Exelon Generation

TS 5.6.5.d

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U.S. Nuclear Regulatory Commission
Attention: 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 for Implementation of the Maximum Extended Load Line Limit Analysis Plus Analysis

Enclosed are copies of Revision 10 and Revision 9 of the Core Operating Limits Reports (COLRs) for Peach Bottom Atomic Power Station (PBAPS) Units 2 and 3, respectively. These revisions incorporate the implementation of the Maximum Extended Load Line Limit Analysis Plus license amendments 305/307.

The COLR revisions are being submitted to the NRC as required by the PBAPS, Units 2 and 3 Technical Specifications (TS) Section 5.6.5.d.

If you have any questions concerning this letter, please contact Dave Foss at (717) 456-4311.

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Attachments

Unit 2 Core Operating Limits Report for Reload 20, Cycle 21, Revision 10
Unit 3 Core Operating Limits Report for Reload 20, Cycle 21, Revision 9

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

ATTACHMENT

Unit 2 Core Operating Limits Report for Reload 20, Cycle 21, Revision 10

CORE OPERATING LIMITS REPORT FOR

PEACH BOTTOM ATOMIC POWER STATION UNIT 2

RELOAD 20, CYCLE 21

(This is a Complete Re-write)

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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	Defines two (2) loop operation with at least seven turbine bypass valves in service and the reactor recirculation pump trip system in service.
BOC	Beginning Of Cycle
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% (3951 MWth) 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
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
TBVOOS	Turbine Bypass Valves Out of Service
TCV/TSVOOS	Turbine Control Valve/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 2 CYCLE 21 (RELOAD 20):

- 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
- Single Loop Operation (SLO) MCPR adjustment
- Linear Heat Generation Rate (LHGR)
- ARTS LHGR thermal limit multipliers
- Single Loop Operation (SLO) LHGR multipliers
- Rod Block Monitor (RBM) Analytical Limits, 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 83% of rated core flow during full power (3951 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 FFWTR)
- Asymmetric Feedwater Temperature Operation (AFTO)

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 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.

Also note that the following description of MAPLHGR, LHGR and MCPR limits pertain to **NON** – AFTO conditions. A separate description of AFTO limits and their associated ARTS tables are located in Section 10.
Preparation of this report was performed in accordance with Exelon Nuclear procedures. This report is provided to the NRC in accordance with Technical Specification 5.6.5 of Reference 1 and contains all thermal limit parameters related to the implementation of the ARTS Improvement Program and MELLLA+ for Peach Bottom Unit 2 Cycle 21.

The "BASE" thermal limit values shown in tables are for normal two loop operation with at least the minimum number of turbine bypass valves in service per Section 7.0 and the reactor recirculation pump trip system in service.

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. The MAPLHGR tables are used when hand calculations are required. 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.

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, 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).

Separate OLMCPR values are presented in Table 4-1 for the following conditions:

- TBVs In-Service (per section 7.0), RPT In-Service (per section 8.0), and maximum FFWTR of 90 °F (a.k.a. "BASE")
- TBVs Out-of-Service (per section 7.0), RPT In-Service (per section 8.0), and maximum FFWTR of 90 °F
- TBVs In-Service (per section 7.0), RPT Out-of-Service (per section 8.0), and maximum FFWTR 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.

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

EOOS Combination	SCRAM Time Option[1]	Cycle Exposure	
		< EOR - 4409 MWd/ST	≥ EOR – 4409 MWd/ST
BASE	B	1.40	1.40
	A	1.41	1.48
BASE SLO	B	1.43	1.43
	A	1.43	1.48
TBVOOS	B	1.44	1.44
	A	1.44	1.52
TBVOOS SLO	B	1.44	1.44
	A	1.44	1.52
RPTOOS	B	1.40	1.47
	A	1.56	1.64
RPTOOS SLO	B	1.43	1.47
	A	1.56	1.64

(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	23	<26.7	≥26.7	40	55	65	85	100
		Operating Limit MCPR			Operating Limit MCPR Multiplier, Kp					
Base	≤ 60	2.67	2.67	2.60	1.352	1.352	1.317	1.131	1.082	1.000
	> 60	2.99	2.99	2.83						
Base SLO	≤ 60	2.67	2.67	2.60	1.352	1.352	1.317	1.131	1.082	1.000
	> 60	2.99	2.99	2.83						
RPTOOS	≤ 60	2.67	2.67	2.60	1.352	1.352	1.317	1.131	1.082	1.000
	> 60	2.99	2.99	2.83						
RPTOOS SLO	≤ 60	2.67	2.67	2.60	1.352	1.352	1.317	1.131	1.082	1.000
	> 60	2.99	2.99	2.83						
TBVOOS	≤ 60	3.64	3.64	3.25	1.659	1.479	1.373	1.155	1.082	1.000
	> 60	4.15	4.15	3.78						
TBVOOS SLO	≤ 60	3.64	3.64	3.25	1.659	1.479	1.373	1.155	1.082	1.000
	> 60	4.15	4.15	3.78						

