Tennessee Valley Authority, Post Office Box 2000, Decatur, Alabama 35609-2000

June 12, 2009

U.S. Nuclear Regulatory Commission
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Washington, D.C. 20555-0001

In the Matter of) Docket No. 50-260
Tennessee Valley Authority)

BROWNS FERRY NUCLEAR PLANT (BFN) - UNIT 2 - CORE OPERATING LIMITS REPORT (COLR), FOR CYCLE 16 OPERATION

In accordance with the requirements of Technical Specification 5.6.5.d, enclosed is the Unit 2 Cycle 16, Core Operating Limits Report.

There are no new commitments contained in this letter. If you have any questions, please contact F. R. Godwin at (256) 729-2636.

Sincerely,

R. G. West
Site Vice President

Enclosure
cc: See page 2

A001
NRR

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ENCLOSURE

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNIT 2

CORE OPERATING LIMITS REPORT (COLR)
FOR CYCLE 16 OPERATION

(SEE ATTACHED)

TVA Nuclear

Nuclear Fuel Design - BWRFE
1101 Market Street, Chattanooga, TN 37402

Browns Ferry Unit 2 Cycle 16

Core Operating Limits Report, (COLR, for 105% OLTP)

TVA-COLR-BF2C16 **Revision 0 (Final)**

March 2009

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Total Number of Pages = 29 (*including review cover sheet*)

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Revision Log

Number	Page	Description
1-R0	All	New document, per NFDP-1, Section 3.2, Item N.

Nomenclature

APLHGR	Average Planar LHGR
APRM	Average Power Range Monitor
AREVA NP	Vendor (Framatome, Siemens)
ARTS	APRM, Rod Block Monitor, and Technical Specification Improvement Program
BOC	Beginning of Cycle
BWR	Boiling Water Reactor
CAVEX	Core Average Exposure
CD	Coastdown
COLR	Core Operating Limits Report
CPR	Critical Power Ratio
CRWE	Control Rod Withdrawal Error
DTSP	Dual TSP
EIS	Equipment-In-Service
EOC	End of Cycle
EOFP	End of Full Power (no ICF or FFWTR)
EOOS	Equipment OOS
FFWTR	Final Feedwater Temperature Reduction
FHOOS	Feedwater Heaters OOS
GWd	Giga Watt Day
HPSP	High PSP
HTSP	High TSP
ICF	Increased Core Flow (beyond rated)
IPSP	Intermediate PSP
ITSP	Intermediate TSP
LHGR	Linear Heat Generation Rate
LHGRFAC	LHGR Multiplier (Power or Flow dependent)
LPRM	Low Power Range Monitor
LPSP	Low PSP
LRNB	Generator Load Reject, No Bypass
LTSP	Low TSP
MAPFAC	MAPLHGR multiplier (Power or Flow dependent)
MCPR	Minimum CPR
MSIV	Main Steam Isolation Valve
MSIVOOS	MSIV OOS
MSR	Moisture Separator Reheater
MSROOS	MSR OOS
MTU	Metric Ton Uranium
MWd/MTU	Mega Watt Day per Metric Ton Uranium

NEOC	Near EOC
NFT	Nuclear Fuel Type
NRC	United States Nuclear Regulatory Commission
NSS	Nominal Scram Speed
NTSP	Nominal TSP
OLMCPR	MCPR Operating Limit
OOS	Out-Of-Service
OLTP	Original Licensed Thermal Power (100% OLTP, 3293 MW_t)
Pbypass	Power, below which TSV Position and TCV Fast Closure Scrams are bypassed
PLU	Power Load Unbalance
PLUOOS	PLU OOS
PSP	Power Setpoint
RBM	Rod Block Monitor
RPT	Recirculation Pump Trip
RPTOOS	RPT OOS
SDM	Shutdown Margin
SLMCPR	MCPR Safety Limit
SLO	Single Loop Operation
SRV	Safety Relief Valve
SRVOOS	SRV OOS
TBV	Turbine Bypass Valve
TBVIS	Turbine Bypass Valves IS
TBVOOS	Turbine Bypass Valves OOS
TCV	Turbine Control Valve
TIP	Transverse In-Core Probe
TIPOOS	TIP OOS
TLO	Two Loop Operation
TSP	Trip Setpoint
TSSS	Technical Specification Scram Speed
TSV	Turbine Stop Valve
TVA	Tennessee Valley Authority

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Methodology References

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18. EMF-2209(P)(A) Revision 2, **SPCB Critical Power Correlation**, Siemens Power Corporation, September 2003.

19. EMF-2361(P)(A) Revision 0, **EXEM BWR-2000 ECCS Evaluation Model**, Framatome ANP Inc., May 2001.

20. EMF-2292(P)(A) Revision 0, **ATRIUM™-10: Appendix K Spray Heat Transfer Coefficients**, Siemens Power Corporation, September 2000.

PRNM Setpoint References

21. Filtered Setpoints - EDE-28-0990 Rev. 3 Supplement E, "PRNM (APRM, RBM, and RFM) Setpoint Calculations [ARTS/MELLL (NUMAC) - Power-Uprate Condition] for Tennessee Valley Authority Browns Ferry Nuclear Plant", October 1997

22. Unfiltered Setpoints - EDE-28-0990 Rev. 2 Supplement E, "PRNM (APRM, RBM, and RFM) Setpoint Calculations [ARTS/MELLL (NUMAC) - Power-Uprate Condition] for Tennessee Valley Authority Browns Ferry Nuclear Plant", October 1997.

23. GE Letter LB#: 262-97-133, *Browns Ferry Nuclear Plant Rod Block Monitor Setpoint Clarification - GE Proprietary Information*, September 12, 1997

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1 Introduction

In anticipation of cycle startup, it is necessary to describe the expected limits of operation.

1.1 Purpose

The primary purpose of this document is to satisfy requirements identified by unit technical specification section 5.6.5. This document may be provided, upon final approval, to the NRC.

1.2 Scope

This document will discuss the following areas:

- Average Planar Linear Heat Generation Rate (APLHGR) Limit
  (Technical Specifications 3.2.1 and 3.7.5)
- Linear Heat Generation Rate (LHGR) Limit
  (Technical Specification 3.2.3, 3.3.4.1, and 3.7.5)
- Minimum Critical Power Ratio Operating Limit (OLMCPR)
  (Technical Specifications 3.2.2, 3.3.4.1, and 3.7.5)
- Average Power Range Monitor (APRM) Flow Biased Rod Block Trip Setting
  (Technical Requirements Manual Section 5.3.1 and Table 3.3.4-1)
- Rod Block Monitor (RBM) Trip Setpoints and Operability
  (Technical Specification Table 3.3.2.1-1)
- Shutdown Margin (SDM) Limit
  (Technical Specification 3.1.1)

1.3 Fuel Loading

The core will contain all AREVA NP, Inc., ATRIUM™-10 fuel. Nuclear fuel types used in the core loading are shown in Table 1.1.

