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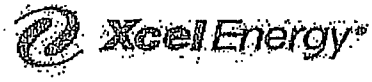

Monticello Nuclear Generating Plant

Cycle 27

at Current Licensed Thermal Power

Core Operating Limits Report

NAD-MN-033

Revision 0

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1.0 Core Operating Limits Report (COLR)

This Core Operating Limits Report for Monticello Nuclear Generating Plant (MNGP) Cycle 27 at the Current Licensed Thermal Power (CLTP) of 1775 MWt is prepared in accordance with the requirements of Technical Specification 5.6.3. The core operating limits are developed using NRC approved methodology (References 1, 3, 4, 10, and 13), and are established such that all applicable thermal limits of the plant safety analysis are met.

The SLMCPR of 1.15 was used for two-loop operation for all fuel types in Cycle 27. The SLMCPR for single loop operation is 1.15. These values are consistent with the values specified in Reference 2.

This report includes the Option III Generic Shape Function (GSF) definition for the Backup Stability Protection (BSP) region, which is used in providing backup thermal hydraulic stability protection when the Option III OPRM system is declared INOPERABLE.

Figure 4, which shows the flow-dependent CPR limits, is now bounded by the ECCS MCPR value as specified in Reference 2.

2.0 References

1.0 General Electric Standard Application for Reactor Fuel (GESTAR-II), NEDE-24011-P-A-19, May 2012.

2.0 Supplemental Reload Licensing Report for Monticello Reload 26, Cycle 27 Current Licensed Thermal Power (CLTP), 0000-0140-2542-SRLR, Revision 1, April 2013.

3.0 General Electric Licensing Topical Report ODYSY Application for Stability Licensing Calculations, NEDC-32992-P-A, DRF AI3-00426-00, July 2001.

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

5.0 Fuel Bundle Information Report for Monticello, Reload 26, Cycle 27 Current Licensed Thermal Power (CLTP), 0000-0140-2542-FBIR, Revision 0, April 2013

6.0 Letter from M. F. Hammer (NSP) to USNRC dated December 4 1997, Revision 1 to License Amendment Request dated July 26, 1996 Supporting the Monticello Nuclear Generating Plant Rerate Program, including attached exhibits.

7.0 Document GE14 Fuel Design Cycle-Independent Analysis for Monticello Nuclear Generating Plant, GE-NE-0000-0013-9576P, GE Nuclear Energy (Proprietary), March 2003.

8.0 Letter from Les Conner (GNF) to R. J. Rohrer (NMC), dated March 24, 2003, Monticello Option B Licensing Basis, IC.MN.2003.010, Global Nuclear Fuel.

9.0 GE14 Fuel Design, Cycle Independent Transient Analysis for Monticello Nuclear Generating Plant, GE-NE-0000-0014-7048-01P, Rev. 0, March 2003 (GNF Proprietary).

10.0 BWR Owners Group Long Term Stability Solution Licensing Methodology, NEDO-31960-A, Licensing Topical Report, November 1995 (including Supplement 1).

11.0 Reactor Long-Term Stability Solution Option III: Licensing Basis Hot Channel Oscillation Magnitude for Monticello Nuclear Generating Plant, GHNE-0000-0073-4167-R2, December 2007.

12.0 Plant-Specific Regional Mode DIVOM Procedure Guideline, GE-NE-0000-0028-9714-R1, June 2005.

13.0 Backup Stability Protection (BSP) for Inoperable Option III Solution, OG-02-0119-260, July 2002.

14.0 Letter from M. F. Hammer (NSP) to USNRC dated July 30, 1998, "Supplementary Information Regarding the Monticello Power Rerate (TAC No. 96238)", including attachments.

15.0 Letter from Tae Kim (USNRC) to Roger O Anderson (NSP), "Monticello Nuclear Generating Plant – Issuance of Amendment Re. Power Uprate Program (TAC No. M96238)," including enclosures, September 16, 1998.

16.0 Calculation CA-08-051, Rev 0, Instrument Setpoint Calculation - Rod Block Monitor (RBM) PRNM Setpoints for CLTP and EPU Operation.

17.0 GE BWR Licensing Report, Average Power Range Monitor, Rod Block Monitor, and Technical Specification Improvement (ARTS) Program for Monticello Nuclear Generation Plant, NEDC-30492-P, Section 4, April 1984.

18.0 GE Services Information Letter, Backup Pressure Regulator, GE SIL No. 614 Revision 1, March 15, 1999.

19.0 Nuclear Management Company Monticello Nuclear Generating Plant Pressure Regulator Downscale Failure Analysis, GE-NE-0000-0051-2643-R0, September 2007.

20.0 Letter from Peter S. Tam (USNRC) to Timothy J. O'Connor (Northern States Power Company), "Monticello Nuclear Generating Plant (MNGP) – Issuance Of Amendment Regarding The Power Range Neutron Monitoring System (TAC No. MD8064)," dated January 30, 2009.

21.0 Fuel Bundle Information Report for Monticello, Reload 25, Cycle 26, 0000-0118-4010-FBIR, Revision 0, February 2011.

22.0 Supplemental Reload Licensing Report for Monticello Reload 25, Cycle 26, 0000-0118-4010-SRLR, Revision 1, March 2011.

23.0 Monticello Nuclear Generating Plant, Cycle 26 Core Operating Limits Report. NAD-MN-025, Revision 0, April 2011.

24.0 Letter from D. Musolf (NSP) to Director, Office of Nuclear Reactor Regulation, NRC "Revision 1 to License Amendment Request Dated September 7, 1976, Single Loop Operation" dated July 2, 1982.

25.0 ODYSY Application for Stability Licensing Calculations Including Option I-D and II Long Term Solutions, Licensing Topical Report, NEDE-33213P-A, April 2009.

3.0 Rod Block Monitor Operability Requirements

The ARTS Rod Withdrawal Error (RWE) analysis (Reference 2) validated that the following MCPR values provide the required margin for full withdrawal of any control rod during Monticello Cycle 27:

For Power < 90%: MCPR ≥ 1.83

For Power ≥ 90%: MCPR ≥ 1.50

When the core power is less than 90% of rated and the MCPR is less than 1.83, then a limiting control rod pattern exists and the Rod Block Monitor is required to be operable. If the core power is greater than or equal to 90% and the MCPR is less than 1.50, then a limiting control rod pattern exists and the Rod Block Monitor is required to be operable.

Reference:Technical Specification Table 3.3.2.1-1 Function 1.

4.0 Rod Block Monitor Upscale Trip Setpoint

4.1 Technical Specification Trip Setpoints and Allowable Values

Function		Trip Setpoint	Allowable Values
Low Power Range – Upscale	(a)	≤ 120/125 of full scale	≤ 120.4/125 of full scale
Intermediate Power Range – Upscale	(b)	≤ 115/125 of full scale	≤ 115.4/125 of full scale
High Power Range – Upscale	(c), (d)	≤ 110/125 of full scale	≤ 110.4/125 of full scale

Applicable Thermal Power

(a) Thermal Power ≥ 30% and < 65% RTP and MCPR is below the limit specified in Section 3.
(b) Thermal Power ≥ 65% and < 85% RTP and MCPR is below the limit specified in Section 3.
(c) Thermal Power ≥ 85% and < 90% RTP and MCPR is below the limit specified in Section 3.
(d) Thermal Power ≥ 90% RTP and MCPR is below the limit specified in Section 3.

Reference:Technical Specification Table 3.3.2.1-1 Functions 1.a, 1.b, and 1.c. The Reference for the **"Trip Setpoints"** and **"Allowable Values"** is Reference 16.

5.0 Minimum Critical Power Ratio (MCPR)

5.1 Option A

The Operating Limit Minimum Critical Power Ratio (OLMCPR) for Option A does not account for scram speeds that are faster than those required by Technical Specifications.

5.1.1 Option A OLMCPR for Two Recirculation Loop Operation

The Option A OLMCPR shall be determined for two recirculation loop operation as follows:

If core thermal power (P) is ≥ 45% of rated core thermal power, then the Option A OLMCPR for all fuel types is the greater of {1.75 * K(P) from Figure 3} or {MCPR(F) from Figure 4}, where 1.75 is the Option A OLMCPR at rated (100%) core thermal power reported in Table 33.

i.e. if P ≥ 45% rated core thermal power,
then Option A OLMCPR limit
= Maximum of 1.75 * {K(P) from Figure 3} or {MCPR(F) from Figure 4}.

If core thermal power (P) is < 45% of rated core thermal power, the Option A OLMCPR for all fuel types is obtained from Figure 3.

Reference: Technical Specification Section 3.2.2.

5.1.2 Option A OLMCPR for Single Recirculation Loop Operation

The Option A OLMCPR as defined above for two recirculation loop operation in Section 5.1.1 is the same OLMCPR to be used for single recirculation loop operation.

Reference:Technical Specification Section 3.2.2.

5.2 Option B

Option B does take into account the measured scram speeds that are faster than the Technical Specification requirements, thus reducing the potential consequences of a limiting transient. Calculation of the Option B OLMCPR value as a function of measured scram speeds is described in Section 10.

5.2.1 Option B OLMCPR for Two Recirculation Loop Operation

The Option B OLMCPR shall be determined for two recirculation loop operation as follows:

The rated (100%) core thermal power Option B OLMCPR ($OLMCPR_{OptionB}^{100\%}$) is 1.66, and is reported in Table 33. This $OLMCPR_{OptionB}^{100\%}$ of 1.66 is modified as described in Section 10 to be a function of the measured scram speeds to yield $OLMCPR_{OptionB}^{New}$.

Then, if core thermal power (P) is ≥ 45% of rated core thermal power, the Option B OLMCPR for all fuel types is the greater of:

$OLMCPR_{OptionB}^{New}$ * {K(P) from Figure 3} or {MCPR(F) from Figure 4},

i.e. if P ≥ 45% rated core thermal power, then Option B OLMCPR limit

= Maximum of { $OLMCPR_{OptionB}^{New}$ * K(P) from Figure 3} or {MCPR(F) from Figure 4}.

If core thermal power (P) is < 45% of rated core thermal power, the Option B OLMCPR for all fuel types is obtained from Figure 3.

Reference:Technical Specification 3.2.2.

5.2.2 Option B OLMCPR for Single Recirculation Loop Operation

The Option B OLMCPR as defined above for two recirculation loop operation in Section 5.2.1 is the same OLMCPR to be used for single recirculation loop operation.

Reference:Technical Specification 3.2.2.

5.3 Pressure Regulator Out of Service (PROOS) Operation

Reference 18 GE SIL 614, Revision 1 describes the impact of operation without a backup pressure regulator (also called PROOS). This section provides power dependent MCPR limits when a backup pressure regulator is not operational.

The existing power dependent MAPLHGR and LHGR limits described in Sections 8.1 and 8.2 have been found to be valid (bounding) for operation without a backup pressure regulator (References 19 and 2).

A Pressure Regulator Fails Down-Scale (PRFDS) event without backup pressure regulator was evaluated for Monticello (Reference 19). This event resulted in a more restrictive Power Dependent MCPR limit than required for normal reduced power operation with both pressure regulators operational. This event was re-evaluated for Cycle 27 (Reference 2) and determined to be more restrictive than the results in Reference 19. Figure 8 provides the required more restrictive power dependent MCPR ARTS limits for powers below 85% and greater than or equal to 45%. For powers greater than or equal to 85% or below 45%, the power dependent MCPR and K(P) ARTS limits provided in Figure 3 are still valid. The ARTS limits are described in Reference 17. The new Pressure Regulator Out of Service limits are applicable for Cycle 27 (Reference 2).

Figure 8 combines the unchanged limits from Figure 3 along with the more restrictive limits determined in Reference 2 for PROOS operation. Figure 8 should only be used for operation without a backup pressure regulator. Figure 8 is valid for both Option A and Option B OLMCPR limits.

An interim MFLCPR Limit is provided in Figure 9. This limit should only be used if the Gardel thermal limit input has <u>not</u> been modified as described in Sections 5.3.1 or 5.3.2 to account for pressure regulator out of service operation. I.e., only Figure 8 or Figure 9 should be used to provide the appropriate PROOS limit. These figures should not be utilized in combination.

5.3.1 OLMCPR for Two Recirculation Loop Operation, <u>WITHOUT A BACKUP PRESSURE REGULATOR.</u>

The Option A or B OLMCPR shall be determined for two recirculation loop operation as follows:

The Option A OLMCPR is calculated as shown below for the Option B example with the following exception:

- The $OLMCPR^{New}_{OptionB}$ is replaced with the Option A OLMCPR of 1.75.

The Option B OLMCPR is calculated as follows:

The rated (100%) core thermal power Option B OLMCPR ($OLMCPR^{100\%}_{OptionB}$) is 1.66, and is reported in Table 33. This $OLMCPR^{100\%}_{OptionB}$ of 1.66 is modified as described in Section 10 to be a function of the measured scram speeds to yield $OLMCPR^{New}_{OptionB}$.