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

Core Flow (% rated)	MCPR(F) Limit
0.0	1.75
30.0	1.57
79.0	1.28
110.0	1.28

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

Core Flow (% rated)	MCPR(F) Limit
0.0	1.75
30.0	1.57
79.0	1.28
110.0	1.28

5.0 LINEAR HEAT GENERATION RATE 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 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. 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	23	<26.7	≥26.7	40	55	65	85	100
		LHGRFAC(P) Multiplier								
Base	≤ 60	0.508	0.508	0.522	0.748	0.756	0.771	0.817	0.959	1.000
	> 60	0.508	0.508	0.522						
Base SLO	≤ 60	0.508	0.508	0.522	0.748	0.756	0.771	0.817	0.959	1.000
	> 60	0.508	0.508	0.522						
RPTOOS	≤ 60	0.508	0.508	0.522	0.748	0.756	0.771	0.817	0.959	1.000
	> 60	0.508	0.508	0.522						
RPTOOS SLO	≤ 60	0.508	0.508	0.522	0.748	0.756	0.771	0.817	0.959	1.000
	> 60	0.508	0.508	0.522						
TBVOOS	≤ 60	0.397	0.397	0.442	0.635	0.655	0.714	0.817	0.930	1.000
	> 60	0.410	0.410	0.417						
TBVOOS SLO	≤ 60	0.397	0.397	0.442	0.635	0.655	0.714	0.817	0.930	1.000
	> 60	0.410	0.410	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 Analytical Limits, Allowable Values and MCPR Limits are provided in Table 6-1 with supporting documentation in References 2 and 9. These values correspond to the OLMCPR values provide in Table 4-1.

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

Power Level	Analytical Limit[1]	Allowable Value[1]	MCPR Limit
LTSP	123.0%	121.2%	< 1.70 [2] < 1.40 [3]
ITSP	118.0%	116.2%	< 1.70 [2] < 1.40 [3]
HTSP	113.2%	111.4%	< 1.70 [2] < 1.40 [3]
INOP	N/A	N/A	< 1.70 [2] < 1.40 [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 ≥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 Valves Out-of-Service (TBVOOS) must be used. Additionally, the OLMCPR for TBVOOS 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 14.

TABLE 7-1
Turbine Bypass System Response Time
(Reference 14)

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 or generation of the turbine bypass valve flow signal (whichever occurs first)

TABLE 7-2
Minimum Required Bypass Valves To Maintain System Operability
(Reference 14)

Reactor Power	No. of Valves in Service
$P \geq 23\%$	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 14)

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, Section 5.6.5

9.2 Description

Per Reference 2, the Cycle 21 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.

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}	1.65
ABSP APRM flow-biased trip setpoint power intercept. Constant Power Line for Trip from zero Drive Flow to Flow Breakpoint value.	$P_{BSP\text{-}Trip}$	40.5 %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	77.7	53.6	Scram Region Boundary, HFCL
B1	40.5	31.0	Scram Region Boundary, NCL
A2	64.5	50.0	Controlled Entry Region Boundary, MELLLA
B2	28.1	30.1	Controlled Entry Region Boundary, NCL
A3	100	99.0	BSP Boundary Intercept, MELLLA
B3	60.5	44.9	BSP Boundary Intercept, MELLLA Line

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

Endpoint	Power (%)	Flow (%)	Definition
A1	67.1	53.4	Scram Region Boundary, MELLLA
B1	35.1	30.7	Scram Region Boundary, NCL
A2	69.3	56.2	Controlled Entry Region Boundary, MELLLA
B2	28.1	30.1	Controlled Entry Region Boundary, NCL

Note: The BSP Boundary for Reduced Feedwater Temperature is defined by the MELLLA 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 (resulting from removing a heater string, or individual feedwater heaters, from operation) 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 P2C21 COLR Rev. 9 was the first COLR to no longer require implementation of SLO AFTO penalty files. The station no longer requires SLO AFTO files or penalties due to a 3D MONICORE upgrade required for EPU operation. Asymmetric feedwater temperature operation (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 10-1 will be implemented when the threshold asymmetry temperature (temperature above which a penalty is required) is exceeded. This will minimize the number of AFTO thermal limit tables in the COLR and core monitoring system.

TABLE 10-1
AFTO Thermal Limit Penalties
(Asymmetric Feedwater Heating)
(Reference 10)

	MFLCPR	MFLPD/MAPRAT
40F < FWT DELTA ≤ 55F	3%	4%
30F < FWT DELTA ≤ 40F	2%	3%
20F < FWT DELTA ≤ 30F	2%	2%
0F < FWT DELTA ≤ 20F	No Penalty	No Penalty

LHGR LIMITS

The ARTS-based LHGR power-dependent multipliers for AFTO operation are provided in Table 10-2. The flow-dependent multipliers for AFTO in DLO are provided in Table 10-3. The power-and flow-dependent LHGR multipliers were obtained from Reference 2 and were adjusted with the appropriate penalties displayed in Table 10-1 as per Reference 10. 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 Table 10-1 are applied to the thermal limits. Additionally, no LHGR penalties are required for asymmetric feedwater temperature option while in SLO as previously discussed.

