067	1.000
	> 60	3.08	3.08	2.91						
PR/PLUOOS	≤ 60	2.75	2.75	2.68	1.392	1.288	1.237	1.210	1.147	1.000
	> 60	3.08	3.08	2.91						
TBSOOS	≤ 60	3.75	3.75	3.35	1.399	1.323	1.237	1.155	1.079	1.000
	> 60	4.27	4.27	3.89						
PR/PLUOOS + TBSOOS	≤ 60	3.75	3.75	3.35	1.399	1.323	1.237	1.210	1.147	1.000
	> 60	4.27	4.27	3.89						
PR/PLUOOS + RPTOOS	≤ 60	2.75	2.75	2.68	1.392	1.288	1.237	1.210	1.147	1.000
	> 60	3.08	3.08	2.91						

TABLE 10-5
AFTO Flow Dependent MCPR Limits MCPR(F) 20°F < FWT DELTA ≤ 55°F
(Asymmetric Feedwater Heating)
(References 2 and 10)

Flow (% rated)	MCPR(F) Limit
0.0	1.79
30.0	1.62
86.0	1.29
110.0	1.29

MAPLHGR LIMITS

An appropriate penalty must be applied to MAPLHGR limits under asymmetric feedwater temperature operation for varying temperature differentials per Reference 10. The reduction factor listed in Table 10-6 is the maximum penalty for the full range of analyzed FWT mismatches, bounding all smaller temperature deltas.

TABLE 10-6
AFTO MAPLHGR Reduction Factor
(Asymmetric Feedwater Heating)
(References 2 and 10)

AFTO Reduction Factor	
20°F < FWT DELTA ≤ 55°F	0.960

11.0 MODES OF OPERATION

The following conditions are supported by the Peach Bottom 3 Cycle 22 licensing analysis; operation in a condition (or conditions) is controlled by station procedures. If a combination of options is not listed, it is not supported. Table 11-1 provides allowed modes of operation with thermal limit sets in the COLR. Table 11-2 provides allowed modes of operation that do not contain explicit thermal limit sets in the COLR.

TABLE 11-1
Modes of Operation
(Reference 2)

EOOS Options	Supported Scram Speed Option	Supported Recirculation Loop Operation	Supported SFTO/AFTO
Base[1,2]	A or B	DLO or SLO[3]	SFTO or AFTO
TBSOOS	A or B	DLO or SLO[3]	SFTO or AFTO
RPTOOS	A or B	DLO or SLO[3]	SFTO or AFTO
PLUOOS	A or B	DLO or SLO[3]	SFTO or AFTO
PROOS	A or B	DLO or SLO[3]	SFTO or AFTO
PR/PLUOOS and TBSOOS	B	DLO	AFTO[4]
PR/PLUOOS and RPTOOS	B	DLO	AFTO[4]

TABLE 11-2
EOOS Options Included in 'Base' Conditions
(Reference 2)

EOOS Condition
TCV/TSVOOS[5]
MSIVOOS[5]
SRVOOS
TBVOOS

12.0 METHODOLOGY

The analytical methods used in determining the core operating limits have been previously reviewed and approved by the NRC, specifically those described in the following documents:

1. "General Electric Standard Application for Reactor Fuel," Global Nuclear Fuel Document No. NEDE-24011-P-A-25, August 2017 and U.S. Supplement NEDE-24011-P-A-25-US, August 2017.

---

1 The 'Base' condition includes the options listed in Table 11-2.

2 The 'Base' condition includes operation with FWHOOS/FFWTR. Operation not permitted in the MELLLA+ Region for reduced FWT conditions as controlled by station procedures.

3 Operation in SLO not permitted in the MELLLA+ Region as controlled by station procedures.

4 AFTO limits bound SFTO limits.

5 Permitted at power levels provided in the applicable station procedure.

13.0 REFERENCES

1. "Technical Specifications for Peach Bottom Atomic Power Station Unit 3," Exelon Document, Docket No. 50-278, Appendix A to License No. DPR-56.

2. "Supplemental Reload Licensing Report for Peach Bottom Unit 3 Reload 21 Cycle 22," Global Nuclear Fuel Document No. 003N1452, Revision 0, September 2017.

3. "General Electric Standard Application for Reactor Fuel (GESTAR II)," Global Nuclear Fuel Document No. NEDE-24011-P-A-25, August 2017 and U.S. Supplement NEDE-24011-P-A-25-US, August 2017.

4. "GNF2 Advantage Generic Compliance with NEDE-24011-P-A (GESTAR II)," Global Nuclear Fuel Document No. NEDC-33270P, Revision 8, April 2017.

5. "Peach Bottom EPU Evaluation of Feedwater Temperature vs. Reactor Power for Feedwater Temperature Conditions of Nominal Rated, FWHOOS (Nominal -55°F) and FFWTR (Nominal -90°F)," General Electric Hitachi Nuclear Energy Document No. 001N2494-R0, Revision 0, July 2014. This document is searchable in Exelon EDMS under document number "PEAM-EPU-1 Rev. 0A."

6. "Safety Analysis Report for Peach Bottom Atomic Power Station Units 2 and 3 Thermal Power Optimization", General Electric Hitachi Nuclear Energy Document No. NEDO-33873, Revision 0, February 2017.

7. "Determination of Total Time Required to Initiate the Trip Signal to the EOC-RPT Circuit Breakers Trip Coils and to Complete the Recirculation Pump Trip," PECO Calculation No. PE-0173, Revision 1, December 1998.