Then, if core thermal power (P) is ≥ 85% of rated core thermal power, the Option B OLMCPR for all fuel types is the <u>greater</u> of:

$OLMCPR^{New}_{OptionB}$ * {K(P) from Figure 8} or {MCPR(F) from Figure 4},

i.e. if P ≥ 85% rated core thermal power, then Option B OLMCPR limit

= Maximum of { $OLMCPR^{New}_{OptionB}$ * K(P) from Figure 8} or {MCPR(F) from Figure 4}.

If core thermal power (P) is < 85% of rated core thermal power, the OLMCPR for all fuel types is obtained from Figure 8.

5.3.2 OLMCPR for Single Recirculation Loop Operation, WITHOUT A BACKUP PRESSURE REGULATOR

The Option A or B OLMCPR as defined previously for two recirculation loop operation in Section 5.3.1 is the same OLMCPR to be used for single recirculation loop operation:

6.0 Power-Flow Map

The Power-Flow Operating Map based on analysis to support Cycle 27 is shown in Figures 5, and 6. The Power-Flow Operating Map is consistent with a rated power of 1775 MWth as described in References 6, 14, and 15.

7.0 Approved Analytical Methods

NEDE-24011-P-A	Rev. 19	"General Electric Standard Application for Reactor Fuel (GESTAR)"
NEDE-24011-P-A-US	Rev. 19	"General Electric Standard Application for Reactor Fuel (GESTAR) – Supplement for the United States."
NEDO-31960-A		"BWR Owners Group Long-Term Stability Solution Licensing Methodology," Licensing Topical Report, June 1991.
NEDO-31960-A	Sup. 1	"BWR Owners Group Long-Term Stability Solution Licensing Methodology, (Supplement 1)," Licensing Topical Report, Supplement 1, March 1992.
NEDC-32992P-A		General Electric Licensing Topical Report, "ODYSY Application for Stability Licensing Calculations," July 2001.
NEDO-32465-A		General Electric Licensing Topical Report, "Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology and Reload Applications," August 1996.
NSPNAD-8608-A	Rev. 4	"Reload Safety Evaluation Methods for Application to the Monticello Generating Plant." October 1995.
NSPNAD-8609-A	Rev. 3	"Qualification of Reactor Physics Methods for Application to Monticello." October 1995.

8.0 Fuel Rod Heat Generation Rate

8.1 Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) as a Function of Exposure

The MAPLHGR limits in Tables 1 through 14 are conservative values bounding all fuel lattice types (all natural uranium lattices are excluded) in a given fuel bundle design, and are intended only for use in hand calculations as described below to establish MAPLHGR limits for Technical Specification 3.2.1. No channel bow effects are included in the bounding MAPLHGR values in Tables 1 through 14 as there are no reused channels. MAPLHGR limits for each individual fuel lattice for a given bundle design as a function of axial location and average planar exposure are determined based on the approved methodology referenced in Monticello Technical Specification 5.6.3.b and are loaded into the process computer for use in core monitoring calculations.

When and if hand calculations are required:

8.1.1 Two-Recirculation Loop Operation (MAPLHGR)

At rated core thermal power and core flow conditions, the MAPLHGR limit for each fuel bundle design as a function of average planar exposure shall not exceed the bounding limits provided in Tables 1 through 14.

The MAPLHGR limit is adjusted for off-rated core thermal power and core flow conditions by determining the following:

MAPLHGR(P) = MAPFAC(P) * MAPLHGR limit from Tables 1 through 14.
MAPLHGR(F) = MAPFAC(F) * MAPLHGR limit from Tables 1 through 14.

where MAPFAC(P) and MAPFAC(F) are determined from Figures 1 and 2, respectively, and where P is the core thermal power in percent of rated, and F is the core flow in percent of rated.

The Technical Specification (TS) MAPLHGR limit is determined as follows:

MAPLHGR (TS) Limit = Minimum{MAPLHGR(P), MAPLHGR(F)}

Note that all natural uranium lattices are excluded in Tables 1 through 14. Straight line interpolation between nearest data points is permitted only within each individual Tables 1 through 14.

8.1.2 Single Recirculation Loop Operation (MAPLHGR)

When in single recirculation loop operation, perform the following:

8.1.2.1 Perform the action specified in Section 8.1.1 above.

8.1.2.2 Separately, apply the single loop operation multiplier to the limiting values of MAPLHGR from Tables 1 through 14 as follows:

for GE14C: multiplier is 0.90.

8.1.2.3 Select the more limiting (i.e. smaller) value from Sections 8.1.2.1 or 8.1.2.2.

Reference: Technical Specification 3.2.1.

8.2 Linear Heat Generation Rate (LHGR)

The uranium dioxide (UO_2) and gadolinia LHGR limits as a function of fuel rod peak pellet exposure for each bundle type in Cycle 27 is provided in Tables 15 through 28. The gadolinia LHGR limits in Tables 15 through 28 are bounding gadolinia LHGR limits for all the gadolinia concentrations occurring in each of the bundle types used in Cycle 27. The LHGR limits are fuel rod nodal limits, and are to be applied at every node of the fuel rod including the natural uranium lattices.

The individual LHGR limits for the uranium dioxide and gadolinia fuel rods in each fuel bundle type used in Cycle 27, as a function of axial location and pellet exposure are determined based on the approved methodology referenced in Monticello Technical Specification 5.6.3.b and are loaded into the process computer for use in core monitoring calculations.

The LHGR limits are presented in this report for use when and if hand calculations are performed to demonstrate compliance with Technical Specification 3.2.3.

When and if hand calculations are performed:

8.2.1 Two-Recirculation Loop Operation (LHGR)

At rated core thermal power and core flow conditions, the LHGR limit for each fuel bundle design as a function of peak pellet exposure and fuel pin type shall not exceed the bounding limits provided in Tables 15 through 28.

The LHGR limit is adjusted for off-rated core thermal power and core flow conditions by determining the following:

LHGR(P) = MAPFAC(P) * LHGR limit from Tables 15 through 28.
LHGR(F) = MAPFAC(F) * LHGR limit from Tables 15 through 28.

where the multipliers MAPFAC(P) and MAPFAC(F) are determined from Figures 1 and 2, respectively, and where P is the core thermal power in percent of rated, and F is the core flow in percent of rated.

The Technical Specification (TS) LHGR limit is determined as follows:

LHGR TS Limit = Minimum{LHGR(P), LHGR(F)}

Note that the LHGR limits are fuel rod nodal limits, and are to be applied at every node of the fuel rod, including the natural uranium lattices. Straight line interpolation between nearest data points is permitted only within each individual Tables 15 through 28.

8.2.2 Single Recirculation Loop Operation (LHGR)

When in single recirculation loop operation, perform the following:

8.2.2.1 Perform the same action specified in Section 8.2.1 above. There are no separate single loop operation specific multipliers applicable to LHGR, i.e. the multipliers from Section 8.2.1 also apply to single recirculation loop operation.

Reference: Technical Specification Section 3.2.3.

Table 1
MAPLHGR Limits [1]

GE14C EDB-2931[2] GE14-P10DNAB392-16GZ-100T-145-T6-2931

Average Planar Exposure GWD/MTU (GWD/STU)	MAPLHGR Limit (kW/ft)[3]
0.00 (0.00)	8.12
0.22 (0.20)	8.16
1.10 (1.00)	8.23
2.20 (2.00)	8.32
3.31 (3.00)	8.42
4.41 (4.00)	8.52
5.51 (5.00)	8.62
6.61 (6.00)	8.71
7.72 (7.00)	8.79
8.82 (8.00)	8.88
9.92 (9.00)	8.98
11.02 (10.00)	9.09
12.13 (11.00)	9.21
13.23 (12.00)	9.33
14.33 (13.00)	9.39
15.43 (14.00)	9.39
16.53 (15.00)	9.41
18.74 (17.00)	9.43
22.05 (20.00)	9.45
23.01 (20.87)	9.42
27.56 (25.00)	9.27
33.07 (30.00)	9.00
38.58 (35.00)	8.78
44.09 (40.00)	8.50
46.34 (42.04)	8.32
49.60 (45.00)	8.07
55.12 (50.00)	7.56
60.63 (55.00)	6.22
63.50 (57.61)	4.93
63.54 (57.65)	4.91
63.68 (57.77)	4.89
63.99 (58.05)	4.75
64.52 (58.53)	4.75

Notes:
(1) Values in Table 1 are for two recirculation loop operation, see Section 8.1.1. For single loop operation, see Section 8.1.2
(2) Engineering Data Bank (EDB) number, Reference 2.
(3) MAPLHGR Data, Reference 2.

Table 2
MAPLHGR Limits [1]

GE14C EDB-3100[2] GE14-P10DNAB424-14GZ-100T-145-T6-3100

Average Planar Exposure GWD/MTU (GWD/STU)	MAPLHGR Limit (kW/ft)[3]
0.00 (0.00)	7.47
0.22 (0.20)	7.53
1.10 (1.00)	7.63
2.20 (2.00)	7.75
3.31 (3.00)	7.86
4.41 (4.00)	7.96
5.51 (5.00)	8.06
6.61 (6.00)	8.16
7.72 (7.00)	8.26
8.82 (8.00)	8.37
9.92 (9.00)	8.48
11.02 (10.00)	8.59
12.13 (11.00)	8.71
13.23 (12.00)	8.83
14.33 (13.00)	8.89
15.43 (14.00)	8.96
16.53 (15.00)	9.03
17.64 (16.00)	9.11
18.74 (17.00)	9.14
19.84 (18.00)	9.17
20.94 (19.00)	9.19
22.05 (20.00)	9.21
23.01 (20.87)	9.22
23.15 (21.00)	9.22
24.25 (22.00)	9.23
25.35 (23.00)	9.23
26.46 (24.00)	9.22
27.56 (25.00)	9.22
33.07 (30.00)	9.17
38.58 (35.00)	9.02
44.09 (40.00)	8.66
46.34 (42.04)	8.46
49.60 (45.00)	8.18
55.12 (50.00)	7.45
60.63 (55.00)	4.97
60.90 (55.25)	4.85
60.96 (55.30)	4.85
62.80 (56.97)	4.85
63.16 (57.30)	4.85

Notes:
[1] Values in Table 2 are for two recirculation loop operation, see Section 8.1.1. For single loop operation, see Section 8.1.2
[2] Engineering Data Bank (EDB) number, Reference 2.
[3] MAPLHGR Data, Reference 2.

Table 3
MAPLHGR Limits [1]

GE14C EDB-3101[2] GE14-P10DNAB375-16GZ-100T-145-T6-3101

Average Planar Exposure GWD/MTU (GWD/STU)	MAPLHGR Limit (kW/ft)[3]
0.00 (0.00)	7.99
0.22 (0.20)	8.04
1.10 (1.00)	8.12
2.20 (2.00)	8.18
3.31 (3.00)	8.25
4.41 (4.00)	8.32
5.51 (5.00)	8.38
6.61 (6.00)	8.44
7.72 (7.00)	8.51
8.82 (8.00)	8.59
9.92 (9.00)	8.68
11.02 (10.00)	8.78
12.13 (11.00)	8.90
13.23 (12.00)	9.01
14.33 (13.00)	9.11
15.43 (14.00)	9.12
16.53 (15.00)	9.15
17.64 (16.00)	9.18
18.74 (17.00)	9.20
19.84 (18.00)	9.22
20.94 (19.00)	9.23
22.05 (20.00)	9.24
23.01 (20.87)	9.25
23.15 (21.00)	9.25
24.25 (22.00)	9.21
25.35 (23.00)	9.16
26.46 (24.00)	9.10
27.56 (25.00)	9.05
33.07 (30.00)	8.79
38.58 (35.00)	8.58
44.09 (40.00)	8.38
46.34 (42.04)	8.20
49.60 (45.00)	7.94
55.12 (50.00)	7.45
60.63 (55.00)	5.46
61.93 (56.19)	4.87
62.00 (56.24)	4.87
62.73 (56.91)	4.71
63.39 (57.50)	4.71

Notes:
[1] Values in Table 3 are for two recirculation loop operation, see Section 8.1.1. For single loop operation, see Section 8.1.2
[2] Engineering Data Bank (EDB) number, Reference 2.
[3] MAPLHGR Data, Reference 2.

Table 4
MAPLHGR Limits [1]

GE14C EDB-3102[2] GE14-P10DNAB392-16GZ-100T-145-T6-3102

Average Planar Exposure GWD/MTU (GWD/STU)	MAPLHGR Limit (kW/ft)[3]
0.00 (0.00)	8.13
0.22 (0.20)	8.17
1.10 (1.00)	8.24
2.20 (2.00)	8.33
3.31 (3.00)	8.43
4.41 (4.00)	8.52
5.51 (5.00)	8.62
6.61 (6.00)	8.71
7.72 (7.00)	8.79
8.82 (8.00)	8.87
9.92 (9.00)	8.97
11.02 (10.00)	9.08
12.13 (11.00)	9.20
13.23 (12.00)	9.31
14.33 (13.00)	9.33
15.43 (14.00)	9.34
16.53 (15.00)	9.36
17.64 (16.00)	9.39
18.74 (17.00)	9.41
19.84 (18.00)	9.43
20.94 (19.00)	9.43
22.05 (20.00)	9.44
23.01 (20.87)	9.45
23.15 (21.00)	9.45
24.25 (22.00)	9.44
25.35 (23.00)	9.38
26.46 (24.00)	9.32
27.56 (25.00)	9.26
33.07 (30.00)	8.99
38.58 (35.00)	8.76
44.09 (40.00)	8.56
46.34 (42.04)	8.38
49.60 (45.00)	8.13
55.12 (50.00)	7.63
60.63 (55.00)	6.16
63.41 (57.53)	4.90
63.50 (57.61)	4.90
63.52 (57.62)	4.89
63.86 (57.93)	4.74
64.43 (58.45)	4.74

Notes:
[1] Values in Table 4 are for two recirculation loop operation, see Section 8.1.1. For single loop operation, see Section 8.1.2
[2] Engineering Data Bank (EDB) number, Reference 2.
[3] MAPLHGR Data, Reference 2.