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

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of rated)								
		0	23	<26.7	≥26.7	40	55	65	85	100
		LHGRFAC(P) Multiplier								
Base	≤ 60	0.488	0.488	0.501	0.718	0.726	0.740	0.784	0.921	0.960
	> 60	0.488	0.488	0.501						
RPTOOS	≤ 60	0.488	0.488	0.501	0.718	0.726	0.740	0.784	0.921	0.960
	> 60	0.488	0.488	0.501						
TBVOOS	≤ 60	0.381	0.381	0.424	0.610	0.629	0.685	0.784	0.893	0.960
	> 60	0.394	0.394	0.400						

TABLE 10-3
AFTO Flow Dependent LHGR Multiplier LHGRFAC(F) 20F < FWT DELTA ≤ 55F
(Asymmetric Feedwater Heating)
(References 2 and 10)

EOOS Combination	Core Flow (% of rated)					
	0	30	33.60	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 10-4. The ARTS-based power-dependent MCPR limits for use during AFTO conditions are provided in Table 10-5. The flow-dependent MCPR limits for AFTO are provided in Table 10-6. The power and flow-dependent OLMCPR curves were obtained from Reference 2 and were adjusted with a 3% penalty for feedwater temperature difference greater than 20 °F as displayed in Table 10-1 as per Reference 10. No MCPR penalties are required for asymmetric temperature differentials less than or equal to 20 °F. Additionally, no MCPR penalties are required for asymmetric feedwater temperature option while in SLO as previously discussed.

TABLE 10-4
AFTO Operating Limit Minimum Critical Power Ratio 20F < FWT DELTA ≤ 55F
(Asymmetric Feedwater Heating)
(References 2 and 10)

EOOS Combination	SCRAM Time Option[1]	Cycle Exposure	
		< EOR – 4409 MWd/ST	≥ EOR – 4409 MWd/ST
BASE	B	1.44	1.44
	A	1.45	1.52
TBVOOS	B	1.48	1.48
	A	1.48	1.57
RPTOOS	B	1.44	1.51
	A	1.61	1.69

TABLE 10-5
AFTO Power Dependent MCPR Limit Adjustments And Multipliers MCPR(P) 20F < FWT DELTA ≤ 55F
(Asymmetric Feedwater Heating)
(References 2 and 10)

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of rated)								
		0	23	<26.7	≥26.7	40	55	65	85	100
		Operating Limit MCPR			Operating Limit MCPR Multiplier, Kp					
Base	≤ 60	2.75	2.75	2.68	1.352	1.352	1.317	1.131	1.082	1.000
	> 60	3.08	3.08	2.91						
RPTOOS	≤ 60	2.75	2.75	2.68	1.352	1.352	1.317	1.131	1.082	1.000
	> 60	3.08	3.08	2.91						
TBVOOS	≤ 60	3.75	3.75	3.35	1.659	1.479	1.373	1.155	1.082	1.000
	> 60	4.27	4.27	3.89						

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

TABLE 10-6
AFTO Flow Dependent MCPR Limits MCPR(F) 20F < FWT DELTA ≤ 55F
(BOC to EOC)(Asymmetric Feedwater Heating)
(References 2 and 10)

Flow (% rated)	MCPR(F) Limit
0.0	1.80
30.0	1.62
79.0	1.32
110.0	1.32

MAPLHGR LIMITS

An appropriate penalty must be applied to MAPLHGR limits under asymmetric feedwater temperature operation (AFTO) for varying temperature differentials as displayed in Table 10-1 as per Reference 10. No MAPLHGR penalties are required for asymmetric feedwater temperature option while in SLO as previously discussed.

TABLE 10-7
AFTO MAPLHGR Reduction Factor
(Asymmetric Feedwater Heating)
(References 2 and 10)

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

11.0 MODES OF OPERATION

TABLE 11-1
Modes of Operation
(Reference 2)

EOOS Options[1]	Supported Operating Region[2]
Base, Option A or B	Yes
Base SLO, Option A or B	Yes[3]
TBVOOS, Option A or B	Yes
TBVOOS SLO, Option A or B	Yes[3]
RPTOOS, Option A or B	Yes
RPTOOS SLO, Option A or B	Yes[3]
TBVOOS and RPTOOS, Option A or B	No
TBVOOS and RPTOOS SLO, Option A or B	No

TABLE 11-2
Additional Equipment Out Of Service Modes of Operation

EOOS
PLUOOS (controlled via station procedures)
PROOS (controlled via station procedures)
TCV/TSVOOS (controlled via station procedures)
MSIVOOS (controlled via station procedures)
AFTO LFWH (controlled via station procedures)

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", NEDE-24011-P-A-22, November 2015 and U.S. Supplement NEDE-24011-P-A-22-US, November 2015.