1.4 Acceptability

Limits discussed in this document were generated based on NRC approved methodologies per References 6 thru 20.

Table 1.1 Nuclear Fuel Types*

Fuel Description	Original Cycle	Number of Assemblies	Nuclear Fuel Type (NFT)	Fuel Names (Range)
ATRIUM-10 A10-3920B-14GV70	14	107	1	FBA001-FBA279
ATRIUM-10 A10-4227B-15GV80-FBB	15	206	2	FBB001-FBB206
ATRIUM-10 A10-4239B-15GV80-FBB	15	111	3	FBB207-FBB318
ATRIUM-10 A10-3552B-10GV80-FBB	15	56	4	FBB319-FBB374
ATRIUM-10 A10-4218B-13GV80-FCC	16	16	6	FCC291-FCC306
ATRIUM-10 A10-3757B-10GV80-FCC	16	24	7	FCC311-FCC334
ATRIUM-10 A10-4019B-14GV80-FBC	16	168	8	FBC401-FBC568
ATRIUM-10 A10-3841B-14GV80-FBC	16	76	9	FBC569-FBC644

* The table identifies the expected fuel type breakdown in anticipation of final core loading. The final composition of the core depends upon uncertainties during the outage such as discovering a failed fuel bundle, or other bundle damage. Minor core loading changes, due to unforeseen events, will conform to the safety and monitoring requirements identified in this document.

2 APLHGR Limits

(Technical Specifications 3.2.1 & 3.7.5)

The APLHGR limit is determined by adjusting the rated power APLHGR limit for off-rated power, off-rated flow, and SLO conditions. The most limiting of these is then used as follows:

$$\text{APLHGR limit} = \text{MIN} (\text{APLHGR}_P , \text{APLHGR}_F, \text{APLHGR}_{SLO})$$

where:

APLHGR_P	off-rated power APLHGR limit	[APLHGR_{RATED} * MAPFAC_P]
APLHGR_F	off-rated flow APLHGR limit	[APLHGR_{RATED} * MAPFAC_F]
APLHGR_{SLO}	SLO APLHGR limit	[APLHGR_{RATED} * SLO Multiplier]

2.1 Rated Power and Flow Limit: APLHGR_{RATED}

The rated conditions APLHGR, for all fuel types, is identified in Reference 1 and shown in Figure 2.1.

2.2 Off-Rated Power Dependent Limit: APLHGR_P

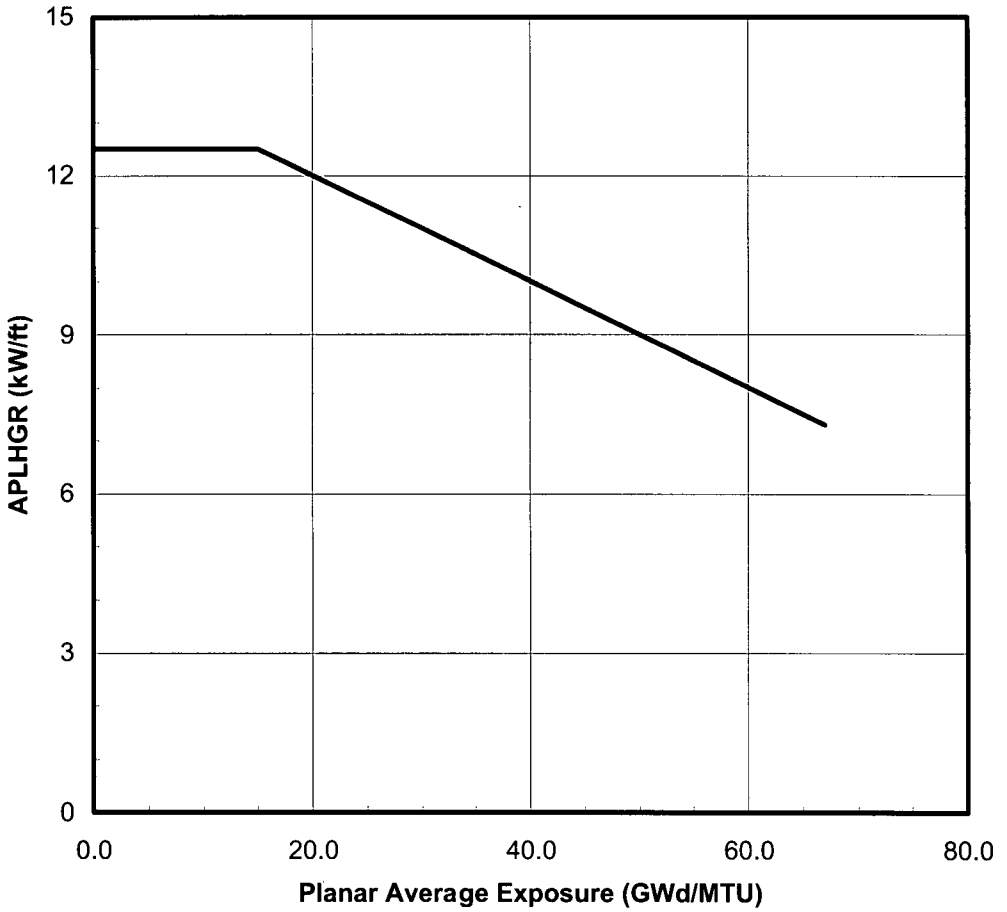
Reference 1, for ATRIUM-10 fuel, does not specify a power dependent APLHGR. Therefore, MAPFAC_P is set to a value of **1.0**.

2.3 Off-Rated Flow Dependent Limit: APLHGR_F

Reference 1, for ATRIUM-10 fuel, does not specify a flow dependent APLHGR. Therefore, MAPFAC_F is set to a value of **1.0**.

2.4 Single Loop Operation Limit: APLHGR_{SLO}

The single loop operation multiplier for ATRIUM-10 fuel is **0.85**, per Reference 1.



Planar Avg. Exposure (GWd/MTU)	APLHGR Limit (kW/ft)
0.0	12.5
15.0	12.5
67.0	7.3

Figure 2.1 $APLHGR_{RATED}$ for ATRIUM-10 Fuel

2.5 Equipment Out-Of-Service Corrections

The limit shown in Figure 2.1 is applicable for operation with all equipment In-Service as well as the following Equipment Out-Of-Service (EOOS) options; including combinations of the options.

