CORE OPERATING LIMITS REPORT FOR

PEACH BOTTOM ATOMIC POWER STATION UNIT 2

RELOAD 23, CYCLE 24

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Revision History

Revision	Description
Revision 16	Initial Issuance for Cycle 24

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1.0 TERMS AND DEFINITIONS

ABSP	Automated Backup Stability Protection
AFTO	Asymmetric Feedwater Temperature Operation
APRM	Average Power Range Monitor
ARTS	APRM, Rod Block and Technical Specification Improvement Program
BASE	The "BASE" condition is for normal, steady state operation. See Section 11 for more details.
BSP	Backup Stability Protection
DLO	Dual Loop Operation
DSS-CD	Detect and Suppress Solution – Confirmation Density
ECCS-LOCA	Emergency Core Cooling System – Loss of Coolant Accident
EOC	End of Cycle
EOC-RPT	End of Cycle Recirculation Pump Trip
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exposure at which reactor power is equal to 100% with recirculation system flow equal to 100%, all control rods fully withdrawn, all feedwater heating in service and equilibrium Xenon.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
ITSP	Rod Block Monitor Intermediate Trip Setpoint
K_P	Off-rated power dependent OLMCPR multiplier
LHGR	Linear Heat Generation Rate
LHGRFAC(F)	Off-rated flow dependent LHGR multiplier
LHGRFAC(P)	Off-rated power dependent LHGR multiplier
LTSP	Rod Block Monitor Low Trip Setpoint
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MCPR	Minimum Critical Power Ratio
$MCPR_{99.9\%}$	Limiting MCPR value such that 99.9% of the fuel in the core is not susceptible to boiling transition
MCPR(F)	Off-rated flow dependent OLMCPR
MCPR(P)	Off-rated power dependent OLMCPR
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
NRC	Nuclear Regulatory Commission
OLMCPR	Operating Limit Minimum Critical Power Ratio
PLUOOS	Power Load Unbalance Out of Service
PROOS	Pressure Regulator Out of Service
PR/PLUOOS	Pressure Regulator and/or Power Load Unbalance Out of Service
RBM	Rod Block Monitor
RDF	Recirculation Drive Flow

RPT	Recirculation Pump Trip
RPTOOS	Recirculation Pump Trip Out of Service
RTP	Rated Thermal Power
RWE	Rod Withdrawal Error
S_{AD}	Amplitude Discriminator Setpoint
SFTO	Symmetric Feedwater Temperature Operation
SLMCPR	Safety Limit Minimum Critical Power Ratio
SLO	Single Loop Operation
SRVOOS	Safety Relief Valve Out of Service
Tau (τ)	A measure of scream time performance to notch position 36 throughout the cycle
TBSOOS	Turbine Bypass System Out of Service
TBVOOS	Turbine Bypass Valve Out of Service
TCVSC	Turbine Control Valve Slow Closure
TCV/TSVOOS	Turbine Control Valve and/or Turbine Stop Valve Out of Service
TPO	Thermal Power Optimization, also known as Measurement Uncertainty Recapture (MUR)

2.0 GENERAL INFORMATION

This report provides the following cycle-specific parameter limits for Peach Bottom Atomic Power Station Unit 2 CYCLE 24 (RELOAD 23):

- 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
- $MCPR_{99.9\%}$
- 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
- Power Level Restrictions

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 Section 2.C(16). Operation in the MELLLA+ Region with up to a 10°F reduction in feedwater temperature below the design feedwater temperature is permitted.

This report provides cycle-specific OLMCPR, LHGR, and 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, 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 (AFTO)
- Equipment Out of Service Conditions per Section 11

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 documented in Reference 13. 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 24 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 SLO, a multiplier is used, which is shown in Table 3-2. The impact of AFTO on MAPLHGR is addressed in Section 10.0. The power and flow dependent LHGR multipliers are sufficient to provide adequate protection for the off-rated conditions from an ECCS-LOCA analysis perspective. The MAPLHGR multipliers can either be set to unity or set equal to the LHGR multipliers, which remain compliant with the basis of the ECCS-LOCA analysis with no loss of ECCS-LOCA margin.

