FENOC®
FirstEnergy Nuclear Operating Company

Perry Nuclear Power Plant
P.O. Box 97
10 Center Road
Perry, Ohio 44081

David B. Hamilton
Vice President

440-280-5382

March 22, 2019
L-19-039

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

SUBJECT:
Perry Nuclear Power Plant
Docket No. 50-440, License No. NPF-58
Core Operating Limits Report for Operating Cycle 18

Enclosed is Revision 28 of the Core Operating Limits Report for the Perry Nuclear Power Plant (PNPP). This revision is submitted to the Nuclear Regulatory Commission (NRC) in accordance with PNPP Technical Specification 5.6.5, "Core Operating Limits Report (COLR)."

There are no regulatory commitments contained in this submittal. If there are any questions or if additional information is required, please contact Mr. Phil H. Lashley, Acting Manager - FENOC Nuclear Licensing and Regulatory Affairs, at (330) 315-6808.

Sincerely,

David B. Hamilton

Enclosure:
Core Operating Limits Report for the Perry Nuclear Power Plant Unit 1 Cycle 18 (Reload 17), Revision 28

cc: NRC Region III Administrator
NRC Resident Inspector
NRC Project Manager

CORE OPERATING LIMITS REPORT FOR THE PERRY NUCLEAR POWER PLANT UNIT 1 CYCLE 18 (RELOAD 17)

Functional Location (J11)

Plant Data Book

Effective Date: 3-18-19

Preparer: Pat Curran / 2-5-19
Date

Approver: Larry Francis / 2-19-19
Date

TABLE OF CONTENTS

TABLE OF CONTENTS

1.0 INTRODUCTION

This Core Operating Limits Report (COLR) for the Perry Nuclear Power Plant (PNPP) Unit 1 is prepared in accordance with the requirements of PNPP Technical Specification Administrative Control 5.6.5. The core operating limits presented herein were determined using NRC-approved methods (Obligation 1 and Obligation 2). The core operating limits for the Global Nuclear Fuel (GNF) fuel in PNPP Unit 1 for Cycle 18 are documented in Obligations 3, 4, 5, 14, 16, 17, and 20 and summarized herein for the following PNPP Unit 1 Technical Specifications:

1. Average Planar Linear Heat Generation Rate (APLHGR) Limits for each fuel/lattice type, including the power and flow dependent MAPFAC multipliers with the single loop MAPLHGR reduction factor. (Technical Specification 3.2.1)

2. Minimum Critical Power Ratio Limit including the Operating Limit MCPR along with the power and flow dependent MCPR curves. (Technical Specification 3.2.2)

   Power dependent MCPR Limit curves are provided for operation with equipment in service (EIS), one pressure regulator out of service (PROOS), and power load unbalance out of service (PLUOOS).

3. Linear Heat Generation Rate (LHGR) Limits for each fuel/lattice type, including the power and flow dependent LHGRFAC curves with the single loop LHGRFAC reduction factor. (Technical Specification 3.2.3)

   Power dependent LHGRFAC curves are provided for operation with equipment in service (EIS), one pressure regulator out of service (PROOS), and power load unbalance out of service (PLUOOS).

4. The simulated thermal power time constant. (Technical Specification 3.3.1.1, SR 3.3.1.1.14)

5. Oscillation Power Range Monitor (OPRM) Instrumentation. (Technical Specification 3.3.1.3)

The oscillation power range monitor setpoint methods have been changed to NEDE-33766P-A, GEH Simplified Stability Solution (GS3). The GS3 methods are a generic approach to establishing the OPRM period - based detection algorithm setpoints. This generic approach assumes feedwater temperature reductions are limited to 120°F anytime during the cycle.

Cycle 18 (Reload 17) core design was developed assuming feedwater temperature reductions of 100°F during the cycle and 170°F beyond the end of the normal fuel cycle. Plant operations will be limited to 100°F during the cycle to account for the assumptions of the core design and 120°F beyond the end of the normal fuel cycle to account for the GS3 limitation.

Calculation FM-075, Support for the Core Operating Limits Report, details the development of the various graphs contained within this COLR.

2.0 REFERENCES

2.1 Discretionary

None

2.2 Obligations

1. General Electric Standard Application for Reactor Fuel, NEDE-24011-P-A-26, January 2018; and the US Supplement, NEDE-24011-P-A-26-US, January 2018

2. Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications, Licensing Topical Report, NEDO-32465-A, August 1996

3. Supplemental Reload Licensing Report for Perry 1 Reload 17 Cycle 18, GNF Document 004N5252, Revision 0, December 2018

4. Fuel Bundle Information Report for Perry 1 Reload 17 Cycle 18, GNF Document 004N5253, Revision 0, November 2018

5. Calculation FM-012, OPRM Device Settings and Setpoints, Revision 5

6. Technical Specification 2.1.1.2, Safety Limit MCPR, Amendment No. 176

7. Technical Specification 3.2.1, Average Planar Linear Heat Generation Rate, Amendment No. 171

8. Technical Specification 3.2.2, Minimum Critical Power Ratio, Amendment No. 171

9. Technical Specification 3.2.3, Linear Heat Generation Rate, Amendment No. 171

10. Technical Specification 3.3.1.1, Reactor Protection System Instrumentation (SR 3.3.1.1.14), Amendment No. 171

11. Technical Specification 3.3.1.3, OPRM Instrumentation (SR 3.3.1.3.3), Amendment 118 and 171

12. Technical Specification 5.6.5, Core Operating Limits Report, Amendment No. 136

13. Neutron Monitoring System Design Specification, 22A3739, Revision 6

14. Calculation FM-075, Support for the Core Operating Limits Report, Revision 6

15. FTI-B0012, Single Loop Operation

16. GEH Safety Communication SC 16-02 R0, February 22, 2016, Clarification of Updates to EOR Exposure for 3DM Databanks

17. Tables B-1 (UO2) and B-2 (U,GdO2) of GNF2 Advantage Generic Compliance with NEDE-24011-P-A, (GESTAR II), NEDC-33270P, Revision 9, December 2017

18. Condition Report 2015-06018 – Use of GNF Provided Proprietary Information

19. NEDE-33766P-A, Revision 1 March 2015, GEH Simplified Stability Solution (GS3)

20. 000N0605 Revision 3, October 2018, GNF2 Fuel Design Cycle-Independent Analyses for Perry Nuclear Power Plant

21. Condition Report 2017-08501, Core Operating Limits Report - Single Loop Power Dependent MCPRp Calculation is Conservative

Commitments addressed in this document:

None

3.0 T.S. 3.2.1 - AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHR)

All Average Planar Linear Heat Generation Rates (APLHGRs) shall be less than or equal to the result obtained from multiplying the applicable MAPLHGR limit by the smaller of either the flow dependent APLHGR factor ($MAPFAC_f$) or the power dependent APLHGR factor ($MAPFAC_p$).