In-Service	All equipment In-Service (includes 1 SRVOOS)
RPTOOS	EOC-Recirculation Pump Trip Out-Of-Service
TBVOOS	Turbine Bypass Valve(s) Out-Of-Service
PLUOOS	Power Load Unbalance Out-Of-Service
FHOOS	Feedwater Heaters Out-Of-Service

Single Recirculation Loop Operation (SLO) requires the application of the SLO multipliers to the rated APLHGR limits as described previously.

3 LHGR Limits

(Technical Specification 3.2.3, 3.3.4.1, & 3.7.5)

The LHGR limit is determined by adjusting the rated power LHGR limit for off-rated power and off-rated flow conditions. The most limiting of these is then used as follows:

$$\text{LHGR limit} = \text{MIN} (\text{LHGR}_P , \text{LHGR}_F)$$

where:

LHGR_P	off-rated power LHGR limit	$[\text{LHGR}_{RATED} * \text{LHGRFAC}_P]$
LHGR_F	off-rated flow LHGR limit	$[\text{LHGR}_{RATED} * \text{LHGRFAC}_F]$

3.1 Rated Power and Flow Limit: LHGR_{RATED}

The rated conditions LHGR, for all fuel types, is identified in Reference 1 and shown in Figure 3.1. The LHGR limit is consistent with References 2, 3, & 4.

3.2 Off-Rated Power Dependent Limit: LHGR_P

The ATRIUM-10 fuel, LHGR limits are adjusted for off-rated power conditions using the LHGRFAC_P multiplier provided in Reference 1. The multiplier is split into two sub cases: turbine bypass valves in and out-of-service. The multipliers are shown in Figure 3.2.

3.3 Off-Rated Flow Dependent Limit: LHGR_F

The ATRIUM-10 fuel, LHGR limits are adjusted for off-rated flow conditions using the LHGRFAC_F multiplier provided in Reference 1. The multiplier is shown in Figure 3.3.

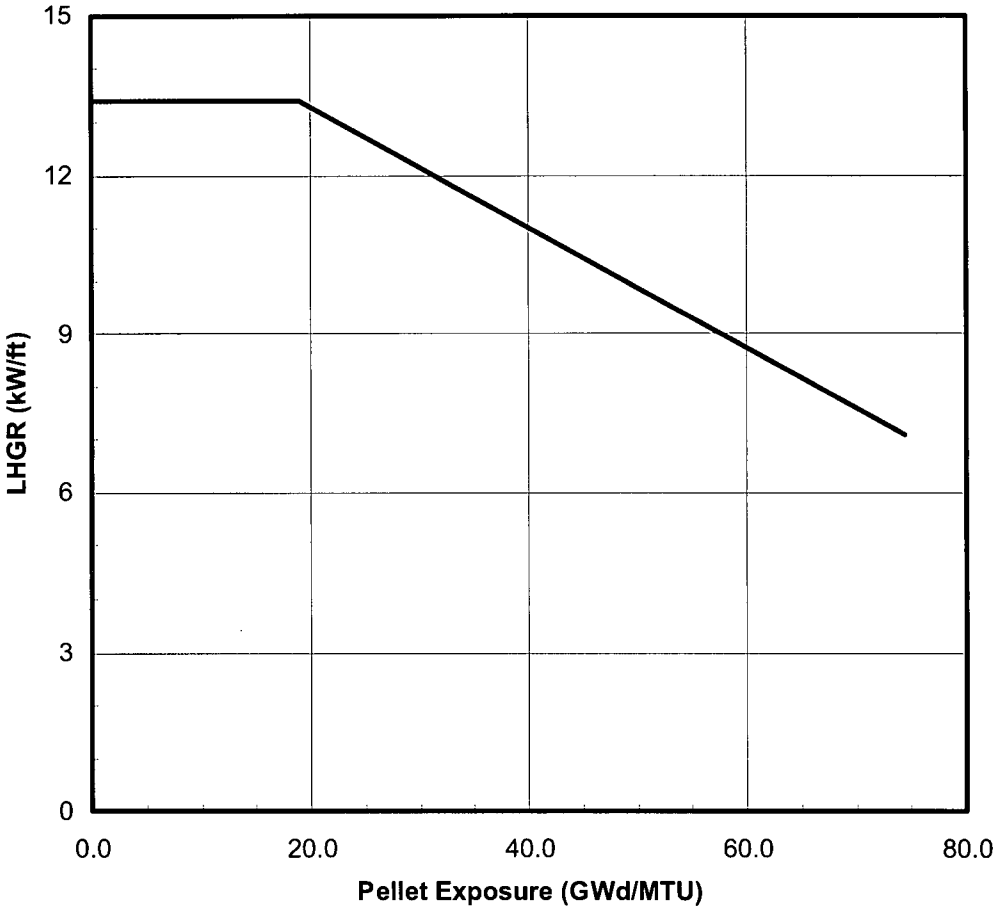
3.4 Equipment Out-Of-Service Corrections

The limit shown in Figure 3.1 is applicable for operation with all equipment In-Service as well as the following Equipment Out-Of-Service (EOOS) options; including combinations of the options.*

In-Service	All equipment In-Service
RPTOOS	EOC-Recirculation Pump Trip Out-Of-Service
TBVOOS	Turbine Bypass Valve(s) Out-Of-Service
PLUOOS	Power Load Unbalance Out-Of-Service
FHOOS	Feedwater Heaters Out-Of-Service
SLO	Single Loop Operation, One Recirculation Pump Out-Of-Service