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 OLMCPR for GNF2 fuel is provided in Table 4-1. 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 Feedwater Temperature (FWT) reduction of 90ºF (Reference 2).

The ARTS-based power-dependent MCPR limits (MCPR(P)) and multipliers (K_p) 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 (MCPR(F)) are provided in Tables 4-3 and 4-4. Table 4-3 is valid for DLO conditions with SFTO, and Table 4-4 is valid for SLO conditions with SFTO.

The impact of AFTO on MCPR 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 cycle-specific SLMCPRs, known as $MCPR_{99.9\%}$ can be found in Table 4-5 for dual loop and single loop operating conditions. The values in Table 4-5 or conservative values were used to calculate the MCPR limits and off-rated limits in this section and Section 10.

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

EOOS Combination	SCRAM Time Option[(1)]	Cycle Exposure	
		< EOR - 3992 MWd/ST	≥ EOR – 3992 MWd/ST
BASE	B	1.39	1.39
	A	1.46	1.47
BASE SLO	B	1.42	1.42
	A	1.48	1.49
RPTOOS	B	1.41	1.41
	A	1.58	1.58
RPTOOS SLO	B	1.43	1.43
	A	1.60	1.60
PR/PLUOOS	B	1.39	1.39
	A	1.46	1.47
PR/PLUOOS SLO	B	1.42	1.42
	A	1.48	1.49
TBSOOS	B	1.45	1.45
	A	1.50	1.53
TBSOOS SLO	B	1.47	1.47
	A	1.52	1.55

(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
		OLMCPR			OLMCPR 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	1.71
30.0	1.54
80.9	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	1.73
30.0	1.56
80.9	1.27
110.0	1.27

TABLE 4-5
Cycle Specific SLMCPR ($MCPR_{99.9\%}$)
(Reference 2)

Loop Operation	$MCPR_{99.9\%}$
DLO	1.13
SLO	1.13

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 (LHGRFAC(P)) are provided in Table 5-3. Table 5-3 is valid for a maximum temperature reduction of 90º F for FFWTR operation (bounding for FWHOOS operation) (Reference 2). The LHGR flow-dependent multipliers (LHGRFAC(F)) 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 10 and 13)

Fuel Type	LHGR Limit
GNF2	See Reference 13

TABLE 5-2
Linear Heat Generation Rate Limits – Gad Rods
(References 10 and 13)

Fuel Type	LHGR Limit
GNF2	See Reference 13

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**
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
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, 3, 8 and 9. The SFTO MCPR Limits apply when FWT difference is below 20°F. The AFTO MCPR Limits apply with FWT difference between 20 and 55°F. AFTO conditions are discussed further in Section 10. These values correspond to the OLMCPR values provided in Table 4-1.

TABLE 6-1
Rod Block Monitor Setpoints
(References 2, 3, 8 and 9)

Power Level	Allowable Value(1)	SFTO MCPR Limit	AFTO MCPR Limit
Low Trip Setpoint (LTSP)	124.0%	< 1.80 (2) < 1.48 (3)	< 1.85 (4) < 1.52 (5)
Intermediate Trip Setpoint (ITSP)	119.2%	< 1.80 (2) < 1.48 (3)	< 1.85 (4) < 1.52 (5)
High Trip Setpoint (HTSP)	114.2%	< 1.80 (2) < 1.48 (3)	< 1.85 (4) < 1.52 (5)
Inoperable (INOP)	N/A	< 1.80 (2) < 1.48 (3)	< 1.85 (4) < 1.52 (5)

(1) These setpoints (with RBM filter time constant between 0.1 seconds and 0.55 seconds) are based on cycle-specific rated RWE MCPR limits which are bounded by the OLMCPRs listed in Table 4-1.
(2) This is the MCPR limit for SFTO (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 for SFTO (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).
(4) This is the MCPR limit for AFTO (given THERMAL POWER is ≥ 28.4% and < 90%) below which the RBM is required to be OPERABLE (see COLR References 2 and 8 and TS Table 3.3.2.1-1).
(5) This is the MCPR limit for AFTO (given THERMAL POWER is ≥ 90%) below which the RBM is required to be OPERABLE (see COLR References 2 and 8 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