MAXIMUM APLHGR LIMIT = MAPLHGR LIMIT * smaller ($MAPFAC_f$ or $MAPFAC_p$)

MAPLHGR Limits and $MAPFAC_f$ and $MAPFAC_p$ are defined in Obligation 3.

3.1 MAPLHGR LIMIT

Maximum Average Planar Linear Heat Generation Rates (MAPLHGRs) Limits for the GNF2 fuel types are depicted in the following figure:

Figure 3.2.1-1 MAPLHGR Versus Average Planar Exposure

The MAPLHGR Limits are independent of the selected Flexibility Option (Equipment In Service, Pressure Regulator Out Of Service, and Power Load Unbalance Out Of Service).

3.2 FLOW DEPENDENT AND POWER DEPENDENT MAPFAC – TWO LOOP OPERATION

The Flow Dependent MAPLHGR Factor ($MAPFAC_f$) and the Power Dependent APLHGR Factor ($MAPFAC_p$) are set equal to 1.0.

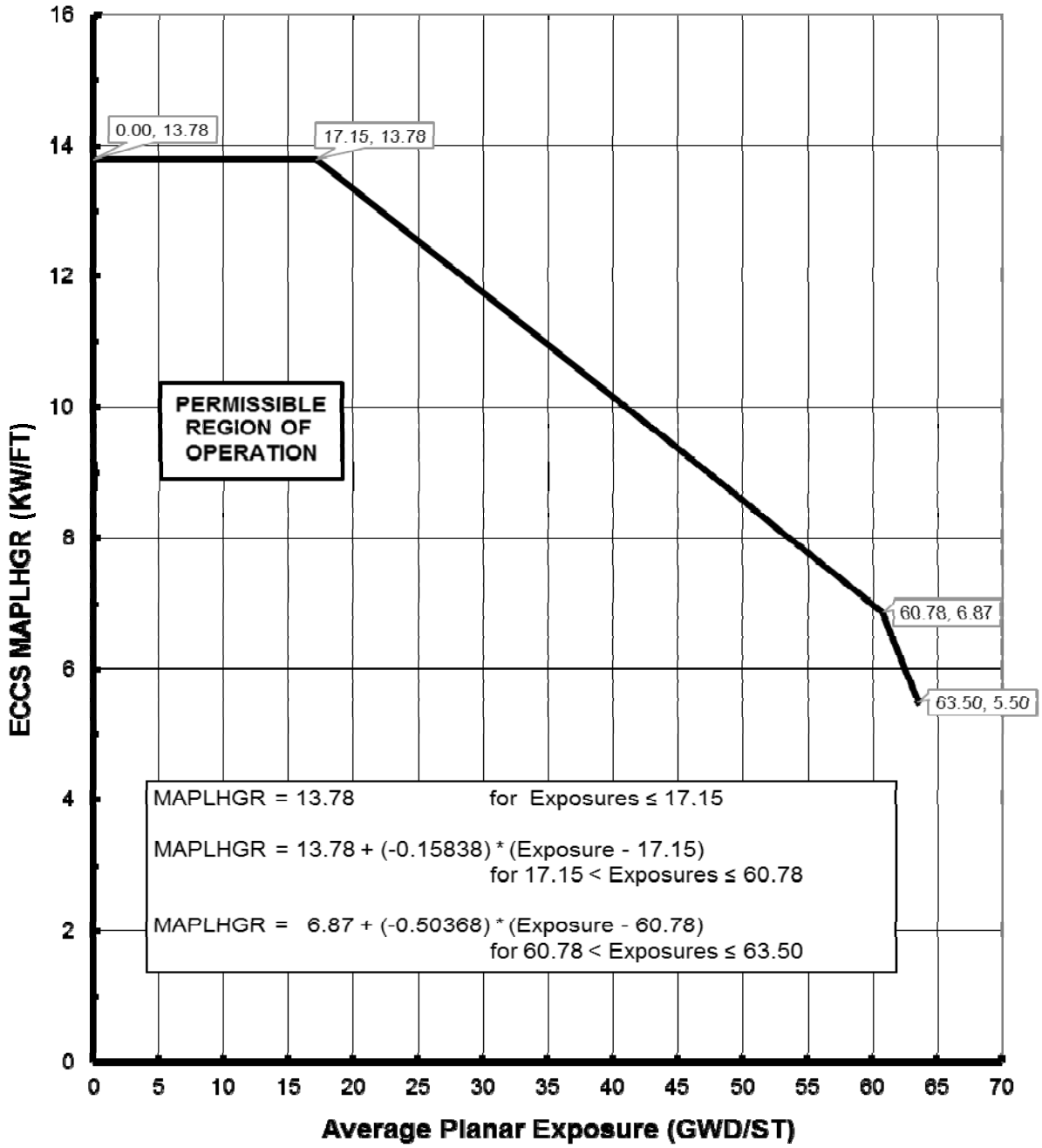
3.3 FLOW DEPENDENT AND POWER DEPENDENT MAPFAC - SINGLE LOOP OPERATION

For Single Loop Operation, the Flow Dependent MAPLHGR Factor ($MAPFAC_f$) and Power Dependent APLHGR Factor ($MAPFAC_p$) are set equal to 0.8.

The Single Loop Operation limits take effect when reset for single loop operation per LCO 3.4.1,"Recirculation Loops Operating". This is consistent with note "(b)" to Table 3.3.1.1-1 of the Technical Specifications.

The 3DMONICORE computer software will automatically shift between 2 LOOPS ON and 1 LOOP ON modes of operation on transfer to Single Loop Operation. The change in $MAPFAC_f$ and $MAPFAC_p$ will occur automatically. Guidance in FTI-B0012 can be used to verify proper functioning of the 3DMONICORE System. If the 3DMONICORE System is not functioning properly, FTI-B0012 will implement administrative limits until 3DMONICORE is properly calculating MAPLHGR Limits.

Figure 3.2.1-1
MAPLHGR Versus Average Planar Exposure



4.0 T.S. 3.2.2 - MINIMUM CRITICAL POWER RATIO (MCPR)

All Minimum Critical Power Ratios (MCPRs) shall be greater than or equal to the MCPR Limit. The MCPR Limit is equal to the higher of the Operating Limit MCPR, the Flow Dependent MCPR ($MCPR_f$), and the Power Dependent MCPR ($MCPR_p$) plus the MCPR Limit Adder.

MCPR Limit = maximum (Operating Limit MCPR, $MCPR_f$, $MCPR_p$) + MCPR Limit Adder

Operating Limit MCPR along with $MCPR_f$, $MCPR_p$, and MCPR Limit Adder are defined in Obligation 3 and Obligation 20.