[1] Modes of operation with thermal limit sets in the COLR

[2] Operating Region refers to operation on the Power to Flow map with or without FFWTR or AFTO. Operation not permitted in the MELLLA+ Region for Reduced Feedwater Temperature conditions as controlled by station procedures.

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

13.0 REFERENCES

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

2. Global Nuclear Fuel Document "Supplemental Reload Licensing Report for Peach Bottom Unit 2, Reload 20, Cycle 21 Extended Power Uprate (EPU)/Maximum Extended Load Line Limit Analysis Plus (MELLLA+)", GNF Document No. 001N2150-SRLR, Revision 1, January 2015.

3. Global Nuclear Fuel Document "General Electric Standard Application for Reactor Fuel", NEDE-24011-P-A-22, November 2015 and U.S. Supplement NEDE-24011-P-A-22-US, November 2015.

4. Global Nuclear Fuel Document NEDC-33270P Rev. 5, "GNF2 Advantage Generic Compliance with NEDE-24011-P-A (GESTAR II)," May 2013.

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-33720, "Safety Analysis Report for Peach Bottom Atomic Power Station Units 2 & 3 Maximum Extended Load Line Limit Analysis Plus", Revision 0, September 2014.

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. General Electric Hitachi Document GEH-0000-0107-7348, "GNF2 Fuel Design Cycle-Independent Analyses For Exelon Peach Bottom Atomic Power Station Units 2 and 3", Revision 6, April 2015. This document is searchable in Exelon EDMS under document number "G-080-VC-399 Rev. 3."

9. PECO Calculation PE-0251, Revision 02B, "PRNMS Setpoint Calculation" dated 5/26/15.

10. General Electric Hitachi Document 001N6733-R1, "Final Evaluation Report Exelon Nuclear Generating Company LLC, Peach Bottom Units 2 & 3, MELLLA+, Asymmetric Feedwater Temperature Operation for EPU/MELLLA+", Revision 1, September 2014. This document is searchable in Exelon EDMS under document number "PEAM-EPU-68 Rev. 1."

11. Global Nuclear Fuel Document 001N6160.1-FBIR, "Fuel Bundle Information Report for Peach Bottom Unit 2 Reload 20 Cycle 21 Extended Power Uprate (EPU)/Maximum Extended Load Line Limit Analysis Plus (MELLLA+) and Extended Power Uprate (EPU)/Maximum Extended Load Line Limit Analysis (MELLLA)", Revision 1, July 2014.