Table 5
MAPLHGR Limits [1]

GE14C EDB-3103[2] GE14-P10DNAB391-12GZ-100T-145-T6-3103

Average Planar Exposure GWD/MTU (GWD/STU)	MAPLHGR Limit (kW/ft)[3]
0.00 (0.00)	8.52
0.22 (0.20)	8.54
1.10 (1.00)	8.58
2.20 (2.00)	8.64
3.31 (3.00)	8.71
4.41 (4.00)	8.77
5.51 (5.00)	8.83
6.61 (6.00)	8.90
7.72 (7.00)	8.95
8.82 (8.00)	9.02
9.92 (9.00)	9.08
11.02 (10.00)	9.15
12.13 (11.00)	9.24
13.23 (12.00)	9.33
14.33 (13.00)	9.33
15.43 (14.00)	9.35
16.53 (15.00)	9.37
17.64 (16.00)	9.40
18.74 (17.00)	9.42
19.84 (18.00)	9.43
20.94 (19.00)	9.44
22.05 (20.00)	9.44
23.01 (20.87)	9.45
23.15 (21.00)	9.45
24.25 (22.00)	9.44
26.46 (24.00)	9.32
27.56 (25.00)	9.27
33.07 (30.00)	9.00
38.58 (35.00)	8.77
44.09 (40.00)	8.55
46.34 (42.04)	8.38
49.60 (45.00)	8.13
55.12 (50.00)	7.63
60.63 (55.00)	6.15
63.50 (57.61)	4.89
63.60 (57.70)	4.85
63.61 (57.71)	4.84
63.84 (57.92)	4.74
64.43 (58.45)	4.74

Notes:
[1] Values in Table 5 are for two recirculation loop operation, see Section 8.1.1. For single loop operation, see Section 8.1.2
[2] Engineering Data Bank (EDB) number, Reference 2.
[3] MAPLHGR Data, Reference 2.

Table 6
MAPLHGR Limits [1]

GE14C EDB-3375[2] GE14-P10DNAB373-16GZ-100T-145-T6-3375

Average Planar Exposure GWD/MTU (GWD/STU)	MAPLHGR Limit (kW/ft)[3]
0.00 (0.00)	7.95
0.22 (0.20)	8.01
1.10 (1.00)	8.08
2.20 (2.00)	8.14
3.31 (3.00)	8.21
4.41 (4.00)	8.28
5.51 (5.00)	8.34
6.61 (6.00)	8.40
7.72 (7.00)	8.47
8.82 (8.00)	8.55
9.92 (9.00)	8.64
11.02 (10.00)	8.74
12.13 (11.00)	8.86
13.23 (12.00)	8.98
14.33 (13.00)	9.09
15.43 (14.00)	9.20
16.53 (15.00)	9.31
17.64 (16.00)	9.40
18.74 (17.00)	9.40
19.84 (18.00)	9.40
20.94 (19.00)	9.40
22.05 (20.00)	9.41
23.01 (20.87)	9.42
23.15 (21.00)	9.42
24.25 (22.00)	9.43
25.35 (23.00)	9.43
26.46 (24.00)	9.36
27.56 (25.00)	9.30
33.07 (30.00)	8.96
38.58 (35.00)	8.65
44.09 (40.00)	8.37
46.34 (42.04)	8.19
49.60 (45.00)	7.94
55.12 (50.00)	7.44
60.63 (55.00)	5.38
61.77 (56.04)	4.86
61.83 (56.09)	4.86
63.07 (57.22)	4.85
63.11 (57.25)	4.84

Notes:
[1] Values in Table 6 are for two recirculation loop operation, see Section 8.1.1. For single loop operation, see Section 8.1.2
[2] Engineering Data Bank (EDB) number, Reference 2.
[3] MAPLHGR Data, Reference 2.

Table 7
MAPLHGR Limits [1]

GE14C EDB-3376[2] GE14-P10DNAB391-16GZ-100T-145-T6-3376

Average Planar Exposure GWD/MTU (GWD/STU)	MAPLHGR Limit (kW/ft)[3]
0.00 (0.00)	8.15
0.22 (0.20)	8.19
1.10 (1.00)	8.25
2.20 (2.00)	8.32
3.31 (3.00)	8.41
4.41 (4.00)	8.49
5.51 (5.00)	8.57
6.61 (6.00)	8.66
7.72 (7.00)	8.75
8.82 (8.00)	8.84
9.92 (9.00)	8.93
11.02 (10.00)	9.01
12.13 (11.00)	9.10
13.23 (12.00)	9.20
14.33 (13.00)	9.31
15.43 (14.00)	9.43
16.53 (15.00)	9.54
17.64 (16.00)	9.65
18.74 (17.00)	9.69
19.84 (18.00)	9.68
20.94 (19.00)	9.67
22.05 (20.00)	9.66
23.01 (20.87)	9.65
23.15 (21.00)	9.65
24.25 (22.00)	9.64
25.35 (23.00)	9.63
26.46 (24.00)	9.61
27.56 (25.00)	9.53
33.07 (30.00)	9.18
38.58 (35.00)	8.88
44.09 (40.00)	8.63
46.34 (42.04)	8.50
49.60 (45.00)	8.28
55.12 (50.00)	7.73
60.63 (55.00)	6.14
63.36 (57.48)	4.89
63.50 (57.61)	4.89
63.51 (57.62)	4.89
64.05 (58.11)	4.89
64.10 (58.15)	4.87

Notes:
[1] Values in Table 7 are for two recirculation loop operation, see Section 8.1.1. For single loop operation, see Section 8.1.2
[2] Engineering Data Bank (EDB) number, Reference 2.
[3] MAPLHGR Data, Reference 2.

Table 8
MAPLHGR Limits [1]

GE14C EDB-3377[2] GE14-P10DNAB391-15GZ-100T-145-T6-3377

Average Planar Exposure GWD/MTU (GWD/STU)	MAPLHGR Limit (kW/ft)[3]
0.00 (0.00)	8.03
0.22 (0.20)	8.08
1.10 (1.00)	8.16
2.20 (2.00)	8.29
3.31 (3.00)	8.43
4.41 (4.00)	8.53
5.51 (5.00)	8.61
6.61 (6.00)	8.70
7.72 (7.00)	8.79
8.82 (8.00)	8.88
9.92 (9.00)	8.97
11.02 (10.00)	9.06
12.13 (11.00)	9.15
13.23 (12.00)	9.25
14.33 (13.00)	9.35
15.43 (14.00)	9.47
16.53 (15.00)	9.58
17.64 (16.00)	9.68
18.74 (17.00)	9.71
19.84 (18.00)	9.70
20.94 (19.00)	9.69
22.05 (20.00)	9.68
23.01 (20.87)	9.67
23.15 (21.00)	9.67
25.35 (23.00)	9.65
26.46 (24.00)	9.61
27.56 (25.00)	9.53
33.07 (30.00)	9.18
38.58 (35.00)	8.88
44.09 (40.00)	8.64
46.34 (42.04)	8.48
49.60 (45.00)	8.25
55.12 (50.00)	7.72
60.63 (55.00)	6.16
63.41 (57.53)	4.89
63.42 (57.53)	4.89
63.50 (57.61)	4.89
63.99 (58.05)	4.89
64.04 (58.09)	4.87

Notes:
[1] Values in Table 8 are for two recirculation loop operation, see Section 8.1.1. For single loop operation, see Section 8.1.2
[2] Engineering Data Bank (EDB) number, Reference 2.
[3] MAPLHGR Data, Reference 2.

Table 9
MAPLHGR Limits [1]

GE14C EDB-3378[2] GE14-P10DNAB391-12GZ-100T-145-T6-3378

Average Planar Exposure GWD/MTU (GWD/STU)	MAPLHGR Limit (kW/ft)[3]
0.00 (0.00)	8.52
0.22 (0.20)	8.55
1.10 (1.00)	8.62
2.20 (2.00)	8.70
3.31 (3.00)	8.76
4.41 (4.00)	8.82
5.51 (5.00)	8.89
6.61 (6.00)	8.95
7.72 (7.00)	9.02
8.82 (8.00)	9.09
9.92 (9.00)	9.16
11.02 (10.00)	9.22
12.13 (11.00)	9.29
13.23 (12.00)	9.36
14.33 (13.00)	9.44
15.43 (14.00)	9.53
16.53 (15.00)	9.61
17.64 (16.00)	9.68
18.74 (17.00)	9.75
19.84 (18.00)	9.76
20.94 (19.00)	9.76
22.05 (20.00)	9.76
23.01 (20.87)	9.75
23.15 (21.00)	9.75
24.25 (22.00)	9.73
25.35 (23.00)	9.72
26.46 (24.00)	9.70
27.56 (25.00)	9.66
33.07 (30.00)	9.32
38.58 (35.00)	9.00
44.09 (40.00)	8.66
46.34 (42.04)	8.51
49.60 (45.00)	8.29
55.12 (50.00)	7.75
60.63 (55.00)	6.22
63.50 (57.61)	4.92
63.64 (57.74)	4.86
63.66 (57.75)	4.86
64.05 (58.10)	4.86
64.09 (58.14)	4.86

Notes:
[1] Values in Table 9 are for two recirculation loop operation, see Section 8.1.1. For single loop operation, see Section 8.1.2
[2] Engineering Data Bank (EDB) number, Reference 2.
[3] MAPLHGR Data, Reference 2.

Table 10
MAPLHGR Limits [1]

GE14C EDB-2932[2] GE14-P10DNAB392-17GZ-100T-145-T6-2932

Average Planar Exposure GWD/MTU (GWD/STU)	MAPLHGR Limit (kW/ft)[3]
0.00 (0.00)	8.00
0.22 (0.20)	8.05
1.10 (1.00)	8.14
2.20 (2.00)	8.25
3.31 (3.00)	8.37
4.41 (4.00)	8.50
5.51 (5.00)	8.62
6.61 (6.00)	8.75
7.72 (7.00)	8.88
8.82 (8.00)	8.99
9.92 (9.00)	9.11
11.02 (10.00)	9.23
12.13 (11.00)	9.35
13.23 (12.00)	9.46
14.33 (13.00)	9.56
15.43 (14.00)	9.66
16.53 (15.00)	9.74
18.74 (17.00)	9.82
22.05 (20.00)	9.81
23.01 (20.87)	9.78
27.56 (25.00)	9.64
33.07 (30.00)	9.30
38.58 (35.00)	8.98
44.09 (40.00)	8.70
46.34 (42.04)	8.51
49.60 (45.00)	8.25
55.12 (50.00)	7.73
60.63 (55.00)	6.25
63.50 (57.61)	4.93
63.57 (57.67)	4.90
63.70 (57.79)	4.89
64.44 (58.46)	4.89
64.48 (58.50)	4.89

Notes:
(1) Values in Table 10 are for two recirculation loop operation, see Section 8.1.1. For single loop operation, see Section 8.1.2
(2) Engineering Data Bank (EDB) number, Reference 2.
(3) MAPLHGR Data, Reference 2.

Table 11
MAPLHGR Limits [1]

GE14C EDB-4175[2] GE14-P10DNAB372-17GZ-100T-145-T6-4175

Average Planar Exposure GWD/MTU (GWD/STU)	MAPLHGR Limit (kW/ft)[3]
0.00 (0.00)	7.98
0.22 (0.20)	8.02
1.10 (1.00)	8.08
2.20 (2.00)	8.18
3.31 (3.00)	8.28
4.41 (4.00)	8.38
5.51 (5.00)	8.49
6.61 (6.00)	8.61
7.72 (7.00)	8.73
8.82 (8.00)	8.86
9.92 (9.00)	8.98
11.02 (10.00)	9.11
12.13 (11.00)	9.22
13.23 (12.00)	9.30
14.33 (13.00)	9.39
15.43 (14.00)	9.49
16.53 (15.00)	9.46
17.64 (16.00)	9.46
18.74 (17.00)	9.46
19.84 (18.00)	9.47
20.94 (19.00)	9.47
23.01 (20.87)	9.47
23.15 (21.00)	9.47
24.25 (22.00)	9.47
25.35 (23.00)	9.47
26.46 (24.00)	9.40
27.56 (25.00)	9.34
33.07 (30.00)	9.03
38.58 (35.00)	8.76
44.09 (40.00)	8.52
46.34 (42.04)	8.36
49.60 (45.00)	8.13
55.12 (50.00)	7.59
60.63 (55.00)	6.16
63.44 (57.55)	4.88
63.50 (57.61)	4.88
63.70 (57.79)	4.87
64.88 (58.86)	4.87
65.11 (59.07)	4.87

Notes:
(1) Values in Table 11 are for two recirculation loop operation, see Section 8.1.1. For single loop operation, see Section 8.1.2
(2) Engineering Data Bank (EDB) number, Reference 2.
(3) MAPLHGR Data, Reference 2.

