



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

March 13, 2020

10 CFR 50.4

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

Browns Ferry Nuclear Plant, Unit 3
Renewed Facility Operating License No. DPR-68
NRC Docket No. 50-296

**Subject: Browns Ferry Nuclear Plant, Unit 3 Core Operating Limits Report for
Cycle 20 Operation, Revision 0**

In accordance with the requirements of Technical Specification (TS) 5.6.5.d, the Tennessee Valley Authority is submitting the Browns Ferry Nuclear Plant (BFN), Unit 3, Cycle 20, Core Operating Limits Report (COLR). Revision 0 of the Unit 3 COLR includes all Modes of operation (Modes 1 through 5).

There are no new commitments contained in this letter. If you have any questions please contact J. L. Paul at (256) 729-7874.

Respectfully,



S. M. Bono
Site Vice President

Enclosure: Core Operating Limits Report, (120% OLTP, MELLLA+), for Unit 3 Cycle 20 Operation, TVA-COLR-BF3C20, Revision 0

cc: (w/ Enclosure)

NRC Regional Administrator - Region II
NRC Senior Resident Inspector - Browns Ferry Nuclear Plant
NRC Project Manager - Browns Ferry Nuclear Plant

**Enclosure
Tennessee Valley Authority
Browns Ferry Nuclear Plant
Unit 3**

**Core Operating Limits Report, (120% OLTP, MELLLA+), for Unit 3 Cycle 20
Operation, TVA-COLR-BF3C20, Revision 0**

(See Attached)



EDMS L94 200213 800
QA Document
BFE-4485, Revision 0

Reactor Engineering and Fuels - BWRFE

1101 Market Street, Chattanooga, TN 37402

Browns Ferry Unit 3 Cycle 20

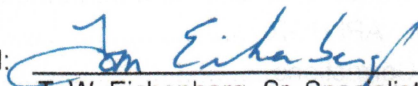
Core Operating Limits Report, (120% OLTP, MELLLA+)

TVA-COLR-BF3C20 Revision 0 (Final)

(Revision Log, Page v)

February 2020

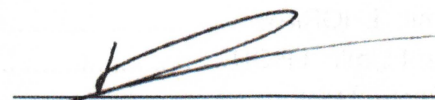
Prepared:


T. W. Eichenberg, Sr. Specialist

Date:

Feb 18, 2020

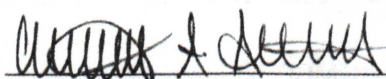
Verified:


B. C. Mitchell, Engineer

Date:

2/19/20

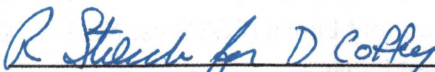
Approved:


C. A. Setter, Manager, BWRFE

Date:

2/20/2020

Reviewed:


D. D. Coffey, Manager, Reactor Engineering

Date:

2/21/20

Approved:


Chairman, PORC

Date:

02/27/20

Approved:


Plant Manager

Date:

3/2/20



Table of Contents

Total Number of Pages = 44 (including review cover sheet)

| | |
|---|------|
| List of Tables | iii |
| List of Figures | iv |
| Revision Log | v |
| Nomenclature | vi |
| References | viii |
| 1 Introduction | 1 |
| 1.1 Purpose | 1 |
| 1.2 Scope | 1 |
| 1.3 Fuel Loading..... | 1 |
| 1.4 Acceptability | 2 |
| 2 APLHGR Limits | 3 |
| 2.1 Rated Power and Flow Limit: $APLHGR_{RATED}$ | 3 |
| 2.2 Off-Rated Power Dependent Limit: $APLHGR_P$ | 3 |
| 2.2.1 Startup without Feedwater Heaters..... | 3 |
| 2.3 Off-Rated Flow Dependent Limit: $APLHGR_F$ | 3 |
| 2.4 Single Loop Operation Limit: $APLHGR_{SLO}$ | 3 |
| 2.5 Equipment Out-Of-Service Corrections..... | 5 |
| 3 LHGR Limits..... | 6 |
| 3.1 Rated Power and Flow Limit: $LHGR_{RATED}$ | 6 |
| 3.2 Off-Rated Power Dependent Limit: $LHGR_P$ | 6 |
| 3.2.1 Startup without Feedwater Heaters..... | 6 |
| 3.3 Off-Rated Flow Dependent Limit: $LHGR_F$ | 7 |
| 3.4 Equipment Out-Of-Service Corrections..... | 7 |
| 4 OLM CPR Limits..... | 13 |
| 4.1 Flow Dependent MCPR Limit: $MCPR_F$ | 13 |
| 4.2 Power Dependent MCPR Limit: $MCPR_P$ | 13 |
| 4.2.1 Startup without Feedwater Heaters..... | 13 |
| 4.2.2 Scram Speed Dependent Limits (TSSS vs. NSS vs. OSS) | 14 |
| 4.2.3 Exposure Dependent Limits | 14 |
| 4.2.4 Equipment Out-Of-Service (EOOS) Options | 15 |
| 4.2.5 Single-Loop-Operation (SLO) Limits | 15 |
| 4.2.6 Below Pbyypass Limits | 15 |
| 5 Thermal-Hydraulic Stability Protection..... | 27 |
| 6 APRM Flow Biased Rod Block Trip Settings..... | 29 |
| 7 Rod Block Monitor (RBM) Trip Setpoints and Operability | 30 |
| 8 Shutdown Margin Limit..... | 32 |
| Appendix A: MBSP Maps..... | A-1 |



List of Tables

| | |
|--|----|
| Nuclear Fuel Types | 2 |
| Startup Feedwater Temperature Basis..... | 6 |
| Nominal Scram Time Basis | 14 |
| MCPR _P Limits for All Fuel Types: Optimum Scram Time Basis | 17 |
| MCPR _P Limits for All Fuel Types: Nominal Scram Time Basis | 18 |
| MCPR _P Limits for All Fuel Types: Technical Specification Scram Time Basis | 20 |
| Startup Operation MCPR _P Limits for Table 3.1 Temperature Range 1 for All Fuel Types: Nominal Scram Time Basis | 22 |
| Startup Operation MCPR _P Limits for Table 3.1 Temperature Range 2 for All Fuel Types: Nominal Scram Time Basis | 23 |
| Startup Operation MCPR _P Limits for Table 3.1 Temperature Range 1 for All Fuel Types: Technical Specification Scram Time Basis | 24 |
| Startup Operation MCPR _P Limits for Table 3.1 Temperature Range 2 for All Fuel Types: Technical Specification Scram Time Basis | 25 |
| MCPR _P Limits for All Fuel Types: Single Loop Operation for All Scram Times | 26 |
| ABSP Setpoints for the Scram Region | 27 |
| Analyzed MBSP Endpoints: Nominal Feedwater Temperature..... | 28 |
| Analyzed MBSP Endpoints: Reduced Feedwater Temperature | 28 |
| Analytical RBM Trip Setpoints | 30 |
| RBM Setpoint Applicability | 30 |
| Control Rod Withdrawal Error Results..... | 31 |



List of Figures

APLHGR_{RATED} for ATRIUM-10XM Fuel 4

LHGR_{RATED} for ATRIUM-10XM Fuel 8

Base Operation LHGRFAC_P for ATRIUM-10XM Fuel..... 9

LHGRFAC_F for ATRIUM-10XM Fuel10

Startup Operation LHGRFAC_P for ATRIUM-10XM Fuel: Table 3.1 Temperature Range 111

Startup Operation LHGRFAC_P for ATRIUM-10XM Fuel: Table 3.1 Temperature Range 212

MCPR_F for All Fuel Types 16

MBSP Boundaries For Nominal Feedwater Temperature.....A-2

MBSP Boundaries For Reduced Feedwater TemperatureA-3



Revision Log

| Number | Page | Description |
|--------|------|---------------|
| 0-R0 | All | New document. |



Nomenclature

| | |
|----------|--|
| ABSP | Automatic Backup Stability Protection |
| APLHGR | Average Planar LHGR |
| APRM | Average Power Range Monitor |
| AREVA NP | Vendor (Framatome, Siemens) |
| BOC | Beginning of Cycle |
| BSP | Backup Stability Protection |
| BWR | Boiling Water Reactor |
| CAVEX | Core Average Exposure |
| CD | Coast Down |
| CMSS | Core Monitoring System Software |
| COLR | Core Operating Limits Report |
| CPR | Critical Power Ratio |
| CRWE | Control Rod Withdrawal Error |
| CSDM | Cold SDM |
| DIVOM | Delta CPR over Initial CPR vs. Oscillation Magnitude |
| DSS-CD | Detect and Suppress Solution – Confirmation Density |
| EOC | End of Cycle |
| EOCLB | End-of-Cycle Licensing Basis |
| EOOS | Equipment OOS |
| EPU | Extended Power Uprate (120% OLTP) |
| FFTR | Final Feedwater Temperature Reduction |
| FFWTR | Final Feedwater Temperature Reduction |
| FHOOS | Feedwater Heaters OOS |
| ft | Foot: English unit of measure for length |
| GNF | Vendor (General Electric, Global Nuclear Fuels) |
| GWd | Giga Watt Day |
| HTSP | High TSP |
| ICA | Interim Corrective Action |
| ICF | Increased Core Flow (beyond rated) |
| IS | In-Service |
| kW | kilo watt: SI unit of measure for power. |
| LCO | License Condition of Operation |
| LFWH | Loss of Feedwater Heating |
| LHGRFAC | LHGR Multiplier (Power or Flow dependent) |
| LPRM | Low Power Range Monitor |
| LRNB | Generator Load Reject, No Bypass |



| | |
|---------|--|
| MAPFAC | MAPLHGR multiplier (Power or Flow dependent) |
| MBSP | Manual Backup Stability Protection |
| MCPR | Minimum CPR |
| MELLLA | Maximum Extended Load Line Limit Analysis |
| MELLLA+ | Maximum Extended Load Line Limit Analysis Plus |
| MSRV | Moisture Separator Reheater Valve |
| MSRVOOS | MSRV OOS |
| MTU | Metric Ton Uranium |
| MWd/MTU | Mega Watt Day per Metric Ton Uranium |
| NEOC | Near EOC |
| NRC | United States Nuclear Regulatory Commission |
| NSS | Nominal Scram Speed |
| NTSP | Nominal TSP |
| OLMCPR | MCPR Operating Limit |
| OLTP | Original Licensed Thermal Power |
| OOS | Out-Of-Service |
| OPRM | Oscillation Power Range Monitor |
| OSS | Optimum Scram Speed |
| PBDA | Period Based Detection Algorithm |
| Pbypass | Power, below which TSV Position and TCV Fast Closure Scrams are Bypassed |
| PLU | Power Load Unbalance |
| PLUOOS | PLU OOS |
| PRNM | Power Range Neutron Monitor |
| RBM | Rod Block Monitor |
| RCPOOS | Recirculation Pump OOS (SLO) |
| RDF | Rated Drive Flow |
| RPS | Reactor Protection System |
| RPT | Recirculation Pump Trip |
| RPTOOS | RPT OOS |
| RTP | Rated Thermal Power |
| SDM | Shutdown Margin |
| SLMCPR | MCPR Safety Limit |
| SLO | Single Loop Operation |
| TBV | Turbine Bypass Valve |
| TBVIS | TBV IS |
| TBVOOS | Turbine Bypass Valves OOS |
| TIP | Transversing In-core Probe |
| TIPOOS | TIP OOS |
| TLO | Two Loop Operation |
| TSP | Trip Setpoint |
| TSSS | Technical Specification Scram Speed |
| TVA | Tennessee Valley Authority |



References

1. ANP-3813, Revision 0, **Browns Ferry Unit 3 Cycle 20 Reload Analysis**, Framatome Inc., January 2020.
2. Not Used.
3. ANP-3150P, Revision 4, **Mechanical Design Report for Browns Ferry ATRIUM 10XM Fuel Assemblies**, AREVA Inc., November 2017.
4. ANP-3793P Revision 0, **Browns Ferry Unit 3 Cycle 20 Plant Parameters Document**, Framatome Inc., June 2019.
5. BFE-4468, Revision 0, **Browns Ferry Unit 3 Cycle 20 In-Core Shuffle**, Tennessee Valley Authority, January 31, 2020.