4.1 OPERATING LIMIT MCPR and MCPR LIMIT ADDER

For Cycle 18, the Operating Limit MCPR is a function of the fuel type and exposure. Middle of Cycle (MOC) exposure point is defined as End of Rated (EOR) exposure point minus the Cycle Delta Exposure. For Cycle 18, the EOR exposure is defined in the Cycle 18 Cycle Management Report. For Cycle 18, the Cycle Delta Exposure is set to 2993 MWd/ST. Thus, MOC is equal to EOR – 2993 MWd/ST.

The End of Rated (EOR) is defined as the cycle exposure corresponding to all rods out, 100% power / 100% flow, and rated feedwater temperature. As such, the EOR is a projection based on various assumptions such as how the previous cycle operated, current cycle operations, core loading changes during the refueling outage, inoperable control rods, suppressed fuel defects, etc. The projected EOR exposure point may have to be updated during the cycle to ensure the appropriate MCPR limits applied (Obligation 16). The changes in the EOR value are documented in supplements or revisions to the Cycle Management Report.

The Operating Limit MCPR is additionally defined by the selected Flexibility Option:

Equipment In Service (EIS)
Pressure Regulator Out Of Service (PROOS)
Power Load Unbalance Out of Service (PLUOOS)

Cycle 18 Operating Limit MCPR is defined as:

Operating Limit MCPR	EIS/PROOS /PLUOOS
BOC to < MOC	1.35
≥ MOC to EOC	1.40

For Cycle 18, the MCPR Limit Adder is equal to 0.00.

For Cycle 18, no change to MCPR limits is required for planned reduction of feedwater temperature to as low as 325.5°F. Final feedwater temperature may be reduced to 305.5°F after all control rods are withdrawn at the end of cycle if the OPRMs are OPERABLE.

The 3DMONICORE computer software will automatically shift the Operating Limit MCPR based on the MOC exposure point.

4.2 FLOW DEPENDENT $MCPR_f$

The Flow Dependent MCPR Limit ($MCPR_f$) is independent of fuel type, exposure, and the selected Flexibility Option (Equipment In Service, Pressure Regulator Out Of Service, and Power Load Unbalance Out Of Service).

The Flow Dependent MCPR Limit is depicted in the following figure:

Figure 3.2.2-1, Flow Dependent MCPR Limit ($MCPR_f$)

4.3 POWER DEPENDENT $MCPR_p$

The Power Dependent MCPR Limit ($MCPR_p$) is independent of the fuel type and exposure but is dependent on the Flexibility Option selected. $MCPR_p$ figures are provided for Equipment In Service (EIS) and Pressure Regulator Out Of Service / Power Load Unbalance Out Of Service.

When operating below or equal to 38% RTP, $MCPR_p$ is independent of fuel type, exposure, and flexibility option.

When above 38% RTP, the power dependent $MCPR_p$ is dependent on the fuel type, exposure, flexibility option, and the variable K_p.

$MCPR_p = K_p$ * Operating Limit MCPR (fuel type, exposure, flexibility option)

The Power Dependent MCPR Limit is depicted in the following figures:

Figure 3.2.2-2 Power Dependent MCPR Limit ($MCPR_p$) Equipment in Service

Figure 3.2.2-3 Power Dependent MCPR Limit ($MCPR_p$) Pressure Regulator Out of Service

Figure 3.2.2-4 Power Dependent MCPR Limit ($MCPR_p$) Power Load Unbalance Out of Service

The 3DMONICORE computer software will not automatically shift to the Pressure Regulator Out of Service Thermal Limits. The 3DMONICORE databank will be manually changed using a software change request. Until the 3DMONICORE databank is updated for the Pressure Regulator Out of Service Thermal Limits, an MFLCPR Administrative Limit will be issued to Operations. Reactor Engineering will ratio the calculated $MCPR_p$ Multipliers to establish the MFLCPR Administrative Limit.

The 3DMONICORE computer software will not automatically shift to the Power Load Unbalance Out of Service Thermal Limits. The 3DMONICORE databank will be manually changed using a software change request. Until the 3DMONICORE databank is updated for the Power Load Unbalance Out of Service Thermal Limits, an MFLCPR Administrative Limit will be issued to Operations. Reactor Engineering will ratio the calculated $MCPR_p$ Multipliers to establish the MFLCPR Administrative Limit.

4.4 SINGLE LOOP OPERATION – MCPR LIMITS

The MCPR Safety Limit for Two Loop Operations is 1.10 and the MCPR Safety Limit for Single Loop Operation is 1.13 <TECHNICAL SPECIFICATIONS 2.1.1.2>. The Safety Limit Delta CPR is equal to 0.03.

To effect Safety Limit change in Single Loop Operations, the MCPR Limit Adder will be set to 0.03 for Single Loop Operations.

Planned reduction of rated feedwater temperature from nominal rated feedwater temperature is not permitted during plant operation with the reactor recirculation system in Single Loop Operation.

The Single Loop Operation limits take effect when reset for single loop operation per LCO 3.4.1,"Recirculation Loops Operating". This is consistent with note "(b)" to Table 3.3.1.1-1 of the Technical Specifications.

The 3DMONICORE computer software will automatically shift between 2 LOOPS ON and 1 LOOP ON modes of operation on transfer to Single Loop Operation. The change in the MCPR Limit Adder will occur automatically. The guidance in FTI-B0012 can be used to verify proper functioning of the 3DMONICORE System. If the 3DMONICORE System is not functioning properly, FTI-B0012 will implement administrative limits until 3DMONICORE is properly calculating MCPR values.

Figure 3.2.2-1
Flow Dependent MCPR Limit ($MCPR_f$)
Equipment in Service
Pressure Regulator Out of Service
Power Load Unbalance Out of Service