Table 12
MAPLHGR Limits [1]

GE14C EDB-4176[2] GE14-P10DNAB386-16GZ-100T-145-T6-4176

Average Planar Exposure GWD/MTU (GWD/STU)	MAPLHGR Limit (kW/ft)[3]
0.00 (0.00)	8.11
0.22 (0.20)	8.15
1.10 (1.00)	8.21
2.20 (2.00)	8.29
3.31 (3.00)	8.36
4.41 (4.00)	8.44
5.51 (5.00)	8.51
6.61 (6.00)	8.59
7.72 (7.00)	8.67
8.82 (8.00)	8.76
9.92 (9.00)	8.84
11.02 (10.00)	8.93
12.13 (11.00)	9.02
13.23 (12.00)	9.11
14.33 (13.00)	9.21
15.43 (14.00)	9.31
16.53 (15.00)	9.42
17.64 (16.00)	9.53
18.74 (17.00)	9.60
19.84 (18.00)	9.64
20.94 (19.00)	9.65
22.05 (20.00)	9.66
23.01 (20.87)	9.66
23.15 (21.00)	9.66
24.25 (22.00)	9.64
25.35 (23.00)	9.63
26.46 (24.00)	9.61
27.56 (25.00)	9.57
33.07 (30.00)	9.24
38.58 (35.00)	8.92
44.09 (40.00)	8.59
46.34 (42.04)	8.43
49.60 (45.00)	8.20
55.12 (50.00)	7.67
60.63 (55.00)	5.93
62.89 (57.06)	4.90
63.16 (57.30)	4.89
63.50 (57.61)	4.89
64.67 (58.67)	4.89
65.28 (59.23)	4.89

Notes:
[1] Values in Table 12 are for two recirculation loop operation, see Section 8.1.1. For single loop operation, see Section 8.1.2
[2] Engineering Data Bank (EDB) number, Reference 2.
[3] MAPLHGR Data, Reference 2.

Table 13
MAPLHGR Limits [1]

GE14C EDB-4177[2] GE14-P10DNAB386-16GZ-100T-145-T6-4177

Average Planar Exposure GWD/MTU (GWD/STU)	MAPLHGR Limit (kW/ft)[3]
0.00 (0.00)	8.13
0.22 (0.20)	8.17
1.10 (1.00)	8.23
2.20 (2.00)	8.30
3.31 (3.00)	8.38
4.41 (4.00)	8.46
5.51 (5.00)	8.54
6.61 (6.00)	8.63
7.72 (7.00)	8.72
8.82 (8.00)	8.81
9.92 (9.00)	8.90
11.02 (10.00)	8.99
12.13 (11.00)	9.07
13.23 (12.00)	9.16
14.33 (13.00)	9.25
15.43 (14.00)	9.34
16.53 (15.00)	9.44
17.64 (16.00)	9.54
18.74 (17.00)	9.61
19.84 (18.00)	9.64
20.94 (19.00)	9.64
22.05 (20.00)	9.65
23.01 (20.87)	9.65
23.15 (21.00)	9.65
24.25 (22.00)	9.65
25.35 (23.00)	9.64
26.46 (24.00)	9.61
27.56 (25.00)	9.55
33.07 (30.00)	9.24
38.58 (35.00)	8.91
44.09 (40.00)	8.59
46.34 (42.04)	8.43
49.60 (45.00)	8.20
55.12 (50.00)	7.67
60.63 (55.00)	5.98
63.02 (57.17)	4.88
63.12 (57.26)	4.88
63.50 (57.61)	4.88
64.64 (58.64)	4.88
65.26 (59.20)	4.88

Notes:
[1] Values in Table 13 are for two recirculation loop operation, see Section 8.1.1. For single loop operation, see Section 8.1.2
[2] Engineering Data Bank (EDB) number, Reference 2.
[3] MAPLHGR Data, Reference 2.

Table 14
MAPLHGR Limits [1]

GE14C EDB-4178[2] GE14-P10DNAB389-11GZ-100T-145-T6-4178

Average Planar Exposure GWD/MTU (GWD/STU)	MAPLHGR Limit (kW/ft)[3]
0.00 (0.00)	8.55
0.22 (0.20)	8.62
1.10 (1.00)	8.70
2.20 (2.00)	8.76
3.31 (3.00)	8.82
4.41 (4.00)	8.88
5.51 (5.00)	8.94
6.61 (6.00)	9.01
7.72 (7.00)	9.08
8.82 (8.00)	9.15
9.92 (9.00)	9.22
11.02 (10.00)	9.30
12.13 (11.00)	9.37
13.23 (12.00)	9.44
14.33 (13.00)	9.51
15.43 (14.00)	9.57
16.53 (15.00)	9.63
17.64 (16.00)	9.69
18.74 (17.00)	9.74
19.84 (18.00)	9.74
20.94 (19.00)	9.73
22.05 (20.00)	9.73
23.01 (20.87)	9.71
23.15 (21.00)	9.71
24.25 (22.00)	9.69
25.35 (23.00)	9.68
26.46 (24.00)	9.66
27.56 (25.00)	9.62
33.07 (30.00)	9.29
38.58 (35.00)	8.93
44.09 (40.00)	8.61
46.34 (42.04)	8.45
49.60 (45.00)	8.22
55.12 (50.00)	7.68
60.63 (55.00)	6.25
63.50 (57.61)	4.93
63.61 (57.71)	4.88
63.63 (57.72)	4.88
65.22 (59.17)	4.88
65.83 (59.72)	4.88

Notes:
(1) Values in Table 14 are for two recirculation loop operation, see Section 8.1.1. For single loop operation, see Section 8.1.2
(2) Engineering Data Bank (EDB) number, Reference 2.
(3) MAPLHGR Data, Reference 2.

Table 15 [2]
UO2/Gd Thermal Mechanical LHGR Limits
(Reference 5)

Bundle Type: GE14-P10DNAB392-16GZ-100T-145-T6-2931 (GE14C)
Engineering Data Bank (EDB) Bundle Number [1]: 2931

Peak Pellet Exposure GWd/MT (GWD/ST)	UO2 LHGR Limit (kW/ft)	Peak Pellet Exposure GWd/MT (GWD/ST)	Most Limiting Gadolinia LHGR Limit (kW/ft)
0.00 (0.00)	13.40	0.00 (0.00)	12.00
16.00 (14.51)	13.40	13.42 (12.17)	12.00
63.50 (57.61)	8.00	60.17 (54.59)	7.16
70.00 (63.50)	5.00	66.57 (60.39)	4.48

Notes:
1. Reference 5.
2. Applicable multipliers per Section 8.2 will be applied to the data in this table for two recirculation loop and single recirculation loop operations.

Table 16 [2]
UO2/Gd Thermal Mechanical LHGR Limits
(Reference 5)

Bundle Type: GE14-P10DNAB392-17GZ-100T-145-T6-2932 (GE14C)
Engineering Data Bank (EDB) Bundle Number [1]: 2932

Peak Pellet Exposure GWd/MT (GWD/ST)	UO2 LHGR Limit (kW/ft)	Peak Pellet Exposure GWd/MT (GWD/ST)	Most Limiting Gadolinia LHGR Limit (kW/ft)
0.00 (0.00)	13.40	0.00 (0.00)	12.26
16.00 (14.51)	13.40	13.53 (12.28)	12.26
63.50 (57.61)	8.00	60.63 (55.00)	7.32
70.00 (63.50)	5.00	67.07 (60.84)	4.57

Notes:
1. Reference 5.
2. Applicable multipliers per Section 8.2 will be applied to the data in this table for two recirculation loop and single recirculation loop operations.

Table 17 [2]
UO2/Gd Thermal Mechanical LHGR Limits
(Reference 5)

Bundle Type: GE14-P10DNAB424-14GZ-100T-145-T6-3100 (GE14C)
Engineering Data Bank (EDB) Bundle Number [1]: 3100

Peak Pellet Exposure GWd/MT (GWD/ST)	UO2 LHGR Limit (kW/ft)	Peak Pellet Exposure GWd/MT (GWD/ST)	Most Limiting Gadolinia LHGR Limit (kW/ft)
0.00 (0.00)	13.40	0.00 (0.00)	12.00
16.00 (14.51)	13.40	13.42 (12.17)	12.00
63.50 (57.61)	8.00	60.17 (54.59)	7.16
70.00 (63.50)	5.00	66.57 (60.39)	4.48

Notes:
1. Reference 5.
2. Applicable multipliers per Section 8.2 will be applied to the data in this table for two recirculation loop and single recirculation loop operations.

Table 18 [2]
UO2/Gd Thermal Mechanical LHGR Limits
(Reference 5)

Bundle Type: GE14-P10DNAB375-16GZ-100T-145-T6-3101 (GE14C)
Engineering Data Bank (EDB) Bundle Number [1]: 3101

Peak Pellet Exposure GWd/MT (GWD/ST)	UO2 LHGR Limit (kW/ft)	Peak Pellet Exposure GWd/MT (GWD/ST)	Most Limiting Gadolinia LHGR Limit (kW/ft)
0.00 (0.00)	13.40	0.00 (0.00)	12.00
16.00 (14.51)	13.40	13.42 (12.17)	12.00
63.50 (57.61)	8.00	60.17 (54.59)	7.16
70.00 (63.50)	5.00	66.57 (60.39)	4.48

Notes:
1. Reference 5.
2. Applicable multipliers per Section 8.2 will be applied to the data in this table for two recirculation loop and single recirculation loop operations.

Table 19 [2]
UO2/Gd Thermal Mechanical LHGR Limits
(Reference 5)

Bundle Type: GE14-P10DNAB392-16GZ-100T-145-T6-3102 (GE14C)
Engineering Data Bank (EDB) Bundle Number [1]: 3102

Peak Pellet Exposure GWd/MT (GWD/ST)	UO2 LHGR Limit (kW/ft)	Peak Pellet Exposure GWd/MT (GWD/ST)	Most Limiting Gadolinia LHGR Limit (kW/ft)
0.00 (0.00)	13.40	0.00 (0.00)	12.00
16.00 (14.51)	13.40	13.42 (12.17)	12.00
63.50 (57.61)	8.00	60.17 (54.59)	7.16
70.00 (63.50)	5.00	66.57 (60.39)	4.48

Notes:
1. Reference 5.
2. Applicable multipliers per Section 8.2 will be applied to the data in this table for two recirculation loop and single recirculation loop operations.

Table 20 [2]
UO2/Gd Thermal Mechanical LHGR Limits
(Reference 5)

Bundle Type: GE14-P10DNAB391-12GZ-100T-145-T6-3103 (GE14C)
Engineering Data Bank (EDB) Bundle Number [1]: 3103

Peak Pellet Exposure GWd/MT (GWD/ST)	UO2 LHGR Limit (kW/ft)	Peak Pellet Exposure GWd/MT (GWD/ST)	Most Limiting Gadolinia LHGR Limit (kW/ft)
0.00 (0.00)	13.40	0.00 (0.00)	12.00
16.00 (14.51)	13.40	13.42 (12.17)	12.00
63.50 (57.61)	8.00	60.17 (54.59)	7.16
70.00 (63.50)	5.00	66.57 (60.39)	4.48

Notes:
1. Reference 5.
2. Applicable multipliers per Section 8.2 will be applied to the data in this table for two recirculation loop and single recirculation loop operations.

Table 21 [2]
UO2/Gd Thermal Mechanical LHGR Limits
(Reference 5)

Bundle Type: GE14-P10DNAB373-16GZ-100T-145-T6-3375 (GE14C)
Engineering Data Bank (EDB) Bundle Number [1]: 3375

Peak Pellet Exposure GWd/MT (GWD/ST)	UO2 LHGR Limit (kW/ft)	Peak Pellet Exposure GWd/MT (GWD/ST)	Most Limiting Gadolinia LHGR Limit (kW/ft)
0.00 (0.00)	13.40	0.00 (0.00)	12.00
16.00 (14.51)	13.40	13.42 (12.17)	12.00
63.50 (57.61)	8.00	60.17 (54.59)	7.16
70.00 (63.50)	5.00	66.57 (60.39)	4.48

Notes:
1. Reference 5.
2. Applicable multipliers per Section 8.2 will be applied to the data in this table for two recirculation loop and single recirculation loop operations.

Table 22 [2]
UO2/Gd Thermal Mechanical LHGR Limits
(Reference 5)

Bundle Type: GE14-P10DNAB391-16GZ-100T-145-T6-3376 (GE14C)
Engineering Data Bank (EDB) Bundle Number [1]: 3376

Peak Pellet Exposure GWd/MT (GWD/ST)	UO2 LHGR Limit (kW/ft)	Peak Pellet Exposure GWd/MT (GWD/ST)	Most Limiting Gadolinia LHGR Limit (kW/ft)
0.00 (0.00)	13.40	0.00 (0.00)	12.00
16.00 (14.51)	13.40	13.42 (12.17)	12.00
63.50 (57.61)	8.00	60.17 (54.59)	7.16
70.00 (63.50)	5.00	66.57 (60.39)	4.48

Notes:
1. Reference 5.
2. Applicable multipliers per Section 8.2 will be applied to the data in this table for two recirculation loop and single recirculation loop operations.

