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RBG-47911

October 24, 2018

Attn: Document Control Desk
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: River Bend Station Core Operating Limits Report Cycle 20 Revision 2

River Bend Station – Unit 1
Docket No. 50-458
License No. NPF-47

Dear Sir or Madam:

Enclosed is Revision 2 of the River Bend Station (RBS) Core Operating Limits Report (COLR) for Cycle 20. This report is submitted in accordance with Technical Specification 5.6.5 of Appendix A of the Facility Operating License NPF-47.

There are no regulatory commitments contained in this document.

If you require additional information, please contact Mr. Tim Schenk at (225) 381-4177 or tschenk@entergy.com.

Sincerely,

TAS/baj

Enclosure 1: River Bend Station Core Operating Limits Report Cycle 20 Revision 2 cc:

NRC Regional Administrator - Region IV

NRC Project Manager - River Bend Station

NRC Senior Resident Inspector - River Bend Station

Louisiana Department of Environmental Quality
Office of Environmental Compliance
Radiological Emergency Planning and Response Section

Public Utility Commission of Texas

Enclosure 1

River Bend Station Core Operating Limits Report

Cycle 20

Revision 2

River Bend Station
Core Operating Limits Report
Cycle 20
Revision 2

REVISION HISTORY	
Revision	**Revision Description**
0	Original Issue – per Section 1.0 and Ref 3.1.5, Rev. 0 of the RBS C20 COLR is valid only for operation from BOC to MOC
1	Issued to reflect core configuration changes from PO-18-01. Added reference 3.1.6 to include Cycle 20 GESTAR Assessment of updated core loading. Other editorial changes were made to correctly identify COLR figures in Sections 7.1 & 8.3 (CR-RBS-2017-07694). Previous Rev.0 restriction continues to apply; this COLR is only valid for operation from BOC20B thru MOC.
2	Revision issued for RBS Cycle 20 TRACG AOO (Anticipated Operational Occurrences) implementation and is valid upon approval to the End of Cycle 20 (EOC20). Added, or revised references and definitions applicable to RBS Cycle 20 TRACG AOO implementation, including the revised Cycle 20 GESTAR Assessment of updated core loading and the revised Cycle 20 Supplemental Reload Licensing Report. Added reference applicable to Cycle 20 loaded GNF2 and GNF3 LUA fuel. RBS Cycle 20 TRACG AOO analysis removed thermal limits difference between Cycle 20 fuel types GNF2 and GNF3 LUA. Both fuel types are bounded by the same thermal limits and MCPR and LHGR figures were appropriately revised. Figures containing duplicate information for different Application Conditions were consolidated and SLO limits were included on the figures. Editorial changes to reflect clarification that SLO ECCS/LOCA multiplier of 0.83 is applied only to SLO $LHGRFAC_F$ multipliers. Table 7.0 and Figures 7.0.a and 7.0.b added. The table provides a summary of TLO and SLO reactor rated power Operating Limit MCPR and figures show TRACG AOO derived Cycle 20 $MCPR_P$ for reactor powers below P_{bypass}, and K(P) multipliers for powers above P_{bypass}. Table of contents corrected the 8.3 title and expanded to include table and figure numbers.

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1.0 PURPOSE

The COLR is controlled as a License Basis Document and revised accordingly for each fuel cycle or remaining portion of a fuel cycle. With RBS Cycle 20 TRACG AOO implementation (References 3.1.1 and 3.1.7), Ref 3.1.5 restriction for operation from BOC to MOC is no longer required, and the COLR is applicable to Cycle 20 operation until EOC. Any revisions to the COLR must be submitted to the NRC for information as required by Tech Spec 5.6.5 and tracked by RBS License Commitment L11358.

2.0 SCOPE

As defined in Technical Specification 1.1, the COLR is the document that provides the core operating limits for the current fuel cycle. This document is prepared in accordance with Technical Specification 5.6.5 for each reload cycle using NRC-approved analytical methods.

The limits included in this report are:

1) LCO 3.2.1, Average Planar Linear Heat Generation Rate (APLHGR)
2) LCO 3.2.2, Minimum Critical Power Ratio (MCPR), including power and flow dependent limits
3) LCO 3.2.3, Linear Heat Generation Rate (LHGR), including power and flow dependent limits
4) LCO 3.2.4, Fraction of Core Boiling Boundary (FCBB)
5) LCO 3.3.1.1, RPS Instrumentation (RPS), Function 2.b
6) LCO 3.3.1.3, Periodic Based Detection System (PBDS)

3.0 REFERENCES

This section contains the background, cycle-specific, and methodology references used in the current cycle reload analysis.

3.1 Current Cycle References

3.1.1 ECH-NE-16-00037 Rev. 1, Supplemental Reload Licensing Report for RBS – Unit 1 Reload 19 Cycle 20, TRACG04 AOO Implementation; GNF 004N9245 Rev.1, Aug. 2018.

3.1.2 ECH-NE-16-00038 Rev. 0, Fuel Bundle Information Report for River Bend Station – Unit 1 Reload 19 Cycle 20; GNF 003N9292 Rev.0, Nov. 2016.

3.1.3 Letter, R. E. Kingston to G. W. Scronce, "Time Constant Values for Simulated Thermal Power Monitor", RBC-46410, November 30, 1995.

3.1.4 RBS Updated Safety Analysis Report

3.1.5 CR-RBS-2016-06418

3.1.6 ECH-NE-17-00032 Rev. 1, RBS C20 ULP-GESTAR Assessment; GNF 004N9396 Rev.1, Aug. 2018.

3.1.7 ECH-NE-18-00033 Rev. 0, Entergy Operations, Inc. River Bend Station TRACG Implementation for Reload Licensing Transient Analysis (T1309); GEH 003N9955-R0, July 2018.

3.2 Methodology References

The following are applicable to GNF supplied fuel.

3.2.1 NEDE-24011-P-A-23-US, September 2016, General Electric Standard Application for Reactor Fuel (GESTAR-II).

3.2.2 GNF2 Advantage Generic Compliance with NEDE-24011-P-A (GESTAR II), NEDC-33270P, Revision 7, October 2016, MFN 16-073, October 12, 2016.

3.2.3 Technical Evaluation to Support Introduction of GNF3 Lead Use Assemblies (LUAs) in River Bend Station, Unit 1, 002N3424.1, Revision 0, December 2014.

4.0 DEFINITIONS

4.1 Average Planar Linear Heat Generation Rate (APLHGR) - the APLHGR shall be applicable to a specific planar height and is equal to the sum of the linear heat generation rates for all the fuel rods in the specified bundle at the specified height divided by the number of fuel rods in the fuel bundle.

4.2 Average Planar Exposure - the Average Planar Exposure shall be applicable to a specific planar height and is equal to the sum of the exposure of all the fuel rods in the specified bundle at the specified height divided by the number of fuel rods in the fuel bundle.

4.3 Critical Power Ratio (CPR) - the ratio of that power in the assembly, which is calculated by application of the fuel vendor's appropriate boiling correlation, to cause some point in the assembly to experience boiling transition, divided by the actual assembly operating power.

4.4 Core Operating Limits Report (COLR) - The River Bend Station specific document that provides core operating limits for the current reload cycle in accordance with Technical Specification 5.6.5.

4.5 Linear Heat Generation Rate (LHGR) - the LHGR shall be the heat generation per unit length of fuel rod. It is the integral of the heat flux over the heat transfer area associated with the unit length.

4.6 Minimum Critical Power Ratio (MCPR) - the MCPR shall be the smallest CPR which exists in the core.

4.7 MCPR Safety Limit - the minimum value of the CPR that ensures that 99.9% of the fuel rods avoid boiling transition during any moderate frequency transient.

4.8 Aligned Drive Flow – Adjusted FCTR card input drive flow signal that accounts for actual variations in the core flow to drive flow relationship.

4.9 Monitored Region – The area of the core power and flow operating domain where the reactor may be susceptible to reactor instabilities under conditions exceeding the licensing basis of the current reactor system.

4.10 Restricted Region – The area of the core power and flow operating domain where the reactor is susceptible to reactor instabilities in the absence of restrictions on core void distributions.

4.11 Setpoint "Setup" – A FCTR card feature that sets the normal "non-setup" E1A APRM flow–biased scram and control rod block trip reference setpoints associated with the Exclusion and Restricted Regions higher to permit required reactor maneuvering in the Restricted Region when stability controls are in effect.

4.12 End of Rated (EOR) - the cycle exposure corresponding to all rods out, 100% power/100% flow, and normal feedwater temperature. (corresponding to Core Average Exposure 35,534 MWd/MTU, or 32,236 MWd/ST) [Reference 3.1.1. Section 3].

4.13 MOC - Middle of Cycle (EOR – 2,343 MWd/MTU, or 2,125 MWd/ST) [Reference 3.1.1, Table 7-1].

4.14 EOC - End of Cycle

4.15 FFWTR – Final Feedwater Temperature Reduction.

4.16 FHOOS – Feedwater Heater Out of Service.

4.17 PROOS – Pressure Regulator Out of Service.

4.18 SLO – Single Loop Operation.

4.19 TBOOS –Turbine Bypass Out of Service

4.20 AREVA – AREVA NP Inc.

4.21 GNF – Global Nuclear Fuel

4.22 EOC-RPT – End of Cycle Recirculation Pump Trip

4.23 Reference Core Loading Pattern – The Core Loading Pattern Used for Reload Licensing Analysis.

4.24 Application Condition – The combination of equipment out of service conditions for which LHGRFAC and MCPR limits are determined [Reference 3.1.1, Section 11]. The Application Conditions are as follows:

Application Condition	FWHOOS / FFWTR	EOC-RPT OOS	PROOS	TBOOS
1	X			
2	X	X		
3	X		X	
4	X			X
5	X	X		X
6	X		X	X
7	X	X	X	X

All application conditions address the licensed core flow.

4.25 P_{bypass} – Reactor Thermal Power (RTP) level below which the Turbine Stop Valve position and the Turbine Control Valve fast closure scrams are bypassed. Per TS Table 3.3.1.1-1, P_{bypass} RTP = 40% RTP.

4.26 Operating Limit MCPR (OLMCPR) - Limiting transients are analyzed either with TRACG or other NRC-approved methodologies. The types of transients evaluated are loss of flow, increase in pressure and power, positive reactivity insertion, and coolant temperature increase. The TRACG methodology calculates an operating limit MCPR (OLMCPR) for the transient initial condition that will result in no more than 0.1% of the fuel rods susceptible to boiling transition. The other methodologies calculate a reduction in CPR for each transient, with the largest change in CPR (delta-CPR) resulting from the limiting transient. When the largest delta-CPR is added to the MCPR SL, an OLMCPR is obtained. The OLMCPR, calculated by either the TRACG or other methodology, sets the core operating limits.

5.0 CORE DESIGN

5.1 Reference Core Loading Pattern

The original Reference Core Loading pattern is presented in Reference 3.1.1.

5.2 Control Rods

The River Bend core utilizes the GE design control rods, non GE design CR-82M and CR-82M-1 bottom entry cruciform control rods. These control rod designs are discussed in more detail in Reference 3.1.4, Sections 4.1 and 4.2.

6.0 AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)

Per Technical Specification 3.2.1, all APLHGR values shall not exceed the exposure-dependent limits reported as follows:

Fuel Type	Figure
GNF2	6.1-1a
GNF3	6.1-1b

For single loop operation (SLO), ECCS/LOCA multiplier of 0.83 [Reference 3.1.1, Table 16.3-2] is applied to the APLHGR limits for all fuel types.

7.0 MINIMUM CRITICAL POWER RATIO (MCPR)

Per Technical Specification 3.2.2, the MCPR values shall be equal to or greater than the operating limit for operation at ≥ 23.8% of rated thermal power. The operating limit is the maximum of the flow-dependent minimum critical power ratio ($MCPR_F$) and the power-dependent minimum critical power ratio ($MCPR_P$).

For power level less than P_{bypass}, the MCPRp can be directly read from Figure 7.0.a for AOO application conditions when Pressure Regulator is operable or from Figure7.0.b, when Pressure Regulator is out of service.

Above P_{bypass}, the MCPRp is the product of the rated power and flow MCPR application condition operating limit presented in Table 7.0 [Ref. 3.1.1, Section 11, Limiting Pressurization Events OLMCPR Summary Table], and the K(P) factor presented in Figure 7.0.a for AOO application conditions when Pressure Regulator is operable, or from Figure 7.0.b, when Pressure Regulator is out of service.

$MCPR_F$ and $MCPR_P$, including the calculated $MCPR_P$ limits for thermal powers above P_{bypass}, are provided in Sections 7.1 and 7.2 below. These limits address the Cycle 20 cycle exposure ranges, two loop (TLO) and single loop operation (SLO), and seven application conditions. There is no MCPR distinction between GNF2 and GNF3 LUA fuel types.

During SLO, the Operating Limit MCPR shall be increased to account for the Pump Seizure limit and the higher SLMCPR in SLO. Rated Power Equivalent SLO Pump Seizure event OLMCPR is limiting at 1.44 for BOC-EOC operation. For SLO, the $MCPR_F$ and $MCPR_P$ below P_{bypass} operating limits are 0.03 greater than the two loop value [Reference 3.1.1, Section 11]. For calculated $MCPR_P$ limits for thermal powers above P_{bypass}, use SLO figures provided for Section 7.2 below.

7.1 Flow-Dependent Minimum Critical Power Ratio ($MCPR_F$) Values:

The $MCPR_F$ curves from Reference 3.1.1, Appendix D, applicable to all Cycle 20 exposures for TLO and SLO limits are found in the following figures:

Application Condition	Figures TLO and SLO GNF2 and GNF3 LUA
1, 2, 3	7.1-1
4, 5, 6, 7	7.1-2

7.2 Power-Dependent Minimum Critical Power Ratio ($MCPR_P$) Values:

The TLO and SLO $MCPR_P$ curves include the Reference 3.1.1, Appendix D reported $MCPR_P$ for thermal powers no larger than P_{bypass}, and the calculated $MCPR_P$ limits for thermal powers above P_{bypass}. They are found in the following figures:

Application Condition	Figure	
	BOC – MOC	MOC - EOC
	GNF2 and GNF3 LUA	GNF2 and GNF3 LUA
1, 4	7.2-1a	7.2-1b
2	7.2-2a	7.2-2b
3, 6	7.2-3a	7.2-3b
5	7.2-4a	7.2-4b
7	7.2-5a	7.2-5b

More limiting values of the power dependent limits may be used in lieu of those indicated by a particular operating mode. For example EOC values may be used instead of the MOC values.

8.0 LINEAR HEAT GENERATION RATE (LHGR)

Per Technical Specification 3.2.3, the LHGR values for any rod at any axial location shall not exceed the exposure-dependent limits multiplied by the smaller of either the power-dependent or flow-dependent LHGR factors.

For single loop operation (SLO), ECCS/LOCA multiplier of 0.83 [Reference 3.1.1, Table 16.3-2] is applied to the $LHGR_F$ limits for all fuel types.

For two recirculation loop and single recirculation loop operation the LHGR multiplier is as follows:

For two recirculation loop operation:

$$LHGRFAC = MIN\ (LHGRFAC_P,\ LHGRFAC_F)$$

For single loop operation:

$$LHGRFAC = MIN\ (LHGRFAC_P,\ LHGRFAC_{F(SLO)})$$

8.1 Exposure-Dependent Linear Heat Generation Rate (LHGR) Values:

GNF2 and GNF3 exposure-dependent LHGR values are considered GNF proprietary and will not be contained in the COLR. The GNF2 LHGR values may be found in Reference 3.1.2, Section 1. Per Reference 3.1.1, Appendix D the GNF2 exposure dependent LHGR values may be applied to the GNF3 fuel.

8.2 Flow-Dependent Linear Heat Generation Rate Factors ($LHGRFAC_F$) Values:

The $LHGRFAC_F$ curves are from Reference 3.1.1, Appendix D and are found on Figure 8.2-1a for TLO, and on Figure 8.2-1b for SLO. Figures 8.2-1a and Figure 8.2-1b are valid for all Cycle 20 fuel types in BOC to EOC exposure range.

8.3 Power-Dependent Linear Heat Generation Rate Factors ($LHGRFAC_P$) Values:

The $LHGRFAC_P$ curves are from Reference 3.1.1, Appendix D and are found in the following figures:

Application Conditions	Figure Applicable to BOC – EOC for all types of fuel (GNF2 and GNF3 LUA) and during TLO, or SLO conditions
1	8.3-1
2	8.3-2
3	8.3-3
4	8.3-4
5	8.3-5
6	8.3-6
7	8.3-7

More limiting values of the power dependent multipliers may be used in lieu of those indicated by a particular operating mode. For example EOC values may be used instead of the MOC values.