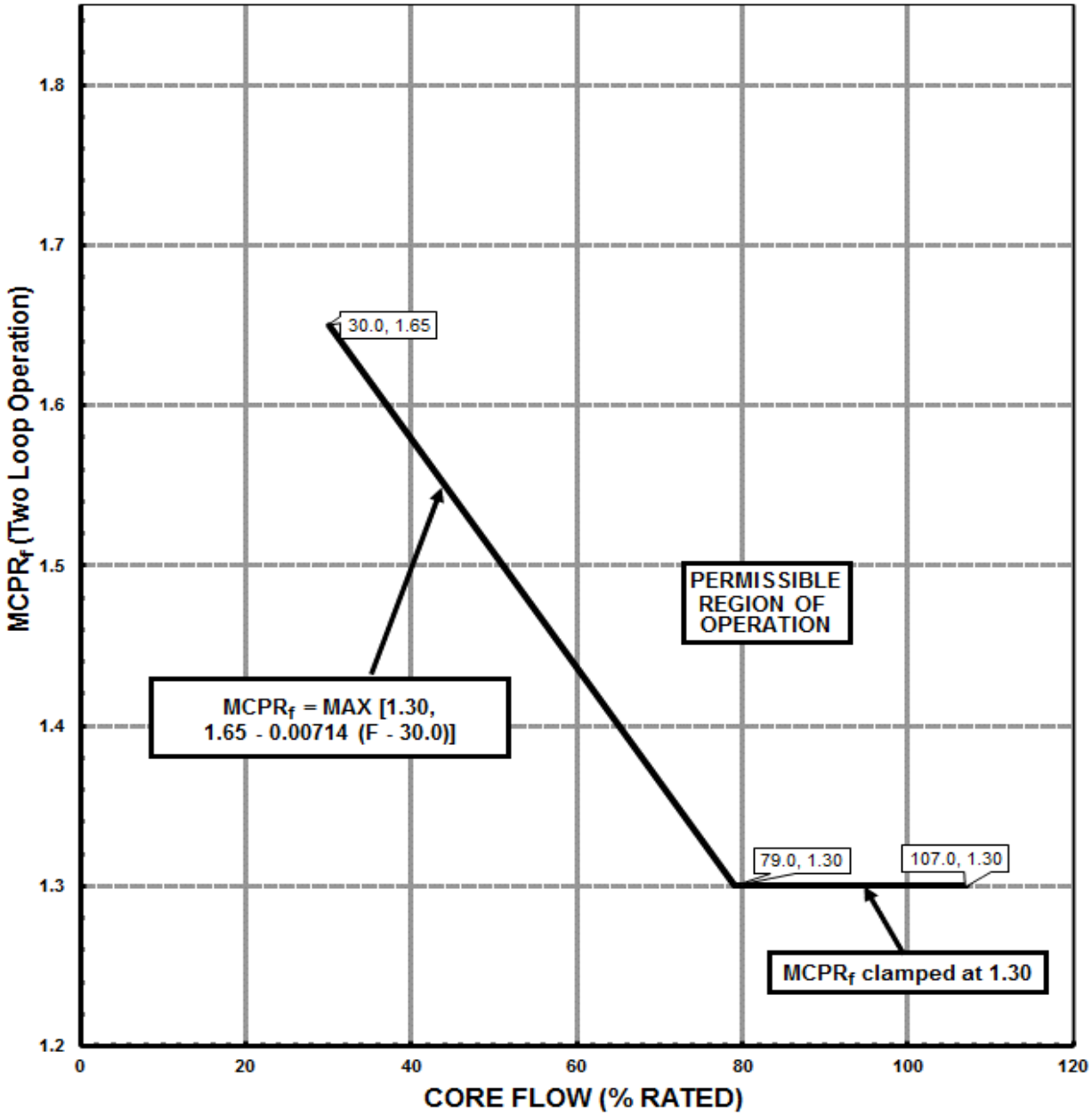


Figure 3.2.2-2
Power Dependent MCPR Limit ($MCPR_p$)
Equipment in Service

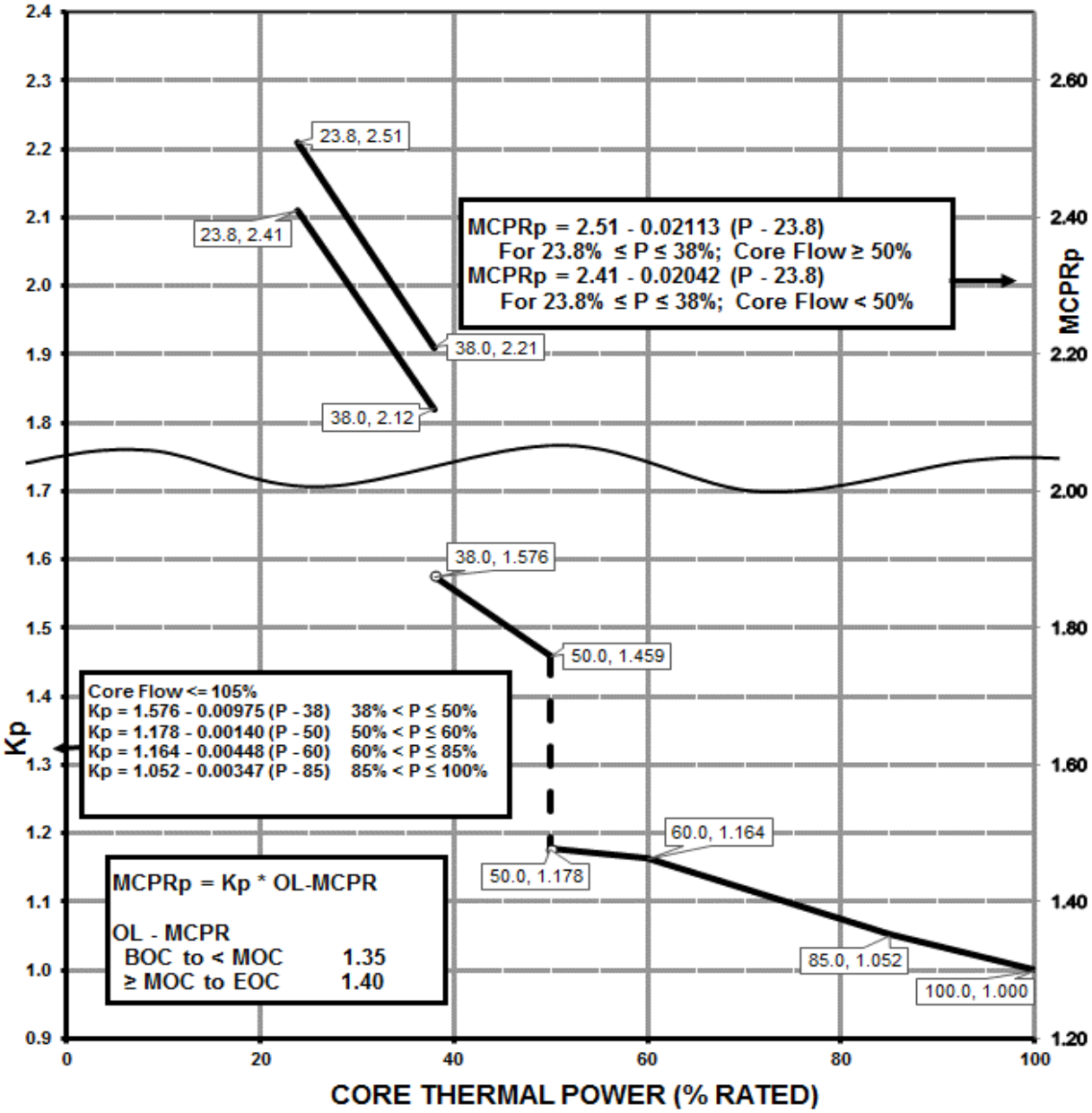


Figure 3.2.2-3
Power Dependent MCPR Limit ($MCPR_p$)
Pressure Regulator Out of Service