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

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

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-RPT 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 24 DSS-CD S_{AD} Setpoint was confirmed to be 1.10 for DLO and SLO. The Automated Backup Stability Protection (BSP) Setpoints are provided in Table 9-1. The Manual BSP Endpoints for Normal FWT and Reduced FWT 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
Automated 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.	$P_{BSP-Trip}$	39.8 %RTP
ABSP APRM flow-biased trip setpoint drive flow intercept. Constant Flow Line for Trip.	$W_{BSP-Trip}$	46.7 %RDF
Flow Breakpoint value	$W_{BSP-Break}$	25.0 %RDF

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

Endpoint	Power (%)	Flow (%)	Definition
A1	72.4	48.2	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 conservatively 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’	62.4	48.6	Scram Region Boundary, HFCL
B1’	33.9	30.6	Scram Region Boundary, NCL
A2’	64.4	51.2	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 conservatively 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, per reference 14.

10.0 ASYMMETRIC FEEDWATER TEMPERATURE OPERATION (AFTO)

AFTO 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. AFTO is defined as operation in a feedwater heater/string configuration that results in a specified threshold difference as described in Reference 8. To simplify the implementation of the AFTO limits, only the maximum AFTO penalties indicated in Table 13 of Reference 8 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 less than or equal to 20ºF, for a difference between 20 and 55ºF there is a 4% LHGR/MAPLHGR penalty and a 3% MCPR penalty, and thermal limits are unanalyzed for a difference above 55ºF. The MCPR penalty for AFTO also applies to RBM Operability MCPR Limits which are addressed in Section 6.0.

10.1 MAPLHGR LIMITS

An appropriate penalty must be applied to MAPLHGR limits under AFTO for varying temperature differentials as per Reference 8. The reduction factor listed in Table 10-1 is the maximum penalty for the full range of analyzed FWT mismatches, bounding all smaller temperature deltas.

TABLE 10-1
AFTO MAPLHGR Reduction Factor
(Asymmetric Feedwater Heating)
(Reference 8)

AFTO Reduction Factor	
$20^{\circ}F < FWT\ DELTA \leq 55^{\circ}F$	0.960

10.2 MCPR LIMITS

The OLMCPRs during AFTO with a FWT difference greater than 20°F are provided in Table 10-2. The ARTS-based MCPR(P) limits and multipliers (K_p) for use during AFTO conditions are provided in Table 10-3. The MCPR(F) limits for AFTO are provided in Table 10-4. 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 8. 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 10-2
AFTO Operating Limit Minimum Critical Power Ratio 20°F < FWT DELTA ≤ 55°F
(Asymmetric Feedwater Heating)
(References 2, 8 and 11)

EOOS Combination	SCRAM Time Option (1)	Cycle Exposure	
		< EOR – 3992 MWd/ST	≥ EOR – 3992 MWd/ST
BASE	B	1.43	1.43
	A	1.50	1.51
RPTOOS	B	1.45	1.45
	A	1.63	1.63
PR/PLUOOS	B	1.43	1.43
	A	1.50	1.51
TBSOOS	B	1.49	1.49
	A	1.55	1.58
PR/PLUOOS + TBSOOS	B	1.49	1.49
	A	N/A	N/A
PR/PLUOOS + RPTOOS	B	1.45	1.45
	A	N/A	N/A

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

TABLE 10-3
AFTO Power Dependent MCPR Limit Adjustments And Multipliers MCPR(P) 20°F < FWT DELTA ≤ 55°F
(Asymmetric Feedwater Heating)
(References 2, 8 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
		OLMCPR			OLMCPR 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 10-4
AFTO Flow Dependent MCPR Limits MCPR(F) 20°F < FWT DELTA ≤ 55°F
(Asymmetric Feedwater Heating)
(References 2 and 8)

Flow (% rated)	MCPR(F) Limit
0.0	1.77
30.0	1.59
80.9	1.29
110.0	1.29

10.3 LHGR LIMITS

The ARTS-based LHGRFAC(P) values for AFTO operation are provided in Table 10-5. The LHGRFAC(F) values for AFTO in DLO are provided in Table 10-6. The power- and flow-dependent LHGR multipliers were obtained from Reference 2 and were adjusted with the appropriate penalties as per Reference 8. 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 8 are applied to the thermal limits. Additionally, no LHGR penalties are required for AFTO while in SLO as previously discussed.