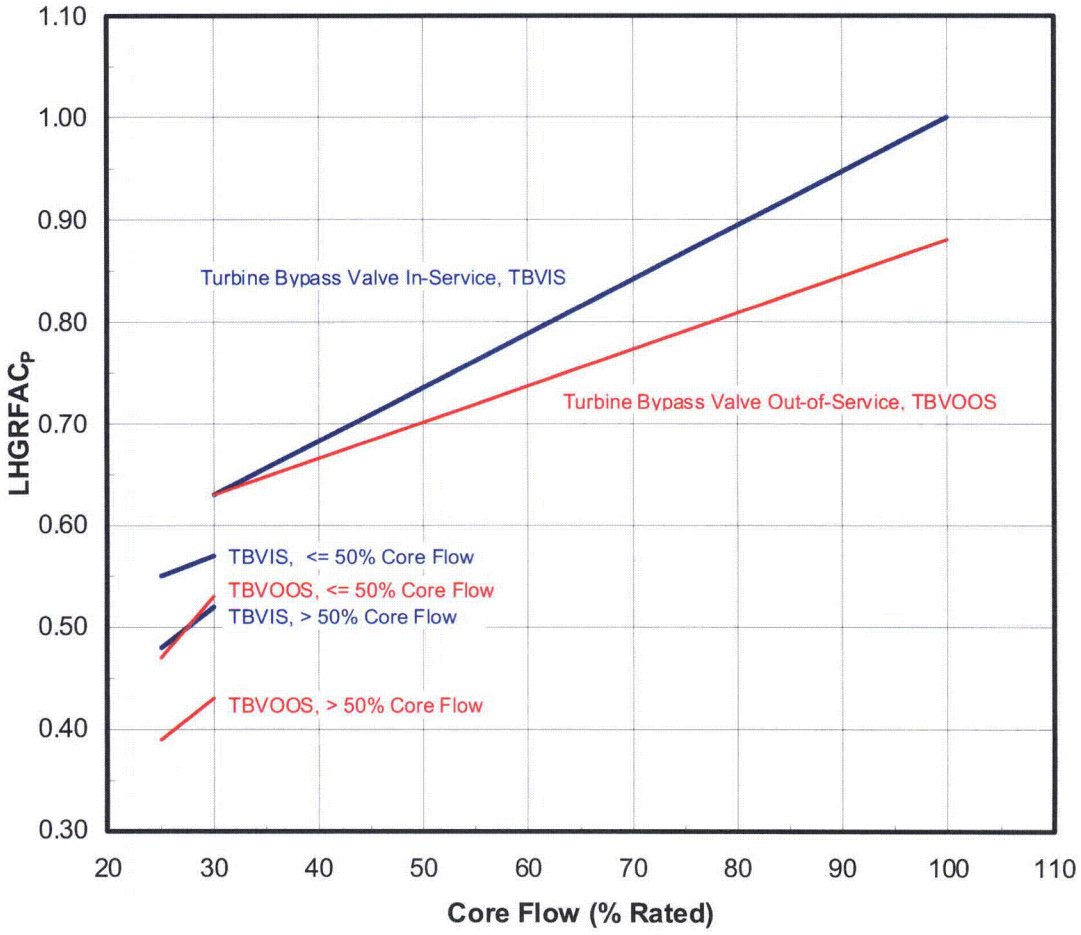
The off-rated power corrections shown in Figure 3.2 are dependent on operation of the Turbine Bypass Valve system. For this reason, separate limits are to be applied for TBVIS or TBVOOS operation. The limits have no dependency on RPTOOS, PLUOOS, FHOOS/FFWTR, or SLO.

* All equipment service conditions assume 1 SRVOOS.



Pellet Exposure (GWd/MTU)	LHGR Limit (kW/ft)
0.0	13.4
18.9	13.4
74.4	7.1

Figure 3.1 $LHGR_{RATED}$ for ATRIUM-10 Fuel



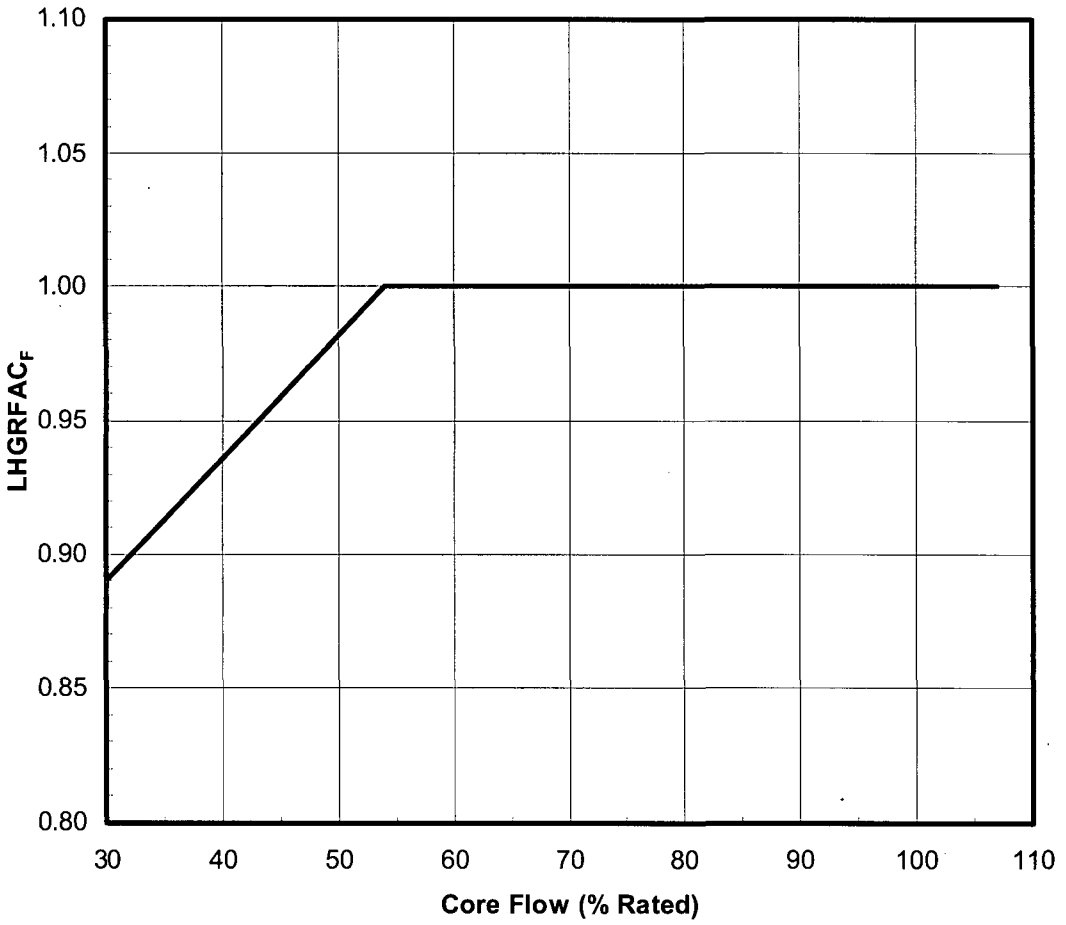
Turbine Bypass In-Service

Core Power (% Rated)	$LHGRFAC_P$
100.0	1.00
30.0	0.63
Core Flow > 50% Rated	
30.0	0.52
25.0	0.48
Core Flow <= 50% Rated	
30.0	0.57
25.0	0.55

Turbine Bypass Out-of-Service

Core Power (% Rated)	$LHGRFAC_P$
100.0	0.88
30.0	0.63
Core Flow > 50% Rated	
30.0	0.43
25.0	0.39
Core Flow <= 50% Rated	
30.0	0.53
25.0	0.47

Figure 3.2 $LHGRFAC_P$ for ATRIUM-10 Fuel
(*Independent of other EOOS conditions*)



Core Flow (% Rated)	LHGRFAC$_F$
30.0	0.89
54.0	1
107.0	1

Figure 3.3 LHGRFAC$_F$ for ATRIUM-10 Fuel
(*Values bound all EOOS conditions*)

(*107.0% maximum core flow line is used to support 105% rated flow operation, ICF*)

4 OLMCPR Limits

(Technical Specification 3.2.2, 3.3.4.1, & 3.7.5)

OLMCPR is calculated to be the most limiting of the flow or power dependent values

$$\text{OLMCPR limit} = \text{MAX} (MCPR_F , MCPR_P)$$

where:

$MCPR_F$	core flow-dependent MCPR limit
$MCPR_P$	power-dependent MCPR limit

4.1 Flow Dependent MCPR Limit: $MCPR_F$

$MCPR_F$ limits are dependent upon core flow (% of Rated), and the max core flow limit, (Rated or Increased Core Flow, ICF). $MCPR_F$ limits are shown in Figure 4.1, per Reference 1. Limits are valid for all EOOS combinations. No adjustment is required for SLO conditions.