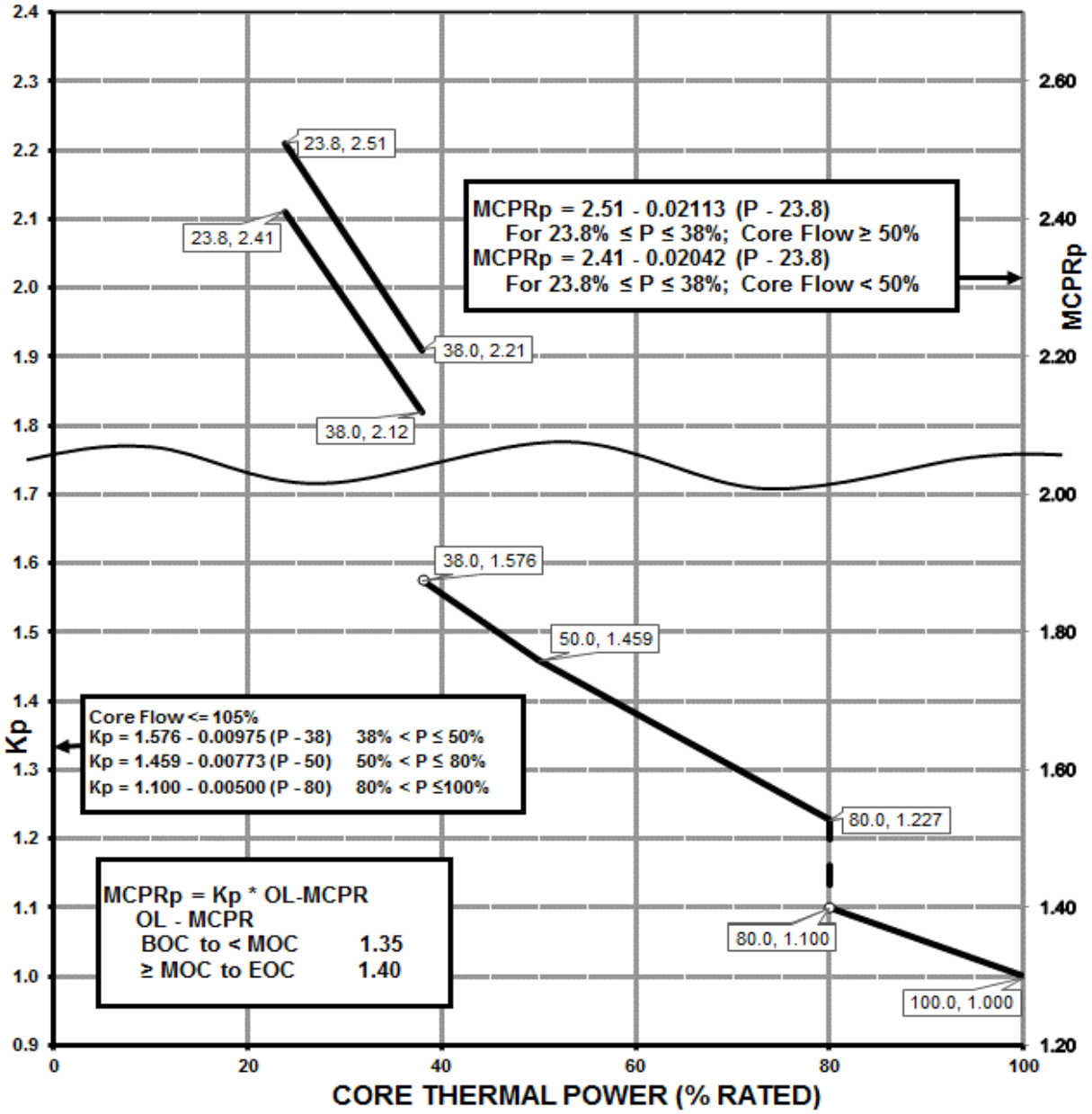
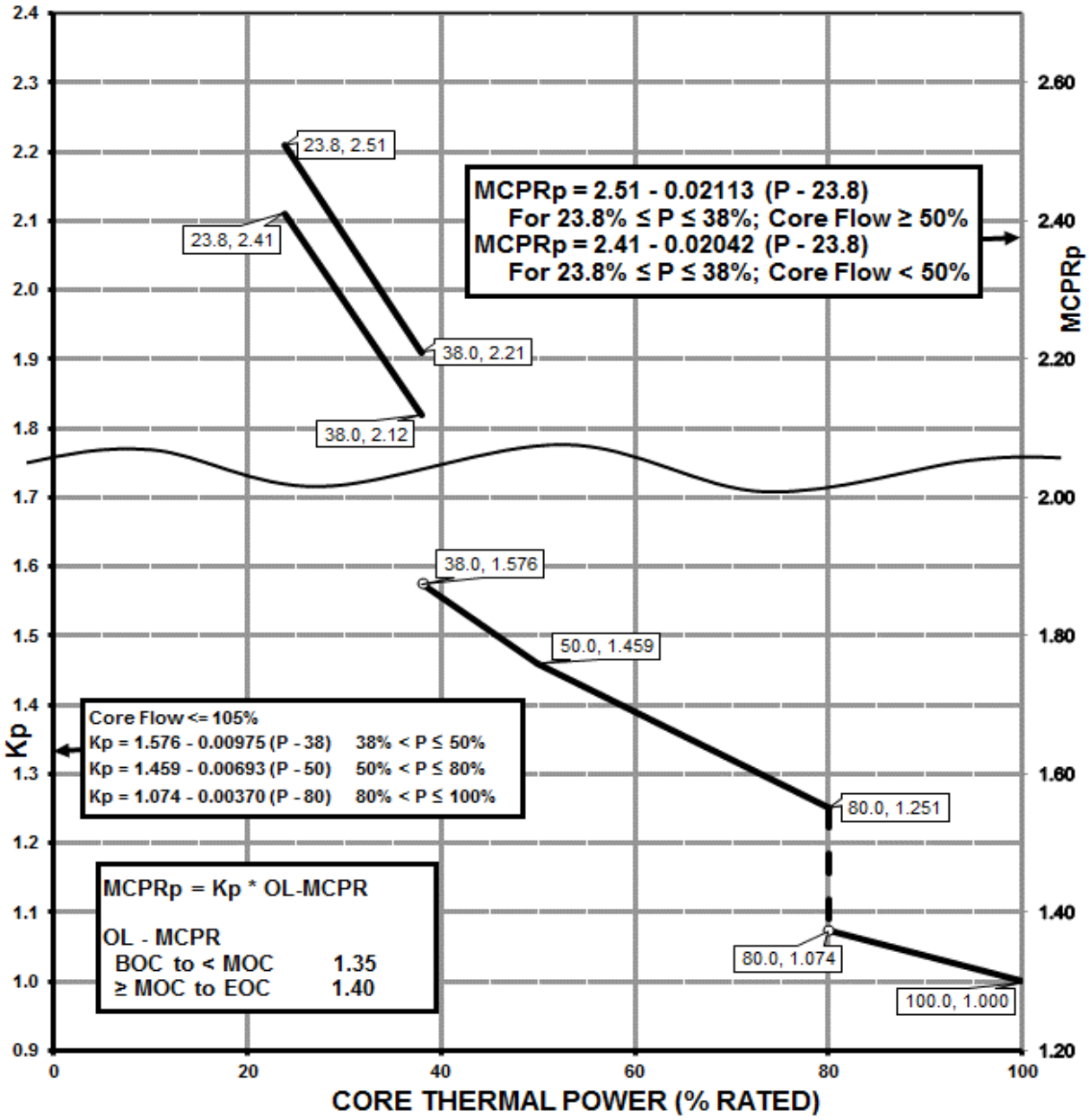