Table 23 [2]
UO2/Gd Thermal Mechanical LHGR Limits
(Reference 5)

Bundle Type: GE14-P10DNAB391-15GZ-100T-145-T6-3377 (GE14C)
Engineering Data Bank (EDB) Bundle Number [1]: 3377

Peak Pellet Exposure GWd/MT (GWD/ST)	UO2 LHGR Limit (kW/ft)	Peak Pellet Exposure GWd/MT (GWD/ST)	Most Limiting Gadolinia LHGR Limit (kW/ft)
0.00 (0.00)	13.40	0.00 (0.00)	12.00
16.00 (14.51)	13.40	13.42 (12.17)	12.00
63.50 (57.61)	8.00	60.17 (54.59)	7.16
70.00 (63.50)	5.00	66.57 (60.39)	4.48

Notes:
1. Reference 5.
2. Applicable multipliers per Section 8.2 will be applied to the data in this table for two recirculation loop and single recirculation loop operations.

Table 24 [2]
UO2/Gd Thermal Mechanical LHGR Limits
(Reference 5)

Bundle Type: GE14-P10DNAB391-12GZ-100T-145-T6-3378 (GE14C)
Engineering Data Bank (EDB) Bundle Number [1]: 3378

Peak Pellet Exposure GWd/MT (GWD/ST)	UO2 LHGR Limit (kW/ft)	Peak Pellet Exposure GWd/MT (GWD/ST)	Most Limiting Gadolinia LHGR Limit (kW/ft)
0.00 (0.00)	13.40	0.00 (0.00)	12.00
16.00 (14.51)	13.40	13.42 (12.17)	12.00
63.50 (57.61)	8.00	60.17 (54.59)	7.16
70.00 (63.50)	5.00	66.57 (60.39)	4.48

Notes:
1. Reference 5.
2. Applicable multipliers per Section 8.2 will be applied to the data in this table for two recirculation loop and single recirculation loop operations.

Table 25 [2]
UO2/Gd Thermal Mechanical LHGR Limits
(Reference 5)

Bundle Type: GE14-P10DNAB372-17GZ-100T-145-T6-4175 (GE14C)
Engineering Data Bank (EDB) Bundle Number [1]: 4175

Peak Pellet Exposure GWd/MT (GWD/ST)	UO2 LHGR Limit (kW/ft)	Peak Pellet Exposure GWd/MT (GWD/ST)	Most Limiting Gadolinia LHGR Limit (kW/ft)
0.00 (0.00)	13.40	0.00 (0.00)	12.00
16.00 (14.51)	13.40	13.42 (12.17)	12.00
63.50 (57.61)	8.00	60.17 (54.59)	7.16
70.00 (63.50)	5.00	66.57 (60.39)	4.48

Notes:
1. Reference 5.
2. Applicable multipliers per Section 8.2 will be applied to the data in this table for two recirculation loop and single recirculation loop operations.

Table 26 [2]
UO2/Gd Thermal Mechanical LHGR Limits
(Reference 5)

Bundle Type: GE14-P10DNAB386-16GZ-100T-145-T6-4176 (GE14C)
Engineering Data Bank (EDB) Bundle Number [1]: 4176

Peak Pellet Exposure GWd/MT (GWD/ST)	UO2 LHGR Limit (kW/ft)	Peak Pellet Exposure GWd/MT (GWD/ST)	Most Limiting Gadolinia LHGR Limit (kW/ft)
0.00 (0.00)	13.40	0.00 (0.00)	12.00
16.00 (14.51)	13.40	13.42 (12.17)	12.00
63.50 (57.61)	8.00	60.17 (54.59)	7.16
70.00 (63.50)	5.00	66.57 (60.39)	4.48

Notes:
1. Reference 5.
2. Applicable multipliers per Section 8.2 will be applied to the data in this table for two recirculation loop and single recirculation loop operations.

Table 27 [2]
UO2/Gd Thermal Mechanical LHGR Limits
(Reference 5)

Bundle Type: GE14-P10DNAB386-16GZ-100T-145-T6-4177 (GE14C)
Engineering Data Bank (EDB) Bundle Number [1]: 4177

Peak Pellet Exposure GWd/MT (GWD/ST)	UO2 LHGR Limit (kW/ft)	Peak Pellet Exposure GWd/MT (GWD/ST)	Most Limiting Gadolinia LHGR Limit (kW/ft)
0.00 (0.00)	13.40	0.00 (0.00)	12.00
16.00 (14.51)	13.40	13.42 (12.17)	12.00
63.50 (57.61)	8.00	60.17 (54.59)	7.16
70.00 (63.50)	5.00	66.57 (60.39)	4.48

Notes:
1. Reference 5.
2. Applicable multipliers per Section 8.2 will be applied to the data in this table for two recirculation loop and single recirculation loop operations.

Table 28 [2]
UO2/Gd Thermal Mechanical LHGR Limits
(Reference 5)

Bundle Type: GE14-P10DNAB389-11GZ-100T-145-T6-4178 (GE14C)
Engineering Data Bank (EDB) Bundle Number [1]: 4178

Peak Pellet Exposure GWd/MT (GWD/ST)	UO2 LHGR Limit (kW/ft)	Peak Pellet Exposure GWd/MT (GWD/ST)	Most Limiting Gadolinia LHGR Limit (kW/ft)
0.00 (0.00)	13.40	0.00 (0.00)	12.00
16.00 (14.51)	13.40	13.42 (12.17)	12.00
63.50 (57.61)	8.00	60.17 (54.59)	7.16
70.00 (63.50)	5.00	66.57 (60.39)	4.48

Notes:
1. Reference 5.
2. Applicable multipliers per Section 8.2 will be applied to the data in this table for two recirculation loop and single recirculation loop operations.

9.0 Core Stability Requirements

Stability Option III Solution

Monticello has implemented the BWR Owners Group Long Term Stability Solution Option III using the Oscillation Power Range Monitor (OPRM) as described in References 4 and 10. The plant specific Hot Channel Oscillation Magnitude (HCOM) (Reference 11) and other cycle specific stability parameters are used in the Cycle 27 Option III Stability Evaluation, which is documented in Reference 2. A Backup Stability Protection (BSP) evaluation is also documented in References 2 and 13, and is used in the event that the Option III OPRM system is declared INOPERABLE.

The following Option III OPRM stability setpoint determination and the implementation of the associated BSP Regions shown in Figures 5 and 6 provide the stability licensing bases for Monticello Cycle 27.

Option III OPRM Setpoints

A reload Option III evaluation has been performed in accordance with the licensing methodology described in Reference 4. The stability based Operating Limit Minimum Critical Power Ratio (OLMCPR) is determined for two conditions as a function of OPRM amplitude setpoint. The two conditions evaluated are: (1) a postulated oscillation at 45% rated core flow quasi steady-state operation (SS), and (2) a postulated oscillation following a two recirculation pump trip (2PT) from the limiting rated power operating state point.

The OPRM-setpoint-dependent OLMCPR(SS) and OLMCPR(2PT) values are calculated for Cycle 27 in accordance with the BWROG regional mode DIVOM guidelines described in Reference 12. The Cycle 27 Option III evaluation provides adequate protection against violation of the Safety Limit MCPR (SLMCPR) for the two postulated reactor instability events as long as the plant OLMCPR is equal to or greater than OLMCPR(SS) and OLMCPR(2PT) for the selected OPRM setpoint in Table 30.

The relationship between the OPRM Successive Confirmation Count Setpoint and the OPRM Amplitude Setpoint is provided in Reference 4 and Table 29. For intermediate OPRM Amplitude Setpoints, the corresponding OPRM Successive Confirmation Count Setpoints have been obtained by using linear interpolation.

The OPRM setpoints for Two Loop Operation (TLO) are conservative relative to Single Loop Operation (SLO) and are, therefore, bounding.

Table 29
Relationship Between OPRM Successive Confirmation Count Setpoint and OPRM Amplitude Setpoint

Successive Confirmation Count Setpoint	OPRM Amplitude Setpoint
6	≥1.04
8	≥1.05
9	≥1.06
10	≥1.07
11	≥1.08
12	≥1.09
13	≥1.10
14	≥1.11
15	≥1.13
16	≥1.14
17	≥1.16
18	≥1.19
19	≥1.21
20	≥1.24

Table 30
OPRM Setpoint Versus OLMCPR

OPRM Amplitude Setpoint	OLMCPR(SS)	OLMCPR(2PT)
1.05	1.26	1.17
1.06	1.28	1.19
1.07	1.30	1.21
1.08	1.33	1.24
1.09	1.35	1.26
1.10	1.38	1.28
1.11	1.40	1.31
1.12	1.43	1.33
1.13	1.46	1.36
1.14	1.49	1.38
1.15	1.52	1.41
OLMCPR Acceptance Criteria	1.87	1.66

The OPRM Period Based Detection Algorithm (PBDA) instrumentation setpoints for use in Technical Specification LCO 3.3.1.1 Table 3.3.1.1-1 Function 2f shall not exceed the following:

Confirmation Count Setpoint: 16

Amplitude Setpoint: 1.15

Backup Stability Protection Regions

The Backup Stability Protection (BSP) regions are shown in Figure 5, and are given in greater detail in Figure 6. The BSP regions are an integral part of the Tech Spec required alternative method to detect and suppress thermal hydraulic instability oscillations in that they identify areas of the power/flow map where there is an increased probability that the reactor core could experience a thermal hydraulic instability.

Regions are identified that are either excluded from planned entry and continued operation (Scram Region), or where planned entry is not permitted unless specific operating restrictions are met and specific actions are required to be taken to immediately leave the region following inadvertent or forced entry (Controlled Entry Region). The boundaries of these regions are established on a cycle specific basis based upon core decay ratio calculations performed using NRC approved methodology (Reference 3).

The BSP regions are only applicable when the Upscale Trip function of the OPRM is INOPERABLE. The BSP region boundaries were calculated for Monticello Cycle 27 for nominal feedwater temperature conditions. The endpoints of the regions are defined in Table 31. The region boundaries shown in Figures 5 and 6 are defined using the Generic Shape Function (GSF), which is described in References 13 and 25.

Table 31
Cycle 27 BSP Region Intercepts for Normal Feedwater Temperature

Region Boundary Intercepts	Power (%)	Core Flow (%)	Core DR	Highest Channel DR
A1	63.9	40.0	<0.80	<0.56
B1	48.1	33.8	<0.80	<0.56
A2	72.8	50.0	<0.80	<0.56
B2	32.3	31.2	<0.80	<0.56

Actions For Entry Into Scram Region

Immediate manual scram upon determination that the region has been entered. If entry is unavoidable, early scram initiation is appropriate.

Actions For Entry Into Controlled Entry Region

If entry is inadvertent or forced, immediately exit from region. The region can be exited by control rod insertion or core flow increase. Increasing the core flow by restarting an idle recirculation pump is not an acceptable method of exiting the region.

Deliberate entry into the Controlled Entry Region requires compliance with at least one of the stability controls outlined below:

1. Maintain core average boiling boundary (BB) ≥ 4.0 feet.
2. Maintain core decay ratio (DR) < 0.6 as calculated by an on-line stability monitor.
3. Continuous dedicated monitoring of real time control room neutron monitoring instrumentation with manual scram required upon indication of a reactor instability induced power oscillation.

Caution is required whenever operating near the Controlled Entry Region boundary (i.e., within approximately 10% of core power or core flow), and it is

recommended that the amount of time spent operating near this region be minimized.

Reference: Technical Specification 3.3.1.1

10.0 Scram Time Dependence

The Technical Specification Option A (no scram times dependence) OLMCPR can be found in Section 5 of this report. If the Option B scram time dependence option is preferred, then the procedure listed in Section 10.1 may be used.

10.1 Technical Specification Scram Time Dependence

Technical Specification 3.1.4 and Table 3.1.4-1 provide the scram insertion time versus position requirements for continued operations. Technical Specification Surveillance Requirements SR 3.1.4.1 – SR 3.1.4.4 provide the surveillance requirements for the CRDs. Data from testing of the CRDs, or from an unplanned scram, is summarized in Surveillance Test 0081. Reference 8 describes the procedure below.

Using this cycle specific information, values of τ_{ave} can be calculated in accordance with the equation below for the notch 36 position.

The Equation (1) used to calculate the average of all the scram data generated to date in the cycle is:

$$\tau_{ave} = \frac{\sum_{i=1}^{n} N_i \tau_i}{\sum_{i=1}^{n} N_i} \qquad (1)$$

where: n = the number of surveillance tests performed to date in the cycle;

$\sum_{i=1}^{n} N_i$ = total number of active control rods measured to date in the cycle; and

$\sum_{i=1}^{n} N_i \tau_i$ = sum of the scram times to the 36th notch position of all active rods measured to date in the cycle to comply with the Technical Specification surveillance requirements SR 3.1.4.1, SR 3.1.4.2, SR 3.1.4.3, SR 3.1.4.4.