4.2 Power Dependent MCPR Limit: $MCPR_P$

$MCPR_P$ limits are dependent upon:

- Core Power Level (% of Rated)
- Technical Specification Scram Speed (TSSS) or Nominal Scram Speed (NSS)
- Cycle Operating Exposure (NEOC & EOC - as defined in this section)
- Equipment Out-Of-Service Options
- Two or Single recirculation Loop Operation (TLO vs. SLO)

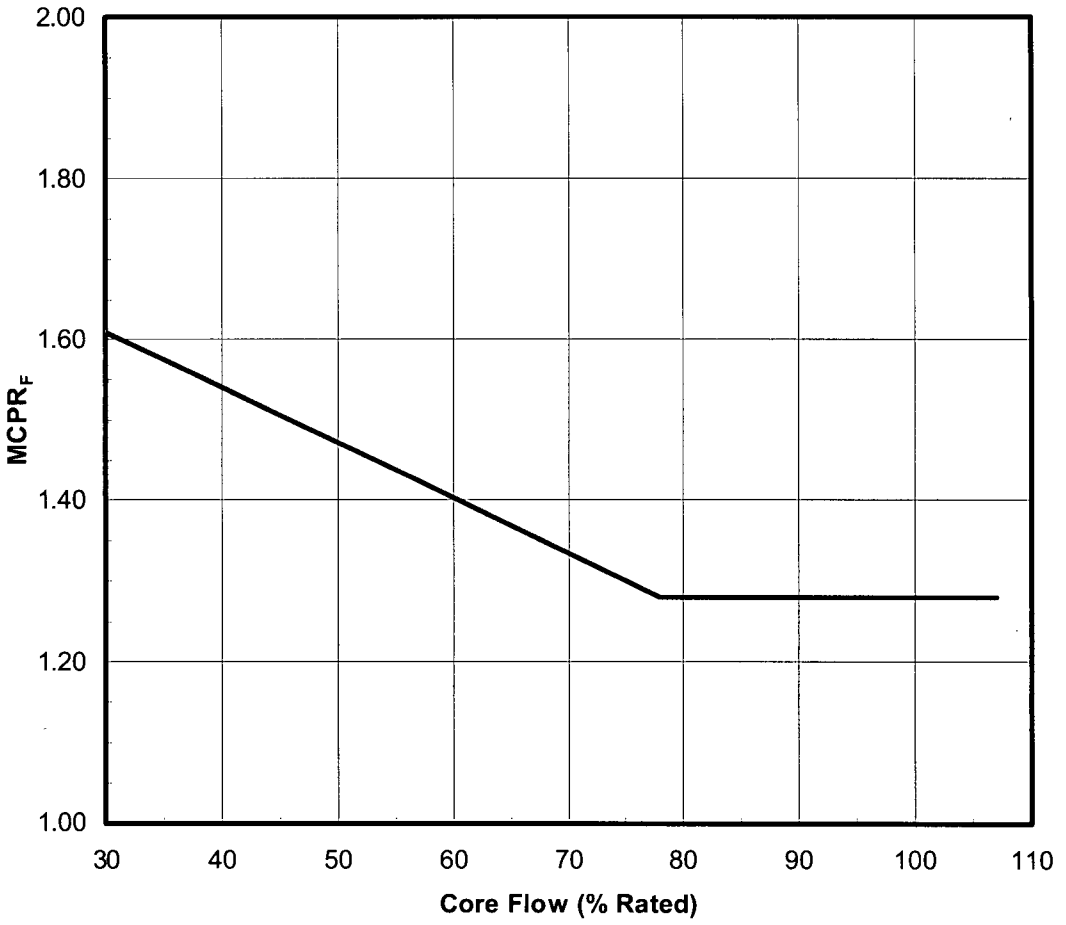
The $MCPR_P$ limits are provided in the following tables, where each table contains the limits for all fuel types and EOOS options (for a specified scram speed and exposure range). The CMSS determines $MCPR_P$ limits, from these tables, based on linear interpolation between the specified powers.

4.2.1 Scram Speed Dependent Limits (TSSS vs. NSS)

$MCPR_P$ limits are provided for two different sets of assumed scram speeds. The Technical Specification Scram Speed (TSSS) $MCPR_P$ limits are applicable at all times, as long as the scram time surveillance demonstrates the times in Technical Specification Table 3.1.4-1 are met. Nominal Scram Speeds (NSS) may be used, as long as the scram time surveillance demonstrates Table 4.1 times are applicable.*†

* Reference 1 analysis results are based on information identified in Reference 5.

† Assumption basis is consistent with method used to perform actual timing measurements, (i.e., including pickup/dropout effects).



Core Flow (% Rated)	$MCPR_F$
30.0	1.61
78.0	1.28
107.0	1.28

Figure 4.1 $MCPR_F$ for ATRIUM-10 Fuel
(*Values bound all EOOS conditions*)

(*107.0% maximum core flow line is used to support 105% rated flow operation, ICF*)

Table 4.1 Nominal Scram Time Basis

Notch Position (index)	Nominal Scram Timing (seconds)
46	0.42
36	0.98
26	1.60
6	2.90

In demonstrating compliance with nominal scram time basis, surveillance requirements from Technical Specification 3.1.4 apply; accepting the definition of SLOW rods should conform to scram speeds shown in Table 4.1. If conformance is not demonstrated, TSSS based $MCPR_P$ limits are applied.

On initial cycle startup, TSSS limits are used until the successful completion of scram timing confirms NSS based limits are applicable.

4.2.2 Exposure Dependent Limits

Exposures are tracked on a Core Average Exposure basis (CAVEX, not Cycle Exposure). Higher exposure $MCPR_P$ limits are always more limiting and may be used for any Core Average Exposure up to the ending exposure. Per Reference 1, $MCPR_P$ limits are provided for the following exposure ranges:

BOC to NEOC	NEOC corresponds to	**28,344 MWd / MTU**
BOC to EOC	EOC corresponds to	**31,102 MWd / MTU**

NEOC refers to a Near EOC exposure point.