Figure 3.2.2-4
Power Dependent MCPR Limit ($MCPR_p$)
Power Load Unbalance Out of Service



5.0 T.S. 3.2.3 - LINEAR HEAT GENERATION RATE (LHGR)

All Linear Heat Generation Rates (LHGRs) shall be less than or equal to the result obtained from multiplying the applicable LHGR limit by the smaller of either the flow dependent LHGR factor ($LHGRFAC_f$) or the power dependent LHGR factor ($LHGRFAC_p$).

MAXIMUM LHGR LIMIT = LHGR LIMIT * smaller ($LHGRFAC_f$ or $LHGRFAC_p$)

LHGR Limits and $LHGRFAC_f$ and $LHGRFAC_p$ are defined in Obligations 3, 4, 16, 17, and 20.

5.1 LHGR LIMIT

Linear Heat Generation Rates (LHGRs) Limits for the GNF2 Uranium only fuel pins and Gadolinia bearing fuel pins are listed in:

Tables B-1 (UO_2) and B-2 (U,GdO_2) of “GNF2 Advantage Generic Compliance with NEDE-24011-P-A, (GESTAR II), NEDC-33270P”, Revision 9, December 2017.

For GNF2 Gadolinia bearing fuel pins, the maximum Gadolinia content of a fuel pin is 7 wt-% Gd_2O_3.

The LHGR Limits are independent of the selected Flexibility Option (Equipment in Service, Pressure Regulator Out of Service, and Power Load Unbalance Out of Service).

5.2 FLOW DEPENDENT $LHGRFAC_f$

The Flow Dependent LHGR Factor ($LHGRFAC_f$) is independent of fuel type, exposure, and the selected Flexibility Option (Equipment in Service, Pressure Regulator Out of Service, and Power Load Unbalance Out of Service).

The Flow Dependent $LHGRFAC_f$ is depicted in the following figure:

Figure 3.2.3-1 Flow Dependent LHGR Factor ($LHGRFAC_f$)

5.3 POWER DEPENDENT $LHGRFAC_p$

The Power Dependent LHGR Factor ($LHGRFAC_p$) is independent of fuel type and exposure but dependent on the selected Flexibility Option (Equipment in Service, Pressure Regulator Out of Service, and Power Load Unbalance Out of Service).

An $LHGRFAC_p$ curve is provided for Equipment in Service / Pressure Regulator Out of Service and an $LHGRFAC_p$ curve is provided for Power Load Unbalance Out of Service.

The Power Dependent $LHGRFAC_p$ are depicted in the following figures:

Figure 3.2.3-2 Power Dependent LHGR Factor ($LHGRFAC_p$)
Equipment in Service
Pressure Regulator Out of Service

Figure 3.2.3-3 Power Dependent LHGR Factor ($LHGRFAC_p$)
Power Load Unbalance Out of Service

The 3DMONICORE computer software will not automatically shift to the Power Load Unbalance Out of Service Thermal Limits. The 3DMONICORE databank will be manually changed using a software change request. Until the 3DMONICORE databank is updated for the Power Load Unbalance Out of Service Thermal Limits, an MFLPD Administrative Limit will be issued to Operations. Reactor Engineering will ratio the calculated $LHGRFAC_p$ Multipliers to establish the MFLPD Administrative Limit.

5.4 SINGLE LOOP OPERATION – LHGR LIMITS

For Single Loop Operation, $LHGRFAC_f$ and $LHGRFAC_p$ shall not exceed 0.8.

The Single Loop Operation limits take effect when reset for single loop operation per LCO 3.4.1,"Recirculation Loops Operating". This is consistent with note "(b)" to Table 3.3.1.1-1 of the Technical Specifications.

The 3DMONICORE computer software will automatically shift between 2 LOOPS ON and 1 LOOP ON modes of operation on transfer to Single Loop Operation. The change in $LHGRFAC_f$ and $LHGRFAC_p$ will occur automatically. Guidance in FTI-B0012 can be used to verify proper functioning of the 3DMONICORE System. If the 3DMONICORE System is not functioning properly, FTI-B0012 will implement administrative limits until 3DMONICORE is properly calculating LHGR Limits.

Figure 3.2.3-1
Flow Dependent LHGR Factor (LHGRFACf)
Equipment in Service
Pressure Regulator Out of Service
Power Load Unbalance Out of Service