TABLE 10-5
AFTO Power Dependent LHGR Multiplier LHGRFAC(P) 20°F < FWT DELTA ≤ 55°F
(Asymmetric Feedwater Heating)
(References 2, 8 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
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 10-6
AFTO Flow Dependent LHGR Multiplier LHGRFAC(F) 20°F < FWT DELTA ≤ 55°F
(Asymmetric Feedwater Heating)
(References 2 and 8)

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

11.0 MODES OF OPERATION

The following conditions are supported by the Peach Bottom 2 Cycle 24 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 11-3 provides power level restrictions that support specific operating conditions.

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 + TBSOOS[6]	B	DLO	AFTO[4]
PR/PLUOOS + RPTOOS	B	DLO	AFTO[4]

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

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

TABLE 11-3
Power Level Restrictions
(Reference 2)

Condition	Power Level Restriction (% rated)
1 TCVOOS and/or 1 TSVOOS	≤ 78
1 TCVOOS and/or 1 TSVOOS + 2 TBVOOS	≤ 78
1 TCVOOS and/or 1 TSVOOS + TBSOOS	≤ 54
1 MSIVOOS	≤ 65

(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 Table 11-3 and in the applicable station procedure.
(6) TCVSC event is bounded by the PR/PLUOOS + TBSOOS condition per Reference 4.

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-29, October 2019 and U.S. Supplement NEDE-24011-P-A-29-US, October 2019.

13.0 REFERENCES

1. "Subsequent Renewed Facility Operating License ", Exelon Document, Docket No. 50-277, Subsequent Renewed License No. DPR-44.

2. "Supplemental Reload Licensing Report for Peach Bottom Unit 2 Reload 23 Cycle 24”, GNF Document No. 006N1965, Revision 0, August 2020.

3. “Removal of Generic ARTS Rated RWE DCPR for Limerick Units 1 and 2, Nine Mile Point Unit 2, and Peach Bottom Units 2 and 3”, General Electric Hitachi Nuclear Energy Document No. 005N2836-R0, Revision 0, July 2019.

4. “Thermal Limits Evaluation for the TCV Slow Closure Event for Peach Bottom”, Exelon Technical Evaluation EC 632705, Revision 0, October 2020.

5. “Clarify Rated Feedwater Temp for Feedwater Temp Reduction Curves”, Exelon Technical Evaluation EC 628049, Revision 0, August 2019.

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

7. “Determination of Time Required to Initiate Trip Signal to the RPT CKT”, Exelon Calculation No. PE-0173, Revision 1A, January 2019.

8. “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 No. 001N6733, Revision 2, September 2017. This is searchable in EDMS as “PEAM-MUR-PCR-E03,” Revision 0.

9. “Provide Allowable Values (AV) and Nominal Trip Setpoints (NTSP) for Various Setpoint Functions of the NUMAC PRNM System”, Exelon Calculation PE-0251, Revision 4, July 31, 2017.

10. "Fuel Bundle Information Report for Peach Bottom Unit 2 Reload 23 Cycle 24", Global Nuclear Fuel Document No. 005N1905, Revision 0, August 2020.