The EOC exposure point is not the true End-Of-Cycle exposure. Instead it corresponds to a licensing exposure window exceeding expected end-of-full-power-life.

4.2.3 *Equipment Out-Of-Service (EOOS) Options*

EOOS options* covered by $MCPR_P$ limits are given by the following:

In-Service	All equipment In-Service
RPTOOS	EOC-Recirculation Pump Trip Out-Of-Service
TBVOOS	Turbine Bypass Valve(s) Out-Of-Service
RPTOOS+TBVOOS	Combined RPTOOS and TBVOOS
PLUOOS	Power Load Unbalance Out-Of-Service
PLUOOS+RPTOOS	Combined PLUOOS and RPTOOS
PLUOOS+TBVOOS	Combined PLUOOS and TBVOOS
PLUOOS+TBVOOS+RPTOOS	Combined PLUOOS, RPTOOS, and TBVOOS
FHOOS	Feedwater Heaters Out-Of-Service

For exposure ranges up to NEOC and EOC, additional combinations of $MCPR_P$ limits are also provided including FHOOS.

4.2.4 *Single-Loop-Operation (SLO) Limits*

$MCPR_P$ limits are increased by 0.02 to support SLO, per Reference 1.

4.2.5 *Below Pbypass Limits*

Below Pbypass (30% rated power), $MCPR_P$ limits depend upon core flow. One set of $MCPR_P$ limits applies for core flow is above 50% of rated; a second set applies if the core flow is less than or equal to 50% rated.

* All equipment service conditions assume 1 SRVOOS.

Table 4.2 $MCPR_P$ Limits for Nominal Scram Time Basis*

Operating Condition	Power (% of rated)	BOC to NEOC	BOC to EOC
Base Case	100	1.41	1.42
	75	1.54	1.54
	65	1.60	1.60
	60	1.64	1.64
	50	1.76	1.76
	50	1.91	1.91
	30	2.18	2.18
	30 at > 50%F	2.67	2.67
	25 at > 50%F	2.93	2.93
	30 at <= 50%F	2.54	2.54
	25 at <= 50%F	2.75	2.75
TBVOOS	100	1.45	1.47
	75	1.58	1.58
	65	1.64	1.64
	60	1.67	1.67
	50	1.79	1.79
	50	1.91	1.91
	30	2.21	2.21
	30 at > 50%F	3.21	3.21
	25 at > 50%F	3.63	3.63
	30 at <= 50%F	2.74	2.74
	25 at <= 50%F	3.12	3.12
RPTOOS	100	1.41	1.42
	75	1.54	1.54
	65	1.60	1.60
	60	1.64	1.64
	50	1.76	1.76
	50	1.91	1.91
	30	2.18	2.18
	30 at > 50%F	2.67	2.67
	25 at > 50%F	2.93	2.93
	30 at <= 50%F	2.54	2.54
	25 at <= 50%F	2.75	2.75
FHOOS	100	1.44	1.44
	75	1.58	1.58
	65	1.65	1.65
	60	1.70	1.70
	50	1.83	1.83
	50	1.91	1.91
	30	2.29	2.29
	30 at > 50%F	2.77	2.77
	25 at > 50%F	3.06	3.06
	30 at <= 50%F	2.63	2.63
	25 at <= 50%F	2.87	2.87

Operating Condition	Power (% of rated)	BOC to NEOC	BOC to EOC
PLUOOS	100	1.41	1.42
	75	1.54	1.54
	65	1.82	1.82
	60	1.84	1.84
	50	---	---
	50	1.91	1.91
	30	2.18	2.18
	30 at > 50%F	2.67	2.67
	25 at > 50%F	2.93	2.93
	30 at <= 50%F	2.54	2.54
	25 at <= 50%F	2.75	2.75
RPTOOS TBVOOS	100	1.45	1.47
	75	1.58	1.58
	65	1.64	1.64
	60	1.67	1.67
	50	1.79	1.79
	50	1.91	1.91
	30	2.21	2.21
	30 at > 50%F	3.21	3.21
	25 at > 50%F	3.63	3.63
	30 at <= 50%F	2.74	2.74
	25 at <= 50%F	3.12	3.12
RPTOOS FHOOS	100	1.44	1.44
	75	1.58	1.58
	65	1.65	1.65
	60	1.70	1.70
	50	1.83	1.83
	50	1.91	1.91
	30	2.29	2.29
	30 at > 50%F	2.77	2.77
	25 at > 50%F	3.06	3.06
	30 at <= 50%F	2.63	2.63
	25 at <= 50%F	2.87	2.87
RPTOOS PLUOOS	100	1.41	1.42
	75	1.54	1.54
	65	1.82	1.82
	60	1.84	1.84
	50	---	---
	50	1.91	1.91
	30	2.18	2.18
	30 at > 50%F	2.67	2.67
	25 at > 50%F	2.93	2.93
	30 at <= 50%F	2.54	2.54
	25 at <= 50%F	2.75	2.75

* The term "Base Case" can be thought of as an all equipment in-service condition. All limits, including the "Base Case," support operation with any combination of 1 MSRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels), and up to 50% of the LPRMs out-of-service. For single-loop operation, $MCPR_P$ limits will be 0.02 higher.

A 50% power step change for PLUOOS limits is not supported. When core power is ≤ 50%, the LRNB event is the same with, or without PLUOOS.