9.0 STABILITY

The following Technical Specifications / Technical Requirements contain stability related requirements:

- TS 3.2.4, Fraction of Core Boiling Boundary (FCBB)
- TS 3.3.1.1, RPS Instrumentation (RPS)
- TS 3.3.1.3, Periodic Based Detection System (PBDS)
- TR 3.3.1.1, RPS Instrumentation (RPS)
- TR 3.3.2.1, Control Rod Block Instrumentation

9.1 Stability Region Boundaries and Setpoints

This section contains region boundaries, setpoints and other stability related requirements. The stability region boundaries and setpoints are as follows

Description	Figure
Monitored Region Boundary (Case 1)	9.1-1
Monitored Region Boundary (Case 2)	9.1-2
APRM Flow Biased Simulated Thermal Power – High Scram Setpoints and Restricted Region Boundary (Two Recirculation Loop Operation – Case 1)	9.1-3
APRM Flow Biased Simulated Thermal Power – High Scram Setpoints and Restricted Region Boundary (Two Recirculation Loop Operation – Case 2)	9.1-4
APRM Flow Biased Simulated Thermal Power – High Scram Setpoints and Restricted Region Boundary (Single Recirculation Loop Operation – Case 1)	9.1-5
APRM Flow Biased Simulated Thermal Power – High Scram Setpoints and Restricted Region Boundary (Single Recirculation Loop Operation – Case 2)	9.1-6
APRM Flow Biased Neutron Flux - High Rod-Block Setpoints (Two Recirculation Loop Operation – Case 1)	9.1-7
APRM Flow Biased Neutron Flux - High Rod-Block Setpoints (Two Recirculation Loop Operation – Case 2)	9.1-8
APRM Flow Biased Neutron Flux - High Rod-Block Setpoints (Single Recirculation Loop Operation – Case 1)	9.1-9
APRM Flow Biased Neutron Flux - High Rod-Block Setpoints (Single Recirculation Loop Operation – Case 2)	9.1-10

Note: For Figures 9.1-3 to 9.1-10, the Nominal Setpoints should be used for indicating the entry into a particular stability region as allowed and appropriate actions be taken prior to the entry

In the table above, two distinct operating states (Case 1 and Case 2) are considered. These are described as follows:

Case 1 - Normal Feedwater Heating Operation or Low Reactor Power :

$T_{FW}\text{(at rated)} \geq T_{FW}^{DESIGN}\text{(at rated)} - 50^\circ F$, and rated equivalent at off-rated reactor conditions

OR

$P \leq 30\%$

Case 2 - Reduced Feedwater Heating Operation:

$T_{FW}\text{(at rated)} < T_{FW}^{DESIGN}\text{(at rated)} - 50^\circ F$

AND

$P > 30\%$

The APRM Flow Biased Simulated Thermal Power - High scram setpoint and Restricted Region Boundary, and APRM Flow Biased Neutron Flux – High Rod-Block Setpoints are given in terms of aligned drive flow. The aligned drive flow is calculated from the input drive flow using the following relationship:

$$W_D = \frac{101.209 \times \Delta^{40} - 31.028 \times \Delta^{100} + 70.181 \times W_{\tilde{D}}}{70.181 - \left(\Delta^{100} - \Delta^{40}\right)}$$

Where: $W_{\tilde{D}}$ = FCTR card input drive flow in percent rated,

W_D = Aligned drive flow in percent rated,

Δ^{40} = Low flow drive flow alignment setting, and

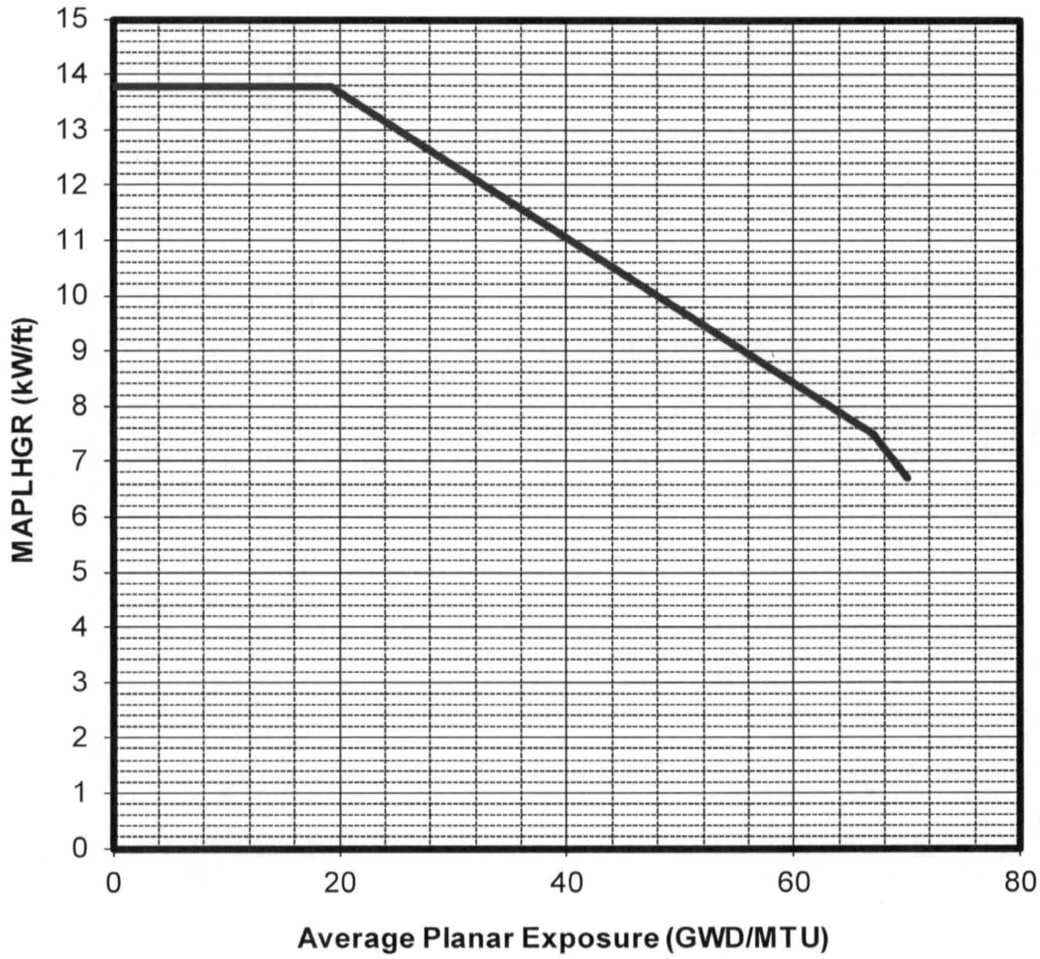
Δ^{100} = High flow drive flow alignment setting.

9.2 APRM Flow Biased Simulated Thermal Power−High Time Constant (SR 3.3.1.1.14)

The simulated thermal power time constant is 6 ± 0.6 seconds (Reference 3.1.3). Thus the maximum simulated thermal power time constant for use in meeting the surveillance requirement is 6.6 seconds.

FIGURE 6.1-1a. MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS AVERAGE PLANAR EXPOSURE

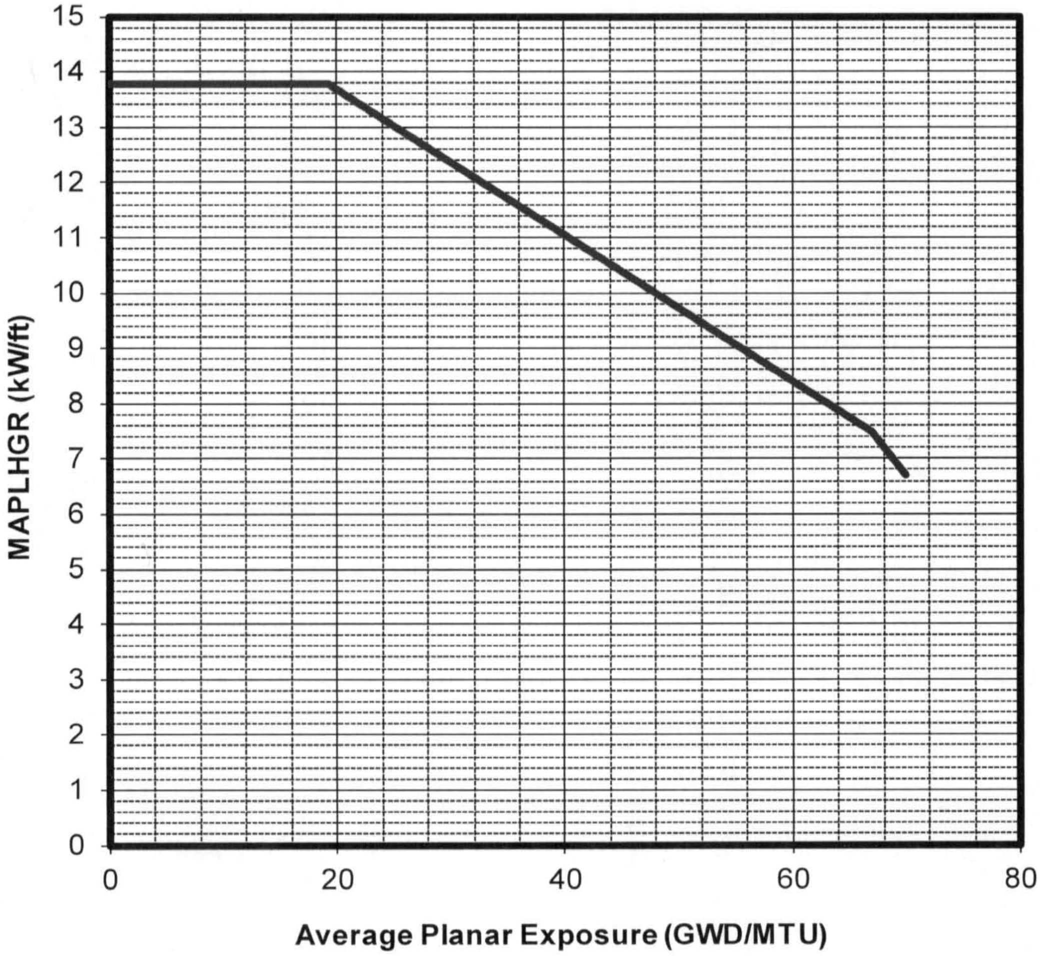
FUEL TYPE: GNF2



Average Planar Exposure (GWd/MT)	MAPLHGR Limit (kW/ft)
0.00	13.78
19.31	13.78
67.00	7.50
70.00	6.69

FIGURE 6.1-1b. MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS AVERAGE PLANAR EXPOSURE

FUEL TYPE: GNF3



Average Planar Exposure (GWd/MT)	MAPLHGR Limit (kW/ft)
0.00	13.78
19.31	13.78
67.00	7.50
70.00	6.69

Table 7.0: OLMCPR Summary Table

Application Condition	Operating Limit MCPR (OLMCPR) for 100% RTP for all GNF2 and GNF3 LUA fuel types, TLO	
	BOC – MOC	MOC – EOC
1	1.29	1.33
2	1.31	1.38
3	1.31	1.36
4	1.29	1.33
5	1.31	1.39
6	1.31	1.36
7	1.31	1.39

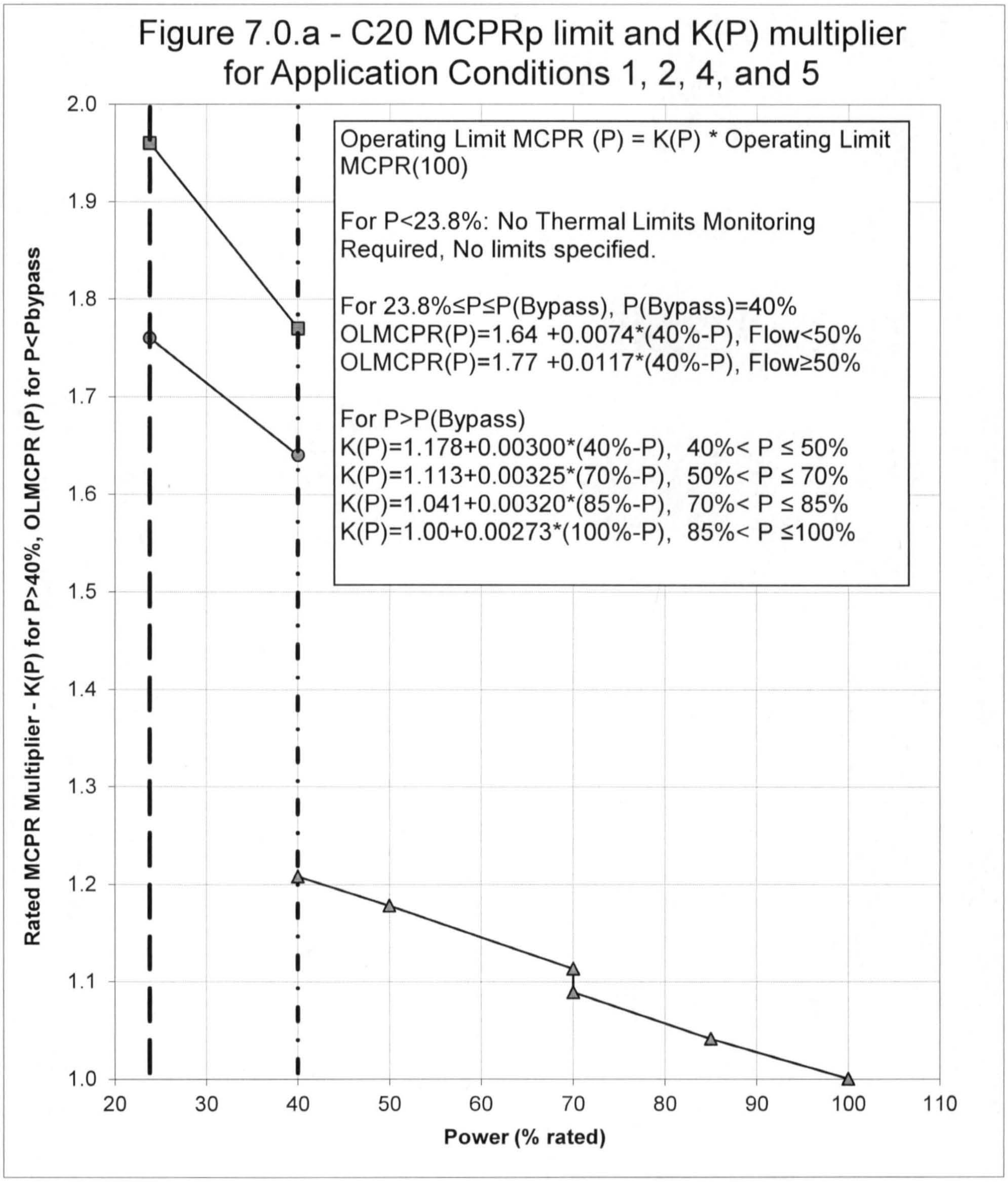


Figure 7.0.a - C20 MCPRp limit and K(P) multiplier for Application Conditions 1, 2, 4, and 5
Operating Limit MCPR (P) = K(P) * Operating Limit MCPR(100)
For P<23.8%: No Thermal Limits Monitoring Required, No limits specified.
For 23.8%≤P≤P(Bypass), P(Bypass)=40%
OLMCPR(P)=1.64 +0.0074*(40%-P), Flow<50%
OLMCPR(P)=1.77 +0.0117*(40%-P), Flow≥50%
For P>P(Bypass)
K(P)=1.178+0.00300*(40%-P), 40%< P ≤ 50%
K(P)=1.113+0.00325*(70%-P), 50%< P ≤ 70%
K(P)=1.041+0.00320*(85%-P), 70%< P ≤ 85%
K(P)=1.00+0.00273*(100%-P), 85%< P ≤100%
Rated MCPR Multiplier - K(P) for P>40%, OLMCPR (P) for P<Pbypass
Power (% rated)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
20
30
40
50
60
70
80
90
100
110

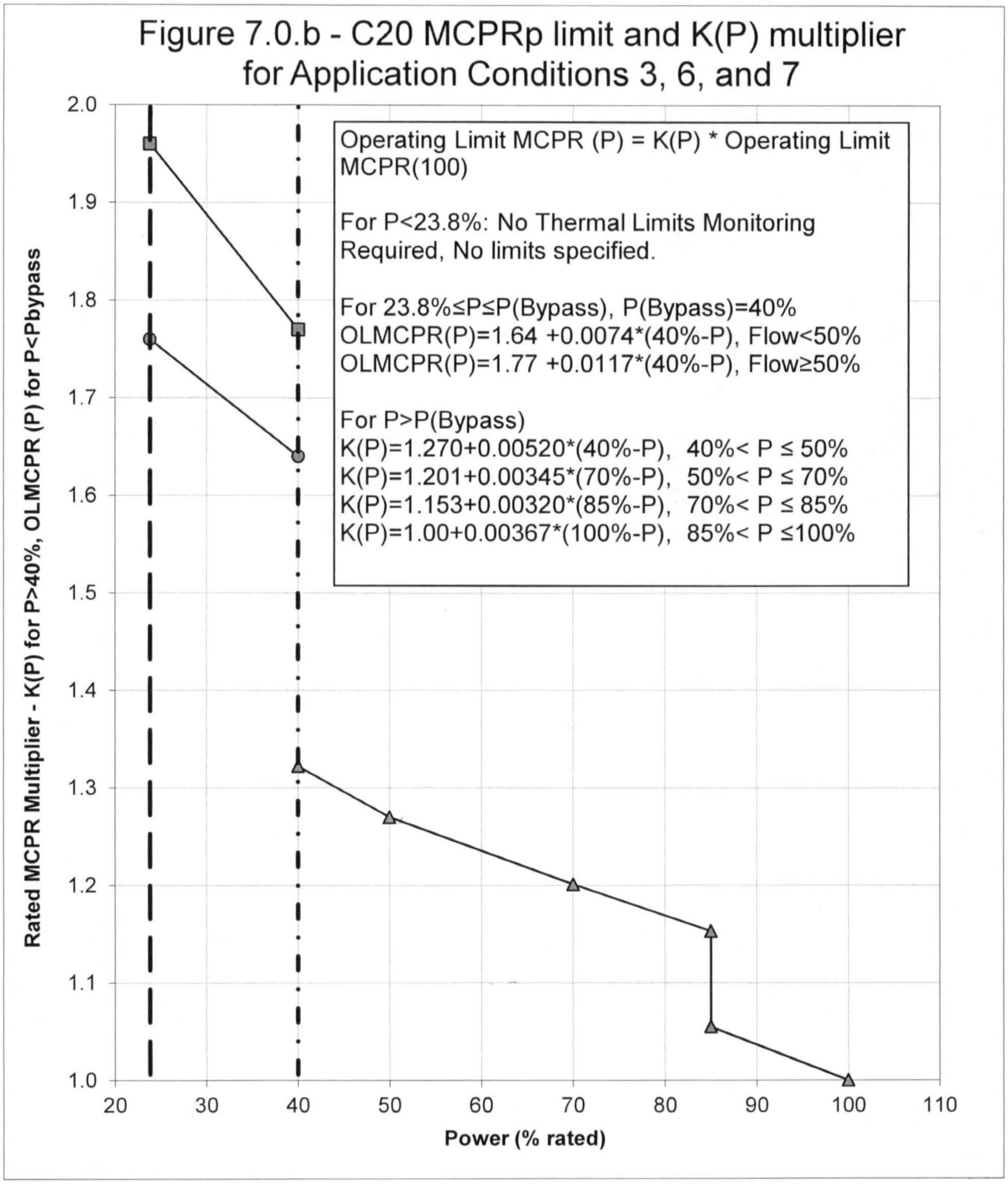
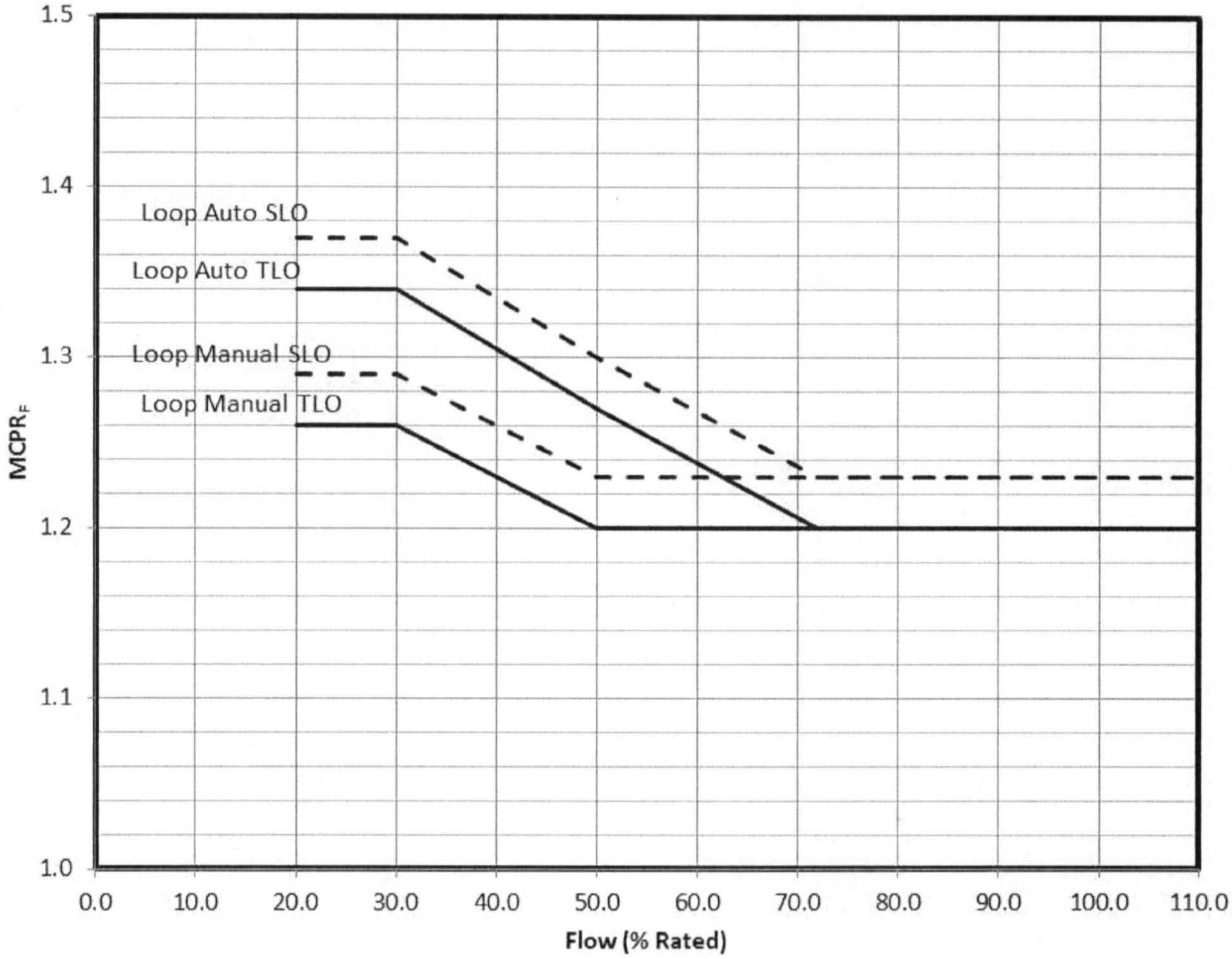