Methodology References

6. XN-NF-81-58(P)(A) Revision 2 and Supplements 1 and 2, **RODEX2 Fuel Rod Thermal-Mechanical Response Evaluation Model**, Exxon Nuclear Company, March 1984.
7. XN-NF-85-67(P)(A) Revision 1, **Generic Mechanical Design for Exxon Nuclear Jet Pump BWR Reload Fuel**, Exxon Nuclear Company, September 1986.
8. EMF-85-74(P) Revision 0 Supplement 1(P)(A) and Supplement 2(P)(A), **RODEX2A (BWR) Fuel Rod Thermal-Mechanical Evaluation Model**, Siemens Power Corporation, February 1998.
9. ANF-89-98(P)(A) Revision 1 and Supplement 1, **Generic Mechanical Design Criteria for BWR Fuel Designs**, Advanced Nuclear Fuels Corporation, May 1995.
10. XN-NF-80-19(P)(A) Volume 1 and Supplements 1 and 2, **Exxon Nuclear Methodology for Boiling Water Reactors - Neutronic Methods for Design and Analysis**, Exxon Nuclear Company, March 1983.
11. XN-NF-80-19(P)(A) Volume 4 Revision 1, **Exxon Nuclear Methodology for Boiling Water Reactors: Application of the ENC Methodology to BWR Reloads**, Exxon Nuclear Company, June 1986.
12. EMF-2158(P)(A) Revision 0, **Siemens Power Corporation Methodology for Boiling Water Reactors: Evaluation and Validation of CASMO-4/MICROBURN-B2**, Siemens Power Corporation, October 1999.
13. XN-NF-80-19(P)(A) Volume 3 Revision 2, **Exxon Nuclear Methodology for Boiling Water Reactors, THERMEX: Thermal Limits Methodology Summary Description**, Exxon Nuclear Company, January 1987.
14. XN-NF-84-105(P)(A) Volume 1 and Volume 1 Supplements 1 and 2, **XCOBRA-T: A Computer Code for BWR Transient Thermal-Hydraulic Core Analysis**, Exxon Nuclear Company, February 1987.
15. ANP-10307PA, Revision 0, **AREVA MCPR Safety Limit Methodology for Boiling Water Reactors**, AREVA NP Inc., June 2011.



16. ANF-913(P)(A) Volume 1 Revision 1 and Volume 1 Supplements 2, 3 and 4, **COTRANSA2: A Computer Program for Boiling Water Reactor Transient Analyses**, Advanced Nuclear Fuels Corporation, August 1990.
17. ANF-1358(P)(A) Revision 3, **The Loss of Feedwater Heating Transient in Boiling Water Reactors**, Advanced Nuclear Fuels Corporation, September 2005.
18. EMF-2209(P)(A) Revision 3, **SPCB Critical Power Correlation**, AREVA NP Inc., September 2009.
19. EMF-2361(P)(A) Revision 0, **EXEM BWR-2000 ECCS Evaluation Model**, Framatome ANP Inc., May 2001, [as supplemented by the site specific approval in NRC safety evaluations dated February 15, 2013 and July 31, 2014.](#)
20. EMF-2292(P)(A) Revision 0, **ATRIUM™-10: Appendix K Spray Heat Transfer Coefficients**, Siemens Power Corporation, September 2000.
21. EMF-CC-074(P)(A), Volume 4, Revision 0, **BWR Stability Analysis: Assessment of STAIF with Input from MICROBURN-B2**, Siemens Power Corporation, August 2000.
22. BAW-10255(P)(A), Revision 2, **Cycle-Specific DIVOM Methodology Using the RAMONA5-FA Code**, AREVA NP Inc., May 2008.
23. BAW-10247PA, Revision 0, **Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors**, AREVA NP Inc., April 2008.
24. ANP-10298PA, Revision 0, **ACE/ATRIUM 10XM Critical Power Correlation**, AREVA NP Inc., March 2010.
25. ANP-3140(P), Revision 0, **Browns Ferry Units 1, 2, and 3 Improved K-factor Model for ACE/ATRIUM 10XM Critical Power Correlation**, AREVA NP Inc., August 2012.
26. NEDC-33075P-A, Revision 8, **GE Hitachi Boiling Water Reactor Detect and Suppress Solution – Confirmation Density**, GE Hitachi, November 2013.

Setpoint References

27. EDQ2092900118, R35, *Setpoint and Scaling Calculation for Neutron Monitoring & Recirculation Flow Loops*, Calculation File, Tennessee Valley Authority, August 9, 2019.
28. Task T0500, Revision 0, **Neutron Monitoring System w/RBM**, Project Task Report, GE Hitachi Nuclear Energy, June 2017.
29. Task T0506, Revision 0, **TS Instrument Setpoints**, Project Task Report, Tennessee Valley Authority, August, 2017.
30. NEDC-33006P-A, Revision 3, **General Electric Boiling Water Reactor Maximum Extended Load Line Limit Analysis Plus**, GE Energy Nuclear, June 2009.



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)
Applicability: Mode 1, $\geq 23\%$ RTP (Technical Specifications definition of RTP)
- Linear Heat Generation Rate (LHGR) Limit
(Technical Specification 3.2.3, 3.3.4.1, and 3.7.5)
Applicability: Mode 1, $\geq 23\%$ RTP (Technical Specifications definition of RTP)
- Minimum Critical Power Ratio Operating Limit (OLMCPR)
(Technical Specifications 3.2.2, 3.3.4.1, 3.7.5 and Table 3.3.2.1-1)
Applicability: Mode 1, $\geq 23\%$ RTP (Technical Specifications definition of RTP)
- Thermal-Hydraulic Stability Protection
(Technical Specification Table 3.3.1.1)
Applicability: Mode 1, \geq (as specified in Technical Specifications Table 3.3.1.1-1)
- Average Power Range Monitor (APRM) Flow Biased Rod Block Trip Setting
(Technical Requirements Manual Section 5.3.1 and Table 3.3.4-1)
Applicability: Mode 1, \geq (as specified in Technical Requirements Manuals Table 3.3.4-1)
- Rod Block Monitor (RBM) Trip Setpoints and Operability
(Technical Specification Table 3.3.2.1-1)
Applicability: Mode 1, \geq % RTP as specified in Table 3.3.2.1-1 (TS definition of RTP)
- Shutdown Margin (SDM) Limit
(Technical Specification 3.1.1)
Applicability: All Modes

1.3 Fuel Loading

The core will contain fresh, and previously exposed ATRIUM-10XM. Nuclear fuel types used in the core loading are shown in Table 1.1. The core shuffle and final loading were explicitly evaluated for BOC cold shutdown margin performance as documented per Reference 5.



Table 1.1 Nuclear Fuel Types *

| Fuel Description | Original Cycle | Number of Assemblies | Nuclear Fuel Type (NFT) | Fuel Names (Range) |
|-----------------------------------|----------------|----------------------|-------------------------|--------------------|
| ATRIUM-10XM XMLC-4105B-11GV70-FCG | 18 | 72 | 19 | FCG601-FCG672 |
| ATRIUM-10XM XMLC-4096B-12GV80-FCG | 18 | 22 | 20 | FCG673-FCG808 |
| ATRIUM-10XM XMLC-4055B-13GV70-FCG | 18 | 17 | 21 | FCG809-FCG904 |
| ATRIUM-10XM XMLC-3911B-13GV80-FCH | 19 | 238 | 22 | FCH001-FCH240 |
| ATRIUM-10XM XMLC-4053B-12GV80-FCH | 19 | 103 | 23 | FCH241-FCH344 |
| ATRIUM-10XM XMLC-3920B-14GV80-FCJ | 20 | 224 | 24 | FCJ345-FCJ568 |
| ATRIUM-10XM XMLC-3957B-12GV80-FCJ | 20 | 88 | 25 | FCJ569-FCJ656 |

1.4 Acceptability

Limits discussed in this document were generated based on NRC approved methodologies per References 6 through 25.

* 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:

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

where:

| | | |
|-----------------------|------------------------------|--|
| APLHGR _P | off-rated power APLHGR limit | $[\text{APLHGR}_{\text{RATED}} * \text{MAPFAC}_P]$ |
| APLHGR _F | off-rated flow APLHGR limit | $[\text{APLHGR}_{\text{RATED}} * \text{MAPFAC}_F]$ |
| APLHGR _{SLO} | SLO APLHGR limit | $[\text{APLHGR}_{\text{RATED}} * \text{SLO Multiplier}]$ |

2.1 Rated Power and Flow Limit: APLHGR_{RATED}

The rated conditions APLHGR for all fuel are identified per Reference 1. The rated conditions APLHGR for ATRIUM-10XM are shown in Figure 2.1.

2.2 Off-Rated Power Dependent Limit: APLHGR_P

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

2.2.1 Startup without Feedwater Heaters

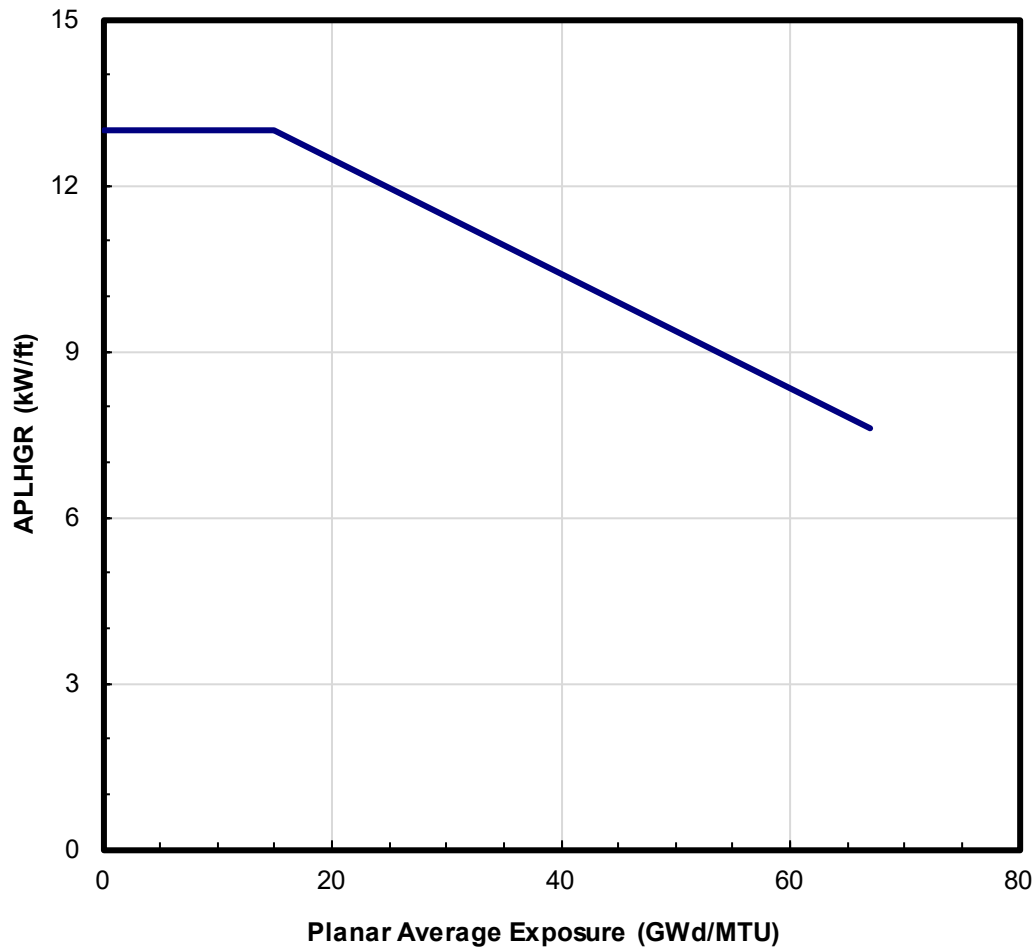
There is a range of operation during startup when the feedwater heaters are not placed into service until after the unit has reached a significant operating power level. No additional power dependent limitation is required.