Table 4.2 $MCPR_P$ Limits for Nominal Scram Time Basis (*continued*)*

Operating Condition	Power (% of rated)	BOC to NEOC	BOC to EOC
TBVOOS FHOOS	100	1.47	1.48
	75	1.62	1.62
	65	1.68	1.68
	60	1.73	1.73
	50	1.86	1.86
	50	1.91	1.91
	30	2.32	2.32
	30 at > 50%F	3.33	3.33
	25 at > 50%F	3.77	3.77
	30 at <= 50%F	2.86	2.86
	25 at <= 50%F	3.28	3.28
TBVOOS PLUOOS	100	1.45	1.47
	75	1.58	1.58
	65	1.82	1.82
	60	1.84	1.84
	50	---	---
	50	1.91	1.91
	30	2.21	2.21
	30 at > 50%F	3.21	3.21
	25 at > 50%F	3.63	3.63
	30 at <= 50%F	2.74	2.74
	25 at <= 50%F	3.12	3.12
FHOOS PLUOOS	100	1.44	1.44
	75	1.58	1.58
	65	1.82	1.82
	60	1.84	1.84
	50	---	---
	50	1.91	1.91
	30	2.29	2.29
	30 at > 50%F	2.77	2.77
	25 at > 50%F	3.06	3.06
	30 at <= 50%F	2.63	2.63
	25 at <= 50%F	2.87	2.87
RPTOOS TBVOOS FHOOS	100	1.47	1.48
	75	1.62	1.62
	65	1.68	1.68
	60	1.73	1.73
	50	1.86	1.86
	50	1.91	1.91
	30	2.32	2.32
	30 at > 50%F	3.33	3.33
	25 at > 50%F	3.77	3.77
	30 at <= 50%F	2.86	2.86
	25 at <= 50%F	3.28	3.28
RPTOOS TBVOOS PLUOOS	100	1.45	1.47
	75	1.58	1.58
	65	1.82	1.82
	60	1.84	1.84
	50	---	---
	50	1.91	1.91
	30	2.21	2.21
	30 at > 50%F	3.21	3.21
	25 at > 50%F	3.63	3.63
	30 at <= 50%F	2.74	2.74
	25 at <= 50%F	3.12	3.12
RPTOOS FHOOS PLUOOS	100	1.44	1.44
	75	1.58	1.58
	65	1.82	1.82
	60	1.84	1.84
	50	---	---
	50	1.91	1.91
	30	2.29	2.29
	30 at > 50%F	2.77	2.77
	25 at > 50%F	3.06	3.06
	30 at <= 50%F	2.63	2.63
	25 at <= 50%F	2.87	2.87
TBVOOS FHOOS PLUOOS	100	1.47	1.48
	75	1.62	1.62
	65	1.82	1.82
	60	1.84	1.84
	50	---	---
	50	1.91	1.91
	30	2.32	2.32
	30 at > 50%F	3.33	3.33
	25 at > 50%F	3.77	3.77
	30 at <= 50%F	2.86	2.86
	25 at <= 50%F	3.28	3.28
RPTOOS TBVOOS FHOOS PLUOOS	100	1.47	1.48
	75	1.62	1.62
	65	1.82	1.82
	60	1.84	1.84
	50	---	---
	50	1.91	1.91
	30	2.32	2.32
	30 at > 50%F	3.33	3.33
	25 at > 50%F	3.77	3.77
	30 at <= 50%F	2.86	2.86
	25 at <= 50%F	3.28	3.28

* The term "Base Case" can be thought of as an all equipment in-service condition. All limits, including the "Base Case," support operation with any combination of 1 MSRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels), and up to 50% of the LPRMs out-of-service. For single-loop operation, $MCPR_P$ limits will be 0.02 higher.

A 50% power step change for PLUOOS limits is not supported. When core power is ≤ 50%, the LRNB event is the same with, or without PLUOOS.

Table 4.3 $MCPR_P$ Limits for Technical Specification Scram Time Basis*

Operating Condition	Power (% of rated)	BOC to NEOC	BOC to EOC	Operating Condition	Power (% of rated)	BOC to NEOC	BOC to EOC
Base Case	100	1.43	1.44	PLUOOS	100	1.43	1.44
	75	1.56	1.56		75	1.56	1.56
	65	1.62	1.62		65	1.83	1.83
	60	1.66	1.66		60	1.85	1.85
	50	1.77	1.77		50	---	---
	50	1.92	1.92		50	1.92	1.92
	30	2.20	2.20		30	2.20	2.20
	30 at > 50%F	2.67	2.67		30 at > 50%F	2.67	2.67
	25 at > 50%F	2.93	2.93		25 at > 50%F	2.93	2.93
	30 at <= 50%F	2.54	2.54		30 at <= 50%F	2.54	2.54
	25 at <= 50%F	2.75	2.75		25 at <= 50%F	2.75	2.75
TBVOOS	100	1.47	1.48	RPTOOS TBVOOS	100	1.47	1.48
	75	1.62	1.62		75	1.62	1.62
	65	1.66	1.66		65	1.66	1.66
	60	1.70	1.70		60	1.70	1.70
	50	1.81	1.81		50	1.81	1.81
	50	1.92	1.92		50	1.92	1.92
	30	2.23	2.23		30	2.23	2.23
	30 at > 50%F	3.21	3.21		30 at > 50%F	3.21	3.21
	25 at > 50%F	3.63	3.63		25 at > 50%F	3.63	3.63
	30 at <= 50%F	2.74	2.74		30 at <= 50%F	2.74	2.74
	25 at <= 50%F	3.12	3.12		25 at <= 50%F	3.12	3.12
RPTOOS	100	1.43	1.44	RPTOOS FHOOS	100	1.46	1.46
	75	1.56	1.56		75	1.59	1.59
	65	1.62	1.62		65	1.67	1.67
	60	1.66	1.66		60	1.72	1.72
	50	1.77	1.77		50	1.84	1.84
	50	1.92	1.92		50	1.92	1.92
	30	2.20	2.20		30	2.30	2.30
	30 at > 50%F	2.67	2.67		30 at > 50%F	2.77	2.77
	25 at > 50%F	2.93	2.93		25 at > 50%F	3.06	3.06
	30 at <= 50%F	2.54	2.54		30 at <= 50%F	2.63	2.63
	25 at <= 50%F	2.75	2.75		25 at <= 50%F	2.87	2.87
FHOOS	100	1.46	1.46	RPTOOS PLUOOS	100	1.43	1.44
	75	1.59	1.59		75	1.56	1.56
	65	1.67	1.67		65	1.83	1.83
	60	1.72	1.72		60	1.85	1.85
	50	1.84	1.84		50	---	---
	50	1.92	1.92		50	1.92	1.92
	30	2.30	2.30		30	2.20	2.20
	30 at > 50%F	2.77	2.77		30 at > 50%F	2.67	2.67
	25 at > 50%F	3.06	3.06		25 at > 50%F	2.93	2.93
	30 at <= 50%F	2.63	2.63		30 at <= 50%F	2.54	2.54
	25 at <= 50%F	2.87	2.87		25 at <= 50%F	2.75	2.75

* The term "Base Case" can be thought of as an all equipment in-service condition. All limits, including the "Base Case," support operation with any combination of 1 MSRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels), and up to 50% of the LPRMs out-of-service. For single-loop operation, $MCPR_P$ limits will be 0.02 higher.

A 50% power step change for PLUOOS limits is not supported. When core power is ≤ 50%, the LRNB event is the same with, or without PLUOOS.