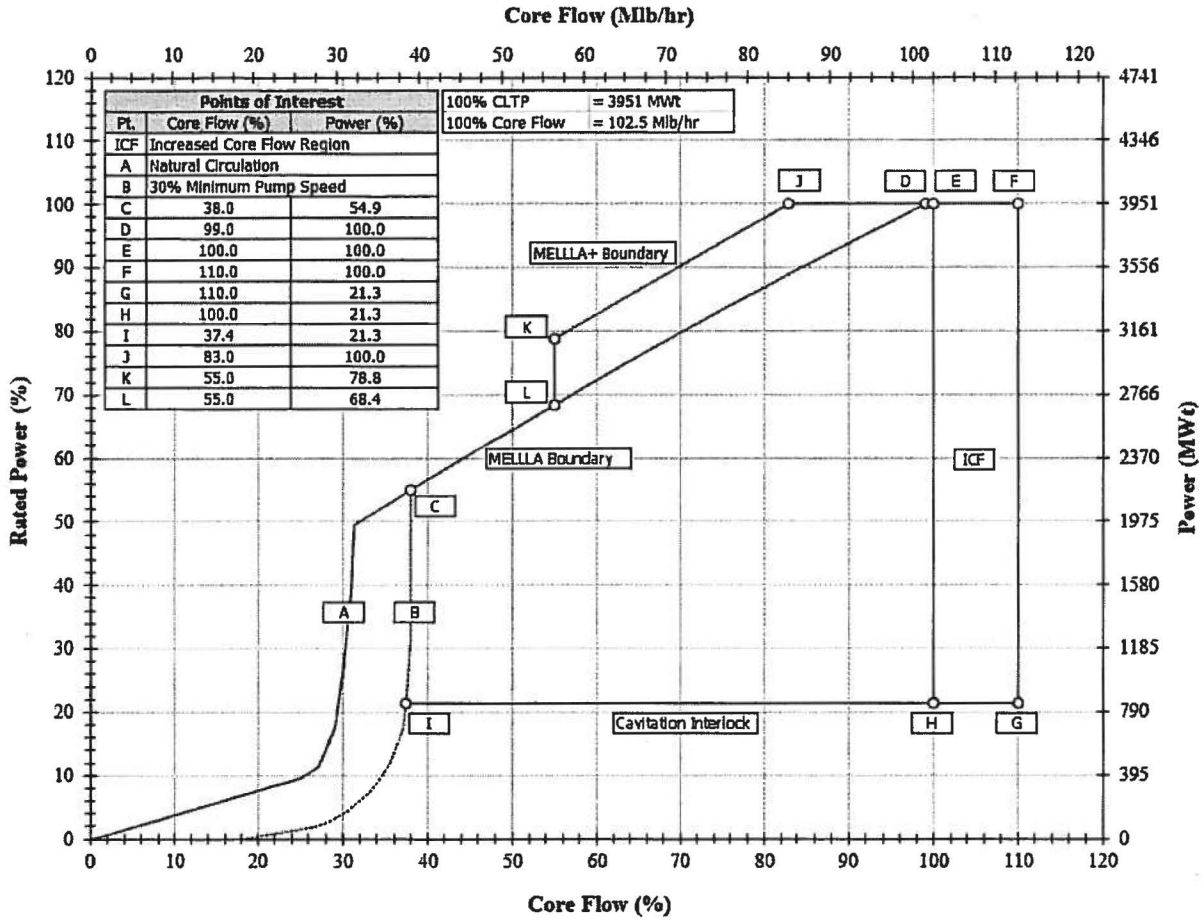
12. Not Used

13. Not Used

14. Exelon TODI ENSAF ID# ES1400004, Rev. 1, "Final Resolved OPL-3 Parameters for Peach Bottom Unit 2 Cycle 21 – EPU/MELLLA+", May 9, 2014.

APPENDIX A
Power/Flow Operating Map for MELLLA+

(Reference 6)



ATTACHMENT

Unit 3 Core Operating Limits Report for Reload 20, Cycle 21, Revision 9

CORE OPERATING LIMITS REPORT FOR

PEACH BOTTOM ATOMIC POWER STATION UNIT 3

RELOAD 20, CYCLE 21

(This is a Complete Re-write)

Prepared By: _____ Date: 4/1/2016
P. Henry

Reviewed By: _____ Date: 4/5/16
Reactor Engineering

Reviewed By: _____ Date: 4/1/2016
Engineering Safety Analysis

Independent Review By: _____ Date: 4/1/2016
B. Miller

Approved By: _____ Date: 4/5/2016
J. J. Tusar

Station Qualified Reviewer: _____ Date: 4/5/16

Table of Contents

Revision History

Revision	Description
Revision 9	Revised COLR for MELLLA+

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	Defines two (2) loop operation with at least seven turbine bypass valves in service and the reactor recirculation pump trip system in service.
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% (3951 MWth) 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
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 Valves Out of Service
TCV/TSVOOS	Turbine Control Valve/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 21 (RELOAD 20):

- 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
- Single Loop Operation (SLO) MCPR adjustment
- Linear Heat Generation Rate (LHGR)
- ARTS LHGR thermal limit multipliers
- Single Loop Operation (SLO) LHGR multipliers
- Rod Block Monitor (RBM) Analytical Limits, 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 MELLLA+ Region down to 83% of rated core flow during full power (3951 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 (AFTO)

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 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.

Also note that the following description of MAPLHGR, LHGR and MCPR limits pertain to **NON** – AFTO conditions. A separate description of AFTO limits and their associated ARTS tables are located in Section 10. Preparation of this report was performed in accordance with Exelon Nuclear procedures. This report is provided to the NRC in accordance with Technical Specification 5.6.5 of Reference 1 and contains all thermal limit parameters related to the implementation of the ARTS Improvement Program and MELLLA+ for Peach Bottom Unit 3 Cycle 21.

The "BASE" thermal limit values shown in tables are for normal two loop operation with at least the minimum number of turbine bypass valves in service per Section 7.0, the reactor recirculation pump trip system in service, the power load unbalance device in service, and both pressure regulators in service.

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. The MAPLHGR tables are used when hand calculations are required. 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.

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, 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).

Separate OLMCPR values are presented in Table 4-1 for the following conditions:

- TBS In-Service (per section 7.0), RPT In-Service (per section 8.0), PLU/PR In-Service, and maximum FFWTR of 90 °F (a.k.a. "BASE")
- TBS Out-of-Service (per section 7.0), RPT In-Service (per section 8.0), PLU/PR In-Service, and maximum FFWTR of 90 °F
- TBS In-Service (per section 7.0), RPT In-Service (per section 8.0), PLU/PR Out-of-Service, and maximum FFWTR of 90°F
- TBS In-Service (per section 7.0), RPT Out-of-Service (per section 8.0), PLU/PR In-Service, and maximum FFWTR 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. For PR/PLUOOS + TBSOOS and PR/PLUOOS + RPTOOS conditions, the limits are listed in Section 10, 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 - 2523 MWd/ST	≥ EOR – 2523 MWd/ST
BASE	B	1.38	1.41
	A	1.45	1.49
BASE SLO[2]	B	1.43	1.43
	A	1.45	1.49
RPTOOS	B	1.42	1.46
	A	1.59	1.63
RPTOOS SLO[2]	B	1.43	1.46
	A	1.59	1.63
PR/PLUOOS	B	1.38	1.41
	A	1.45	1.49
PR/PLUOOS SLO[2]	B	1.43	1.43
	A	1.45	1.49
TBSOOS	B	1.42	1.43
	A	1.49	1.52
TBSOOS SLO[2]	B	1.43	1.43
	A	1.49	1.52

(1) When Tau does not equal 0 or 1, use linear interpolation.
(2) For single-loop operation, the MCPR operating limit is the same as the analyzed limiting two loop value. However a minimum value of 1.43 is required to obtain an OLMCPR limit set by the Single Loop Operation Recirculation Pump Seizure Event (Reference 2).