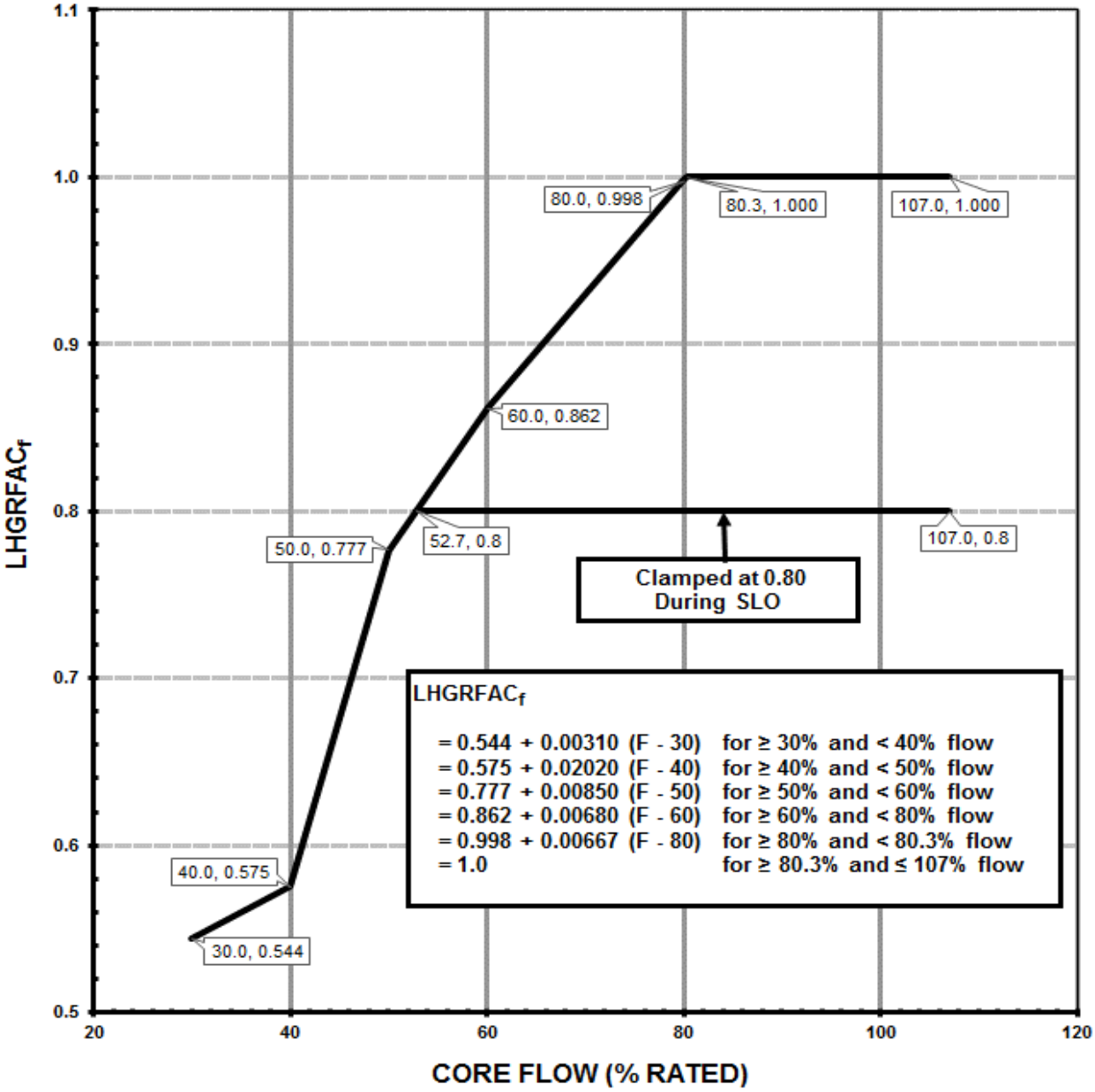


Figure 3.2.3-2
Power Dependent LHGR Factor ($LHGRFAC_p$)
Equipment in Service
Pressure Regulator Out of Service