8. "Peach Bottom Atomic Power Station Units 2 and 3 TRACG Implementation for Reload Licensing Transient Analysis", Global Nuclear Fuel Document Number 0000-0135-9000-R2, June 2017.

9. "Provide Allowable Values (AV) and Nominal Trip Setpoints (NTSP) for Various Setpoint Functions of the NUMAC PRNM System", PECO Calculation No. PE-0251, Revision 4, July 2017.

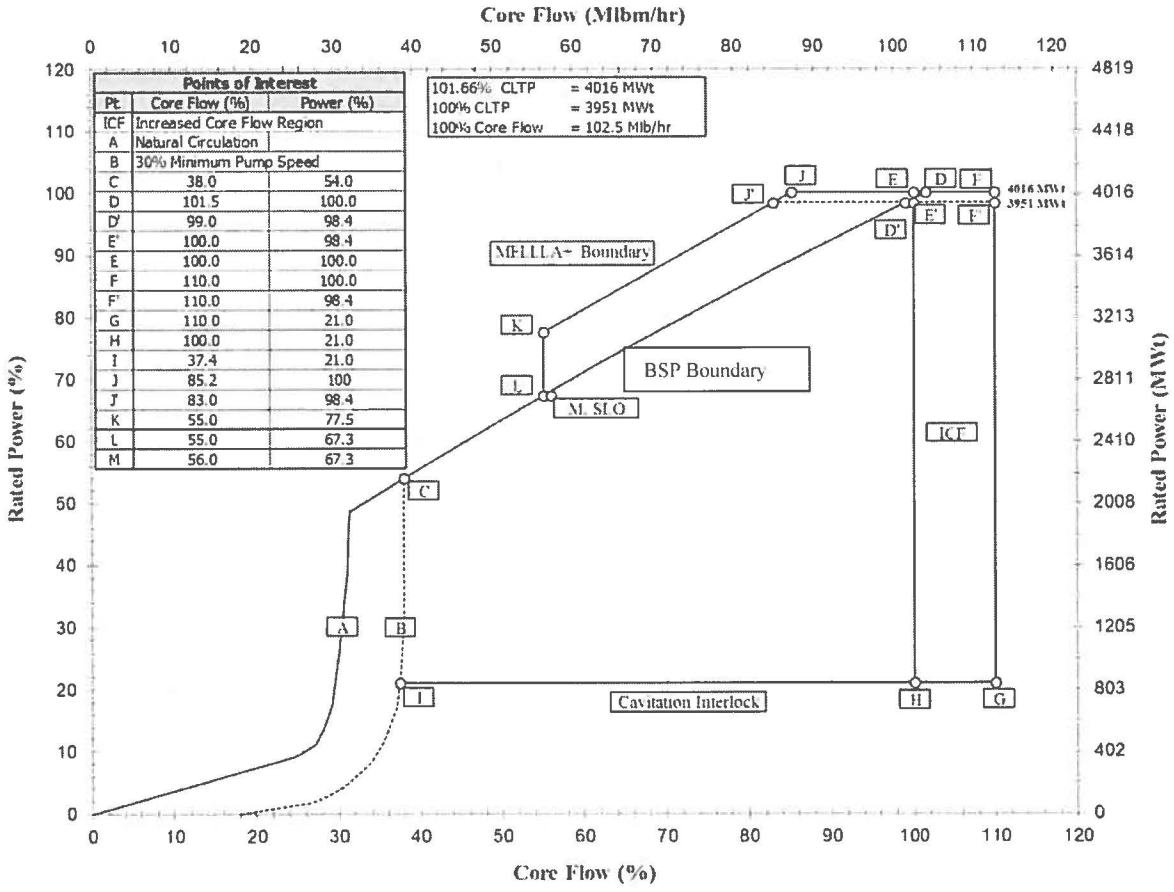
10. "Final Evaluation Report Exelon Nuclear Generating Company LLC Peach Bottom Units 2 & 3 TPO with EPU/MELLLA+ PCR E03: Asymmetric Feedwater Temperature Operation for TPO with EPU/MELLLA+" General Electric Hitachi Nuclear Energy Document Number 001N6733 Rev. 2, Sept. 2017. This is searchable in EDMS as "PEAM-MUR-PCR-E03" Rev. 0.

11. "Fuel Bundle Information Report for Peach Bottom Unit 3 Reload 21 Cycle 22," Global Nuclear Fuel Document No. 003N1453, Revision 0, August 2017.

12. "Final Resolved OPL-3 Parameters for Peach Bottom Unit 3 Cycle 22," Exelon TODI ENSAF ID# ES1700007, Revision 1, June 2017.

APPENDIX A

Power/Flow Operating Map for MELLLA+ with Thermal Power Optimization
(Reference 6)



Points of Interest		
Pt	Core Flow (%)	Power (%)
ICF	Increased Core Flow Region	
A	Natural Circulation	
B	30% Minimum Pump Speed	
C	38.0	54.0
D	101.5	100.0
D'	99.0	98.4
E'	100.0	98.4
E	100.0	100.0
F	110.0	100.0
F'	110.0	98.4
G	110.0	21.0
H	100.0	21.0
I	37.4	21.0
J	85.2	100
J'	83.0	98.4
K	55.0	77.5
L	55.0	67.3
M	56.0	67.3