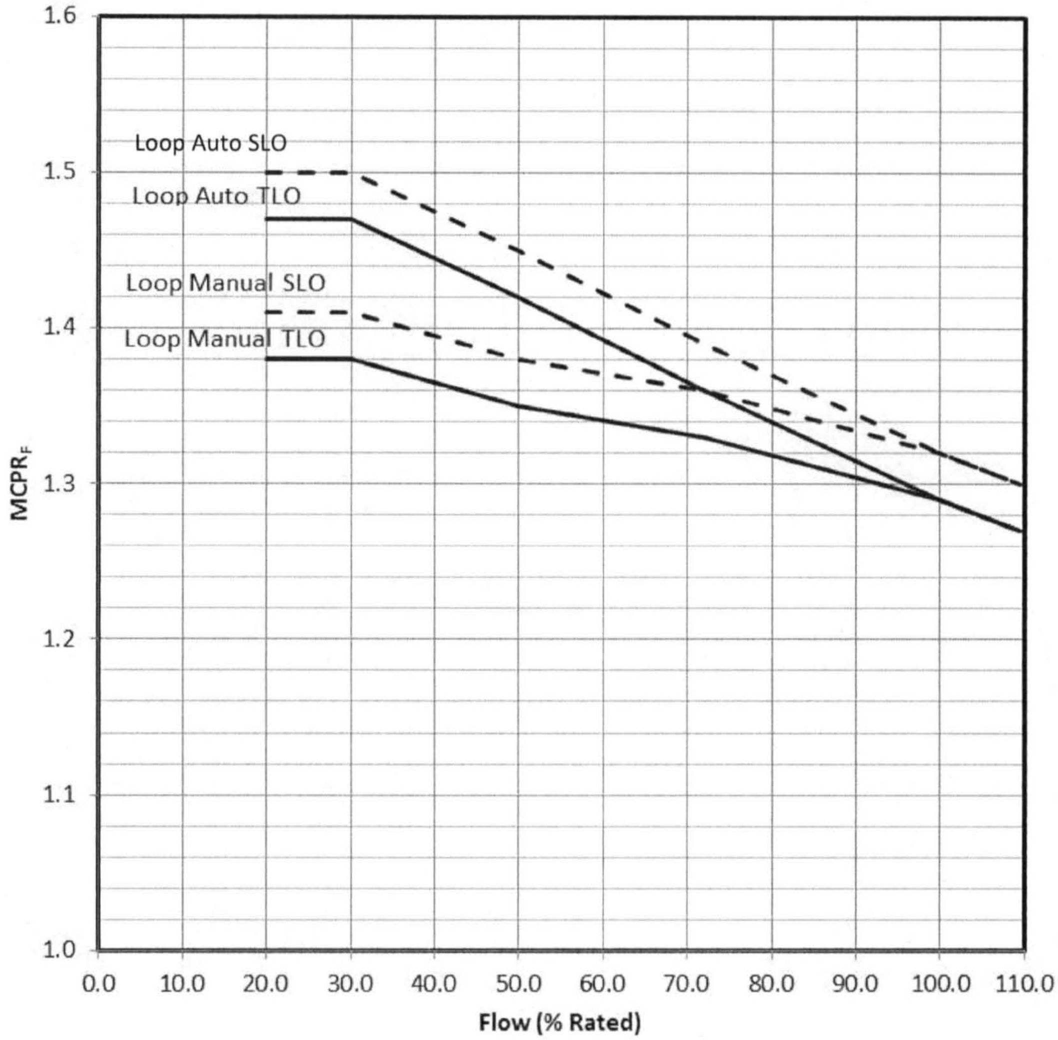
Figure 7.0.b - C20 MCPRp limit and K(P) multiplier for Application Conditions 3, 6, and 7
Operating Limit MCPR (P) = K(P) * Operating Limit MCPR(100)
For P<23.8%: No Thermal Limits Monitoring Required, No limits specified.
For 23.8%≤P≤P(Bypass), P(Bypass)=40%
OLMCPR(P)=1.64 +0.0074*(40%-P), Flow<50%
OLMCPR(P)=1.77 +0.0117*(40%-P), Flow≥50%
For P>P(Bypass)
K(P)=1.270+0.00520*(40%-P), 40%< P ≤ 50%
K(P)=1.201+0.00345*(70%-P), 50%< P ≤ 70%
K(P)=1.153+0.00320*(85%-P), 70%< P ≤ 85%
K(P)=1.00+0.00367*(100%-P), 85%< P ≤100%
Rated MCPR Multiplier - K(P) for P>40%, OLMCPR (P) for P<Pbypass
Power (% rated)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
20
30
40
50
60
70
80
90
100
110

FIGURE 7.1-1 OPERATING LIMIT MCPR VERSUS CORE FLOW ($MCPR_F$), TLO AND SLO
APPLICATION CONDITION: 1, 2, 3
FUEL TYPE: GNF2 & GNF3 LUA



Flow (% Rated)	Loop Manual TLO	Loop Auto TLO	Loop Manual SLO	Loop Auto SLO
20.0	1.26	1.34	1.29	1.37
30.0	1.26	1.34	1.29	1.37
50.0	1.20	1.27	1.23	1.30
72.0	1.20	1.20	1.23	1.23
100.0	1.20	1.20	1.23	1.23
109.5	1.20	1.20	1.23	1.23

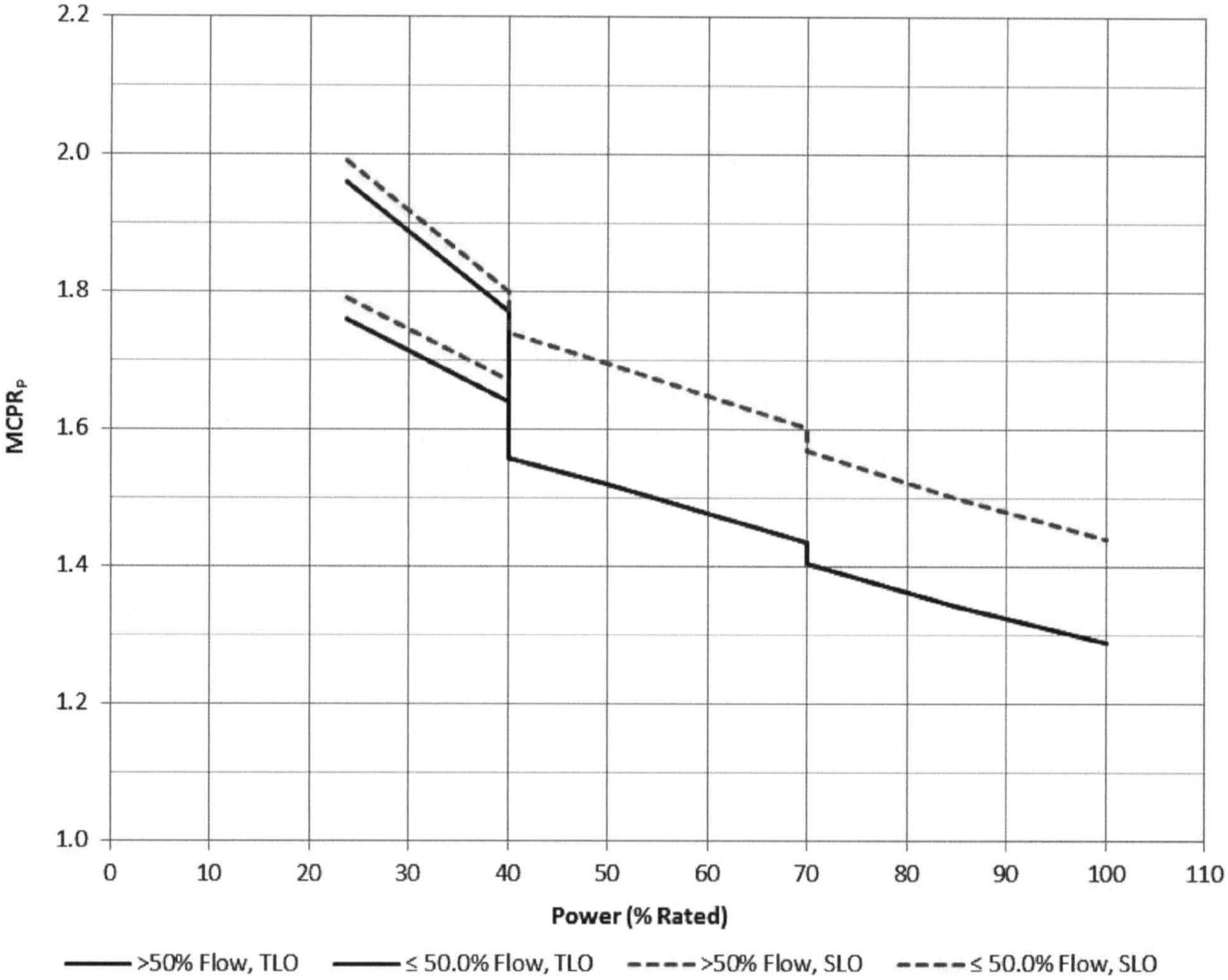
FIGURE 7.1-2 OPERATING LIMIT MCPR VERSUS CORE FLOW ($MCPR_F$), TLO AND SLO
APPLICATION CONDITION: 4, 5, 6, 7
FUEL TYPE: GNF2 & GNF3 LUA



Flow (% Rated)	Loop Manual TLO	Loop Auto TLO	Loop Manual SLO	Loop Auto SLO
20.0	1.38	1.47	1.41	1.50
30.0	1.38	1.47	1.41	1.50
50.0	1.35	1.42	1.38	1.45
72.0	1.33	1.36	1.36	1.39
100.0	1.29	1.29	1.32	1.32
109.5	1.27	1.27	1.30	1.30

FIGURE 7.2-1a OPERATING LIMIT MCPR VERSUS CORE POWER ($MCPR_P$), TLO AND SLO

APPLICATION CONDITION: 1, 4
EXPOSURE RANGE BOC-MOC
FUEL TYPE: GNF2 & GNF3 LUA

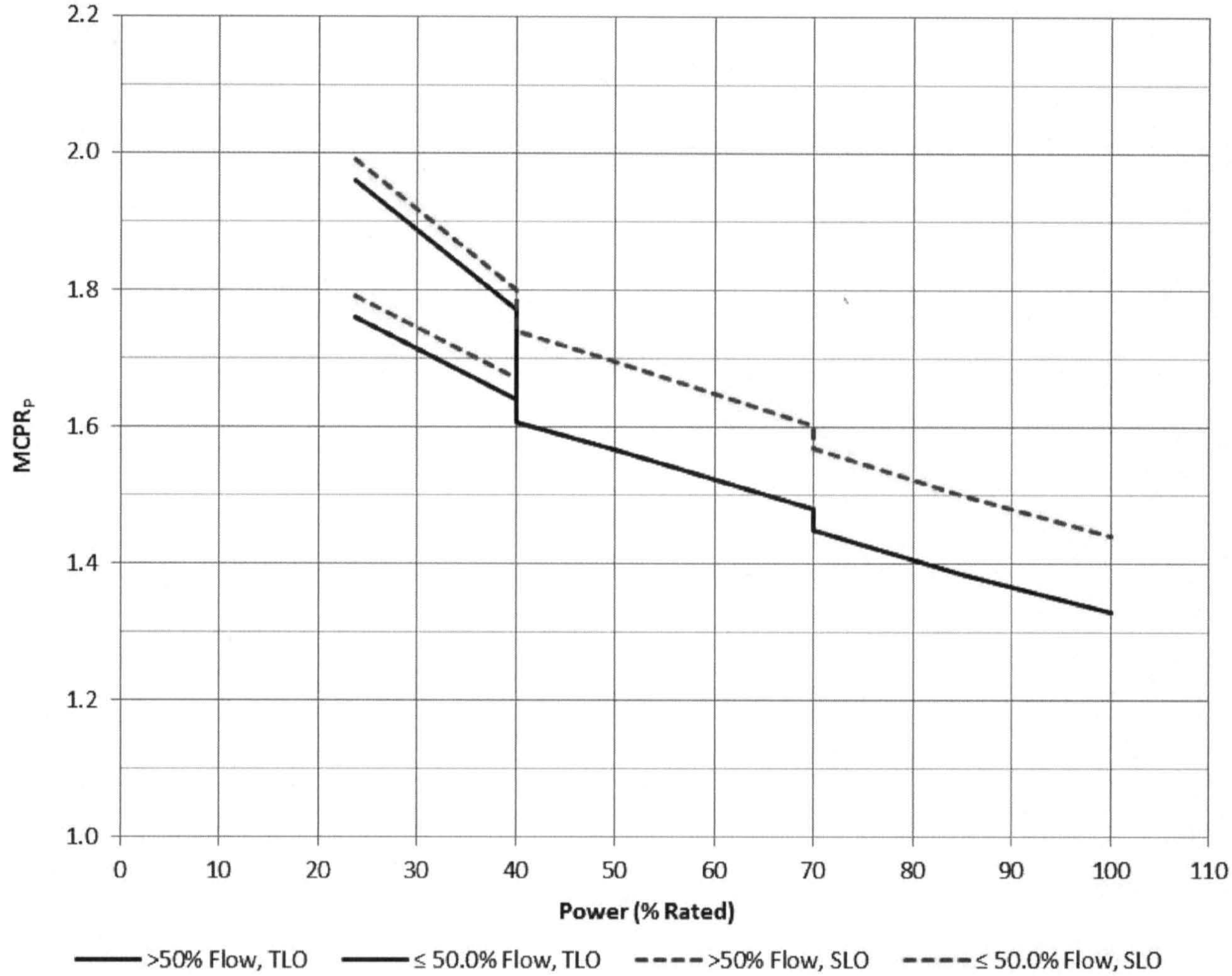


Power (% Rated)	≤ 50.0% Flow, SLO	>50% Flow, SLO	Power (% Rated)	≤ 50.0% Flow, TLO	>50% Flow, TLO
23.8	1.79	1.99	23.8	1.76	1.96
40.0	1.67	1.80	40.0	1.64	1.77
40.0		1.74	40.0		1.56
50.0		1.70	50.0		1.52
70.0		1.60	70.0		1.44
70.0		1.57	70.0		1.40
85.0		1.50	85.0		1.34
85.0		1.50	85.0		1.34
100.0		1.44	100.0		1.29

FIGURE 7.2-1b OPERATING LIMIT MCPR VERSUS CORE POWER ($MCPR_P$),

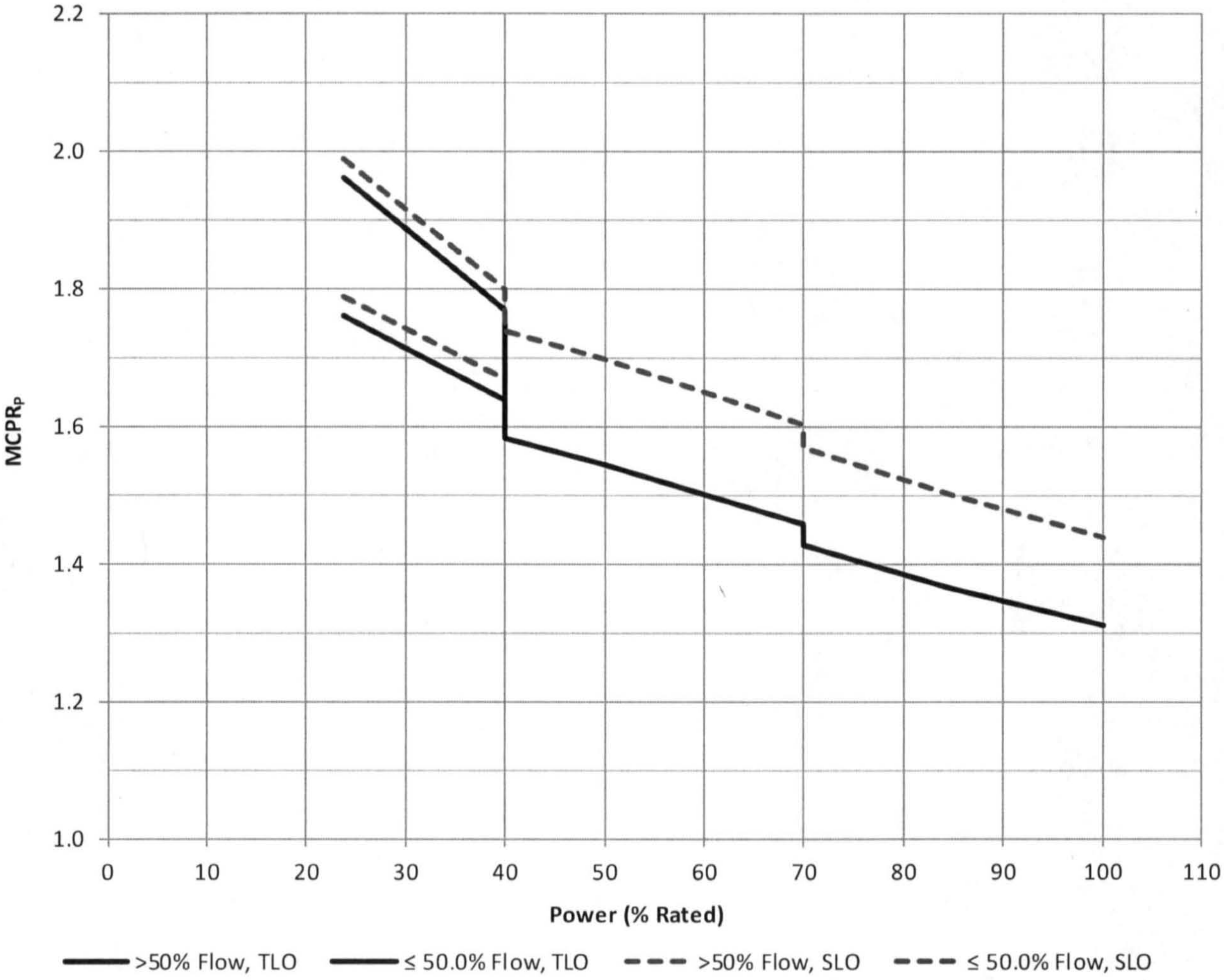
FIGURE 7.2-1b — OPERATING LIMIT MCPR VERSUS CORE POWER ($MCPR_P$), TLO AND SLO