The average scram time, τ_{ave} is tested against the analysis mean using the following equation:

$$\tau_{ave} \leq \tau_B \quad (2)$$

where:

$$\tau_B = \mu + 1.65\sqrt{\left(\frac{N_1}{\sum_{i=1}^{n} N_i}\right)}\sigma \quad (3)$$

The parameters μ and σ are the mean and standard deviation of the distribution of the average scram insertion time to notch 36 position in the ODYN Option B analysis (Table 32), and N_1 = number of active control rods tested at BOC.

Table 32
GEMINI Methods, CRD Notch Position for τ_B Determination

Notch Position	μ	σ
36	0.830	0.019

If the cycle average scram time satisfies the Equation 2 criteria, continued plant operation under the ODYN Option B operating limit minimum critical power ratio (OLMCPR) for pressurization events is permitted. If not, the OLMCPR for pressurization events must be re-established based on linear interpolation between the Option B and Option A OLMCPRs.

Note that Option B has an OLMCPR applicable to two recirculation loop operation, and an OLMCPR applicable to single recirculation loop operation. The Option B OLMCPR value for single recirculation loop operation is the same as the Option B OLMCPR value for two recirculation loop operation.

The equation to establish the new operating limit for pressurization events is given below:

$$\mathrm{OLMCPR}_{\mathrm{NEW}} = MAX\left(\mathrm{OLMCPR}^{100\%}_{\mathrm{OptionB}} + \frac{\tau_{ave} - \tau_B}{\tau_A - \tau_B}\Delta\mathrm{OLMCPR}, \mathrm{OLMCPR}_{\mathrm{TTWBP}}\right) \quad (4)$$

where:

τ_{ave} and τ_B are defined in Equations 1 and 3, respectively; and

τ_A = The Technical Specification limit on scram time to notch position 36 . (Technical Specification Table 3.1.4-1 at notch position 36)

ΔOLMCPR = the difference between the Option A OLMCPR and the Option B OLMCPR reported in Table 33.

Table 33
Cycle OLMCPR Values

Transient	Option A	Option B
Feed Water Controller Failure	**1.75**	**1.58**
Turbine Trip with Bypass[1]	**1.66**	

1. The Turbine Trip with Bypass transient will be used as the Minimum OLMCPR transient for Option B Analysis.
2. All the OLMCPR values reported in Table 33 are for two recirculation loop operation.
3. For Options A and B, the OLMCPR value for single recirculation loop operation is equal to the OLMCPR value for two recirculation loop operation.

Sample Calculation:

Assume two recirculation loop operation.

If τ_{ave} is 0.820 seconds (scram time test) and τ_B (as calculated with equation 3) is 0.850 seconds then the criteria from Equation 2 is met and the Option B OLMCPR of 1.66 can be used.

If τ_{ave} is 0.970 seconds and τ_B is 0.850 seconds, then Equation 2 is not met and a new Option B OLMCPR must be calculated using Equation 4 above.

The example calculation is as follows:

$$\text{OLMCPR}_{\text{NEW}} = MAX\left(\text{OLMCPR}^{100\%}_{\text{OptionB}} + \frac{\tau_{ave} - \tau_B}{\tau_A - \tau_B}\Delta\text{OLMCPR}, \text{OLMCPR}_{\text{TTWBP}}\right)$$

$\text{OLMCPR}^{100\%}_{\text{OptionB}}$ = 1.66 (from Table 33 above.)

τ_{ave} = 0.970

τ_B = 0.850

τ_A = 1.080 (Technical Specification Table 3.1.4-1 at notch position 36)

ΔOLMCPR = 1.75 - 1.58 = 0.17 (from Table 33 above; assume two recirculation loop operation)

$$\text{OLMCPR}_{\text{NEW}} = MAX\left(1.58 + \left(\frac{0.970 - 0.850}{1.080 - 0.850}\right) * 0.17,\ 1.66\right) = MAX(1.67,\ 1.66) = 1.67;$$ two recirculation loop operation

Note: If single recirculation loop operation Option B OLMCPR value is desired, the same value is used, i.e. 1.67.

11.0 Turbine Bypass System Response Time

The TURBINE BYPASS SYSTEM RESPONSE TIME shall be that time interval from when the main turbine trip solenoid is activated until 80% of the turbine bypass capacity is established. The TURBINE BYPASS SYSTEM RESPONSE TIME shall be $\leq$ 1.1 seconds.

Reference: Technical Specification 1.1, Surveillance Requirement 3.7.7.3.

12.0 Shutdown Margin (SDM) Confirmation

Technical Specification 3.1.1 requires that the SDM be confirmed for Monticello Cycle 27. Analytical SDM has been confirmed in the Supplemental Reload Licensing Report (Reference 2, Section 4).

For any mid-cycle core loading changes, the analytical SDM will be re-confirmed, formally documented, and reviewed prior to start-up.

13.0 APRM Simulated Thermal Power – High Delta W Allowable Value

The APRM Simulated Thermal Power – High Flow Biased Scram Setpoint Allowable Value shall be:

$$S_{STP} \leq (0.66(W-\Delta W) + 61.6\%)$$

where:

S_{STP} = Scram setting in percent of rated thermal power (1775 MWt)

W = Loop recirculation flow rate in percent of rated

ΔW = Difference between two-loop and single-loop effective recirculation flow at the same core flow (ΔW = 5.4% for single loop operation, ΔW = 0.0 for two-loop operation)

Reference: Technical Specification 5.6.3, item 5, Technical Specification Table 3.3.1.1-1, Function 2.b, and Reference 24

Figure 1
Monticello Cycle 27
Power Dependent MAPLHGR and LHGR Multipliers
For CLTP Conditions

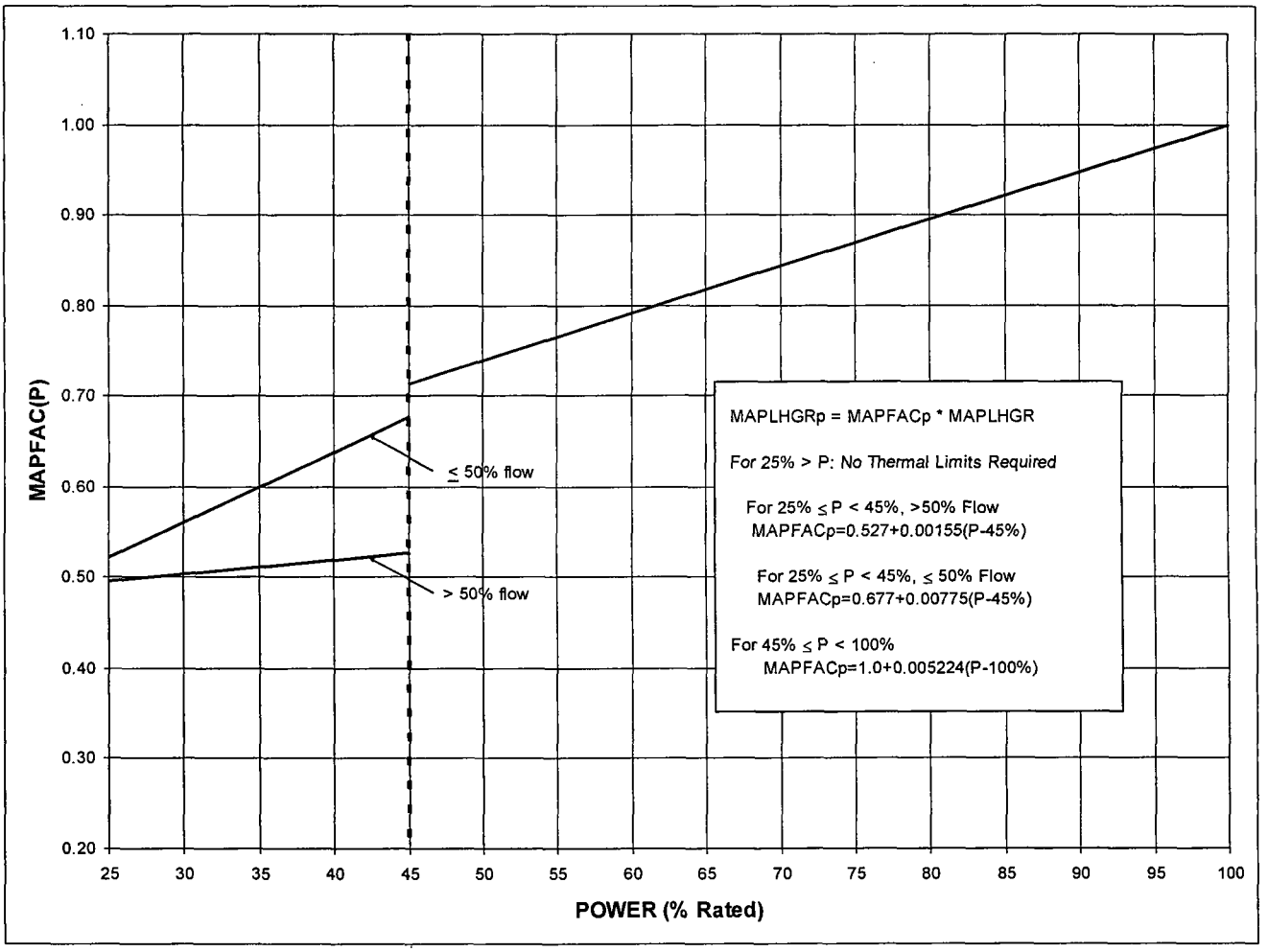


Figure 2
Monticello Cycle 27
Flow Dependent MAPLHGR and LHGR Multipliers
for CLTP Conditions