2.3 Off-Rated Flow Dependent Limit: APLHGR_F

Reference 1 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-10XM fuel is **0.85**, per Reference 1.



| Planar Avg. Exposure (GWd/MTU) | APLHGR Limit (kW/ft) |
|--------------------------------------|----------------------------|
| 0.0 | 13.0 |
| 15.0 | 13.0 |
| 67.0 | 7.6 |

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



2.5 Equipment Out-Of-Service Corrections

The limits shown in Figure 2.1 are 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 (or FFWTR) | Feedwater Heaters Out-Of-Service or Final Feedwater Temperature Reduction |
| RCPOOS | One Recirculation Pump Out-Of-Service |

* All equipment service conditions assume 1 SRVOOS.



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

3.1 Rated Power and Flow Limit: $\text{LHGR}_{\text{RATED}}$

The rated conditions LHGR for all fuel are identified per Reference 1. The rated conditions LHGR for ATRIUM-10XM fuel is shown in Figure 3.1. The LHGR limit is consistent with Reference 3.

3.2 Off-Rated Power Dependent Limit: LHGR_P

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 base case multipliers are shown in Figure 3.2.

3.2.1 Startup without Feedwater Heaters

There is a range of operation during startup when the feedwater heaters are not placed into service until after the unit has reached a significant operating power level. Additional limits are shown in Figure 3.4 and Figure 3.5, based on temperature conditions identified in Table 3.1.

Table 3.1 Startup Feedwater Temperature Basis

| Power (% Rated) | Temperature | |
|--------------------|-------------|---------|
| | Range 1 | Range 2 |
| | (°F) | (°F) |
| 23 | 160.0 | 155.0 |
| 30 | 167.0 | 162.0 |
| 40 | 177.0 | 172.0 |
| 50 | 187.0 | 182.0 |



3.3 Off-Rated Flow Dependent Limit: LHGR_F

LHGR limits are adjusted for off-rated flow conditions using the LHGRFAC_F multiplier provided in Reference 1. Multipliers are shown in Figure 3.3.

3.4 Equipment Out-Of-Service Corrections

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

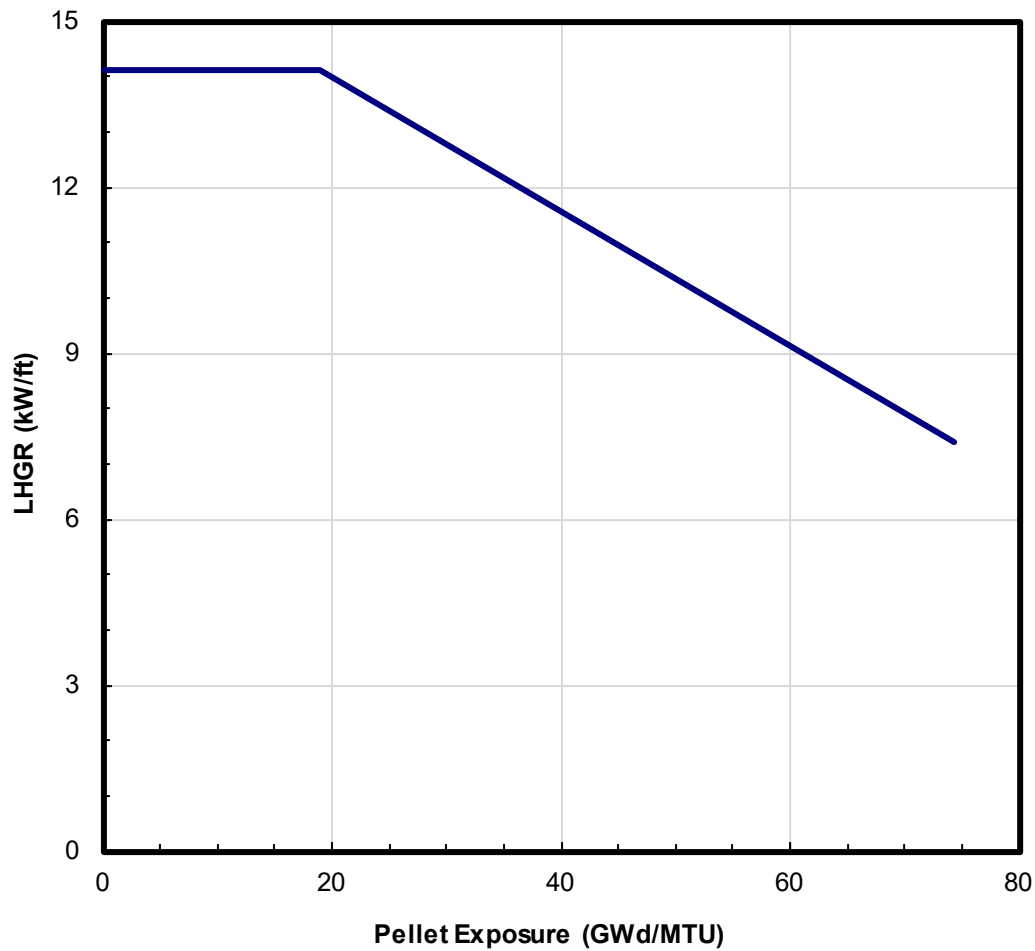
| | |
|------------------|---|
| In-Service | All equipment In-Service |
| RPTOOS | EOC-Recirculation Pump Trip Out-Of-Service |
| TBVOOS | Turbine Bypass Valve(s) Out-Of-Service |
| PLUOOS | Power Load Unbalance Out-Of-Service |
| FHOOS (or FFWTR) | Feedwater Heaters Out-Of-Service or Final Feedwater Temperature Reduction |
| RCPOOS | One Recirculation Pump Out-Of-Service |

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.

Off-rated flow corrections shown in Figure 3.3 are bounding for all EOOS conditions.

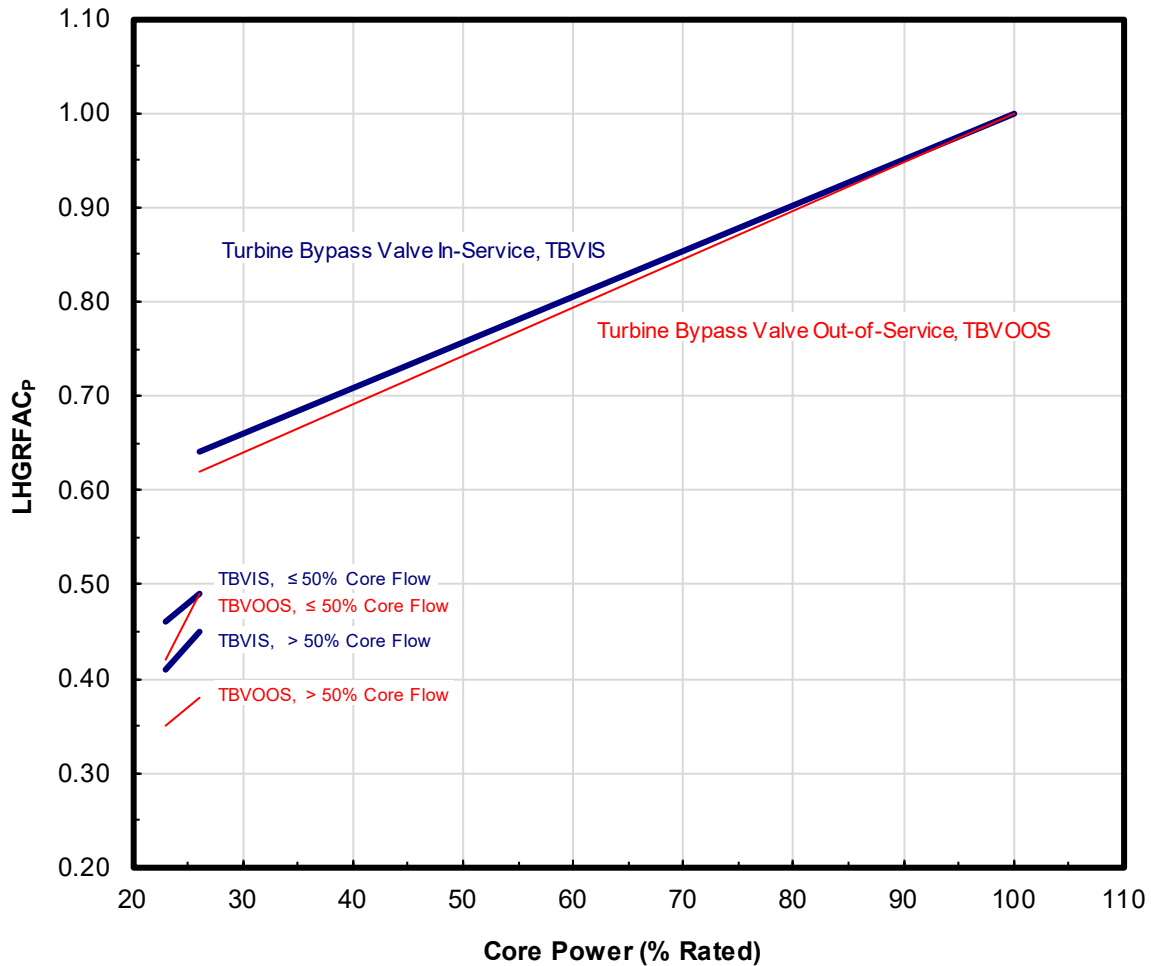
Off-rated power corrections shown in Figure 3.4 and Figure 3.5 are also dependent on operation of the Turbine Bypass Valve system. In this case, limits support FHOOS operation during startup. These limits have no dependency on RPTOOS, PLUOOS, or SLO.

* All equipment service conditions assume 1 SRVOOS.



| Pellet Exposure (GWd/MTU) | LHGR Limit (kW/ft) |
|------------------------------|-----------------------|
| 0.0 | 14.1 |
| 18.9 | 14.1 |
| 74.4 | 7.4 |

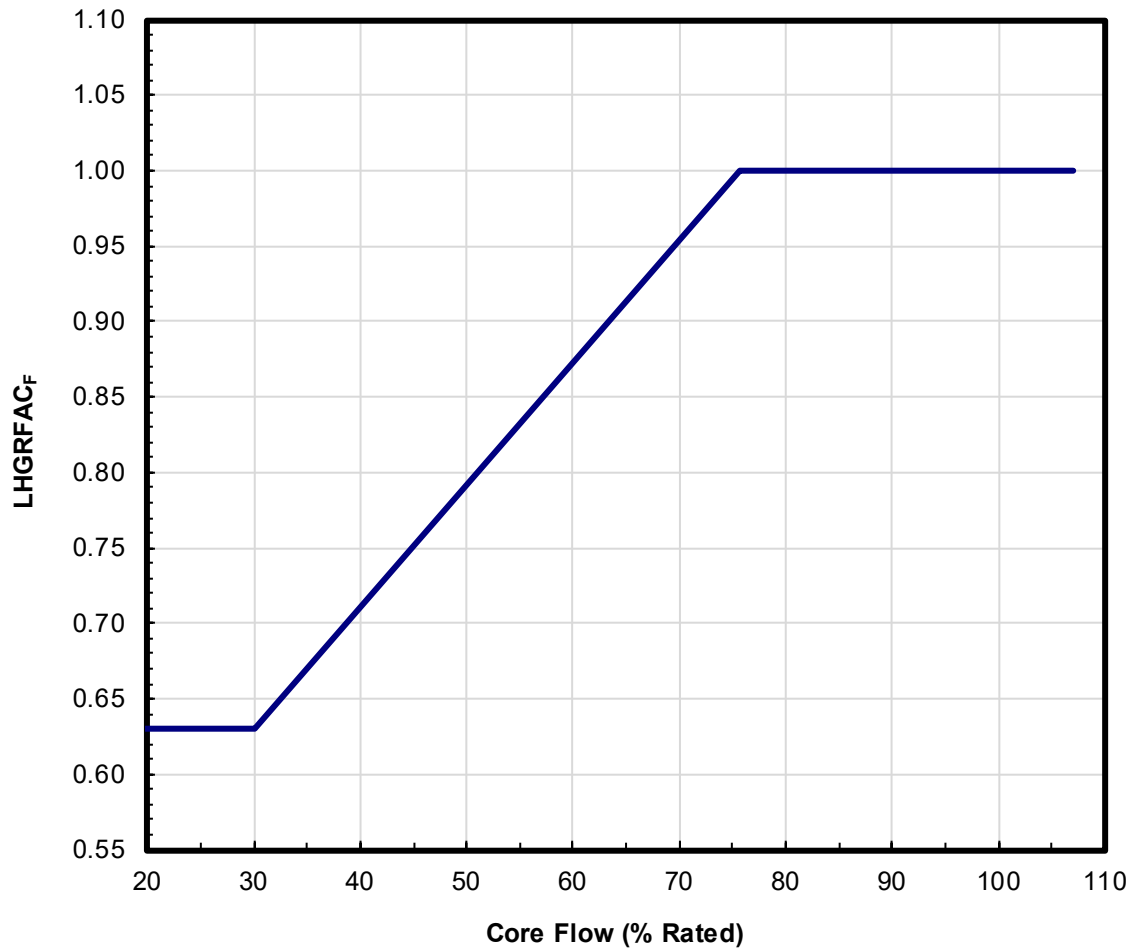
Figure 3.1 LHGR_{RATED} for ATRIUM-10XM Fuel