Table 4.3 $MCPR_P$ Limits for Technical Specification Scram Time Basis (*continued*)*

Operating Condition	Power (% of rated)	BOC to NEOC	BOC to EOC
TBVOOS FHOOS	100	1.50	1.50
	75	1.63	1.63
	65	1.70	1.70
	60	1.75	1.75
	50	1.88	1.88
	50	1.92	1.92
	30	2.34	2.34
	30 at > 50%F	3.33	3.33
	25 at > 50%F	3.77	3.77
	30 at <= 50%F	2.86	2.86
	25 at <= 50%F	3.28	3.28
TBVOOS PLUOOS	100	1.47	1.48
	75	1.62	1.62
	65	1.83	1.83
	60	1.85	1.85
	50	---	---
	50	1.92	1.92
	30	2.23	2.23
	30 at > 50%F	3.21	3.21
	25 at > 50%F	3.63	3.63
	30 at <= 50%F	2.74	2.74
	25 at <= 50%F	3.12	3.12
FHOOS PLUOOS	100	1.46	1.46
	75	1.59	1.59
	65	1.83	1.83
	60	1.85	1.85
	50	---	---
	50	1.92	1.92
	30	2.30	2.30
	30 at > 50%F	2.77	2.77
	25 at > 50%F	3.06	3.06
	30 at <= 50%F	2.63	2.63
	25 at <= 50%F	2.87	2.87
RPTOOS TBVOOS FHOOS	100	1.50	1.50
	75	1.63	1.63
	65	1.70	1.70
	60	1.75	1.75
	50	1.88	1.88
	50	1.92	1.92
	30	2.34	2.34
	30 at > 50%F	3.33	3.33
	25 at > 50%F	3.77	3.77
	30 at <= 50%F	2.86	2.86
	25 at <= 50%F	3.28	3.28
RPTOOS TBVOOS PLUOOS	100	1.47	1.48
	75	1.62	1.62
	65	1.83	1.83
	60	1.85	1.85
	50	---	---
	50	1.92	1.92
	30	2.23	2.23
	30 at > 50%F	3.21	3.21
	25 at > 50%F	3.63	3.63
	30 at <= 50%F	2.74	2.74
	25 at <= 50%F	3.12	3.12
RPTOOS FHOOS PLUOOS	100	1.46	1.46
	75	1.59	1.59
	65	1.83	1.83
	60	1.85	1.85
	50	---	---
	50	1.92	1.92
	30	2.30	2.30
	30 at > 50%F	2.77	2.77
	25 at > 50%F	3.06	3.06
	30 at <= 50%F	2.63	2.63
	25 at <= 50%F	2.87	2.87
TBVOOS FHOOS PLUOOS	100	1.50	1.50
	75	1.63	1.63
	65	1.83	1.83
	60	1.85	1.85
	50	---	---
	50	1.92	1.92
	30	2.34	2.34
	30 at > 50%F	3.33	3.33
	25 at > 50%F	3.77	3.77
	30 at <= 50%F	2.86	2.86
	25 at <= 50%F	3.28	3.28
RPTOOS TBVOOS FHOOS PLUOOS	100	1.50	1.50
	75	1.63	1.63
	65	1.83	1.83
	60	1.85	1.85
	50	---	---
	50	1.92	1.92
	30	2.34	2.34
	30 at > 50%F	3.33	3.33
	25 at > 50%F	3.77	3.77
	30 at <= 50%F	2.86	2.86
	25 at <= 50%F	3.28	3.28

* The term "Base Case" can be thought of as an all equipment in-service condition. All limits, including the "Base Case," support operation with any combination of 1 MSRVOOS, up to 2 TIPOOS (or the equivalent number of TIP channels), and up to 50% of the LPRMs out-of-service. For single-loop operation, $MCPR_P$ limits will be 0.02 higher.

A 50% power step change for PLUOOS limits is not supported. When core power is ≤ 50%, the LRNB event is the same with, or without PLUOOS.

5 APRM Flow Biased Rod Block Trip Settings

(Technical Requirements Manual Section 5.3.1 and Table 3.3.4-1)

The APRM rod block trip setting is based upon References 21 & 22, and is defined by the following:

$SRB \leq (0.66(W-\Delta W) + 61\%)$ Allowable Value

$SRB \leq (0.66(W-\Delta W) + 59\%)$ Nominal Trip Setpoint (NTSP)

where:

SRB = Rod Block setting in percent of rated thermal power (3458 MW_t)

W = Loop recirculation flow rate in percent of rated

ΔW = Difference between two-loop and single-loop effective recirculation flow at the same core flow (ΔW=0.0 for two-loop operation)

The APRM rod block trip setting is clamped at a maximum allowable value of 115% (corresponding to a NTSP of 113%).

6 Rod Block Monitor (RBM) Trip Setpoints and Operability

(Technical Specification Table 3.3.2.1-1)

The RBM trip setpoints and applicable power ranges, based on References 21 & 22, are shown in Table 6.1. Setpoints are based on an HTSP, unfiltered analytical limit of 117%. Unfiltered setpoints are consistent with a nominal RBM filter setting of 0.0 seconds; filtered setpoints are consistent with a nominal RBM filter setting less than 0.5 seconds. A CRWE based OLMCPR of 1.39 is identified in Reference 1. Cycle specific CRWE analyses of OLMCPR are documented in Reference 1, superceding values reported in References 21, 22, and 24.

Table 6.1 Analytical RBM Trip Setpoints*

RBM Trip Setpoint		Allowable Value (AV)	Nominal Trip Setpoint (NTSP)
LPSP		27%	25%
IPSP		62%	60%
HPSP		82%	80%
LTSP	- unfiltered	124.7%	123.0%
	- filtered	123.5%	121.8%
ITSP	- unfiltered	119.7%	118.0%
	- filtered	118.7%	117.0%
HTSP	- unfiltered	114.7%	113.0%
	- filtered	113.7%	112.0%
DTSP		90%	92%

As a result of cycle specific CRWE analyses, RBM setpoints in Technical Specification Table 3.3.2.1-1 are applicable as shown in Table 6.2. Cycle specific analysis results show the SLMCPR remains protected for RBM inoperable conditions (i.e., unblocked) per Reference 1.

Table 6.2 RBM Setpoint Applicability

Thermal Power (% Rated)	Applicable MCPR†	Notes from Table 3.3.2.1-1	Comment
> 27% and < 90%	< 1.72	(a), (b), (f), (h)	two loop operation
	< 1.75	(a), (b), (f), (h)	single loop operation
≥ 90%	< 1.42	(g)	two loop operation‡

* Values are considered maximums. Using lower values, due to RBM system hardware/software limitations, is conservative, and acceptable.

† MCPR values shown correspond with, (support), SLMPCR values identified in Reference 1.

‡ Greater than 90% rated power is not attainable in single loop operation.

7 Shutdown Margin Limit

(Technical Specification 3.1.1)

Assuming the strongest OPERABLE control blade is fully withdrawn, and all other OPERABLE control blades are fully inserted, the core shall be sub-critical and meet the following minimum shutdown margin:

SDM > 0.38% dk/k