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	23	<26.7	≥26.7	40	55	65	85	100
		Operating Limit MCPR			Operating Limit MCPR Multiplier, Kp					
Base	≤ 60	2.67	2.67	2.60	1.352	1.352	1.317	1.131	1.082	1.000
	> 60	2.99	2.99	2.83						
Base SLO	≤ 60	2.67	2.67	2.60	1.352	1.352	1.317	1.131	1.082	1.000
	> 60	2.99	2.99	2.83						
RPTOOS	≤ 60	2.67	2.67	2.60	1.352	1.352	1.317	1.131	1.082	1.000
	> 60	2.99	2.99	2.83						
RPTOOS SLO	≤ 60	2.67	2.67	2.60	1.352	1.352	1.317	1.131	1.082	1.000
	> 60	2.99	2.99	2.83						
PR/PLUOOS	≤ 60	2.67	2.67	2.60	1.392	1.352	1.317	1.210	1.147	1.000
	> 60	2.99	2.99	2.83						
PR/PLUOOS SLO	≤ 60	2.67	2.67	2.60	1.392	1.352	1.317	1.210	1.147	1.000
	> 60	2.99	2.99	2.83						
TBSOOS	≤ 60	3.64	3.64	3.25	1.659	1.479	1.373	1.155	1.082	1.000
	> 60	4.15	4.15	3.78						
TBSOOS SLO	≤ 60	3.64	3.64	3.25	1.659	1.479	1.373	1.155	1.082	1.000
	> 60	4.15	4.15	3.78						

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

Core Flow (% rated)	MCPR(F) Limit
0.0	1.75
30.0	1.57
79.0	1.28
110.0	1.28

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

Core Flow (% rated)	MCPR(F) Limit
0.0	1.75
30.0	1.57
79.0	1.28
110.0	1.28

5.0 LINEAR HEAT GENERATION RATE 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 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. 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	23	<26.7	≥26.7	40	55	65	85	100
		LHGRFAC(P) Multiplier								
Base	≤ 60	0.508	0.508	0.522	0.748	0.756	0.771	0.817	0.959	1.000
	> 60	0.508	0.508	0.522						
Base SLO	≤ 60	0.508	0.508	0.522	0.748	0.756	0.771	0.817	0.959	1.000
	> 60	0.508	0.508	0.522						
RPTOOS	≤ 60	0.508	0.508	0.522	0.748	0.756	0.771	0.817	0.959	1.000
	> 60	0.508	0.508	0.522						
RPTOOS SLO	≤ 60	0.508	0.508	0.522	0.748	0.756	0.771	0.817	0.959	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	0.959	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	0.959	1.000
	> 60	0.508	0.508	0.522						
TBSOOS	≤ 60	0.397	0.397	0.442	0.635	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	0.635	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 Analytical Limits, 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	Analytical Limit(1)	Allowable Value(1)	MCPR Limit
LTSP	120.0%	118.2%	< 1.70 (2) < 1.40 (3)
ITSP	115.2%	113.4%	< 1.70 (2) < 1.40 (3)
HTSP	110.2%	108.4%	< 1.70 (2) < 1.40 (3)
INOP	N/A	N/A	< 1.70 (2) < 1.40 (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 ≥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 14.

TABLE 7-1
Turbine Bypass System Response Time
(Reference 14)

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 or generation of the turbine bypass valve flow signal (whichever occurs first)

TABLE 7-2
Minimum Required Bypass Valves To Maintain System Operability
(Reference 14)

Reactor Power	No. of Valves in Service
$P \geq 23\%$	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 14)

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, Section 5.6.5

9.2 Description

Per Reference 2, the Cycle 21 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.

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}	1.39
ABSP APRM flow-biased trip setpoint power intercept. Constant Power Line for Trip from zero Drive Flow to Flow Breakpoint value.	$P_{BSP\text{-}Trip}$	39.9 %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	76.7	52.2	Scram Region Boundary, MELLLA+ Extension
B1	39.9	31.0	Scram Region Boundary, NCL
A2	64.5	50.0	Controlled Entry Region Boundary, HFCL
B2	28.1	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	65.7	51.5	Scram Region Boundary, HFCL
B1	34.9	30.7	Scram Region Boundary, NCL
A2	67.3	53.5	Controlled Entry Region Boundary, HFCL
B2	28.1	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 (resulting from removing a heater string, or individual feedwater heaters, from operation) 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 P3C21 COLR Rev. 8 was the first COLR to no longer require implementation of SLO AFTO penalty files for this unit. The station no longer requires SLO AFTO files or penalties due to a 3D MONICORE upgrade required for EPU operation. Asymmetric feedwater temperature operation (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 10-1 will be implemented when the threshold asymmetry temperature (temperature above which a penalty is required) is exceeded. This will minimize the number of AFTO thermal limit tables in the COLR and core monitoring system.