APPLICATION CONDITION: 1, 4
EXPOSURE RANGE MOC-EOC
FUEL TYPE: GNF2 & GNF3 LUA



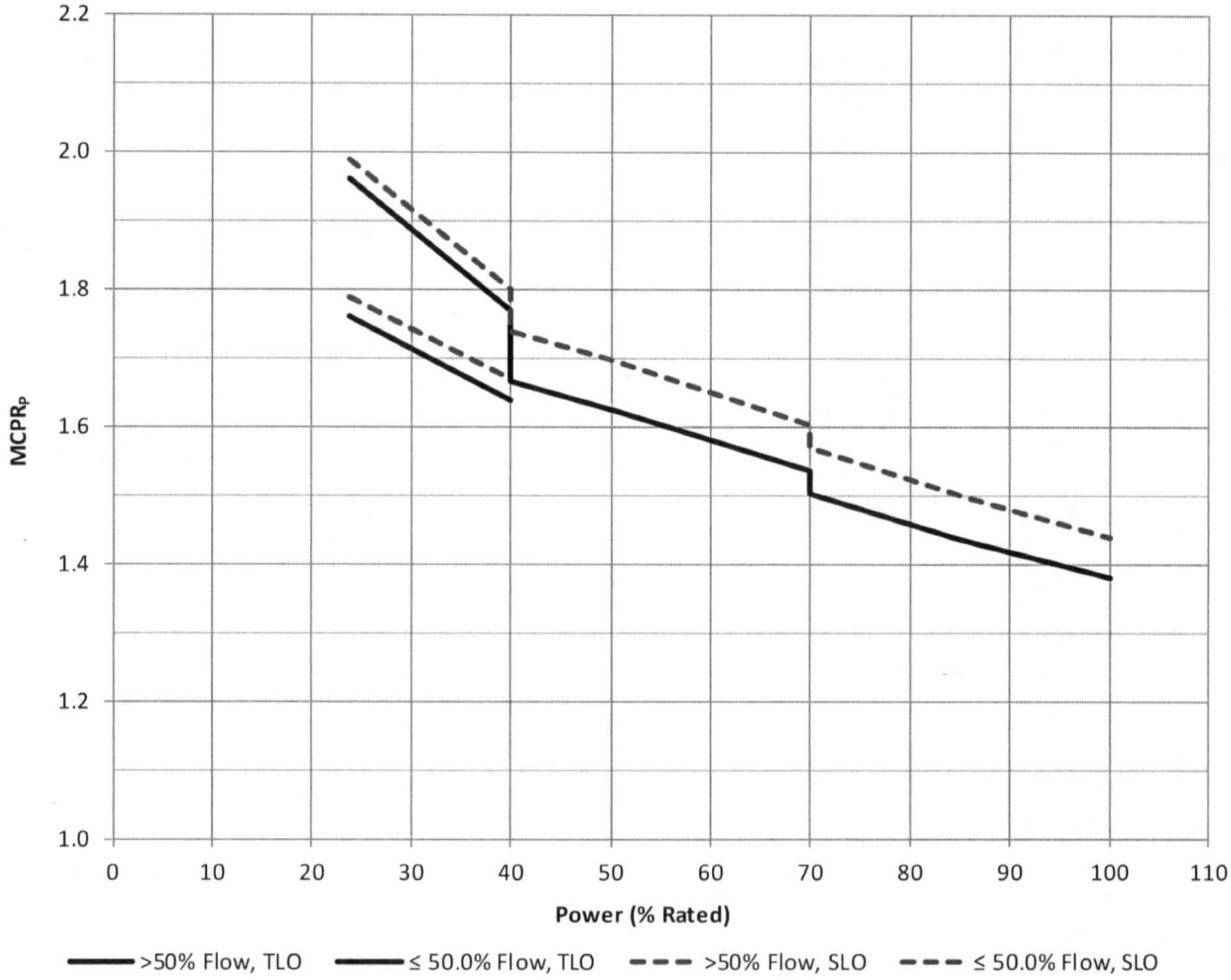
Power (% Rated)	≤ 50.0% Flow, SLO	>50% Flow, SLO	Power (% Rated)	≤ 50.0% Flow, TLO	>50% Flow, TLO
23.8	1.79	1.99	23.8	1.76	1.96
40.0	1.67	1.80	40.0	1.64	1.77
40.0		1.74	40.0		1.61
50.0		1.70	50.0		1.57
70.0		1.60	70.0		1.48
70.0		1.57	70.0		1.45
85.0		1.50	85.0		1.38
85.0		1.50	85.0		1.38
100.0		1.44	100.0		1.33

FIGURE 7.2-2a. OPERATING LIMIT MCPR VERSUS CORE POWER ($MCPR_P$) for TLO and SLO
APPLICATION CONDITION: 2
EXPOSURE RANGE: BOC TO MOC
FUEL TYPE: GNF2 & GNF3 LUA



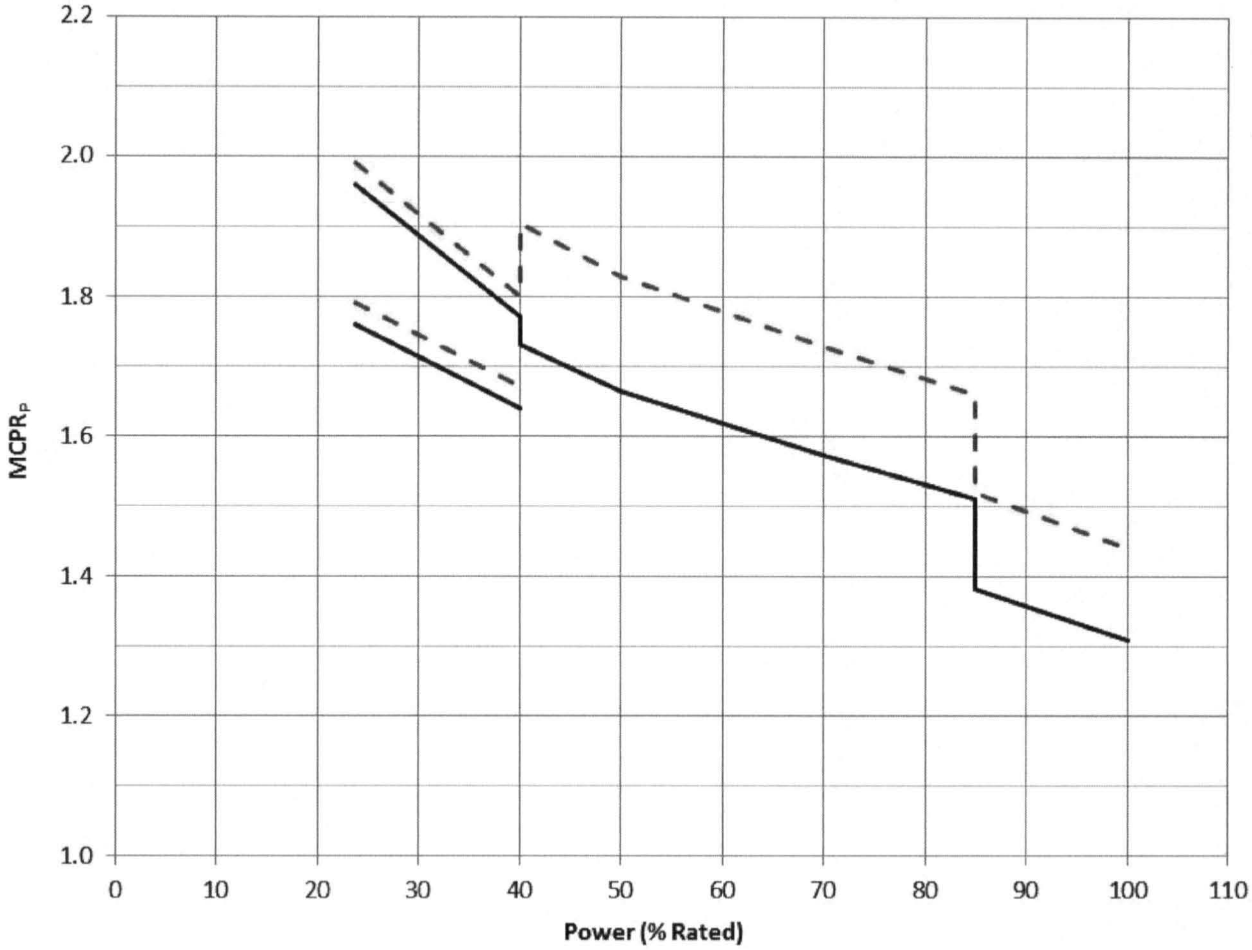
Power (% Rated)	≤ 50.0% Flow, SLO	>50% Flow, SLO	Power (% Rated)	≤ 50.0% Flow, TLO	>50% Flow, TLO
23.8	1.79	1.99	23.8	1.76	1.96
40.0	1.67	1.80	40.0	1.64	1.77
40.0		1.74	40.0		1.58
50.0		1.70	50.0		1.54
70.0		1.60	70.0		1.46
70.0		1.57	70.0		1.43
85.0		1.50	85.0		1.36
85.0		1.50	85.0		1.36
100.0		1.44	100.0		1.31

FIGURE 7.2-2b. OPERATING LIMIT MCPR VERSUS CORE POWER ($MCPR_P$) for TLO and SLO
APPLICATION CONDITION: 2
EXPOSURE RANGE: MOC TO EOC
FUEL TYPE: GNF2 & GNF3 LUA



Power (% Rated)	≤ 50.0% Flow, SLO	>50% Flow, SLO	Power (% Rated)	≤ 50.0% Flow, TLO	>50% Flow, TLO
23.8	1.79	1.99	23.8	1.76	1.96
40.0	1.67	1.80	40.0	1.64	1.77
40.0		1.74	40.0		1.67
50.0		1.70	50.0		1.63
70.0		1.60	70.0		1.54
70.0		1.57	70.0		1.50
85.0		1.50	85.0		1.44
85.0		1.50	85.0		1.44
100.0		1.44	100.0		1.38

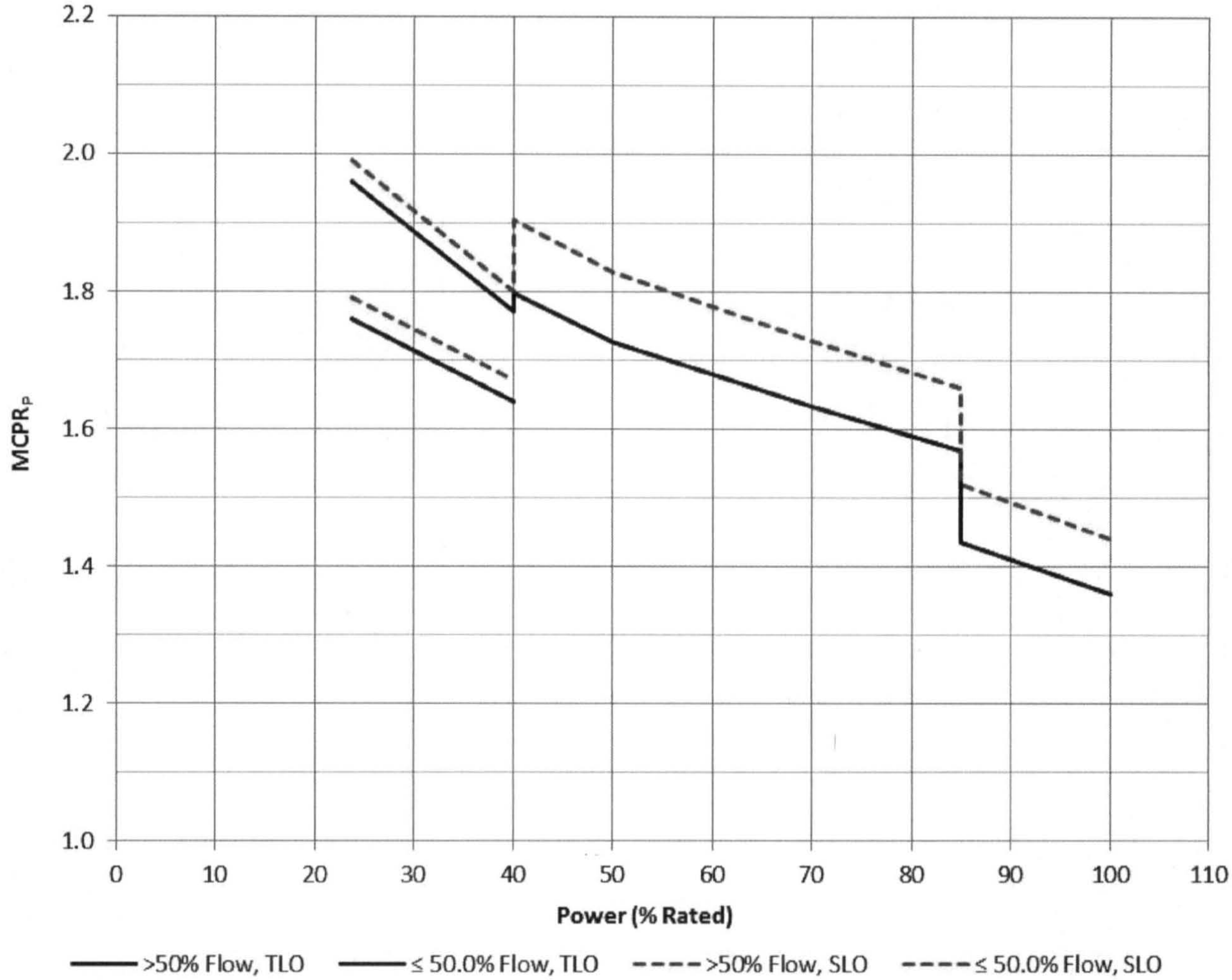
FIGURE 7.2-3a OPERATING LIMIT MCPR VERSUS CORE POWER ($MCPR_P$),
TLO AND SLO
APPLICATION CONDITION: 3, 6
EXPOSURE RANGE BOC-MOC
FUEL TYPE: GNF2 & GNF3 LUA



Power (% Rated)	≤ 50.0% Flow, SLO	>50% Flow, SLO	Power (% Rated)	≤ 50.0% Flow, TLO	>50% Flow, TLO
23.8	1.79	1.99	23.8	1.76	1.96
40.0	1.67	1.80	40.0	1.64	1.77
40.0		1.90	40.0		1.73
50.0		1.83	50.0		1.66
70.0		1.73	70.0		1.57
70.0		1.73	70.0		1.57
85.0		1.66	85.0		1.51
85.0		1.52	85.0		1.38
100.0		1.44	100.0		1.31

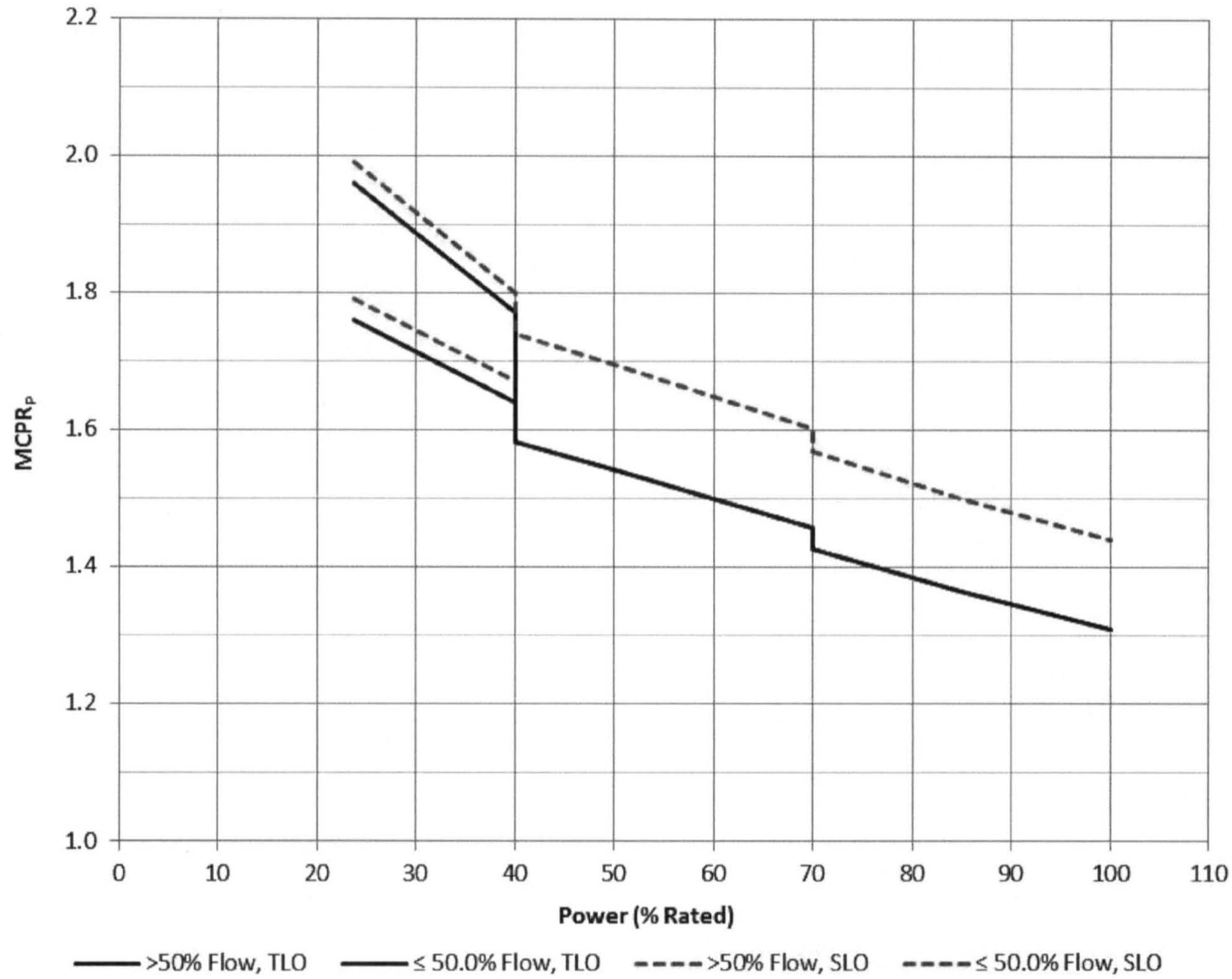
FIGURE 7.2-3b OPERATING LIMIT MCPR VERSUS CORE POWER ($MCPR_P$), TLO AND SLO

APPLICATION CONDITION: 3, 6
EXPOSURE RANGE MOC-EOC
FUEL TYPE: GNF2 & GNF3 LUA



Power (% Rated)	≤ 50.0% Flow, SLO	>50% Flow, SLO	Power (% Rated)	≤ 50.0% Flow, TLO	>50% Flow, TLO
23.8	1.79	1.99	23.8	1.76	1.96
40.0	1.67	1.80	40.0	1.64	1.77
40.0		1.90	40.0		1.80
50.0		1.83	50.0		1.73
70.0		1.73	70.0		1.63
70.0		1.73	70.0		1.63
85.0		1.66	85.0		1.57
85.0		1.52	85.0		1.43
100.0		1.44	100.0		1.36