| <i>Turbine Bypass In-Service</i> | |
|----------------------------------|----------------------|
| Core Power | LHGRFAC _p |
| (% Rated) | |
| 100.0 | 1.00 |
| 26.0 | 0.64 |
| Core Flow > 50% Rated | |
| 26.0 | 0.45 |
| 23.0 | 0.41 |
| Core Flow $\leq 50\%$ Rated | |
| 26.0 | 0.49 |
| 23.0 | 0.46 |

| <i>Turbine Bypass Out-of-Service</i> | |
|--------------------------------------|----------------------|
| Core Power | LHGRFAC _p |
| (% Rated) | |
| 100.0 | 1.00 |
| 26.0 | 0.62 |
| Core Flow > 50% Rated | |
| 26.0 | 0.38 |
| 23.0 | 0.35 |
| Core Flow $\leq 50\%$ Rated | |
| 26.0 | 0.49 |
| 23.0 | 0.42 |

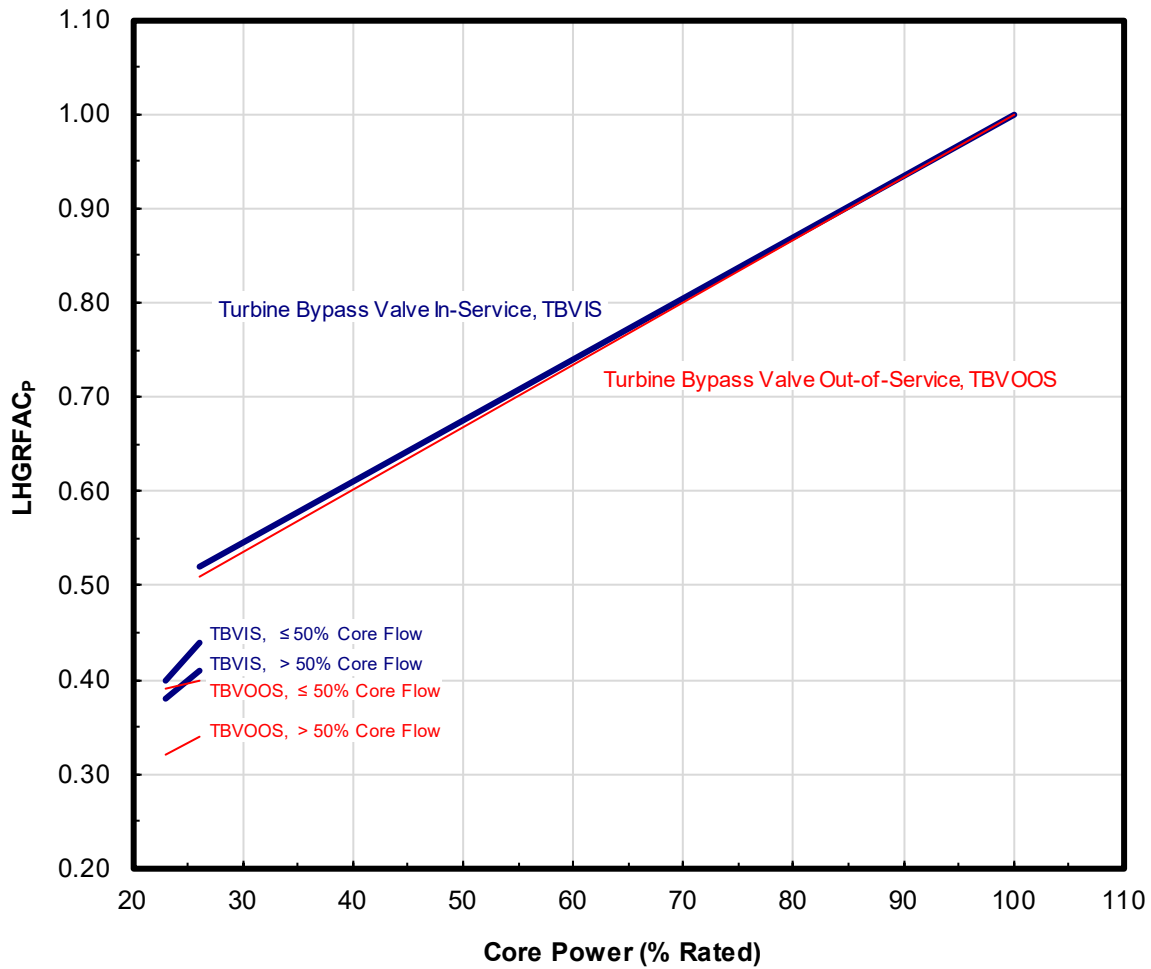
Figure 3.2 Base Operation LHGRFAC_p for ATRIUM-10XM Fuel
(Independent of other EOOS conditions)



| Core Flow (% Rated) | LHGRFAC _F |
|------------------------|----------------------|
| 0.0 | 0.63 |
| 30.0 | 0.63 |
| 75.6 | 1.00 |
| 107.0 | 1.00 |

Figure 3.3 LHGRFAC_F for ATRIUM-10XM Fuel
(Values bound all EOOS conditions)

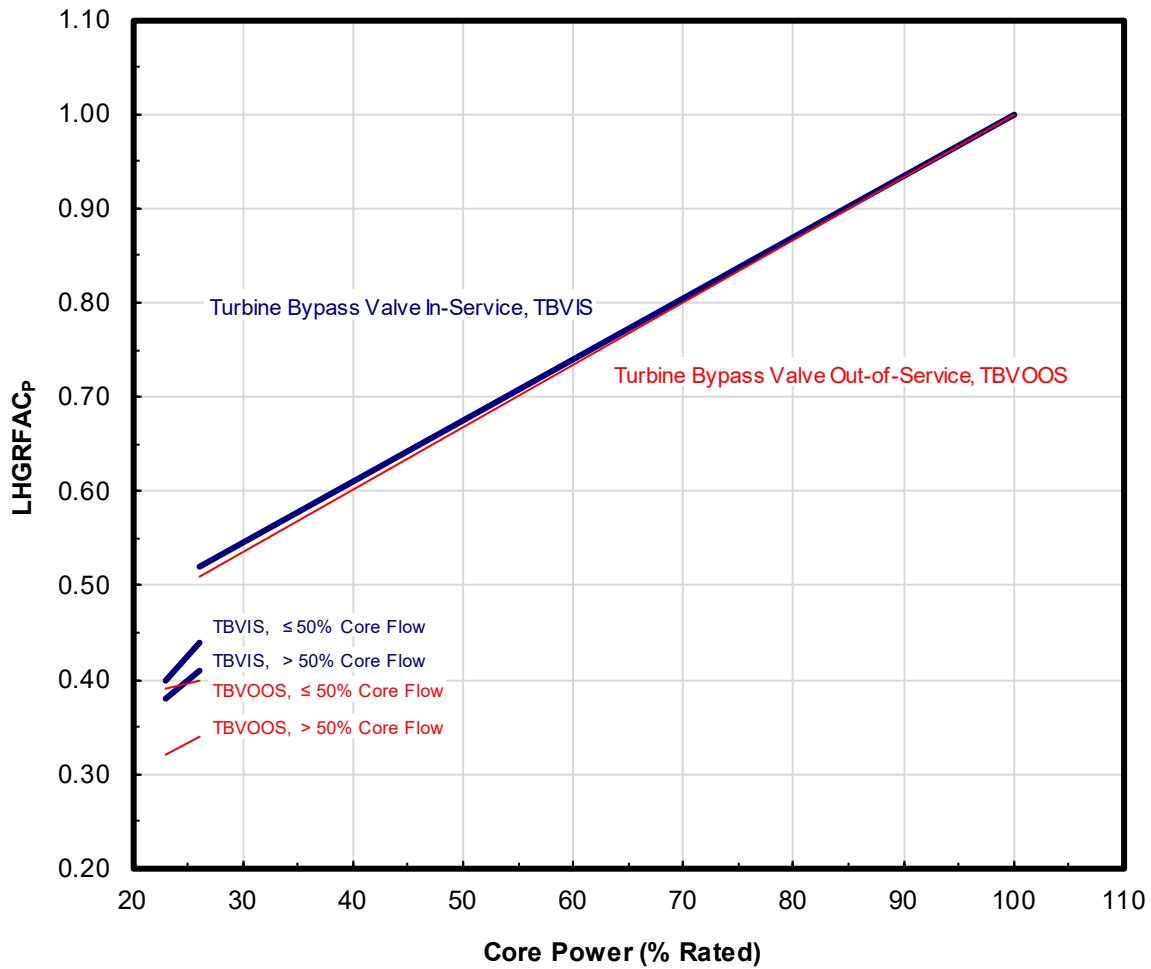
(107.0% maximum core flow line is used to support 105% rated flow operation, ICF)



| Turbine Bypass In-Service | |
|---------------------------|----------------------|
| Core Power | LHGRFAC _p |
| (% Rated) | |
| 100.0 | 1.00 |
| 26.0 | 0.52 |
| Core Flow > 50% Rated | |
| 26.0 | 0.41 |
| 23.0 | 0.38 |
| Core Flow ≤ 50% Rated | |
| 26.0 | 0.44 |
| 23.0 | 0.40 |

| Turbine Bypass Out-of-Service | |
|-------------------------------|----------------------|
| Core Power | LHGRFAC _p |
| (% Rated) | |
| 100.0 | 1.00 |
| 26.0 | 0.51 |
| Core Flow > 50% Rated | |
| 26.0 | 0.34 |
| 23.0 | 0.32 |
| Core Flow ≤ 50% Rated | |
| 26.0 | 0.40 |
| 23.0 | 0.39 |

Figure 3.4 Startup Operation LHGRFAC_p for ATRIUM-10XM Fuel:
Table 3.1 Temperature Range 1
(no Feedwater heating during startup)
(Limits valid at and below 50% power)



| Turbine Bypass In-Service | |
|---------------------------|----------------------|
| Core Power | LHGRFAC _p |
| (% Rated) | |
| 100.0 | 1.00 |
| 26.0 | 0.52 |
| Core Flow > 50% Rated | |
| 26.0 | 0.41 |
| 23.0 | 0.38 |
| Core Flow ≤ 50% Rated | |
| 26.0 | 0.44 |
| 23.0 | 0.40 |

| Turbine Bypass Out-of-Service | |
|-------------------------------|----------------------|
| Core Power | LHGRFAC _p |
| (% Rated) | |
| 100.0 | 1.00 |
| 26.0 | 0.51 |
| Core Flow > 50% Rated | |
| 26.0 | 0.34 |
| 23.0 | 0.32 |
| Core Flow ≤ 50% Rated | |
| 26.0 | 0.40 |
| 23.0 | 0.39 |

Figure 3.5 Startup Operation LHGRFAC_p for ATRIUM-10XM Fuel:
Table 3.1 Temperature Range 2
(no Feedwater heating during startup)
(Limits valid at and below 50% power)



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

$$\text{OLMCPR limit} = \text{MAX} (\text{MCPR}_F , \text{MCPR}_P)$$

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), Nominal Scram Speed (NSS), or Optimum Scram Speed (OSS)
- Cycle Operating Exposure (NEOC, EOC, and CD - 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 Table 4.2 through Table 4.9, 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 Startup without Feedwater Heaters

There is a range of operation during startup when the feedwater heaters are not placed into service until after the unit has reached a significant operating power level. Additional power dependent limits are shown in Table 4.5 through Table 4.8 based on temperature conditions identified in Table 3.1.