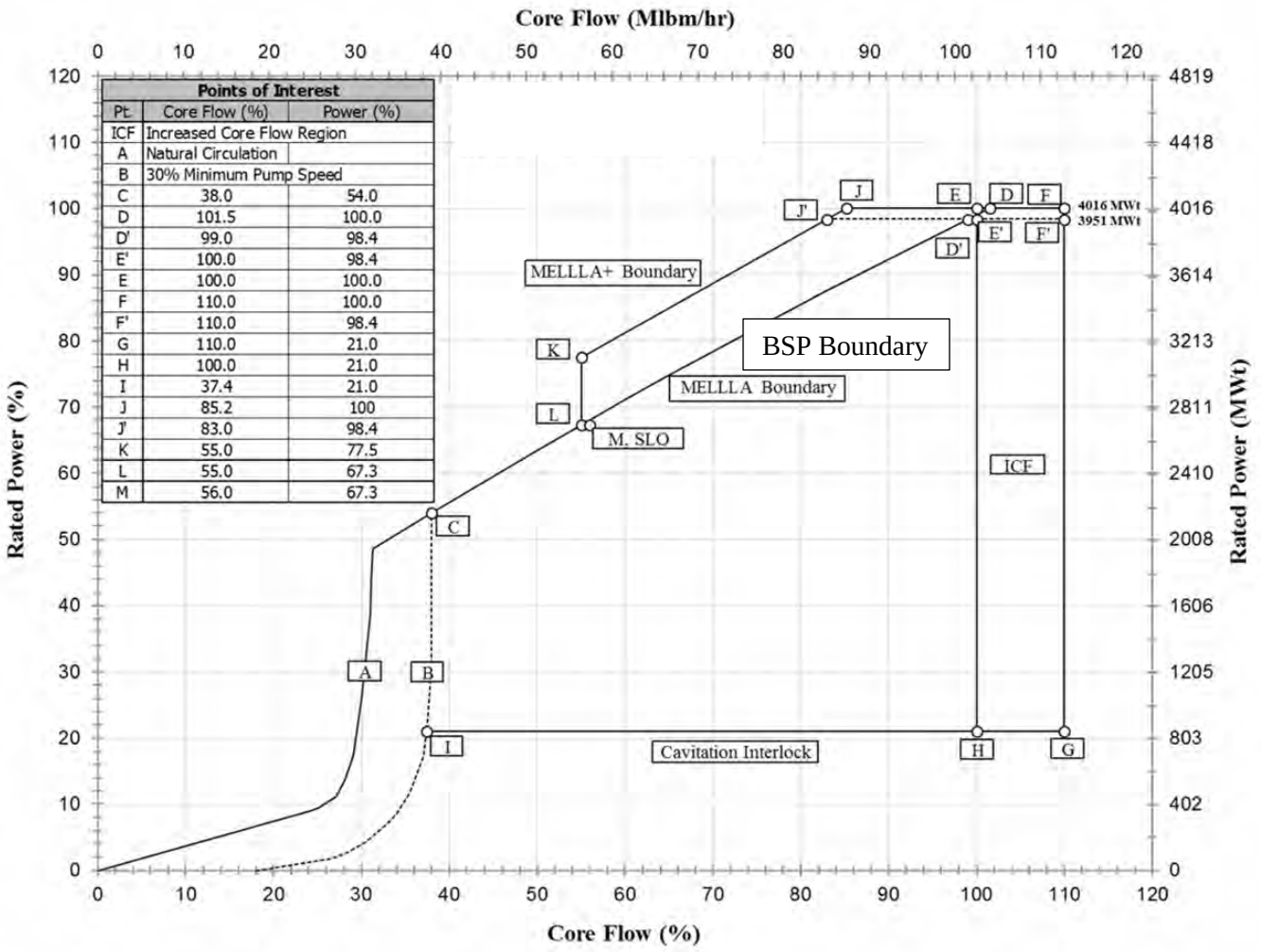
11. “Peach Bottom Atomic Power Station Units 2 and 3 TRACG Implementation for Reload Licensing Transient Analysis”, General Electric Hitachi Document 0000-0135-9000-R2, June 2017.

12. “Peach Bottom 2 Cycle 24 OPL-3 (TODI)”, Exelon TODI NF205600, Rev. 0, May 11, 2020.

13. “PRIME-Based GNF2 LHGR Envelopes for Peach Bottom Atomic Power Station Units 2 and 3”, Global Nuclear Fuel Document 004N7833-P, Rev. 0, April 2018.

14. “GE Hitachi Boiling Water Reactor Detect and Suppress Solution – Confirmation Density”, General Electric Hitachi Document NEDC-33075P-A, Revision 8, November 2013.

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