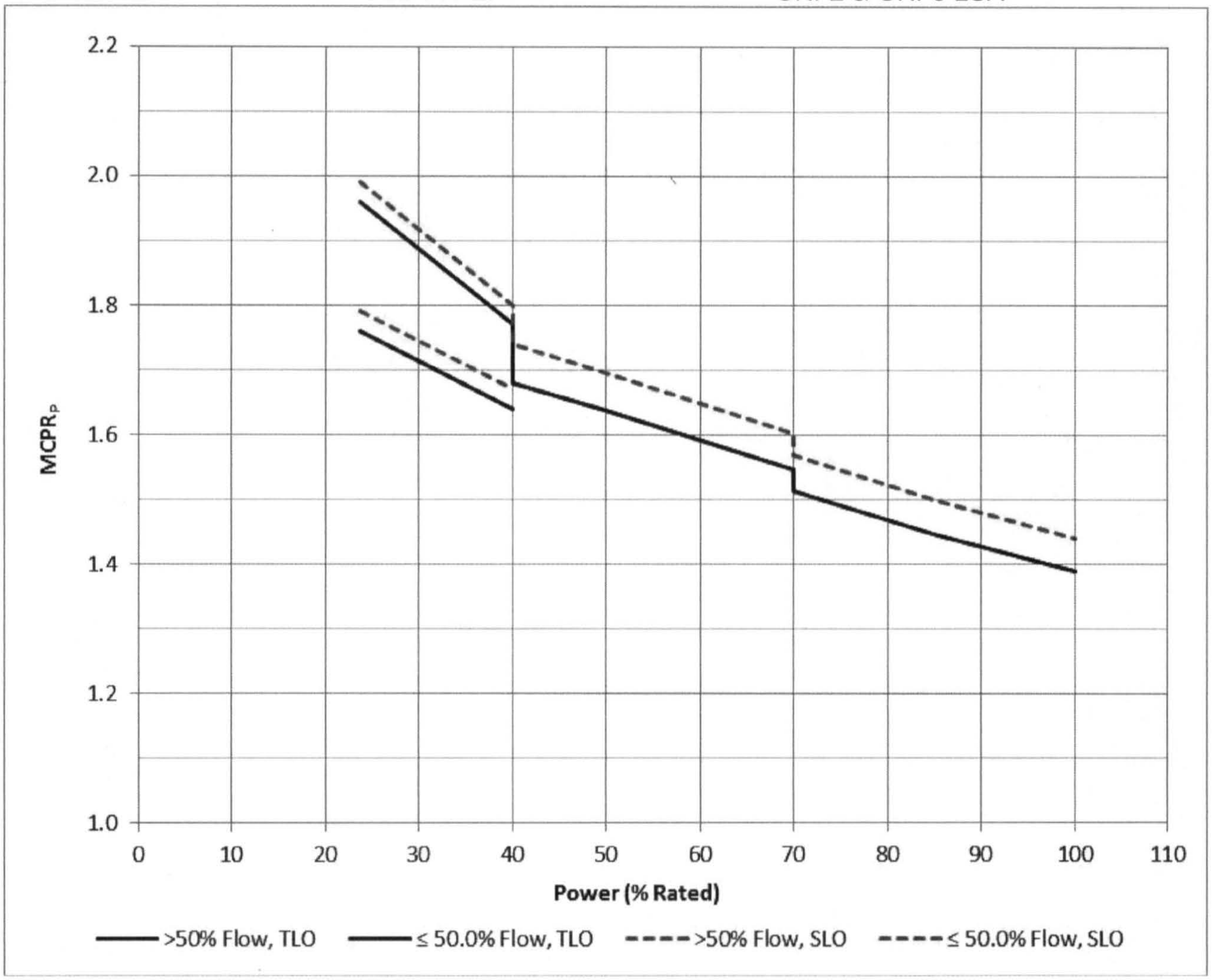
FIGURE 7.2-4a	OPERATING LIMIT MCPR VERSUS CORE POWER ($MCPR_P$), TLO AND SLO	
	APPLICATION CONDITION:	5
	EXPOSURE RANGE	BOC-MOC
	FUEL TYPE:	GNF2 & GNF3 LUA



Power (% Rated)	≤ 50.0% Flow, SLO	>50% Flow, SLO	Power (% Rated)	≤ 50.0% Flow, TLO	>50% Flow, TLO
23.8	1.79	1.99	23.8	1.76	1.96
40.0	1.67	1.80	40.0	1.64	1.77
40.0		1.74	40.0		1.58
50.0		1.70	50.0		1.54
70.0		1.60	70.0		1.46
70.0		1.57	70.0		1.43
85.0		1.50	85.0		1.36
85.0		1.50	85.0		1.36
100.0		1.44	100.0		1.31

FIGURE 7.2-4b OPERATING LIMIT MCPR VERSUS CORE POWER ($MCPR_P$), TLO AND SLO

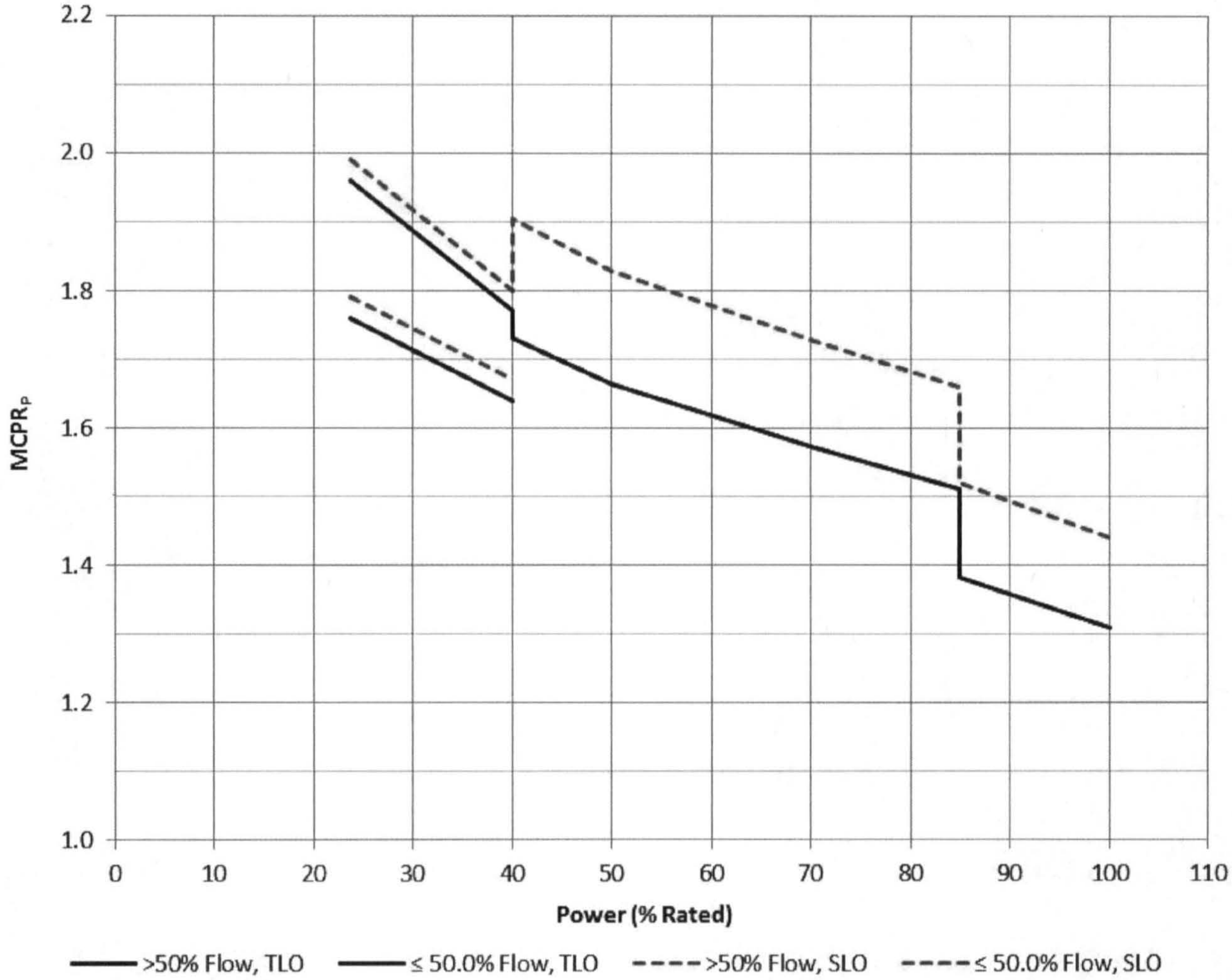
APPLICATION CONDITION: 5
EXPOSURE RANGE MOC-EOC
FUEL TYPE: GNF2 & GNF3 LUA



Power (% Rated)	≤ 50.0% Flow, SLO	>50% Flow, SLO	Power (% Rated)	≤ 50.0% Flow, TLO	>50% Flow, TLO
23.8	1.79	1.99	23.8	1.76	1.96
40.0	1.67	1.80	40.0	1.64	1.77
40.0		1.74	40.0		1.68
50.0		1.70	50.0		1.64
70.0		1.60	70.0		1.55
70.0		1.57	70.0		1.51
85.0		1.50	85.0		1.45
85.0		1.50	85.0		1.45
100.0		1.44	100.0		1.39

FIGURE 7.2-5a — OPERATING LIMIT MCPR VERSUS CORE POWER ($MCPR_P$), TLO AND SLO

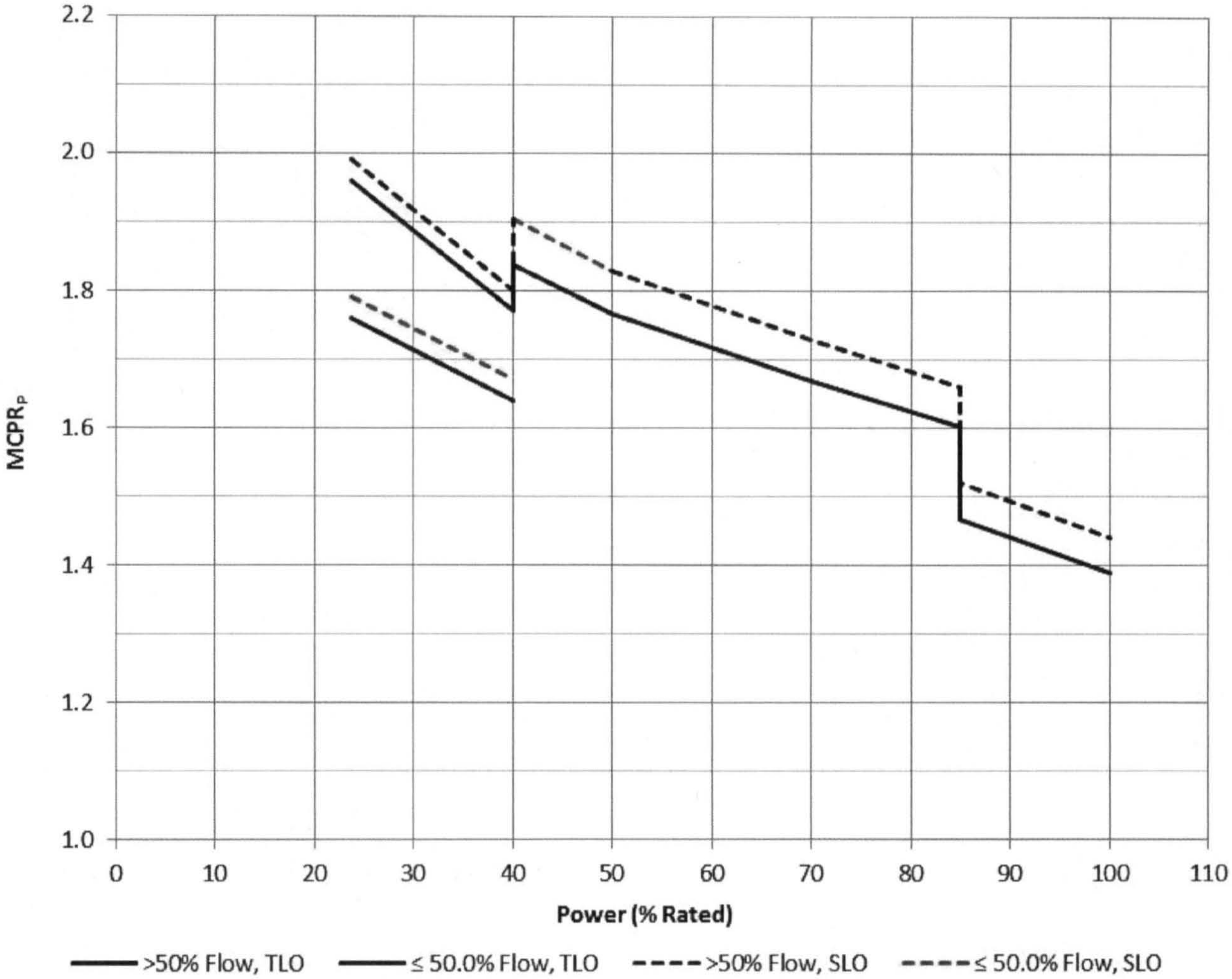
APPLICATION CONDITION:	7
EXPOSURE RANGE	BOC-MOC
FUEL TYPE:	GNF2 & GNF3 LUA



Power (% Rated)	≤ 50.0% Flow, SLO	>50% Flow, SLO	Power (% Rated)	≤ 50.0% Flow, TLO	>50% Flow, TLO
23.8	1.79	1.99	23.8	1.76	1.96
40.0	1.67	1.80	40.0	1.64	1.77
40.0		1.90	40.0		1.73
50.0		1.83	50.0		1.66
70.0		1.73	70.0		1.57
70.0		1.73	70.0		1.57
85.0		1.66	85.0		1.51
85.0		1.52	85.0		1.38
100.0		1.44	100.0		1.31

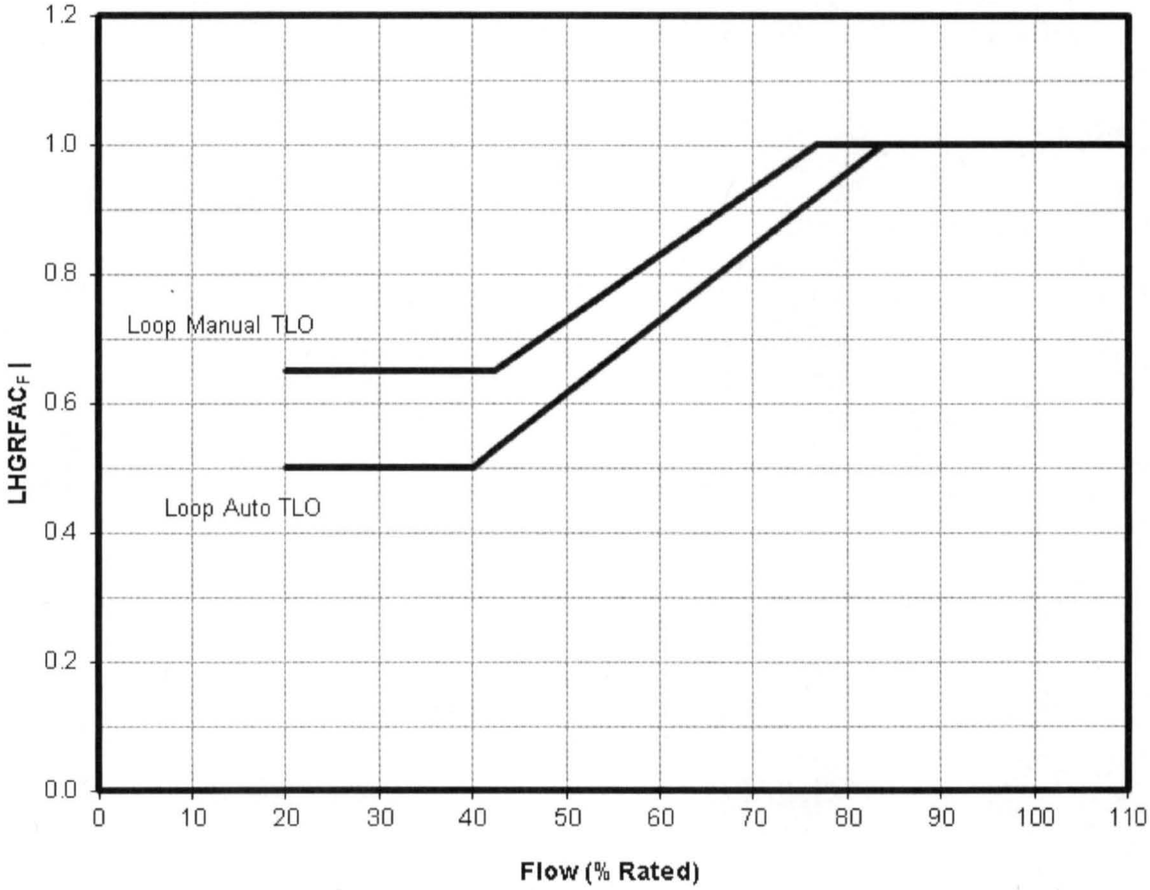
FIGURE 7.2-5b OPERATING LIMIT MCPR VERSUS CORE POWER ($MCPR_P$), TLO AND SLO

APPLICATION CONDITION:	7
EXPOSURE RANGE	MOC-EOC
FUEL TYPE:	GNF2 & GNF3 LUA



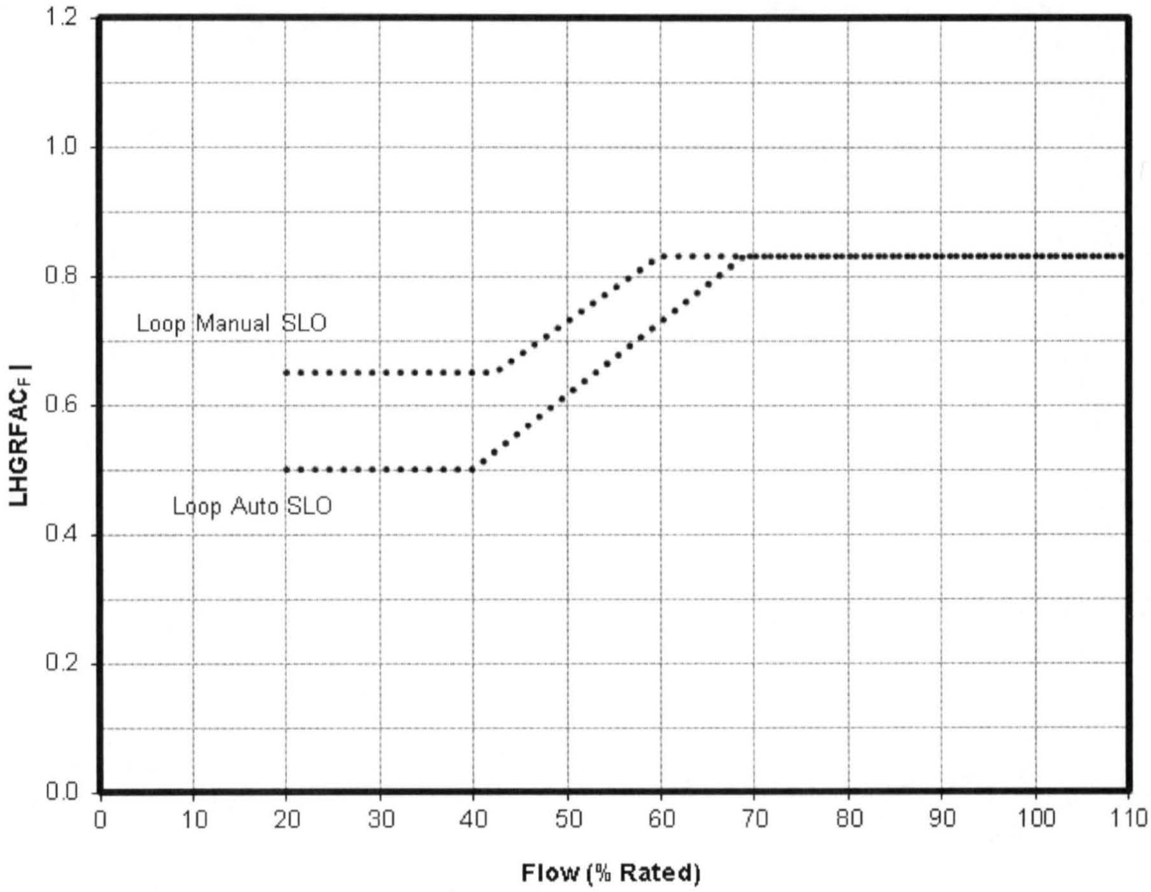
Power (% Rated)	≤ 50.0% Flow, SLO	>50% Flow, SLO	Power (% Rated)	≤ 50.0% Flow, TLO	>50% Flow, TLO
23.8	1.79	1.99	23.8	1.76	1.96
40.0	1.67	1.80	40.0	1.64	1.77
40.0		1.90	40.0		1.84
50.0		1.83	50.0		1.77
70.0		1.73	70.0		1.67
70.0		1.73	70.0		1.67
85.0		1.66	85.0		1.60
85.0		1.52	85.0		1.47
100.0		1.44	100.0		1.39