4.2.2 Scram Speed Dependent Limits (TSSS vs. NSS vs. OSS)

MCPR_P limits are provided for three 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. Both Nominal Scram Speeds (NSS) and/or Optimum Scram Speeds (OSS) may be used, as long as the scram time surveillance demonstrates Table 4.1 times are applicable.*†

Table 4.1 Nominal Scram Time Basis

| Notch Position | Nominal Scram Timing | Optimum Scram Timing |
|-------------------|-------------------------|-------------------------|
| (index) | (seconds) | (seconds) |
| 46 | 0.421 | 0.392 |
| 36 | 0.991 | 0.887 |
| 26 | 1.620 | 1.487 |
| 6 | 3.040 | 3.040 |

In demonstrating compliance with the NSS and/or OSS 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 and/or OSS based limits are applicable.

4.2.3 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 | 27,972.7 MWd / MTU |
| BOC to EOCLB | EOCLB corresponds to | 33,104.7 MWd / MTU |
| BOC to End of Coast | End of Coast | 34,799.5 MWd / MTU |

NEOC refers to a Near EOC exposure point.

* Reference 1 analysis results are based on information identified in Reference 4.

† Drop out times consistent with method used to perform actual timing measurements (i.e., including pickup/dropout effects).



The EOCLB 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.

The End of Coast exposure point represents a licensing exposure point exceeding the expected end-of-cycle exposure including cycle extension options.

4.2.4 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 (or FFWTR) | Feedwater Heaters Out-Of-Service (or Final Feedwater Temperature Reduction) |
| RCPOOS | One Recirculation Pump Out-Of-Service |

For exposure ranges up to NEOC and EOCLB, additional combinations of MCPR_P limits are also provided including FHOOS. The coast down exposure range assumes application of FFWTR. FHOOS based MCPR_P limits for the coast down exposure are redundant because the temperature setdown assumption is identical with FFWTR.

4.2.5 Single-Loop-Operation (SLO) Limits

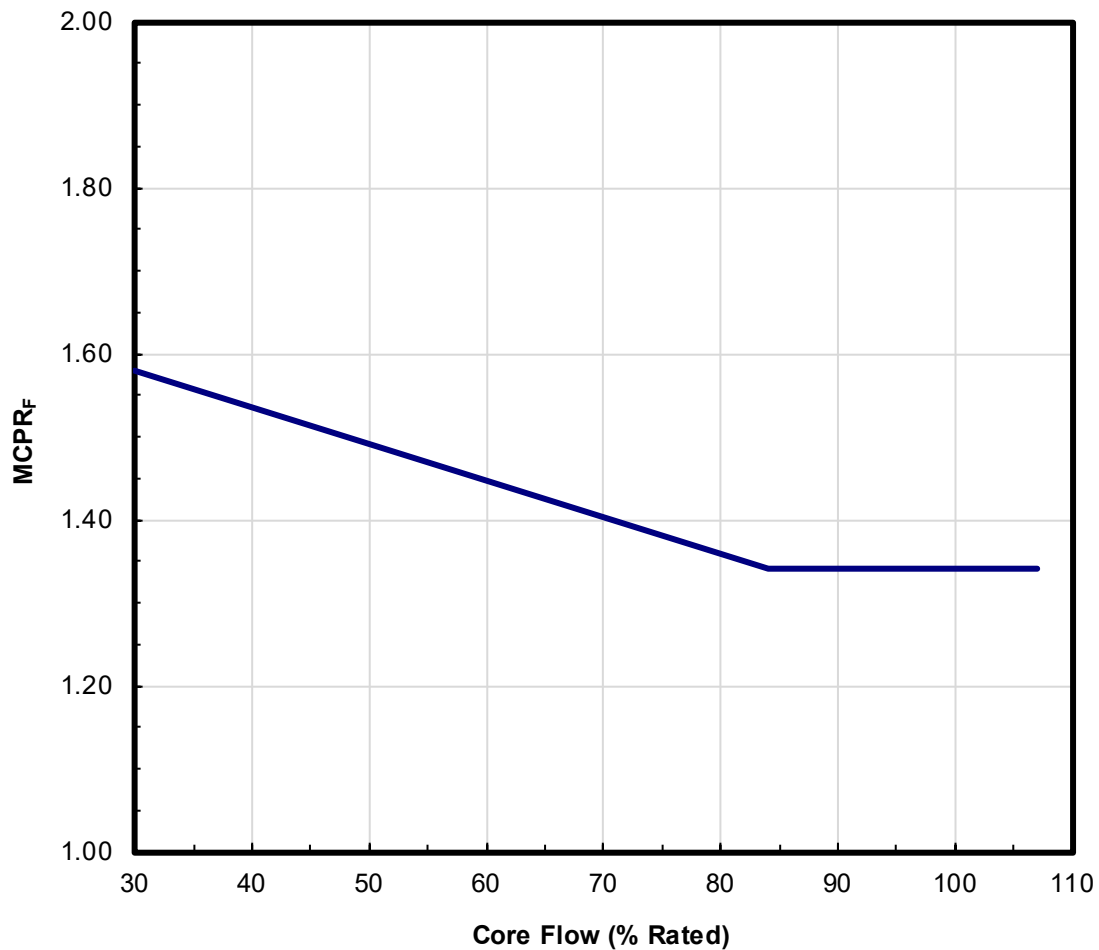
When operating in RCPOOS conditions, MCPR_P limits are constructed differently from the normal operating RCP conditions. The limiting event for RCPOOS is a pump seizure scenario, which sets the upper bound for allowed core power and flow[†]. This event is not impacted by scram time assumptions. Specific MCPR_P limits are shown in Table 4.9.

4.2.6 Below Pbypass Limits

Below Pbypass (26% rated power), MCPR_P limits depend upon core flow. One set of MCPR_P limits applies for core flow 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.

† RCPOOS limits are only valid up to 43.75% rated core power, 50% rated core flow, and an active recirculation drive flow of 17.73 Mlb_m/hr.



| Core Flow | MCPR _F |
|-----------|-------------------|
| (% Rated) | |
| 30.0 | 1.58 |
| 84.0 | 1.34 |
| 107.0 | 1.34 |

Figure 4.1 MCPR_F for All Fuel Types
 (Values bound all EOOS conditions)

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

Table 4.2 MCPR_P Limits for All Fuel Types: Optimum Scram Time Basis *

| Operating Condition | Power (% of rated) | ATRIUM-10XM | | |
|---------------------|--------------------|-------------|--------------|---------------------|
| | | BOC to NEOC | BOC to EOCLB | BOC to End of Coast |
| Base Case | 100 | 1.39 | 1.41 | 1.44 |
| | 90 | 1.45 | 1.46 | 1.48 |
| | 77.6 | 1.50 | 1.51 | 1.54 |
| | 65 | 1.57 | 1.57 | 1.61 |
| | >50 | 1.65 | 1.65 | 1.70 |
| | ≤50 | 1.79 | 1.79 | 1.79 |
| | 40 | 1.87 | 1.87 | 1.88 |
| | 26 | 2.27 | 2.27 | 2.38 |
| | 26 at > 50%F | 2.60 | 2.60 | 2.70 |
| | 23 at > 50%F | 2.76 | 2.76 | 2.88 |
| | 26 at ≤ 50%F | 2.49 | 2.49 | 2.60 |
| | 23 at ≤ 50%F | 2.64 | 2.64 | 2.77 |
| FHOOS | 100 | 1.42 | 1.44 | --- |
| | 90 | 1.48 | 1.48 | --- |
| | 77.6 | 1.54 | 1.54 | --- |
| | 65 | 1.61 | 1.61 | --- |
| | >50 | 1.70 | 1.70 | --- |
| | ≤50 | 1.79 | 1.79 | --- |
| | 40 | 1.88 | 1.88 | --- |
| | 26 | 2.38 | 2.38 | --- |
| | 26 at > 50%F | 2.70 | 2.70 | --- |
| | 23 at > 50%F | 2.88 | 2.88 | --- |
| | 26 at ≤ 50%F | 2.60 | 2.60 | --- |
| | 23 at ≤ 50%F | 2.77 | 2.77 | --- |

* All limits, including "Base Case," support RPTOOS operation; operation is supported for 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.

FFWTR/FHOOS is supported for the BOC to End of Coast limits.

Table 4.3 MCPR_p Limits for All Fuel Types: Nominal Scram Time Basis *

| Operating Condition | Power (% of rated) | ATRIUM-10XM | | |
|---------------------|--------------------|-------------|--------------|---------------------|
| | | BOC to NEOC | BOC to EOCLB | BOC to End of Coast |
| Base Case | 100 | 1.42 | 1.44 | 1.46 |
| | 90 | 1.48 | 1.48 | 1.51 |
| | 77.6 | 1.53 | 1.53 | 1.56 |
| | 65 | 1.59 | 1.59 | 1.63 |
| | >50 | 1.67 | 1.67 | 1.72 |
| | ≤50 | 1.80 | 1.80 | 1.80 |
| | 40 | 1.88 | 1.88 | 1.90 |
| | 26 | 2.30 | 2.30 | 2.41 |
| | 26 at > 50°F | 2.60 | 2.60 | 2.70 |
| | 23 at > 50°F | 2.76 | 2.76 | 2.88 |
| | 26 at ≤ 50°F | 2.49 | 2.49 | 2.60 |
| | 23 at ≤ 50°F | 2.64 | 2.64 | 2.77 |
| TBVOOS | 100 | 1.46 | 1.47 | 1.50 |
| | 90 | 1.51 | 1.51 | 1.54 |
| | 77.6 | 1.56 | 1.56 | 1.60 |
| | 65 | 1.62 | 1.62 | 1.66 |
| | >50 | 1.70 | 1.70 | 1.75 |
| | ≤50 | 1.80 | 1.80 | 1.81 |
| | 40 | 1.88 | 1.88 | 1.91 |
| | 26 | 2.30 | 2.30 | 2.42 |
| | 26 at > 50°F | 3.11 | 3.11 | 3.25 |
| | 23 at > 50°F | 3.36 | 3.36 | 3.50 |
| | 26 at ≤ 50°F | 2.83 | 2.83 | 2.99 |
| | 23 at ≤ 50°F | 3.11 | 3.11 | 3.28 |
| FHOOS | 100 | 1.46 | 1.46 | --- |
| | 90 | 1.51 | 1.51 | --- |
| | 77.6 | 1.56 | 1.56 | --- |
| | 65 | 1.63 | 1.63 | --- |
| | >50 | 1.72 | 1.72 | --- |
| | ≤50 | 1.80 | 1.80 | --- |
| | 40 | 1.90 | 1.90 | --- |
| | 26 | 2.41 | 2.41 | --- |
| | 26 at > 50°F | 2.70 | 2.70 | --- |
| | 23 at > 50°F | 2.88 | 2.88 | --- |
| | 26 at ≤ 50°F | 2.60 | 2.60 | --- |
| | 23 at ≤ 50°F | 2.77 | 2.77 | --- |
| PLUOOS | 100 | 1.42 | 1.44 | 1.46 |
| | 90 | 1.48 | 1.48 | 1.51 |
| | 77.6 | 1.53 | 1.53 | 1.56 |
| | 65 | 1.72 | 1.73 | 1.73 |
| | >50 | --- | --- | --- |
| | ≤50 | 1.80 | 1.80 | 1.80 |
| | 40 | 1.88 | 1.88 | 1.90 |
| | 26 | 2.30 | 2.30 | 2.41 |
| | 26 at > 50°F | 2.60 | 2.60 | 2.70 |
| | 23 at > 50°F | 2.76 | 2.76 | 2.88 |
| | 26 at ≤ 50°F | 2.49 | 2.49 | 2.60 |
| | 23 at ≤ 50°F | 2.64 | 2.64 | 2.77 |

* All limits, including "Base Case," support RPTOOS operation; operation is supported for 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.

FFWTR and FHOOS assume the same value of temperature drop. Consequently, FHOOS limits are not provided for BOC to End of COAST due to redundancy. Thermal limits for the "BOC to End of COAST" exposure applicability window are developed to conservatively bound FHOOS limits for earlier exposure applicability windows.