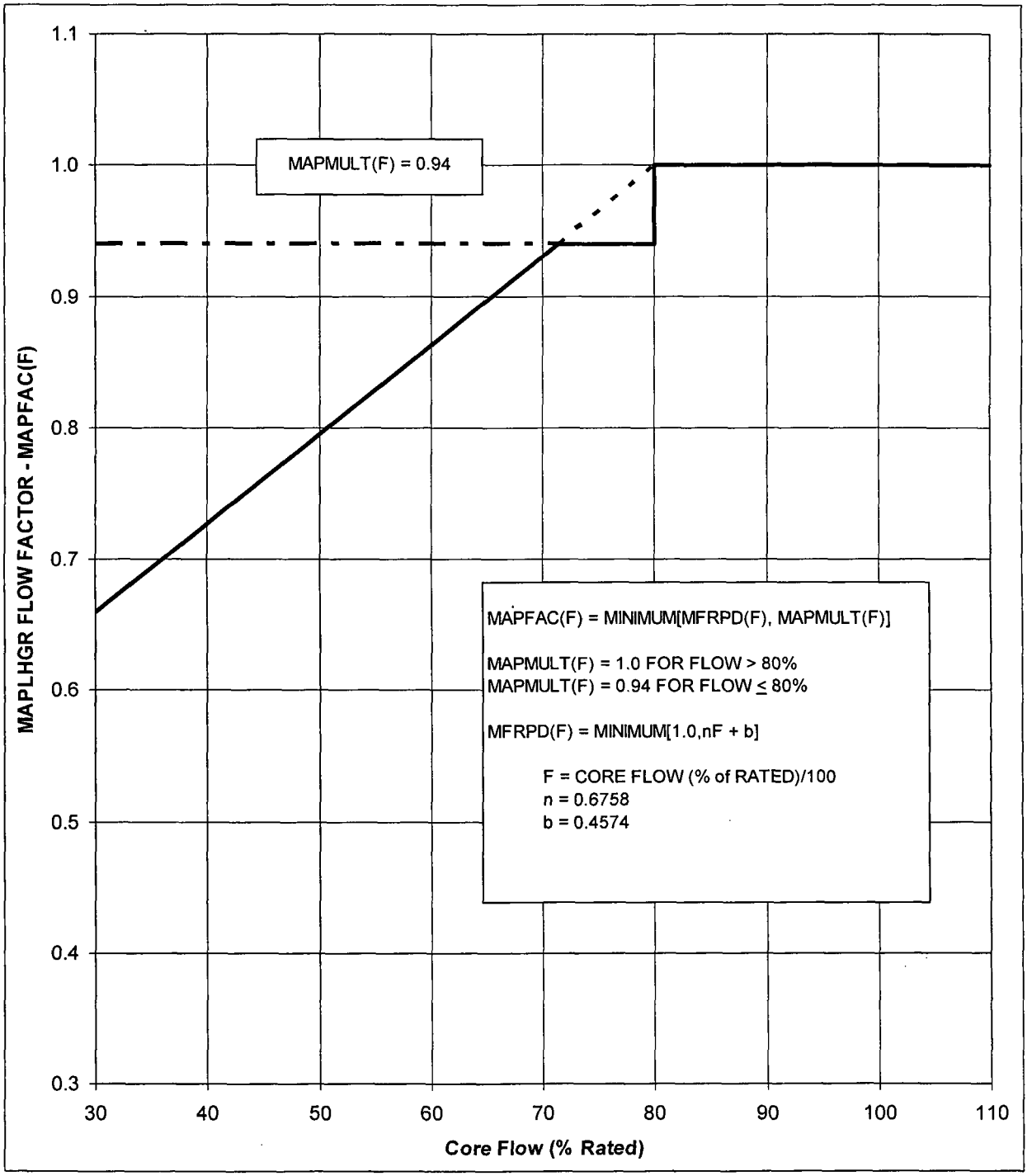


Figure 3
Monticello Cycle 27
Power Dependent K(P) / MCPR(P) Limits

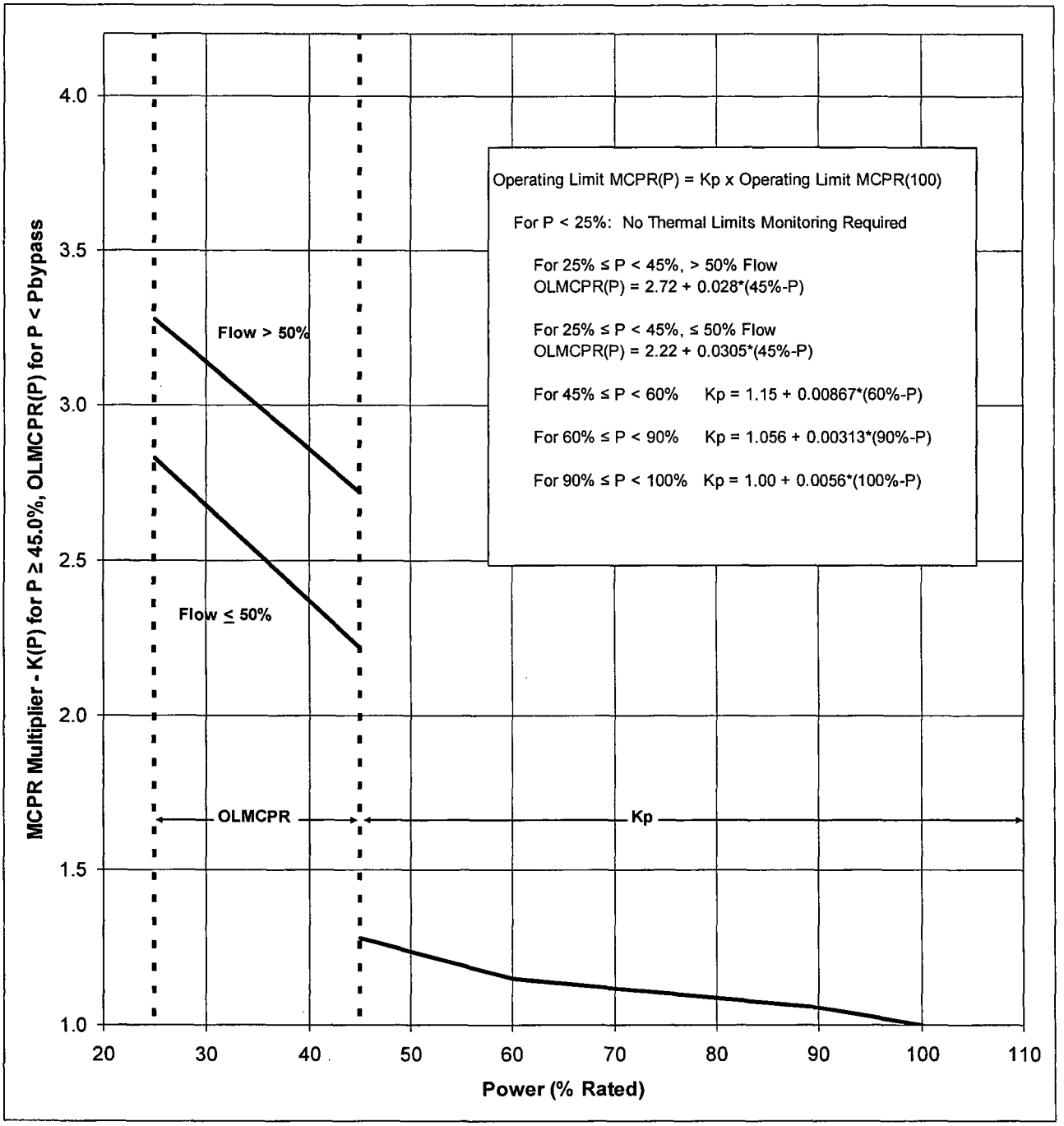
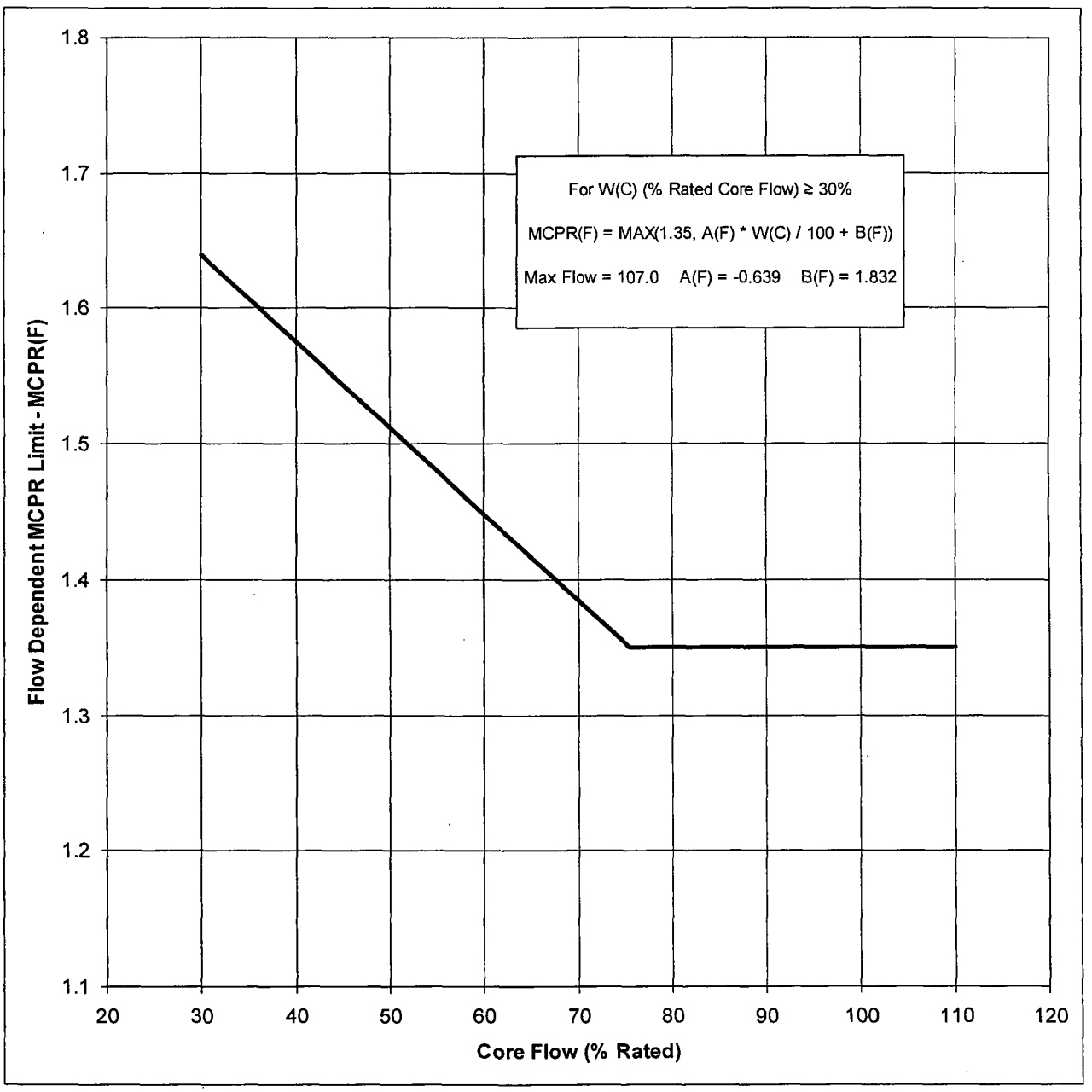


Figure 4
Monticello Cycle 27
Flow Dependent CPR Limits



The MCPRf limits shown above are cut-off at the ECCS-LOCA MCPR = 1.35 as specified in Section 16.3 and Appendix D of Reference 2.