FIGURE 8.2-1a. OPERATING LIMIT LHGRFAC VERSUS CORE Flow ($LHGRFAC_F$), TLO
APPLICATION CONDITION: 1-7
FUEL TYPE: GNF2 & GNF3 LUA



Flow (% Rated)	Loop Manual TLO	Loop Auto TLO
20.0	0.650	0.500
40.0	0.650	0.500
42.4	0.650	0.527
76.6	1.000	0.919
83.7	1.000	1.000
109.5	1.000	1.000

FIGURE 8.2-1b. OPERATING LIMIT LHGRFAC VERSUS CORE Flow ($LHGRFAC_F$), SLO
APPLICATION CONDITION: 1-7
FUEL TYPE: GNF2 & GNF3 LUA



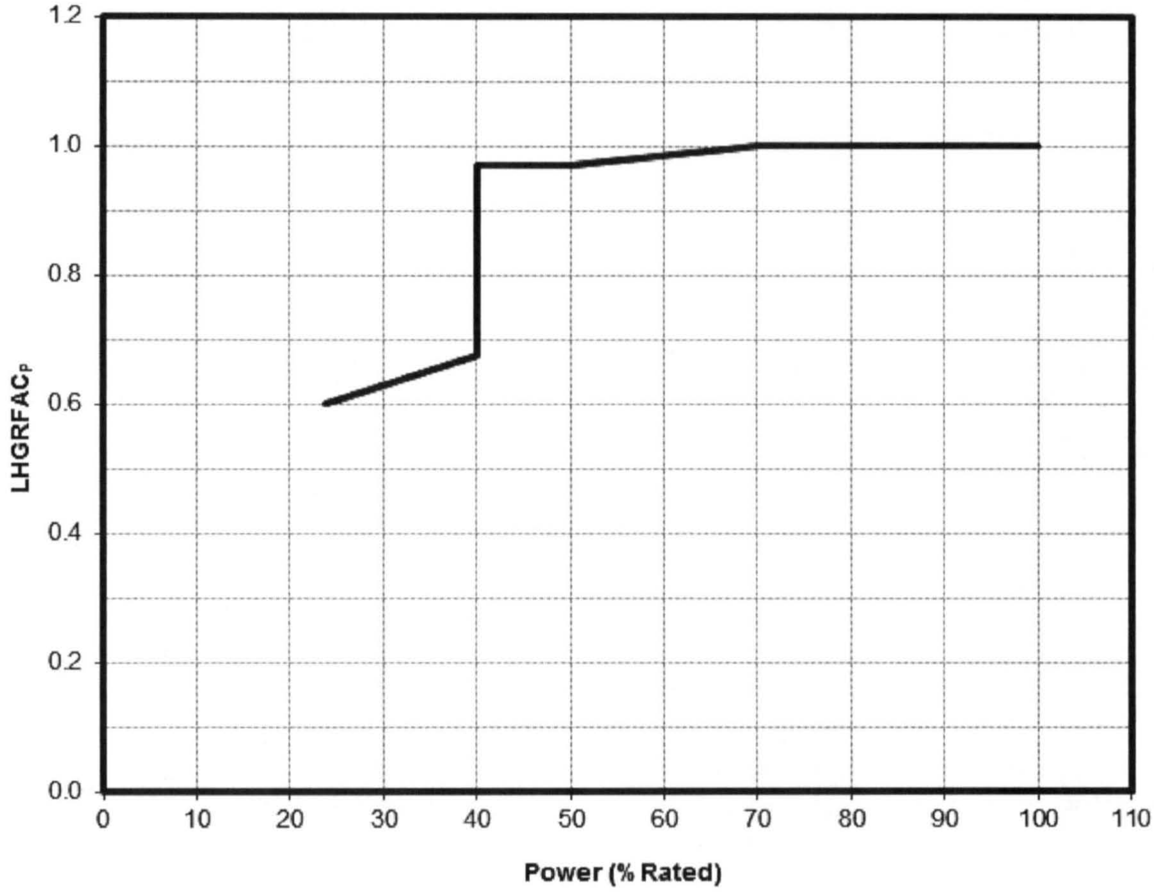
Flow (% Rated)	Loop Manual SLO	Loop Auto SLO
20.0	0.650	0.500
40.0	0.650	0.500
42.4	0.650	0.527
59.99	0.830	0.729
68.84	0.830	0.830
109.5	0.830	0.830

FIGURE 8.3-1. OPERATING LIMIT LHGRFAC VERSUS CORE POWER (LHGRFAC$_P$), TLO+SLO

APPLICATION CONDITION: 1

EXPOSURE RANGE: BOC-EOC

FUEL TYPE: GNF2 & GNF3 LUA



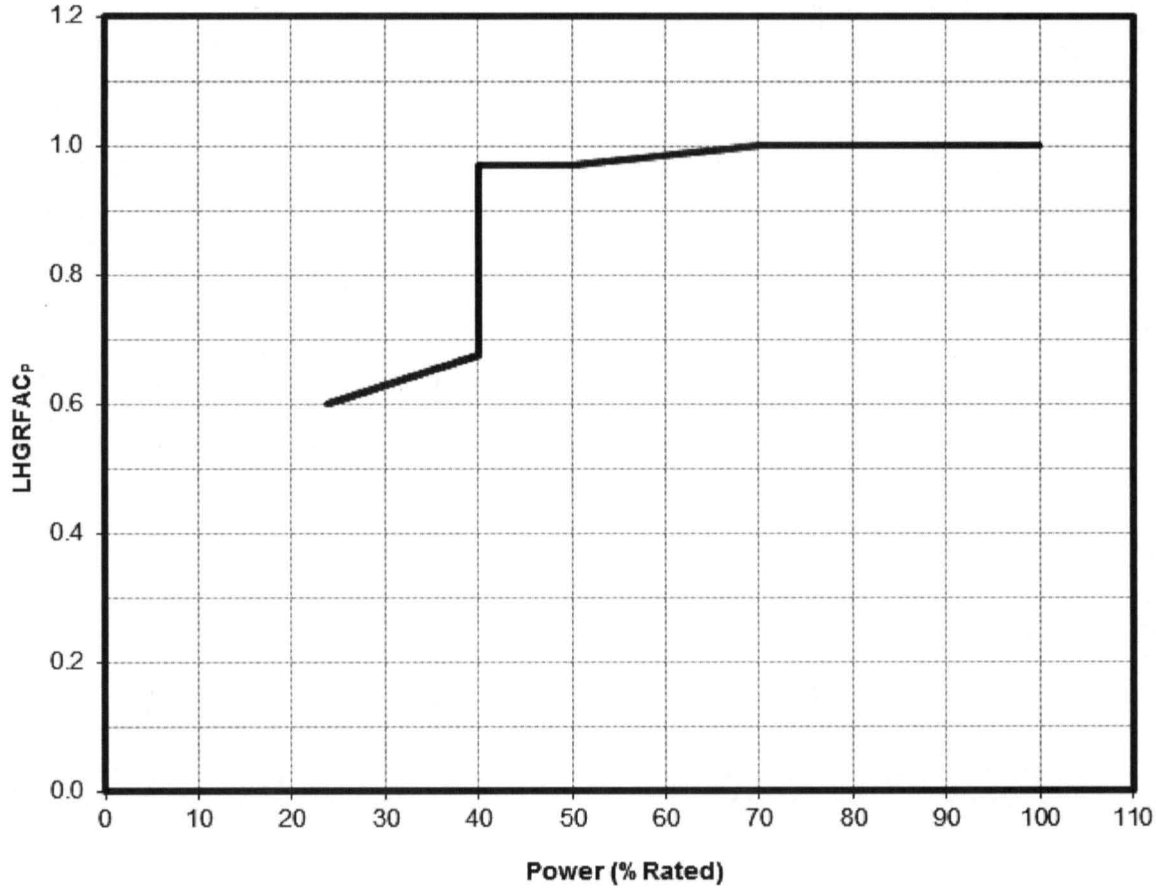
Power (% Rated)	≤ 50.0% Flow	>50% Flow
23.8	0.600	0.600
40.0	0.675	0.675
40.0		0.970
50.0		0.970
70.0		1.000
85.0		1.000
85.0		1.000
100.0		1.000

FIGURE 8.3-2. OPERATING LIMIT LHGRFAC VERSUS CORE POWER ($LHGRFAC_P$), TLO+SLO

APPLICATION CONDITION: 2

EXPOSURE RANGE: BOC-EOC

FUEL TYPE: GNF2 & GNF3 LUA



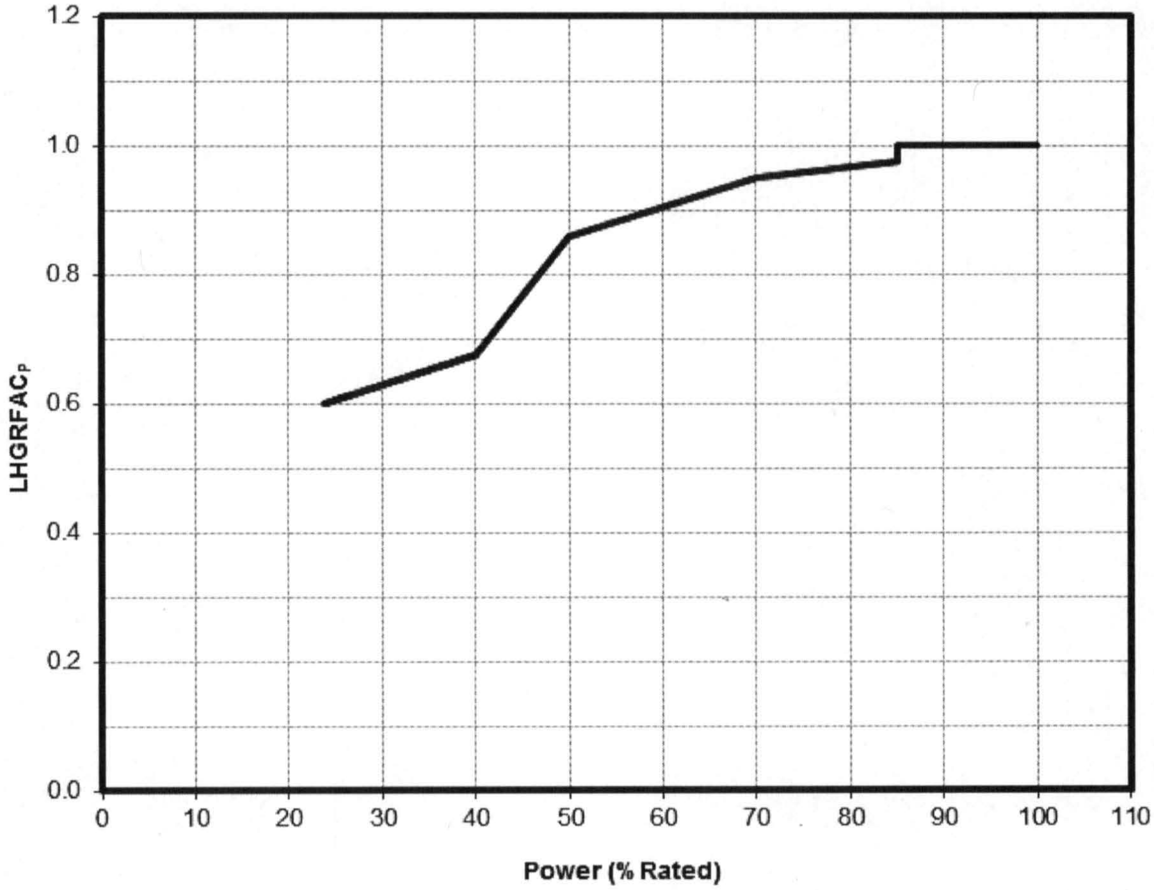
Power (% Rated)	≤ 50.0% Flow	>50% Flow
23.8	0.600	0.600
40.0	0.675	0.675
40.0		0.970
50.0		0.970
70.0		1.000
85.0		1.000
85.0		1.000
100.0		1.000

FIGURE 8.3-3. OPERATING LIMIT LHGRFAC VERSUS CORE POWER (LHGRFAC$_P$), TLO+SLO

APPLICATION CONDITION: 3

EXPOSURE RANGE: BOC-EOC

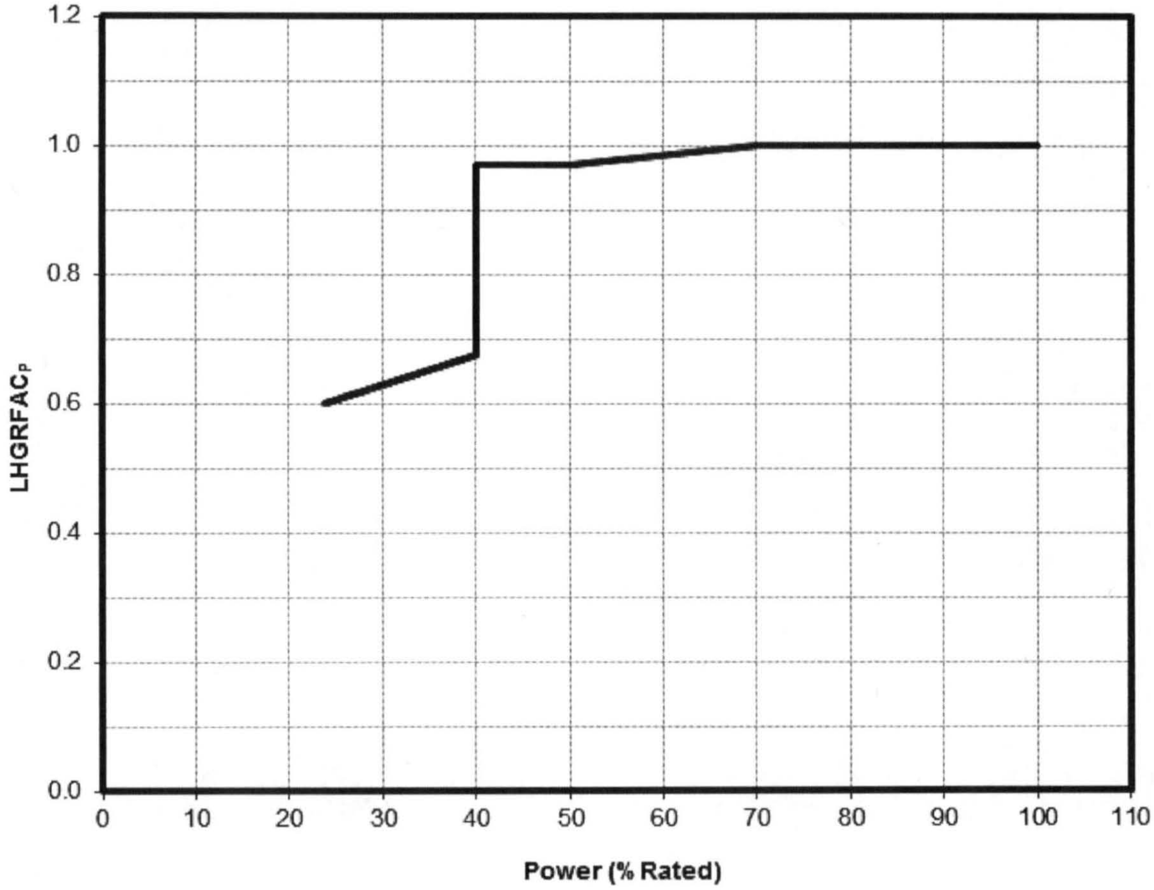
FUEL TYPE: GNF2 & GNF3 LUA



Power (% Rated)	≤ 50.0% Flow	>50% Flow
23.8	0.600	0.600
40.0	0.675	0.675
40.0		0.675
50.0		0.860
70.0		0.950
85.0		0.975
85.0		1.000
100.0		1.000

FIGURE 8.3-4. OPERATING LIMIT LHGRFAC VERSUS CORE POWER ($LHGRFAC_P$), TLO+SLO

APPLICATION CONDITION:	4
EXPOSURE RANGE:	BOC-EOC
FUEL TYPE:	GNF2 & GNF3 LUA



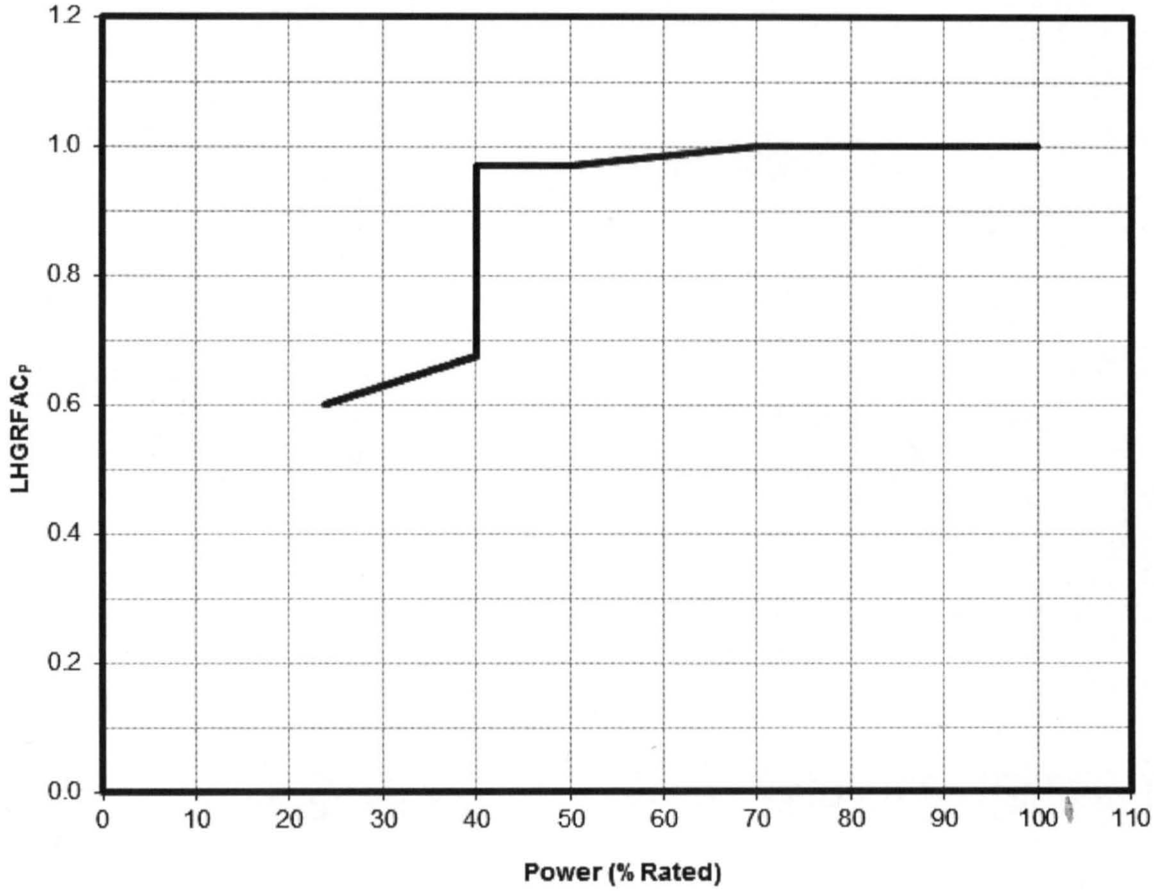
Power (% Rated)	≤ 50.0% Flow	>50% Flow
23.8	0.600	0.600
40.0	0.675	0.675
40.0		0.970
50.0		0.970
70.0		1.000
85.0		1.000
85.0		1.000
100.0		1.000