Table 4.3 MCPR_P Limits for All Fuel Types: Nominal Scram Time Basis (*continued*) *

| Operating Condition | Power (% of rated) | ATRIUM-10XM | | |
|---------------------------|--------------------|-------------|--------------|---------------------|
| | | BOC to NEOC | BOC to EOCLB | BOC to End of Coast |
| TBVOOS FHOOS | 100 | 1.49 | 1.50 | --- |
| | 90 | 1.54 | 1.54 | --- |
| | 77.6 | 1.60 | 1.60 | --- |
| | 65 | 1.66 | 1.66 | --- |
| | >50 | 1.75 | 1.75 | --- |
| | ≤50 | 1.81 | 1.81 | --- |
| | 40 | 1.91 | 1.91 | --- |
| | 26 | 2.42 | 2.42 | --- |
| | 26 at > 50°F | 3.25 | 3.25 | --- |
| | 23 at > 50°F | 3.50 | 3.50 | --- |
| | 26 at ≤ 50°F | 2.99 | 2.99 | --- |
| | 23 at ≤ 50°F | 3.28 | 3.28 | --- |
| TBVOOS PLUOOS | 100 | 1.46 | 1.47 | 1.50 |
| | 90 | 1.51 | 1.51 | 1.54 |
| | 77.6 | 1.56 | 1.56 | 1.60 |
| | 65 | 1.72 | 1.73 | 1.74 |
| | >50 | --- | --- | --- |
| | ≤50 | 1.80 | 1.80 | 1.81 |
| | 40 | 1.88 | 1.88 | 1.91 |
| | 26 | 2.30 | 2.30 | 2.42 |
| | 26 at > 50°F | 3.11 | 3.11 | 3.25 |
| | 23 at > 50°F | 3.36 | 3.36 | 3.50 |
| | 26 at ≤ 50°F | 2.83 | 2.83 | 2.99 |
| | 23 at ≤ 50°F | 3.11 | 3.11 | 3.28 |
| FHOOS PLUOOS | 100 | 1.46 | 1.46 | --- |
| | 90 | 1.51 | 1.51 | --- |
| | 77.6 | 1.56 | 1.56 | --- |
| | 65 | 1.72 | 1.73 | --- |
| | >50 | --- | --- | --- |
| | ≤50 | 1.80 | 1.80 | --- |
| | 40 | 1.90 | 1.90 | --- |
| | 26 | 2.41 | 2.41 | --- |
| | 26 at > 50°F | 2.70 | 2.70 | --- |
| | 23 at > 50°F | 2.88 | 2.88 | --- |
| | 26 at ≤ 50°F | 2.60 | 2.60 | --- |
| | 23 at ≤ 50°F | 2.77 | 2.77 | --- |
| TBVOOS FHOOS PLUOOS | 100 | 1.49 | 1.50 | --- |
| | 90 | 1.54 | 1.54 | --- |
| | 77.6 | 1.60 | 1.60 | --- |
| | 65 | 1.73 | 1.74 | --- |
| | >50 | --- | --- | --- |
| | ≤50 | 1.81 | 1.81 | --- |
| | 40 | 1.91 | 1.91 | --- |
| | 26 | 2.42 | 2.42 | --- |
| | 26 at > 50°F | 3.25 | 3.25 | --- |
| | 23 at > 50°F | 3.50 | 3.50 | --- |
| | 26 at ≤ 50°F | 2.99 | 2.99 | --- |
| | 23 at ≤ 50°F | 3.28 | 3.28 | --- |

* All limits, including "Base Case," support RPTOOS operation; operation is supported for 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.

FFWTR and FHOOS assume the same value of temperature drop. Consequently, FHOOS limits are not provided for BOC to End of COAST due to redundancy. Thermal limits for the "BOC to End of COAST" exposure applicability window are developed to conservatively bound FHOOS limits for earlier exposure applicability windows.

Table 4.4 MCPR_p Limits for All Fuel Types: Technical Specification Scram Time Basis *

| Operating Condition | Power (% of rated) | ATRIUM-10XM | | |
|---------------------|--------------------|-------------|--------------|---------------------|
| | | BOC to NEOC | BOC to EOCLB | BOC to End of Coast |
| Base Case | 100 | 1.46 | 1.46 | 1.50 |
| | 90 | 1.50 | 1.50 | 1.55 |
| | 77.6 | 1.55 | 1.55 | 1.59 |
| | 65 | 1.61 | 1.61 | 1.66 |
| | >50 | 1.68 | 1.68 | 1.75 |
| | ≤50 | 1.80 | 1.80 | 1.82 |
| | 40 | 1.88 | 1.88 | 1.94 |
| | 26 | 2.32 | 2.32 | 2.44 |
| | 26 at > 50°F | 2.60 | 2.60 | 2.71 |
| | 23 at > 50°F | 2.76 | 2.76 | 2.89 |
| | 26 at ≤ 50°F | 2.49 | 2.49 | 2.61 |
| | 23 at ≤ 50°F | 2.64 | 2.64 | 2.78 |
| TBVOOS | 100 | 1.50 | 1.50 | 1.54 |
| | 90 | 1.55 | 1.55 | 1.59 |
| | 77.6 | 1.59 | 1.59 | 1.64 |
| | 65 | 1.65 | 1.65 | 1.70 |
| | >50 | 1.73 | 1.73 | 1.79 |
| | ≤50 | 1.81 | 1.81 | 1.84 |
| | 40 | 1.89 | 1.89 | 1.96 |
| | 26 | 2.34 | 2.34 | 2.47 |
| | 26 at > 50°F | 3.12 | 3.12 | 3.27 |
| | 23 at > 50°F | 3.37 | 3.37 | 3.52 |
| | 26 at ≤ 50°F | 2.84 | 2.84 | 3.01 |
| | 23 at ≤ 50°F | 3.12 | 3.12 | 3.30 |
| FHOOS | 100 | 1.50 | 1.50 | --- |
| | 90 | 1.55 | 1.55 | --- |
| | 77.6 | 1.59 | 1.59 | --- |
| | 65 | 1.66 | 1.66 | --- |
| | >50 | 1.75 | 1.75 | --- |
| | ≤50 | 1.81 | 1.81 | --- |
| | 40 | 1.94 | 1.94 | --- |
| | 26 | 2.44 | 2.44 | --- |
| | 26 at > 50°F | 2.71 | 2.71 | --- |
| | 23 at > 50°F | 2.89 | 2.89 | --- |
| | 26 at ≤ 50°F | 2.61 | 2.61 | --- |
| | 23 at ≤ 50°F | 2.78 | 2.78 | --- |
| PLUOOS | 100 | 1.46 | 1.46 | 1.50 |
| | 90 | 1.50 | 1.50 | 1.55 |
| | 77.6 | 1.55 | 1.55 | 1.59 |
| | 65 | 1.73 | 1.74 | 1.75 |
| | >50 | --- | --- | --- |
| | ≤50 | 1.80 | 1.80 | 1.82 |
| | 40 | 1.88 | 1.88 | 1.94 |
| | 26 | 2.32 | 2.32 | 2.44 |
| | 26 at > 50°F | 2.60 | 2.60 | 2.71 |
| | 23 at > 50°F | 2.76 | 2.76 | 2.89 |
| | 26 at ≤ 50°F | 2.49 | 2.49 | 2.61 |
| | 23 at ≤ 50°F | 2.64 | 2.64 | 2.78 |

* All limits, including "Base Case," support RPTOOS operation; operation is supported for 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.

FFWTR and FHOOS assume the same value of temperature drop. Consequently, FHOOS limits are not provided for BOC to End of COAST due to redundancy. Thermal limits for the "BOC to End of COAST" exposure applicability window are developed to conservatively bound FHOOS limits for earlier exposure applicability windows.

Table 4.4 MCPR_P Limits for All Fuel Types: Technical Specification Scram Time Basis (*continued*) *

| Operating Condition | Power (% of rated) | ATRIUM-10XM | | |
|---------------------------|--------------------|-------------|--------------|---------------------|
| | | BOC to NEOC | BOC to EOCLB | BOC to End of Coast |
| TBVOOS FHOOS | 100 | 1.54 | 1.54 | --- |
| | 90 | 1.59 | 1.59 | --- |
| | 77.6 | 1.64 | 1.64 | --- |
| | 65 | 1.70 | 1.70 | --- |
| | >50 | 1.79 | 1.79 | --- |
| | ≤50 | 1.83 | 1.83 | --- |
| | 40 | 1.96 | 1.96 | --- |
| | 26 | 2.47 | 2.47 | --- |
| | 26 at > 50°F | 3.27 | 3.27 | --- |
| | 23 at > 50°F | 3.52 | 3.52 | --- |
| | 26 at ≤ 50°F | 3.01 | 3.01 | --- |
| | 23 at ≤ 50°F | 3.30 | 3.30 | --- |
| TBVOOS PLUOOS | 100 | 1.50 | 1.50 | 1.54 |
| | 90 | 1.55 | 1.55 | 1.59 |
| | 77.6 | 1.59 | 1.59 | 1.64 |
| | 65 | 1.74 | 1.75 | 1.77 |
| | >50 | --- | --- | --- |
| | ≤50 | 1.81 | 1.81 | 1.84 |
| | 40 | 1.89 | 1.89 | 1.96 |
| | 26 | 2.34 | 2.34 | 2.47 |
| | 26 at > 50°F | 3.12 | 3.12 | 3.27 |
| | 23 at > 50°F | 3.37 | 3.37 | 3.52 |
| | 26 at ≤ 50°F | 2.84 | 2.84 | 3.01 |
| | 23 at ≤ 50°F | 3.12 | 3.12 | 3.30 |
| FHOOS PLUOOS | 100 | 1.50 | 1.50 | --- |
| | 90 | 1.55 | 1.55 | --- |
| | 77.6 | 1.59 | 1.59 | --- |
| | 65 | 1.74 | 1.75 | --- |
| | >50 | --- | --- | --- |
| | ≤50 | 1.81 | 1.81 | --- |
| | 40 | 1.94 | 1.94 | --- |
| | 26 | 2.44 | 2.44 | --- |
| | 26 at > 50°F | 2.71 | 2.71 | --- |
| | 23 at > 50°F | 2.89 | 2.89 | --- |
| | 26 at ≤ 50°F | 2.61 | 2.61 | --- |
| | 23 at ≤ 50°F | 2.78 | 2.78 | --- |
| TBVOOS FHOOS PLUOOS | 100 | 1.54 | 1.54 | --- |
| | 90 | 1.59 | 1.59 | --- |
| | 77.6 | 1.64 | 1.64 | --- |
| | 65 | 1.76 | 1.77 | --- |
| | >50 | --- | --- | --- |
| | ≤50 | 1.83 | 1.83 | --- |
| | 40 | 1.96 | 1.96 | --- |
| | 26 | 2.47 | 2.47 | --- |
| | 26 at > 50°F | 3.27 | 3.27 | --- |
| | 23 at > 50°F | 3.52 | 3.52 | --- |
| | 26 at ≤ 50°F | 3.01 | 3.01 | --- |
| | 23 at ≤ 50°F | 3.30 | 3.30 | --- |

* All limits, including "Base Case," support RPTOOS operation; operation is supported for 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.

FFWTR and FHOOS assume the same value of temperature drop. Consequently, FHOOS limits are not provided for BOC to End of COAST due to redundancy. Thermal limits for the "BOC to End of COAST" exposure applicability window are developed to conservatively bound FHOOS limits for earlier exposure applicability windows.