Figure 5
Monticello Cycle 27 Power/Flow Map

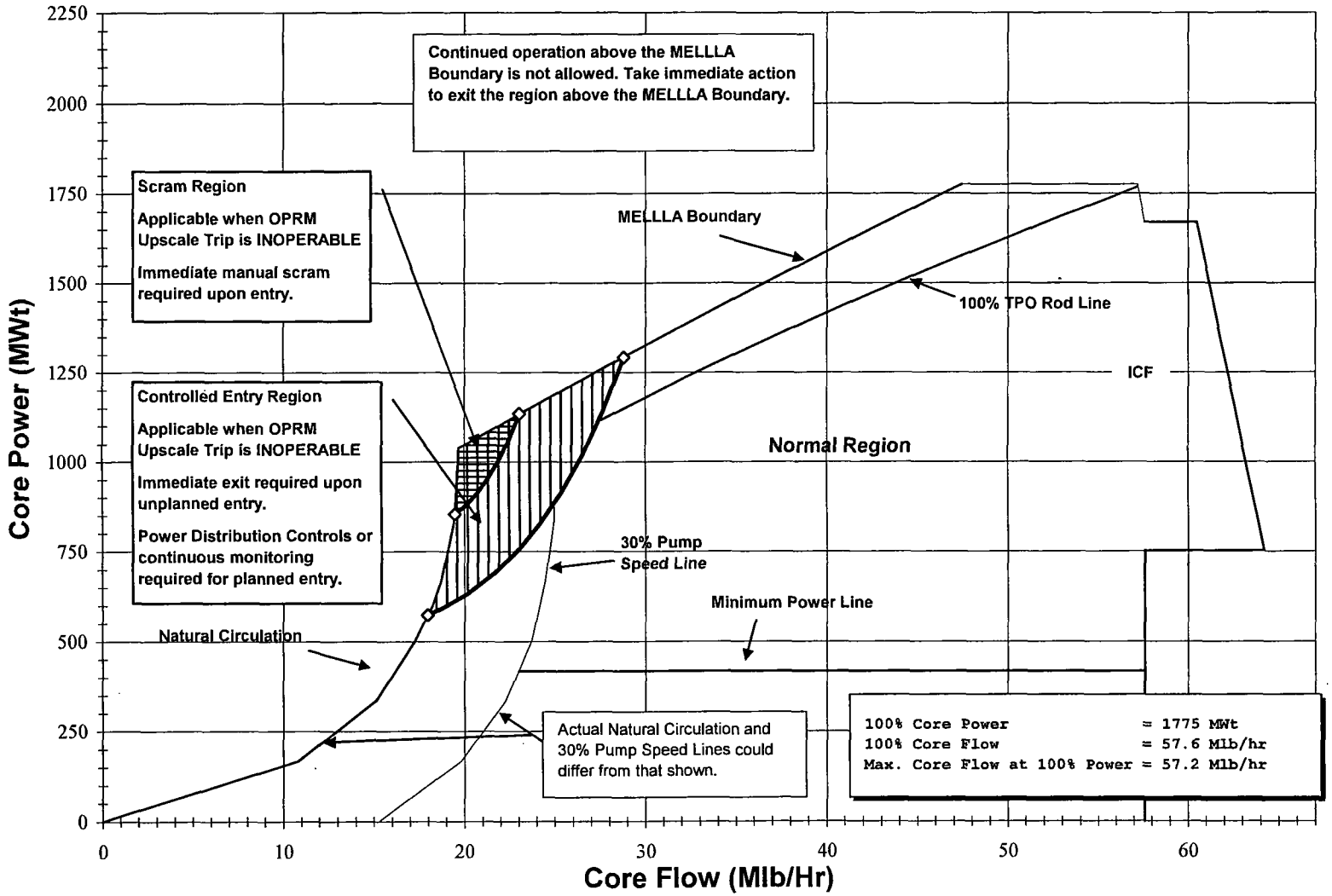


Figure 6
Monticello Cycle 27 Power/Flow Map

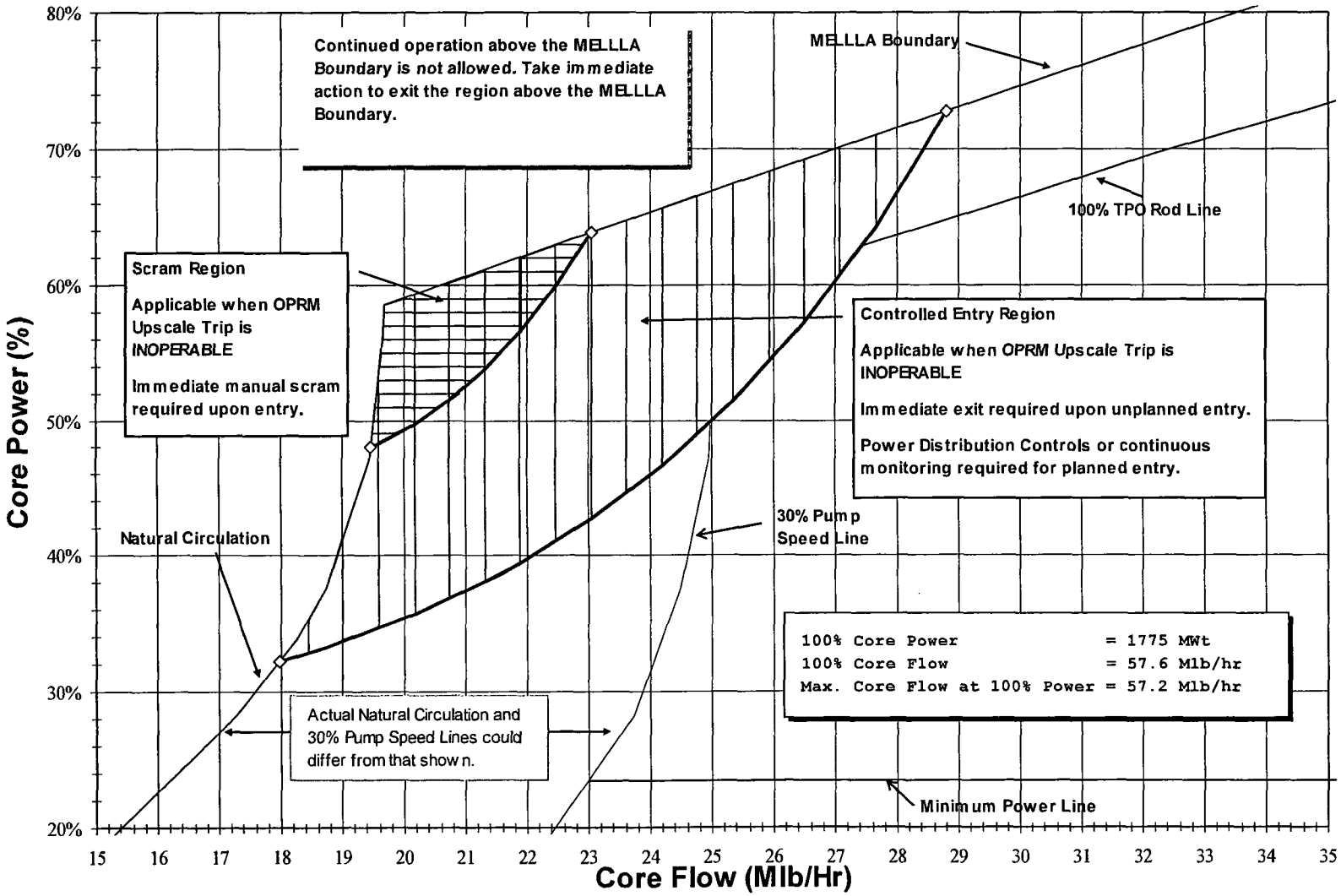


Figure 7
Stability Criterion Map

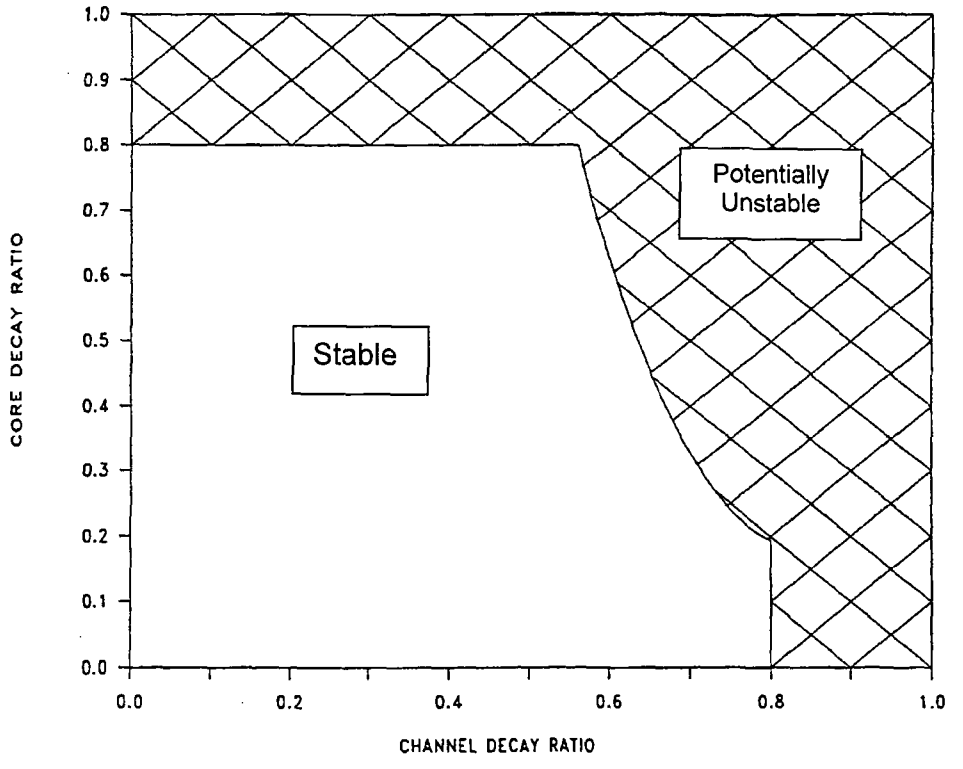


Figure 8
Monticello Cycle 27
Power Dependent K(P) and MCPR(P) Limits for Pressure Regulator Out of Service (PROOS) for CLTP Conditions

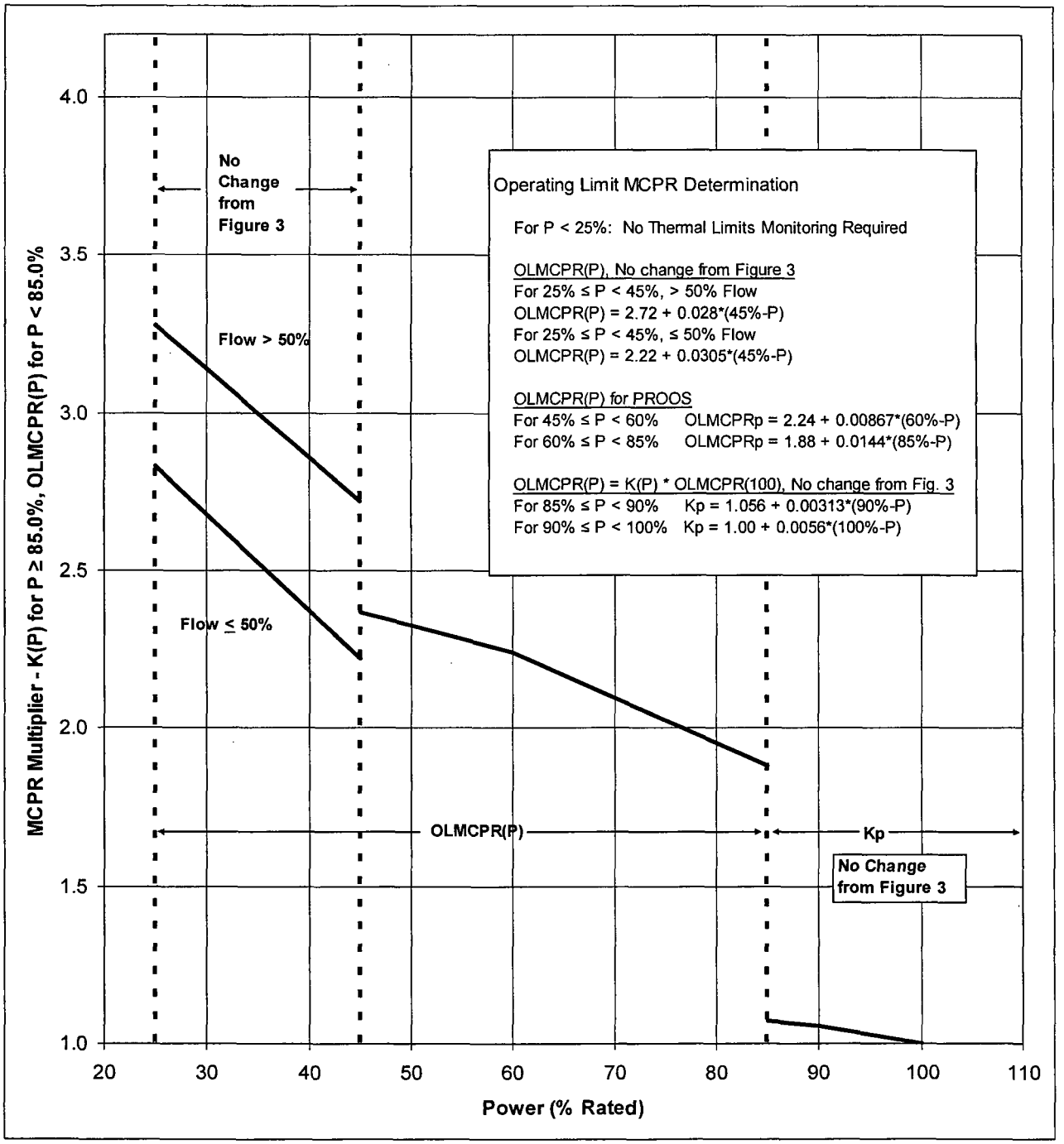
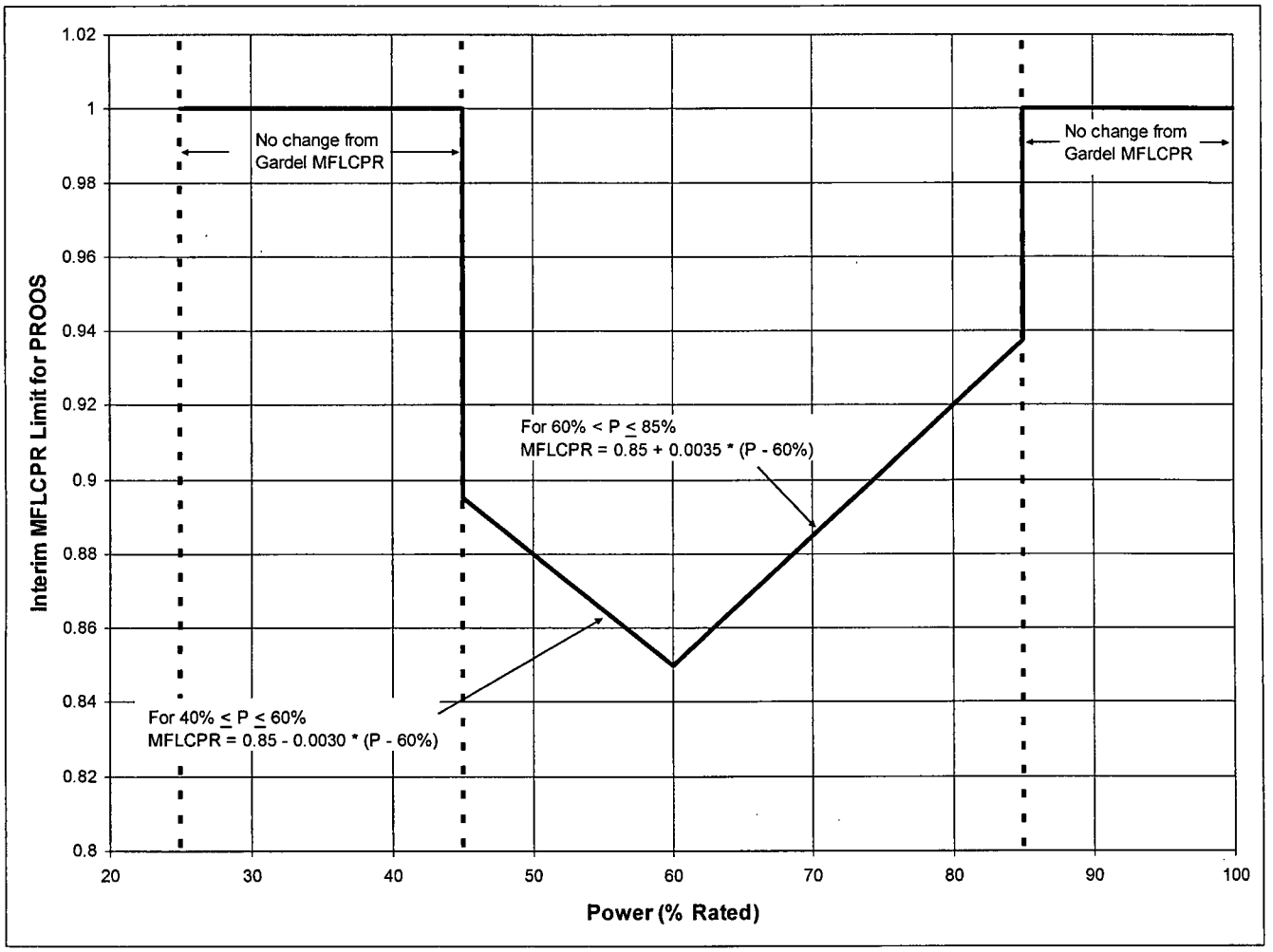


Figure 9
Pressure Regulator Out Of Service
Interim MFLCPR Limit
for CLTP Conditions



The plot is valid for Option A & B scram times.
The limit is not dependent on core flow.