FIGURE 8.3-5. OPERATING LIMIT LHGRFAC VERSUS CORE POWER ($LHGRFAC_P$), TLO+SLO

APPLICATION CONDITION: 5

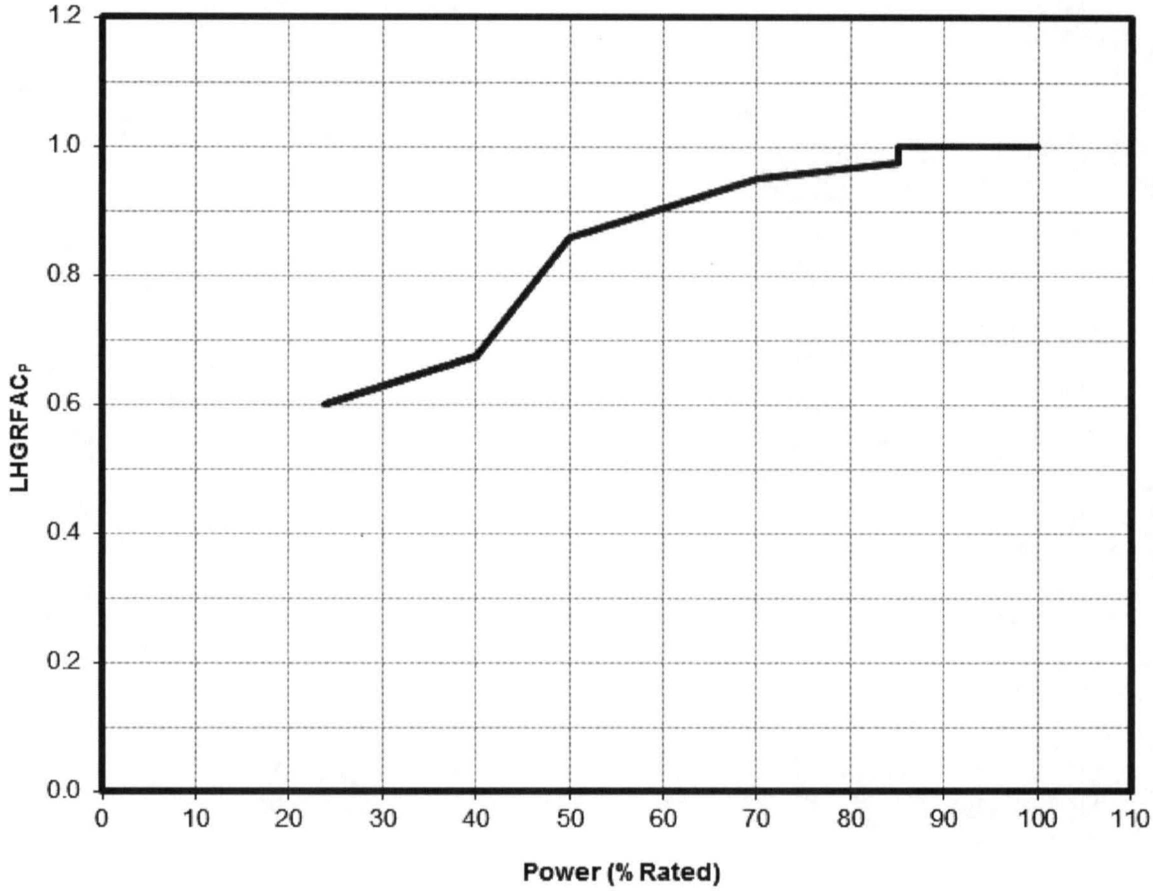
EXPOSURE RANGE: BOC-EOC

FUEL TYPE: GNF2 & GNF3 LUA



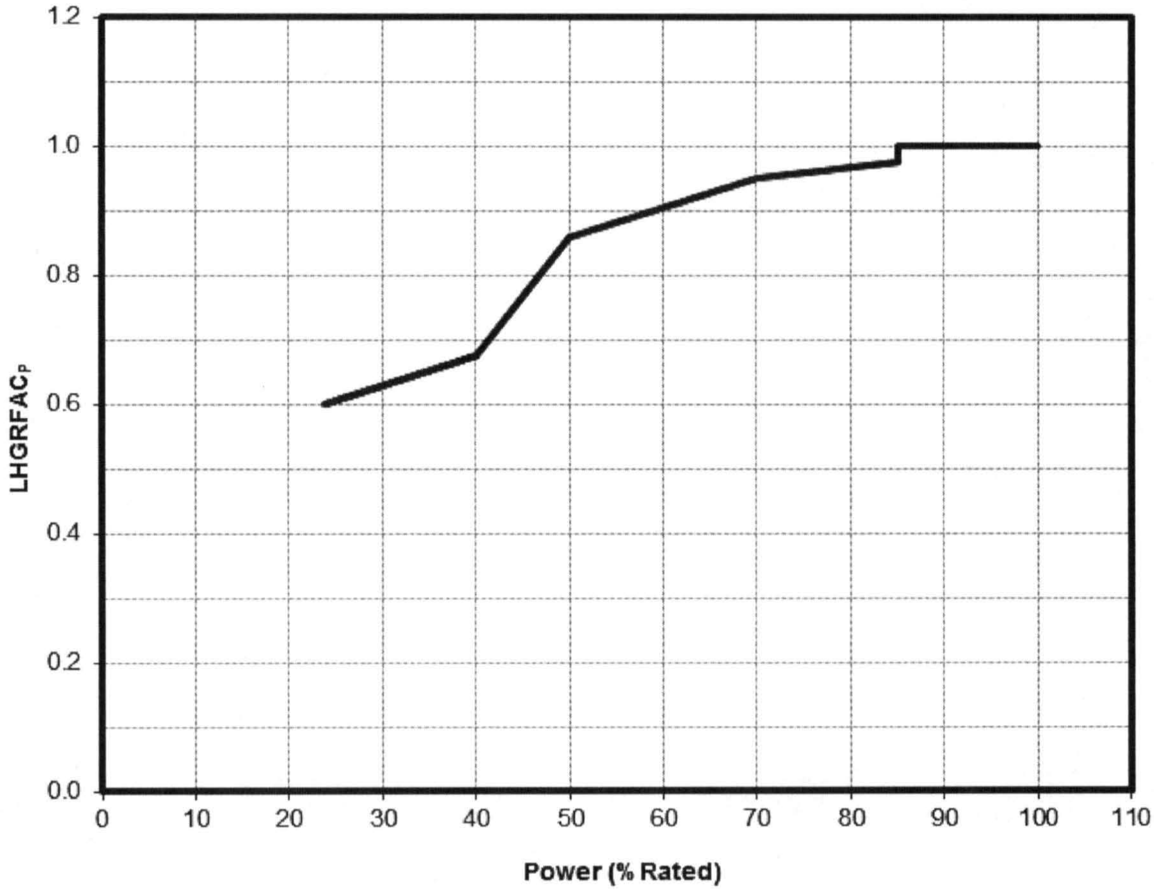
Power (% Rated)	≤ 50.0% Flow	>50% Flow
23.8	0.600	0.600
40.0	0.675	0.675
40.0		0.970
50.0		0.970
70.0		1.000
85.0		1.000
85.0		1.000
100.0		1.000

FIGURE 8.3-6. OPERATING LIMIT LHGRFAC VERSUS CORE POWER ($LHGRFAC_P$), TLO+SLO
APPLICATION CONDITION: 6
EXPOSURE RANGE: BOC-EOC
FUEL TYPE: GNF2 & GNF3 LUA



Power (% Rated)	≤ 50.0% Flow	>50% Flow
23.8	0.600	0.600
40.0	0.675	0.675
40.0		0.675
50.0		0.860
70.0		0.950
85.0		0.975
85.0		1.000
100.0		1.000

FIGURE 8.3-7. OPERATING LIMIT LHGRFAC VERSUS CORE POWER ($LHGRFAC_P$), TLO+SLO
APPLICATION CONDITION: 7
EXPOSURE RANGE: BOC-EOC
FUEL TYPE: GNF2 & GNF3 LUA



Power (% Rated)	≤ 50.0% Flow	>50% Flow
23.8	0.600	0.600
40.0	0.675	0.675
40.0		0.675
50.0		0.860
70.0		0.950
85.0		0.975
85.0		1.000
100.0		1.000

Figure 9.1-1: Monitored Region Boundary (Case 1)

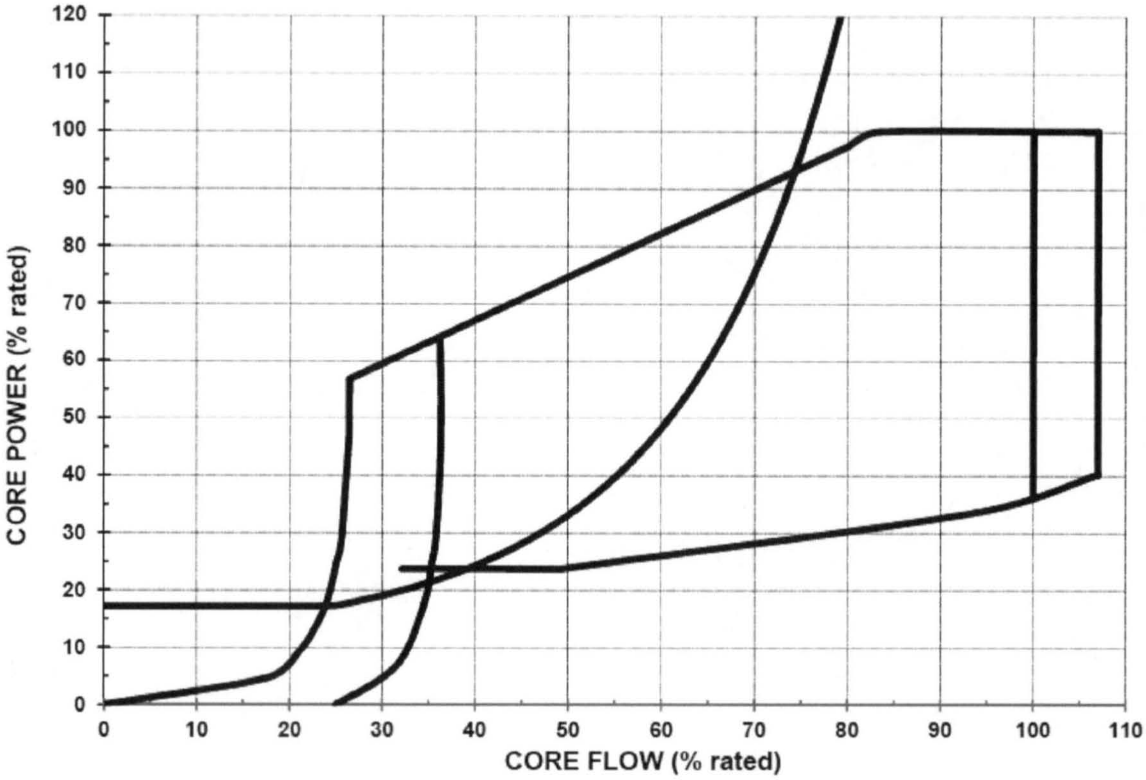


Figure 9.1-2: Monitored Region Boundary (Case 2)

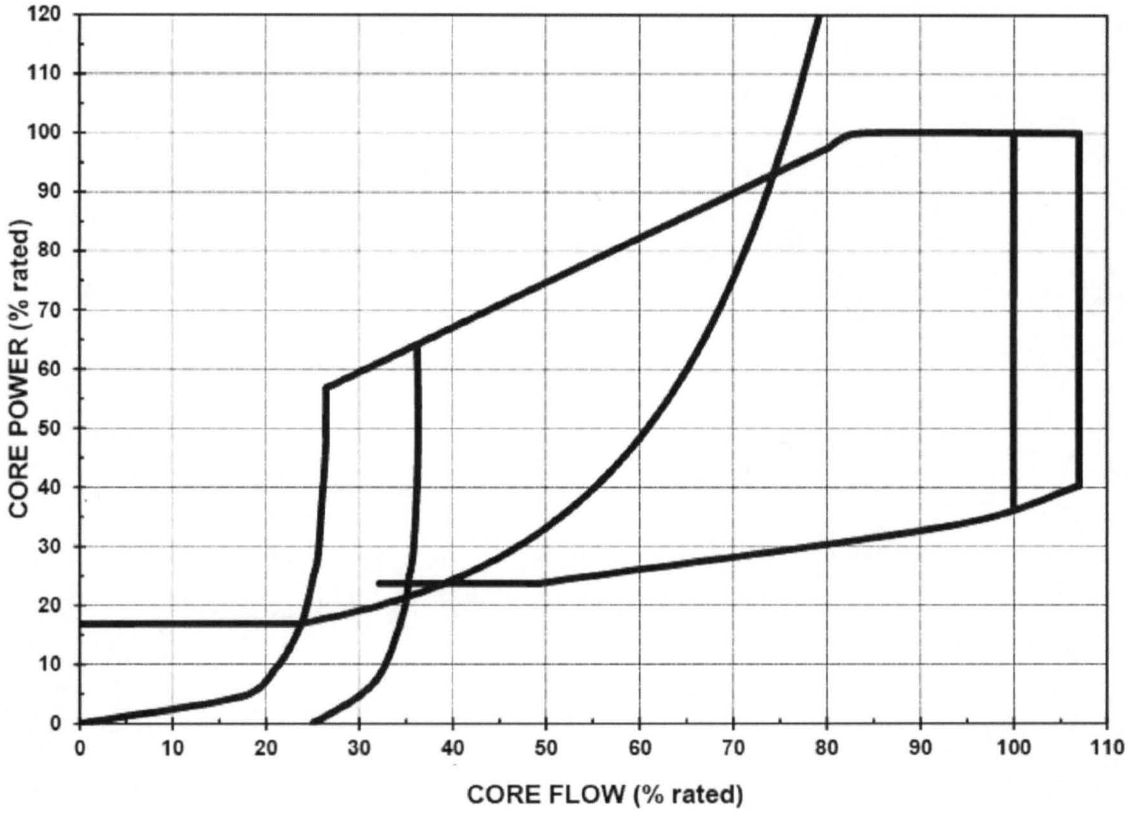


Figure 9.1-3: APRM Flow Biased Simulated Thermal Power – High Scram Setpoints and Restricted Region Boundary (Two Recirculation Loop Operation – Case 1)

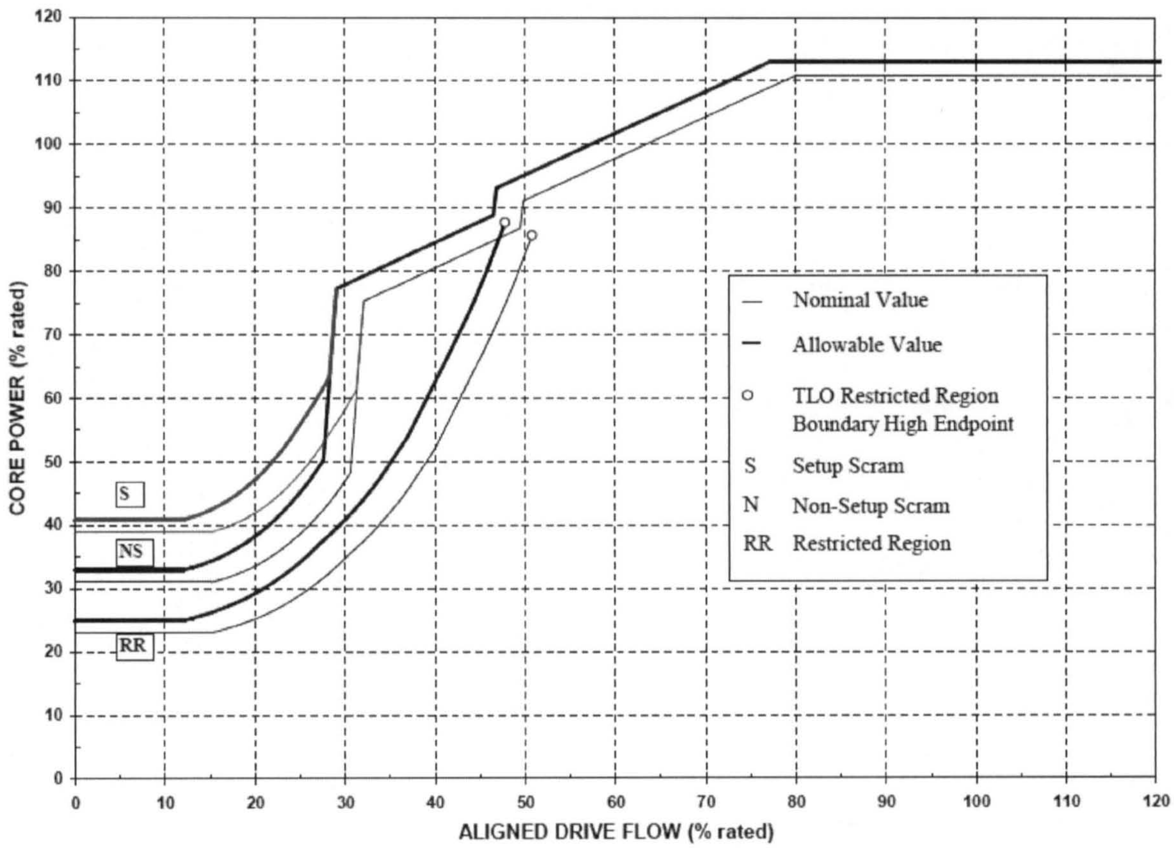


Figure 9.1-4: APRM Flow Biased Simulated Thermal Power – High Scram Setpoints and Restricted Region Boundary (Two Recirculation Loop Operation – Case 2)