TABLE 10-1
AFTO Thermal Limit Penalties
(Asymmetric Feedwater Heating)
(Reference 10)

	MFLCPR	MFLPD/MAPRAT
40F < FWT DELTA ≤ 55F	3%	4%
30F < FWT DELTA ≤ 40F	2%	3%
20F < FWT DELTA ≤ 30F	2%	2%
0F < FWT DELTA ≤ 20F	No Penalty	No Penalty

LHGR LIMITS

The ARTS-based LHGR power-dependent multipliers for AFTO operation are provided in Table 10-2. The flow-dependent multipliers for AFTO in DLO are provided in Table 10-3. The power-and flow-dependent LHGR multipliers were obtained from Reference 2 and were adjusted with the appropriate penalties displayed in Table 10-1 as per Reference 10. PR/PLUOOS + TBSOOS and PR/PLUOOS + RPTOOS values were obtained by taking the most limiting OLMCPR values of the two EOOS conditions, these values are bounding for non-AFTO conditions. 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 Table 10-1 are applied to the thermal limits. Additionally, no LHGR penalties are required for asymmetric feedwater temperature option while in SLO as previously discussed.

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

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of rated)								
		0	23	<26.7	≥26.7	40	55	65	85	100
		LHGRFAC(P) Multiplier								
Base	≤ 60	0.488	0.488	0.501	0.718	0.726	0.740	0.784	0.921	0.960
	> 60	0.488	0.488	0.501						
RPTOOS	≤ 60	0.488	0.488	0.501	0.718	0.726	0.740	0.784	0.921	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	0.921	0.960
	> 60	0.488	0.488	0.501						
TBSOOS	≤ 60	0.381	0.381	0.424	0.610	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	0.921	0.960
	> 60	0.488	0.488	0.501						

TABLE 10-3
AFTO Flow Dependent LHGR Multiplier LHGRFAC(F) 20F < FWT DELTA ≤ 55F
(Asymmetric Feedwater Heating)
(References 2 and 10)

EOOS Combination	Core Flow (% of rated)					
	0	30	33.60	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 10-4. The ARTS-based power-dependent MCPR limits for use during AFTO conditions are provided in Table 10-5. The flow-dependent MCPR limits for AFTO are provided in Table 10-6. The power and flow-dependent OLMCPR curves were obtained from Reference 2 and were adjusted with a 3% penalty for feedwater temperature difference greater than 20 °F as displayed in Table 10-1 as per Reference 10. PR/PLUOOS + TBSOOS and PR/PLUOOS + RPTOOS values were obtained by taking the most limiting OLMCPR values of the two EOOS conditions, these values are bounding for non-AFTO conditions. No MCPR penalties are required for asymmetric temperature differentials less than or equal to 20 °F. Additionally, no MCPR penalties are required for asymmetric feedwater temperature option while in SLO as previously discussed.

TABLE 10-4
AFTO Operating Limit Minimum Critical Power Ratio 20F < FWT DELTA ≤ 55F
(Asymmetric Feedwater Heating)
(References 2 and 10)

EOOS Combination	SCRAM Time Option[1]	Cycle Exposure	
		< EOR – 2523 MWd/ST	≥ EOR – 2523 MWd/ST
BASE	B	1.42	1.45
	A	1.49	1.53
RPTOOS	B	1.46	1.50
	A	1.64	1.68
PR/PLUOOS	B	1.42	1.45
	A	1.49	1.53
TBSOOS	B	1.46	1.47
	A	1.53	1.57
PR/PLUOOS + TBSOOS	B	1.46	1.47
	A	N/A	N/A
PR/PLUOOS + RPTOOS	B	1.46	1.50
	A	N/A	N/A

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

TABLE 10-5
AFTO Power Dependent MCPR Limit Adjustments And Multipliers MCPR(P) 20F < FWT DELTA ≤ 55F
(Asymmetric Feedwater Heating)
(References 2 and 10)

EOOS Combination	Core Flow (% of rated)	Core Thermal Power (% of rated)								
		0	23	<26.7	≥26.7	40	55	65	85	100
		Operating Limit MCPR			Operating Limit MCPR Multiplier, Kp					
Base	≤ 60	2.75	2.75	2.68	1.352	1.352	1.317	1.131	1.082	1.000
	> 60	3.08	3.08	2.91						
RPTOOS	≤ 60	2.75	2.75	2.68	1.352	1.352	1.317	1.131	1.082	1.000
	> 60	3.08	3.08	2.91						
PR/PLUOOS	≤ 60	2.75	2.75	2.68	1.392	1.352	1.317	1.210	1.147	1.000
	> 60	3.08	3.08	2.91						
TBSOOS	≤ 60	3.75	3.75	3.35	1.659	1.479	1.373	1.155	1.082	1.000
	> 60	4.27	4.27	3.89						
PR/PLUOOS + TBSOOS	≤ 60	3.75	3.75	3.35	1.659	1.479	1.373	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	1.352	1.317	1.210	1.147	1.000
	> 60	3.08	3.08	2.91						