Table 4.5 Startup Operation MCP_R Limits for Table 3.1 Temperature Range 1 for All Fuel Types: Nominal Scram Time Basis *

| Operating Condition | Power (% of rated) | ATRIUM-10XM | | |
|---------------------|--------------------|-------------|--------------|---------------------|
| | | BOC to NEOC | BOC to EOCLB | BOC to End of Coast |
| TBVIS | 100 | 1.46 | 1.46 | 1.46 |
| | 90 | 1.51 | 1.51 | 1.51 |
| | 77.6 | 1.56 | 1.56 | 1.56 |
| | 65 | 1.72 | 1.73 | 1.73 |
| | >50 | --- | --- | --- |
| | ≤50 | 1.84 | 1.84 | 1.84 |
| | 40 | 2.07 | 2.07 | 2.07 |
| | 26 | 2.66 | 2.66 | 2.66 |
| | 26 at > 50°F | 2.92 | 2.92 | 2.92 |
| | 23 at > 50°F | 3.14 | 3.14 | 3.14 |
| | 26 at ≤ 50°F | 2.82 | 2.82 | 2.82 |
| | 23 at ≤ 50°F | 3.04 | 3.04 | 3.04 |
| TBVOOS | 100 | 1.49 | 1.50 | 1.50 |
| | 90 | 1.54 | 1.54 | 1.54 |
| | 77.6 | 1.60 | 1.60 | 1.60 |
| | 65 | 1.73 | 1.74 | 1.74 |
| | >50 | --- | --- | --- |
| | ≤50 | 1.85 | 1.85 | 1.85 |
| | 40 | 2.08 | 2.08 | 2.08 |
| | 26 | 2.67 | 2.67 | 2.67 |
| | 26 at > 50°F | 3.44 | 3.44 | 3.44 |
| | 23 at > 50°F | 3.69 | 3.69 | 3.69 |
| | 26 at ≤ 50°F | 3.18 | 3.18 | 3.18 |
| | 23 at ≤ 50°F | 3.51 | 3.51 | 3.51 |

* Limits support RPTOOS operation; operation is supported for 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.

Limits are applicable for all other EOOS scenarios, apart from TBV.

Limits are only valid up to 50% rated core power.



Table 4.6 Startup Operation MCPR_P Limits for Table 3.1 Temperature Range 2 for All Fuel Types: Nominal Scram Time Basis *

| Operating Condition | Power (% of rated) | ATRIUM-10XM | | |
|---------------------|--------------------|-------------|--------------|---------------------|
| | | BOC to NEOC | BOC to EOCLB | BOC to End of Coast |
| TBVIS | 100 | 1.46 | 1.46 | 1.46 |
| | 90 | 1.51 | 1.51 | 1.51 |
| | 77.6 | 1.56 | 1.56 | 1.56 |
| | 65 | 1.72 | 1.73 | 1.73 |
| | >50 | --- | --- | --- |
| | ≤50 | 1.85 | 1.85 | 1.85 |
| | 40 | 2.08 | 2.08 | 2.08 |
| | 26 | 2.68 | 2.68 | 2.68 |
| | 26 at > 50°F | 2.94 | 2.94 | 2.94 |
| | 23 at > 50°F | 3.15 | 3.15 | 3.15 |
| | 26 at ≤ 50°F | 2.84 | 2.84 | 2.84 |
| | 23 at ≤ 50°F | 3.06 | 3.06 | 3.06 |
| TBVOOS | 100 | 1.49 | 1.50 | 1.50 |
| | 90 | 1.54 | 1.54 | 1.54 |
| | 77.6 | 1.60 | 1.60 | 1.60 |
| | 65 | 1.73 | 1.74 | 1.74 |
| | >50 | --- | --- | --- |
| | ≤50 | 1.86 | 1.86 | 1.86 |
| | 40 | 2.09 | 2.09 | 2.09 |
| | 26 | 2.69 | 2.69 | 2.69 |
| | 26 at > 50°F | 3.45 | 3.45 | 3.45 |
| | 23 at > 50°F | 3.71 | 3.71 | 3.71 |
| | 26 at ≤ 50°F | 3.20 | 3.20 | 3.20 |
| | 23 at ≤ 50°F | 3.52 | 3.52 | 3.52 |

* Limits support RPTOOS operation; operation is supported for 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.

Limits are applicable for all other EOOS scenarios, apart from TBV.

Limits are only valid up to 50% rated core power.



Table 4.7 Startup Operation MCPR_P Limits for Table 3.1 Temperature Range 1 for All Fuel Types: Technical Specification Scram Time Basis *

| Operating Condition | Power (% of rated) | ATRIUM-10XM | | |
|---------------------|--------------------|-------------|--------------|---------------------|
| | | BOC to NEOC | BOC to EOCLB | BOC to End of Coast |
| TBVIS | 100 | 1.50 | 1.50 | 1.50 |
| | 90 | 1.55 | 1.55 | 1.55 |
| | 77.6 | 1.59 | 1.59 | 1.59 |
| | 65 | 1.74 | 1.75 | 1.75 |
| | >50 | --- | --- | --- |
| | ≤50 | 1.88 | 1.88 | 1.88 |
| | 40 | 2.11 | 2.11 | 2.11 |
| | 26 | 2.70 | 2.70 | 2.70 |
| | 26 at > 50°F | 2.93 | 2.93 | 2.93 |
| | 23 at > 50°F | 3.15 | 3.15 | 3.15 |
| | 26 at ≤ 50°F | 2.83 | 2.83 | 2.83 |
| | 23 at ≤ 50°F | 3.05 | 3.05 | 3.05 |
| TBVOOS | 100 | 1.54 | 1.54 | 1.54 |
| | 90 | 1.59 | 1.59 | 1.59 |
| | 77.6 | 1.64 | 1.64 | 1.64 |
| | 65 | 1.76 | 1.77 | 1.77 |
| | >50 | --- | --- | --- |
| | ≤50 | 1.90 | 1.90 | 1.90 |
| | 40 | 2.13 | 2.13 | 2.13 |
| | 26 | 2.72 | 2.72 | 2.72 |
| | 26 at > 50°F | 3.46 | 3.46 | 3.46 |
| | 23 at > 50°F | 3.71 | 3.71 | 3.71 |
| | 26 at ≤ 50°F | 3.20 | 3.20 | 3.20 |
| | 23 at ≤ 50°F | 3.53 | 3.53 | 3.53 |

* Limits support RPTOOS operation; operation is supported for 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.

Limits are applicable for all other EOOS scenarios, apart from TBV.

Limits are only valid up to 50% rated core power.



Table 4.8 Startup Operation MCPR_P Limits for Table 3.1 Temperature Range 2 for All Fuel Types: Technical Specification Scram Time Basis *

| Operating Condition | Power (% of rated) | ATRIUM-10XM | | |
|---------------------|--------------------|-------------|--------------|---------------------|
| | | BOC to NEOC | BOC to EOCLB | BOC to End of Coast |
| TBVIS | 100 | 1.50 | 1.50 | 1.50 |
| | 90 | 1.55 | 1.55 | 1.55 |
| | 77.6 | 1.59 | 1.59 | 1.59 |
| | 65 | 1.74 | 1.75 | 1.75 |
| | >50 | --- | --- | --- |
| | ≤50 | 1.89 | 1.89 | 1.89 |
| | 40 | 2.12 | 2.12 | 2.12 |
| | 26 | 2.72 | 2.72 | 2.72 |
| | 26 at > 50°F | 2.95 | 2.95 | 2.95 |
| | 23 at > 50°F | 3.16 | 3.16 | 3.16 |
| | 26 at ≤ 50°F | 2.85 | 2.85 | 2.85 |
| | 23 at ≤ 50°F | 3.07 | 3.07 | 3.07 |
| TBVOOS | 100 | 1.54 | 1.54 | 1.54 |
| | 90 | 1.59 | 1.59 | 1.59 |
| | 77.6 | 1.64 | 1.64 | 1.64 |
| | 65 | 1.76 | 1.77 | 1.77 |
| | >50 | --- | --- | --- |
| | ≤50 | 1.91 | 1.91 | 1.91 |
| | 40 | 2.14 | 2.14 | 2.14 |
| | 26 | 2.74 | 2.74 | 2.74 |
| | 26 at > 50°F | 3.47 | 3.47 | 3.47 |
| | 23 at > 50°F | 3.73 | 3.73 | 3.73 |
| | 26 at ≤ 50°F | 3.22 | 3.22 | 3.22 |
| | 23 at ≤ 50°F | 3.54 | 3.54 | 3.54 |

* Limits support RPTOOS operation; operation is supported for 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.

Limits are applicable for all other EOOS scenarios, apart from TBV.

Limits are only valid up to 50% rated core power.

Table 4.9 MCPR_P Limits for All Fuel Types: Single Loop Operation for All Scram Times *

| Operating Condition | Power (% of rated) | BOC to End of COAST |
|-------------------------------------|--------------------|---------------------|
| | | ATRIUM-10XM |
| RCPOOS FHOOS | 100 | 2.10 |
| | 43.75 | 2.10 |
| | 40 | 2.10 |
| | 26 | 2.46 |
| | 26 at > 50%F | 2.73 |
| | 23 at > 50%F | 2.91 |
| | 26 at ≤ 50%F | 2.63 |
| | 23 at ≤ 50%F | 2.80 |
| RCPOOS TBVOOS PLUOOS FHOOS | 100 | 2.10 |
| | 43.75 | 2.10 |
| | 40 | 2.10 |
| | 26 | 2.49 |
| | 26 at > 50%F | 3.29 |
| | 23 at > 50%F | 3.54 |
| | 26 at ≤ 50%F | 3.03 |
| | 23 at ≤ 50%F | 3.32 |
| RCPOOS TBVOOS FHOOS1 | 100 | 2.15 |
| | 43.75 | 2.15 |
| | 40 | 2.15 |
| | 26 | 2.74 |
| | 26 at > 50%F | 3.48 |
| | 23 at > 50%F | 3.73 |
| | 26 at ≤ 50%F | 3.22 |
| | 23 at ≤ 50%F | 3.55 |
| RCPOOS TBVOOS FHOOS2 | 100 | 2.16 |
| | 43.75 | 2.16 |
| | 40 | 2.16 |
| | 26 | 2.76 |
| | 26 at > 50%F | 3.49 |
| | 23 at > 50%F | 3.75 |
| | 26 at ≤ 50%F | 3.24 |
| | 23 at ≤ 50%F | 3.56 |

* All limits, including "Base Case," support RPTOOS operation; operation is supported for 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.

FFWTR and FHOOS assume the same value of temperature drop.

RCPOOS limits are only valid up to 50% rated core power, 50% rated core flow, and an active recirculation drive flow of 17.73 Mlbm/hr.



5 Thermal-Hydraulic Stability Protection

(Technical Specification 3.3.1.1)

Technical Specification Table 3.3.1.1-1, Function 2f, identifies the function.

Instrument setpoints are established, such that the reactor will be tripped before an oscillation can grow to the point where the SLMCPR is exceeded. With application of Reference 30, the DSS-CD stability solution will be used per Reference 26. The DSS-CD S_{AD} setpoint is 1.10 for TLO and SLO.

New analyses have been developed based on Reference 26. With the implementation of the MELLLA+ operating domain expansion, an ABSP trip is required when the OPRM is out-of-service. The ABSP trip settings define a region of the power to flow map within which an automatic reactor scram occurs. The ABSP trip settings are provided in Table 5.1. If both the OPRM and ABSP are out-of-service, operation within the MELLLA+ domain is not allowed and the MBSP Regions provide stability protection. Table 5.2 and Table 5.3 provide the endpoints for the MBSP regions for nominal and reduced feedwater temperature conditions.

Table 5.1 ABSP Setpoints for the Scram Region

| Parameter | Symbol | Setting Value (unit) | Comments |
|------------------------------|-----------------|----------------------|---|
| Slope for Trip | m_{TRIP} | 2.00 (% RTP/% RDF) | Slope of ABSP APRM low Flow Biased Trip Linear Segment |
| Constant Power Line for Trip | $P_{BSP-TRIP}$ | 35.0 (% RTP) | ABSP APRM Flow Biased Trip Setpoint Power Intercept. Constant Power Line for Trip from Zero Drive Flow to Flow Breakpoint Value |
| Constant Flow Line for Trip | $W_{BSP-TRIP}$ | 49 (% RDF) | ABSP APRM Flow Biased Trip Setpoint Drive Flow Intercept. Constant Flow Line for Trip (see Note 1 below) |
| Flow Breakpoint | $W_{BSP-BREAK}$ | 30.0 (% RDF) | Flow Breakpoint Value |

Note 1: $W_{BSP-TRIP}$ can be set to 49.0 % RDF or any higher value up to the intersection of the ABSP sloped line with the APRM Flow Biased STP scram line.