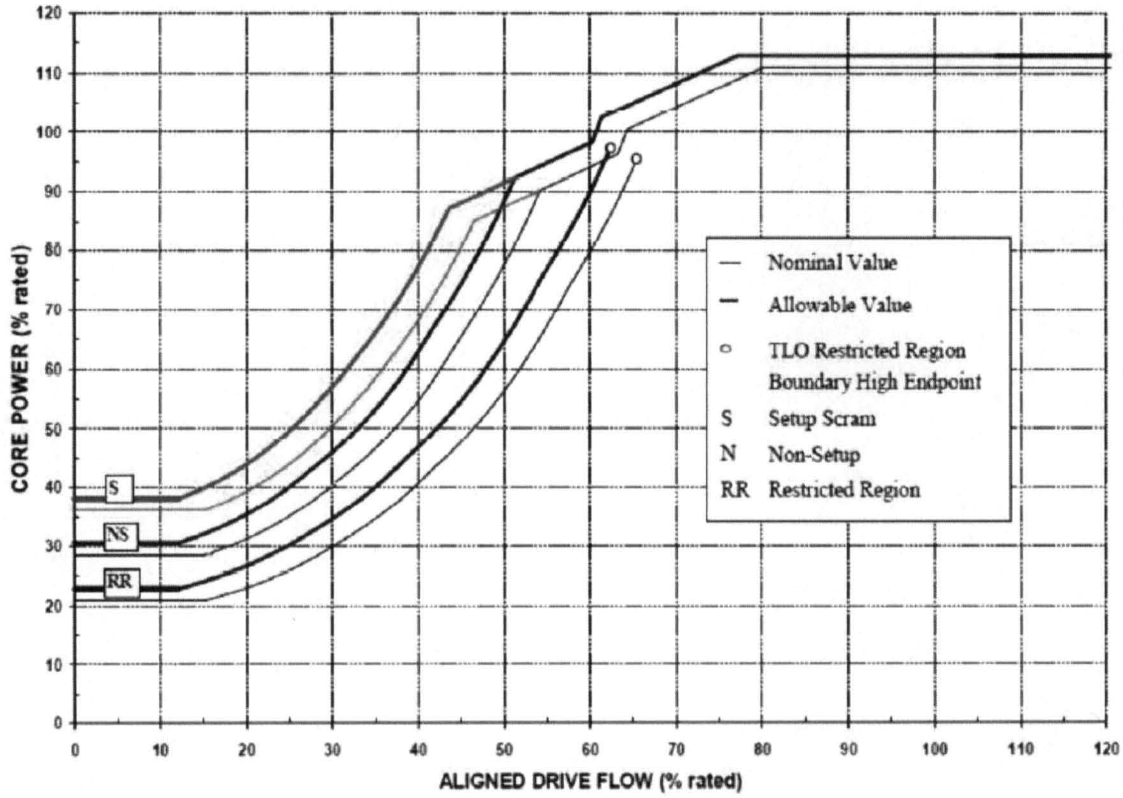


Figure 9.1-5: APRM Flow Biased Simulated Thermal Power – High Scram Setpoints and Restricted Region Boundary (Single Recirculation Loop Operation – Case 1)

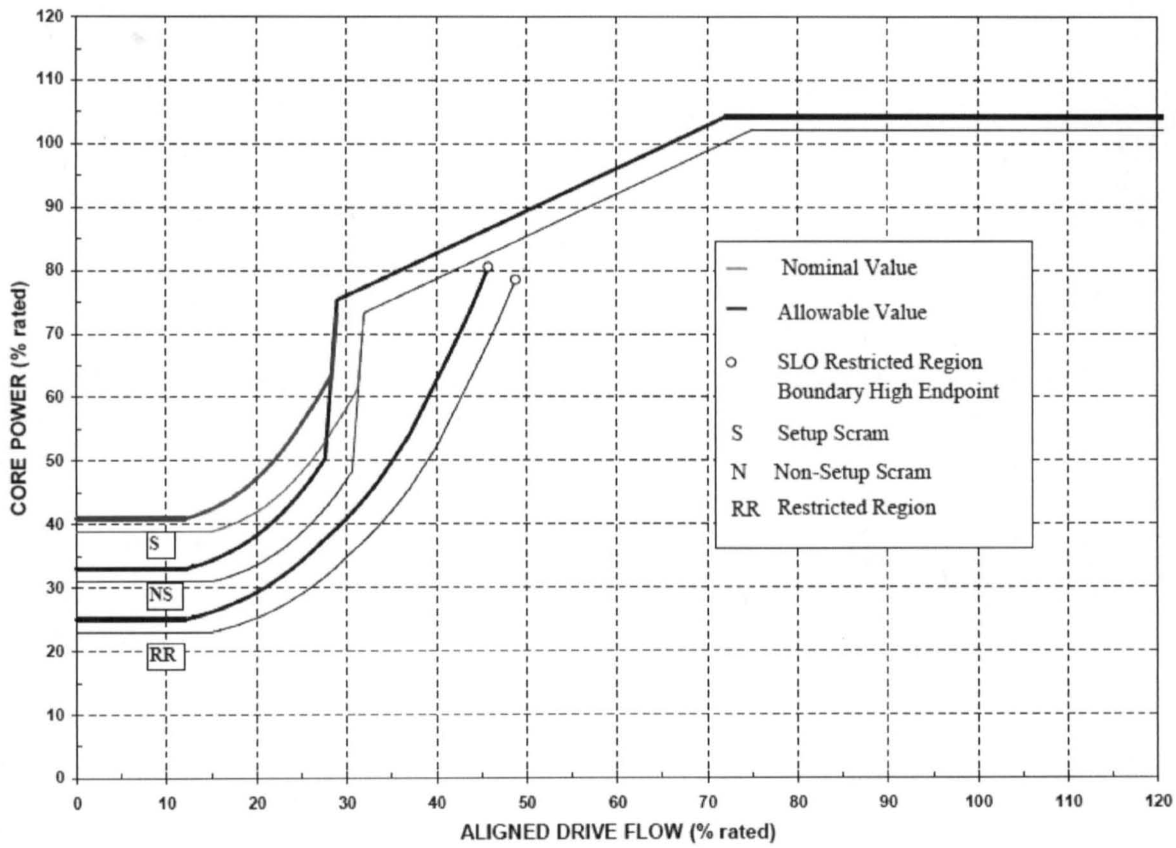


Figure 9.1-6: APRM Flow Biased Simulated Thermal Power – High Scram Setpoints and Restricted Region Boundary (Single Recirculation Loop Operation – Case 2)

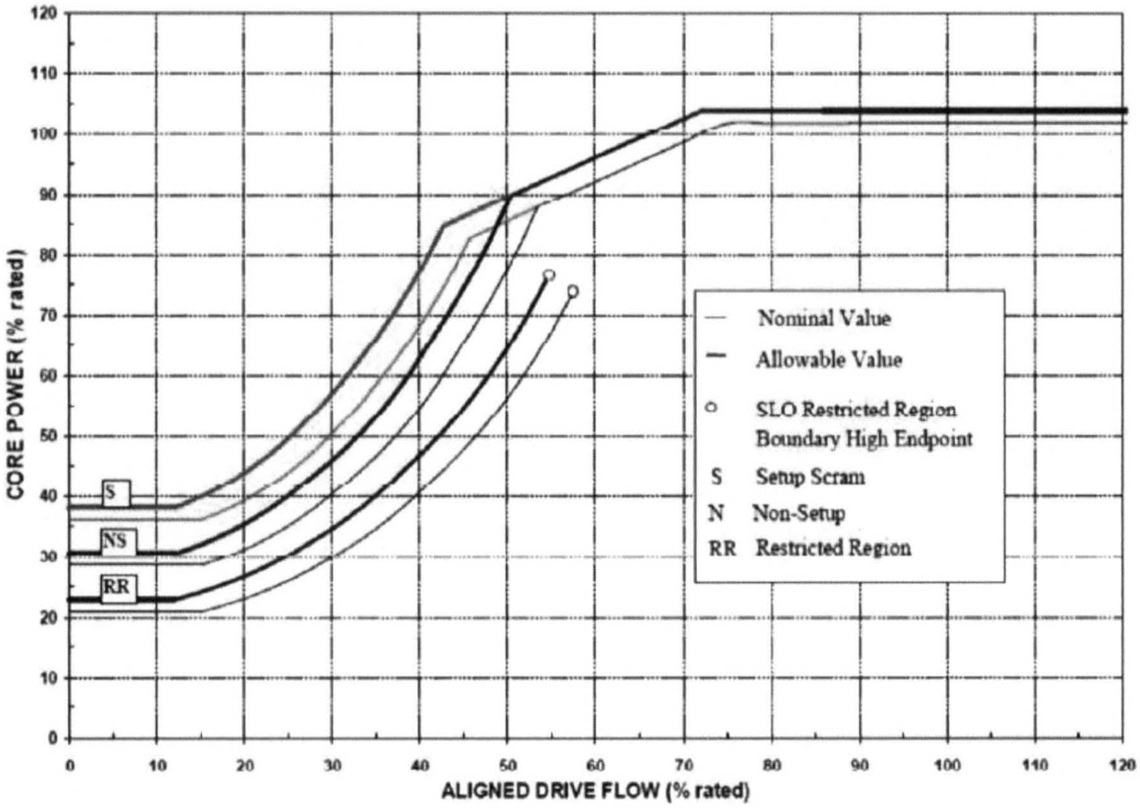


Figure 9.1-7: APRM Flow Biased Neutron Flux - High Rod-Block Setpoints (Two Recirculation Loop Operation - Case 1)

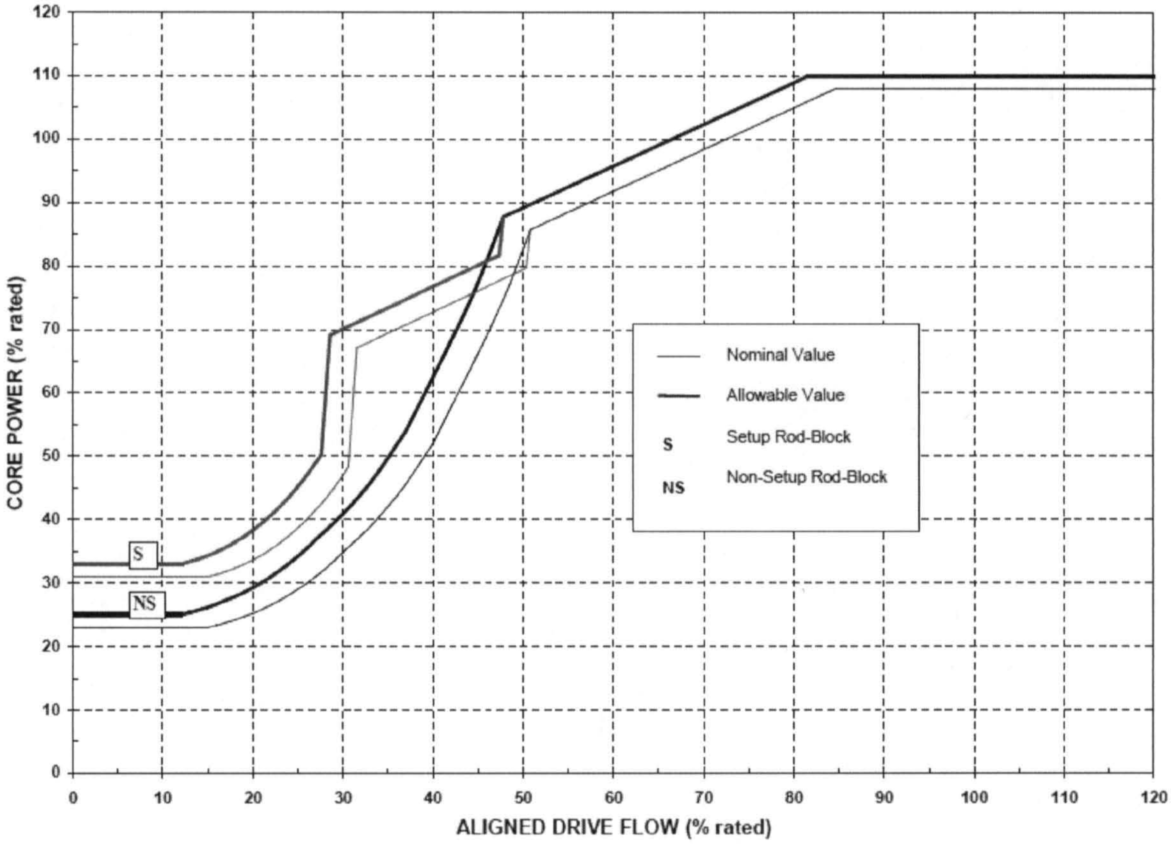


Figure 9.1-8: **APRM Flow Biased Neutron Flux - High Rod-Block Setpoints (Two Recirculation Loop Operation - Case 2)**

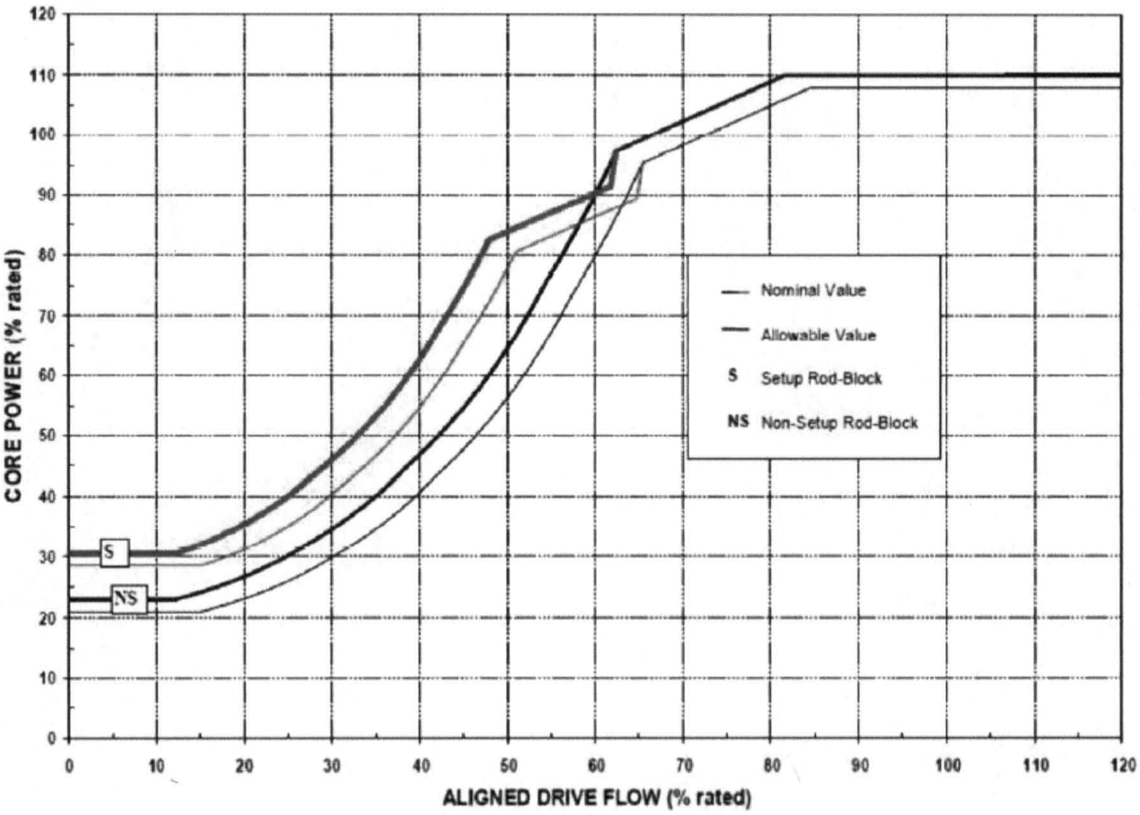


Figure 9.1-9: APRM Flow Biased Neutron Flux - High Rod-Block Setpoints (Single Recirculation Loop Operation - Case 1)

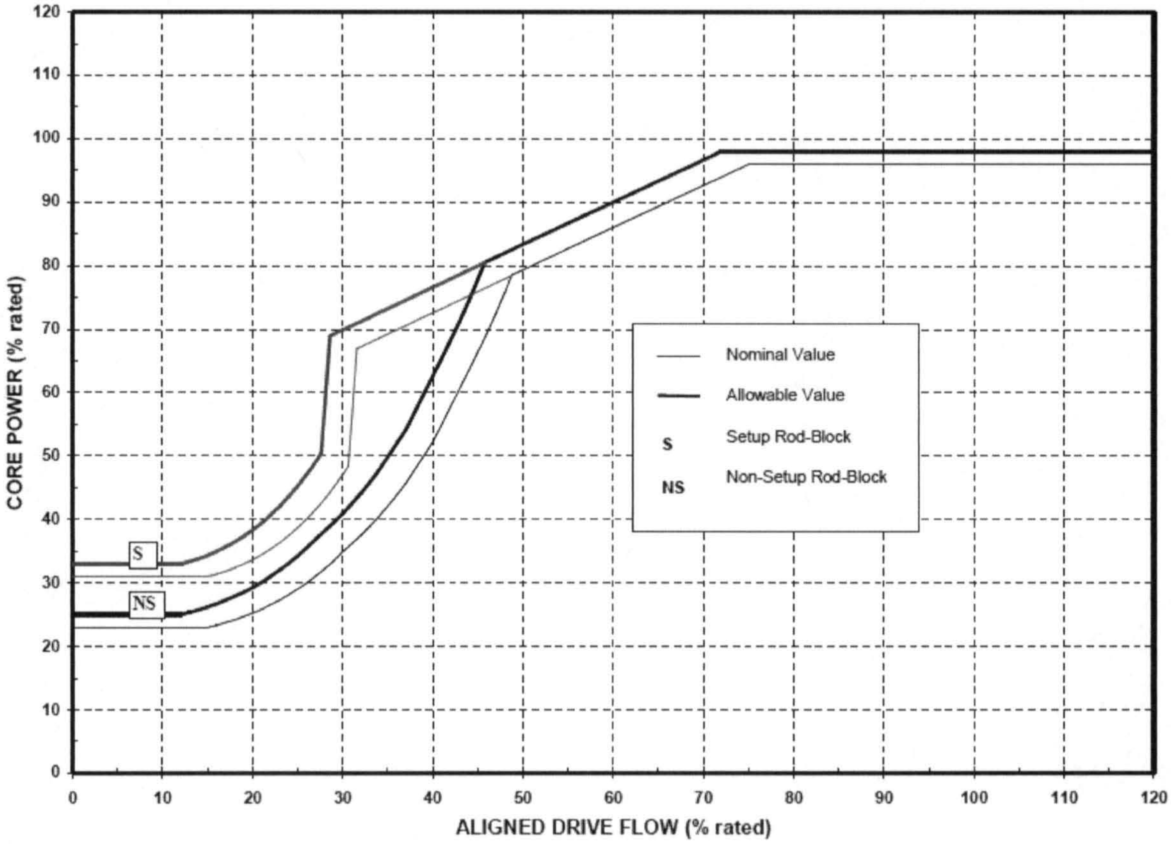


Figure 9.1-10: APRM Flow Biased Neutron Flux - High Rod-Block Setpoints (Single Recirculation Loop Operation - Case 2)