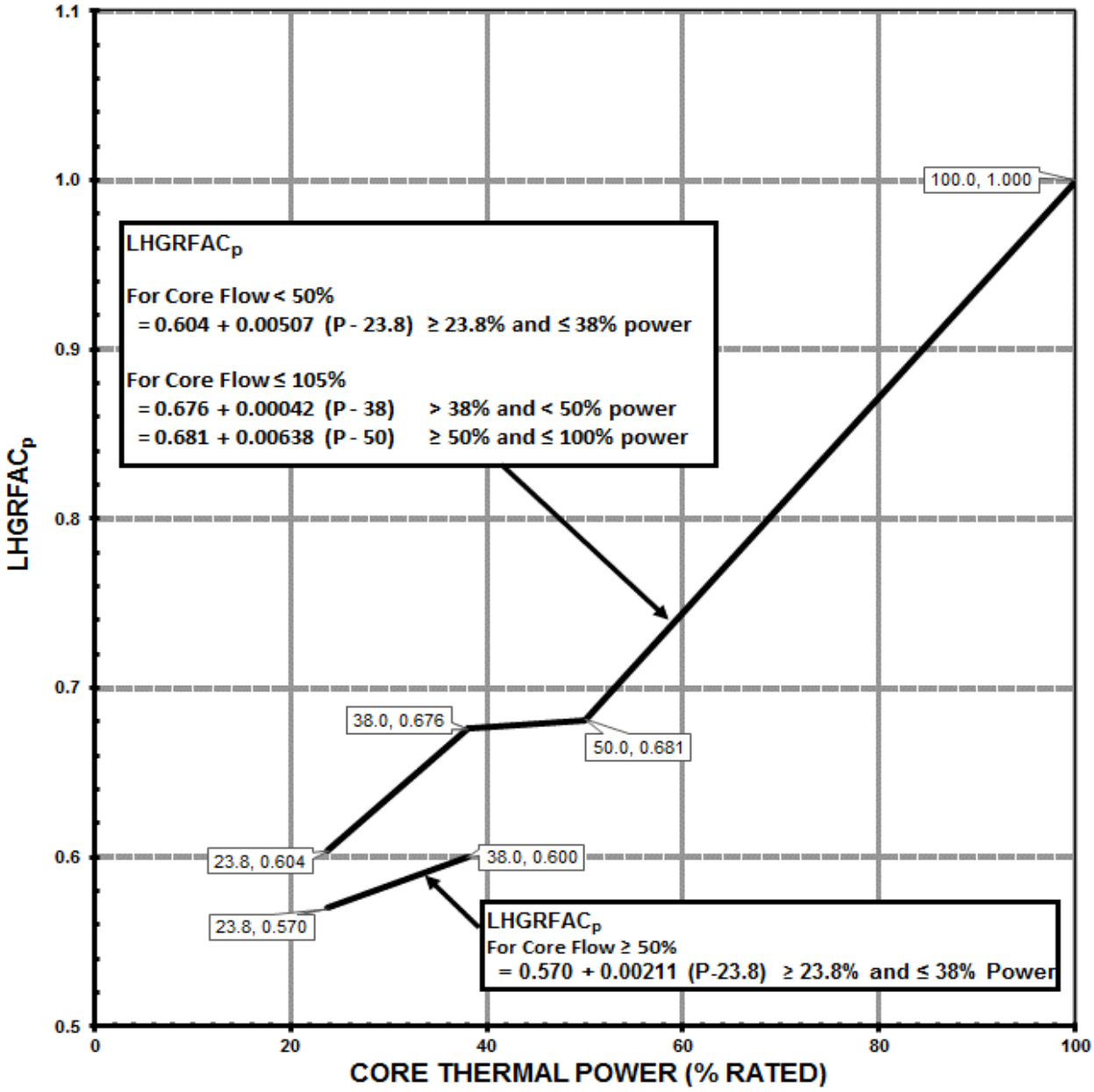
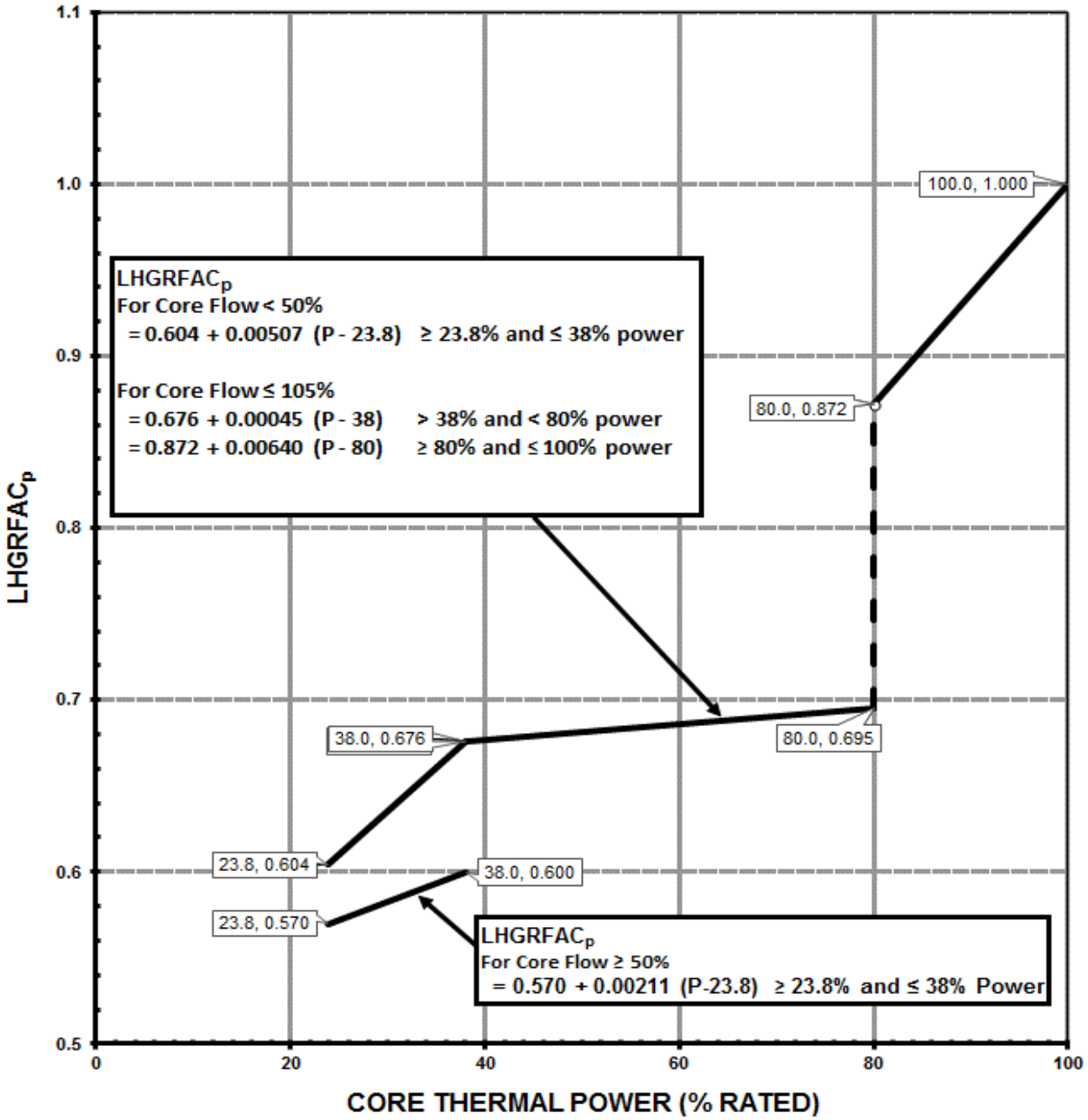


Figure 3.2.3-3
Power Dependent LHGR Factor ($LHGRFAC_p$)
Power Load Unbalance Out of Service



6.0 T.S. 3.3.1.1 - REACTOR PROTECTION SYSTEM INSTRUMENTATION

The simulated thermal power time constant shall be 6 +/-0.6 seconds (Obligation 13).

7.0 T.S. 3.3.1.3 - OSCILLATION POWER RANGE MONITOR (OPRM) INSTRUMENTATION

OPRM setpoints for operable OPRMs:

1. Confirmation Count Setpoint ($N_p = N_2$): 16

2. Amplitude Setpoint (S_p): 1.15

(Obligation 3)

8.0 SCOPE OF REVISION

Rev. 28 - Incorporate Operating Limits for Cycle 18:

1. The cycle number was updated from Cycle 17 to Cycle 18 and the reload number was updated from Reload 16 to Reload 17 as appropriate. The figure names were updated for consistency. Revision bars are not included (for this change only).
2. Removed all Thermal Limits and references to GE14 fuel type as there is no GE14 loaded in the Cycle 18 core.
3. Updated Obligations 1 and 17 to reflect the current GNF Document revisions and basis for the Cycle 18 Core Design and Transient Analysis.
4. Updated Obligations 3 and 4 to reflect the Cycle 18 Core Design and Transient Analysis.
5. Updated Obligation 14, as calculation FM-075 Revision 6 is used to support the Cycle 18 Core Operating Limits Report.
6. Added Obligation 16 (SC 16-02) for completeness.
7. Updated Obligation 20 from a Cycle 17 specific analysis to the Cycle 18 update to the GNF2 Fuel Design Cycle-Independent Analyses for Perry Nuclear Power Plant.
8. The Cycle Delta Exposure used in determining the Middle of Cycle Exposure point was updated based on the Cycle 18 Transient Analysis (Obligation 3).

8.0 SCOPE OF REVISION (Cont.)

9. The Cycle 18 OL MCPR values were updated based on the Cycle 18 Transient Analysis (Obligation 3).
10. The Cycle 18 MCPR Limit Adder for Single Loop Operations was updated based on the Cycle 18 Transient Analysis (Obligation 3).
11. Offrated $MCPR_p$ (EIS, PROOS, PLUOOS) and $LHGRFAC_p$ (EIS, PROOS, PLUOOS) were updated based on the Cycle 18 update to the GNF2 Fuel Design Cycle-Independent Analyses for Perry Nuclear Power Plant. (Obligation 3 and 20).

Note: For Cycle 18, there are no changes to MAPLHGR Limits, $MAPFAC_f$, $MAPFAC_p$, Safety Limit MCPR values, $MCPR_f$, LHGR Limits, $LHGRFAC_f$, OPRM Setpoints, or the Simulated Thermal Power Time Constant.