Table 5.2 Analyzed MBSP Endpoints: Nominal Feedwater Temperature

| Endpoint | Power (% Rated) | Core Flow (% Rated) | Definition |
|----------|--------------------|------------------------|--|
| A1 | 75.9 | 52.7 | Scram Region (Region I) Boundary Intercept on MELLLA+ Line |
| B1 | 35.5 | 29.0 | Scram Region (Region I) Boundary Intercept on Natural Circulation Line (NCL) |
| A2 | 66.1 | 52.0 | Controlled Entry Region (Region II) Boundary Intercept on MELLLA Line |
| B2 | 25.5 | 29.0 | Controlled Entry Region (Region II) Boundary Intercept on Natural Circulation Line (NCL) |

Table 5.3 Analyzed MBSP Endpoints: Reduced Feedwater Temperature

| Endpoint | Power (% Rated) | Core Flow (% Rated) | Definition |
|----------|--------------------|------------------------|--|
| A1 | 64.9 | 50.5 | Scram Region (Region I) Boundary Intercept on MELLLA Line |
| B1 | 29.4 | 29.0 | Scram Region (Region I) Boundary Intercept on Natural Circulation Line (NCL) |
| A2 | 68.3 | 54.9 | Controlled Entry Region (Region II) Boundary Intercept on MELLLA Line |
| B2 | 24.5 | 29.0 | Controlled Entry Region (Region II) Boundary Intercept on Natural Circulation Line (NCL) |



6 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 27 & 29, and is defined by the following:

for two loop operation:

$$\begin{aligned} \text{SRB} &\leq (0.61W_d + 63.3) && \text{Allowable Value} \\ \text{SRB} &\leq (0.61W_d + 62.0) && \text{Nominal Trip Setpoint (NTSP)} \end{aligned}$$

where:

$$\begin{aligned} \text{SRB} &= \text{Rod Block setting in percent of rated thermal power (3952 MW}_t\text{)} \\ W_d &= \text{Recirculation drive flow rate in percent of rated} \\ &\quad \text{(100\% drive flow required to achieve 100\% core power and flow)} \end{aligned}$$

and for single loop operation:

$$\begin{aligned} \text{SRB} &\leq (0.55(W_d - \Delta W) + 60.5) && \text{Allowable Value} \\ \text{SRB} &\leq (0.55(W_d - \Delta W) + 58.5) && \text{Nominal Trip Setpoint (NTSP)} \end{aligned}$$

where:

$$\begin{aligned} \text{SRB} &= \text{Rod Block setting in percent of rated thermal power (3952 MW}_t\text{)} \\ W_d &= \text{Recirculation drive flow rate in percent of rated} \\ &\quad \text{(100\% drive flow required to achieve 100\% core power and flow)} \\ \Delta W &= \text{Difference between two-loop and single-loop effective recirculation flow} \\ &\quad \text{at the same core flow } (\Delta W = 0.0 \text{ for two-loop operation)} \end{aligned}$$

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



7 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 27 & 28, are shown in Table 7.1. Setpoints are based on an HTSP, unfiltered analytical limit of 114%. 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. Cycle specific CRWE analyses of OLMCPR are documented in Reference 1, superseding values reported in References 27, 28, and 29.

Table 7.1 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 | 121.7% | 120.0% |
| - filtered | 120.7% | 119.0% |
| ITSP - unfiltered | 116.7% | 115.0% |
| - filtered | 115.7% | 114.0% |
| HTSP - unfiltered | 111.7% | 110.0% |
| - filtered | 110.9% | 109.2% |
| 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 7.2. Cycle specific setpoint analysis results are shown in Table 7.3, per Reference 1.

Table 7.2 RBM Setpoint Applicability

| Thermal Power (% Rated) | Applicable MCPR [†] | Notes from Table 3.3.2.1-1 | Comment |
|-------------------------|------------------------------|----------------------------|---------------------------------|
| > 27% and < 90% | < 1.74 | (a), (b), (f), (h) | two loop operation |
| | < 1.78 | (a), (b), (f), (h) | single loop operation |
| ≥ 90% | < 1.38 | (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.



Table 7.3 Control Rod Withdrawal Error Results

| RBM HTSP Analytical Limit | CRWE OLMCPR |
|--------------------------------------|------------------------|
| Unfiltered | |
| 107 | 1.26 |
| 111 | 1.28 |
| 114 | 1.30 |
| 117 | 1.36 |

Results, compared against the base case OLMCPR results of Table 4.2, indicate SLMCPR remains protected for RBM inoperable conditions (i.e., 114% unblocked).



8 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:

$$\text{SDM} > 0.38\% \text{ dk/k}$$



Appendix A: MBSP Maps



Core Power (% Rated: 100% = 3952MW_e)

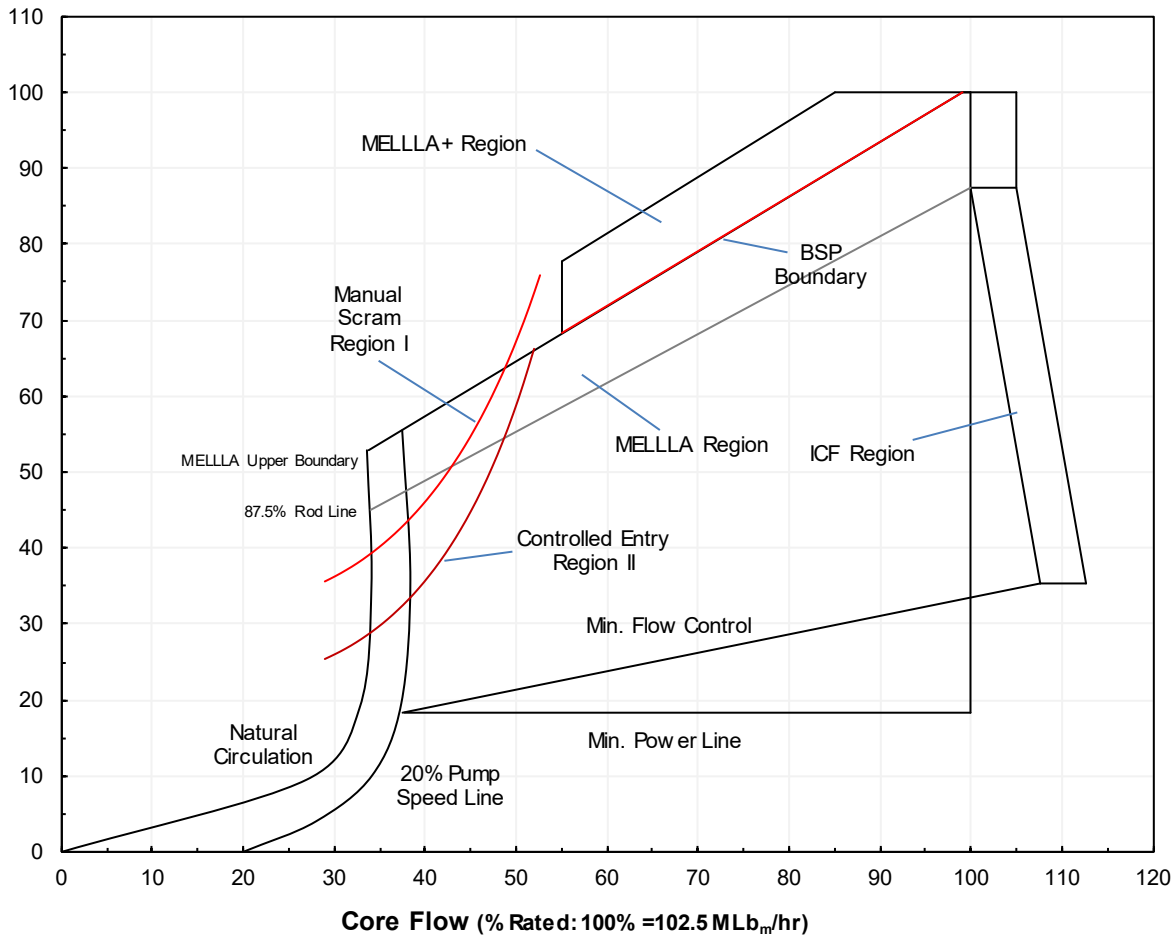


Figure A.1 MBSP Boundaries For Nominal Feedwater Temperature

(Operation in the MELLLA+ Region Prohibited for Feedwater Temperature greater than 10 degrees F below the Nominal Feedwater Temperature)



Core Power (% Rated: 100% = 3952MW_t)

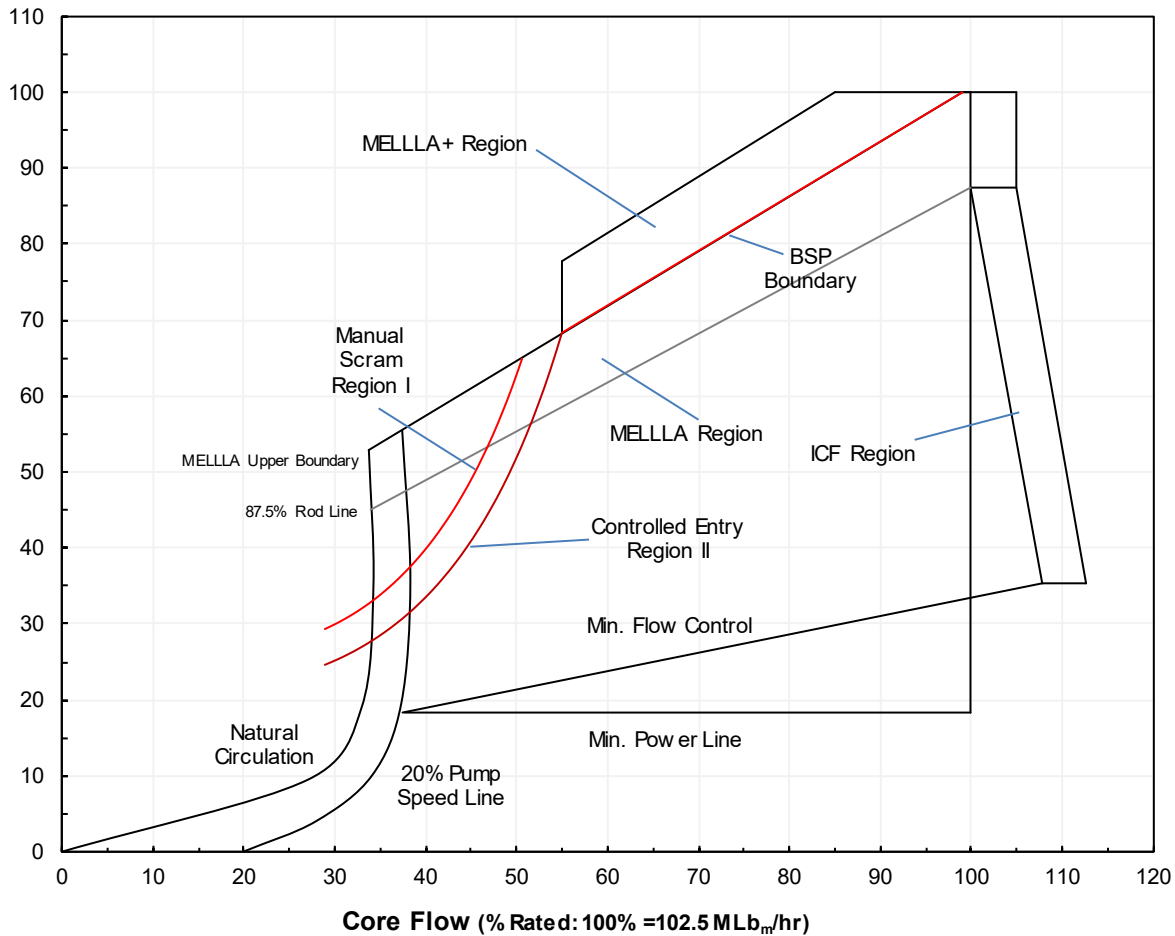


Figure A.2 MBSP Boundaries For Reduced Feedwater Temperature

(Operation in the MELLLA+ Region Prohibited for a Reduced Feedwater Temperature greater than 10 degrees F below the Nominal Feedwater Temperature)