TABLE 10-6
AFTO Flow Dependent MCPR Limits MCPR(F) 20F < FWT DELTA ≤ 55F
(BOC to EOC)(Asymmetric Feedwater Heating)
(References 2 and 10)

Flow (% rated)	MCPR(F) Limit
0.0	1.80
30.0	1.62
79.0	1.32
110.0	1.32

MAPLHGR LIMITS

An appropriate penalty must be applied to MAPLHGR limits under asymmetric feedwater temperature operation (AFTO) for varying temperature differentials as displayed in Table 10-1 as per Reference 10. No MAPLHGR penalties are required for asymmetric feedwater temperature option while in SLO as previously discussed.

TABLE 10-7
AFTO MAPLHGR Reduction Factor
(Asymmetric Feedwater Heating)
(References 2 and 10)

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

11.0 MODES OF OPERATION

TABLE 11-1
Modes of Operation
(Reference 2)

EOOS Options[1]	Supported Operating Region[2]
Base, Option A or B	Yes
Base SLO, Option A or B	Yes[3]
TBSOOS, Option A or B	Yes
TBSOOS SLO, Option A or B	Yes[3]
RPTOOS, Option A or B	Yes
RPTOOS SLO, Option A or B	Yes[3]
PLUOOS, Option A or B	Yes
PLUOOS SLO, Option A or B	Yes[3]
PROOS, Option A or B	Yes
PROOS SLO, Option A or B	Yes[3]
PR/PLUOOS and TBSOOS, Option B	Yes
PR/PLUOOS and RPTOOS, Option B	Yes
TBSOOS and RPTOOS, Option A or B	No
TBSOOS and RPTOOS SLO, Option A or B	No

TABLE 11-2
Additional Equipment Out of Service Modes of Operation

EOOS
TCV/TSVOOS (controlled via station procedures)
MSIVOOS (controlled via station procedures)
AFTO LFWH (controlled via station procedures)

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", NEDE-24011-P-A-22, November 2015 and U.S. Supplement NEDE-24011-P-A-22-US, November 2015.

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[1] Modes of operation with thermal limit sets in the COLR

[2] Operating Region refers to operation on the Power to Flow map with or without FFWTR or AFTO. Operation not permited in the MELLLA+ Region for Reduced Feedwater Temperature conditions as controlled by station procedures.

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

13.0 REFERENCES

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

2. Global Nuclear Fuel Document "Supplemental Reload Licensing Report for Peach Bottom Unit 3, Reload 20, Cycle 21 Extended Power Uprate (EPU)/Maximum Extended Load Line Limit Analysis Plus (MELLLA+)," GNF Document No. 001N3881, Revision 0, July 2015.

3. Global Nuclear Fuel Document "General Electric Standard Application for Reactor Fuel," NEDE-24011-P-A-22, November 2015 and U.S. Supplement NEDE-24011-P-A-22-US, November 2015.

4. Global Nuclear Fuel Document NEDC-33270P Rev. 5, "GNF2 Advantage Generic Compliance with NEDE-24011-P-A (GESTAR II)," May 2013.

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. 00A."

6. General Electric Hitachi Document NEDO-33720, "Safety Analysis Report for Peach Bottom Atomic Power Station Units 2 & 3 Maximum Extended Load Line Limit Analysis Plus", Revision 0, September 2014.

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. Not Used.

9. PECO Calculation PE-0251, Revision 2B, "PRNMS Setpoint Calculation," dated 5/26/15.

10. General Electric Hitachi Document 001N6733-R1, "Final Evaluation Report Exelon Nuclear Generating Company LLC, Peach Bottom Units 2 & 3, MELLLA+, Asymmetric Feedwater Temperature Operation for EPU/MELLLA+," Revision 1, September 2014. This document is searchable in Exelon EDMS under document number "PEAM-EPU-68 Rev. 1."

11. Global Nuclear Fuel Document 002N8938, Revision 0, "Fuel Bundle Information Report for Peach Bottom Unit 3 Reload 20 Cycle 21 Extended Power Uprate (EPU)/Maximum Extended Load Line Limit Analysis Plus (MELLLA+) and Extended Power Uprate (EPU)/Maximum Extended Load Line Limit Analysis (MELLLA)," July 2015.

12. Not Used

13. Not Used

14. Exelon TODI ENSAF ID# ES1500001, Rev. 0, "Final Resolved OPL-3 Parameters for Peach Bottom Unit 3 Cycle 21: EPU/MELLLA+," February 17, 2015.

APPENDIX A
Power/Flow Operating Map for MELLLA+
(Reference 6)