FIRSTENERGY NUCLEAR OPERATING COMPANY

DAVIS-BESSE UNIT 1

CYCLE 13

CORE OPERATING LIMITS REPORT

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FIRSTENERGY NUCLEAR OPERATING COMPANY

DAVIS-BESSE UNIT 1

CYCLE 13

CORE OPERATING LIMITS REPORT

1.0 Core Operating Limits

This CORE OPERATING LIMITS REPORT for DB-1 Cycle 13 has been prepared in accordance with the requirements of Technical Specification 6.9.1.7. The core Operating Limits have been developed using the methodology provided in reference 2.0 (1). The licensed length of Cycle 13 is 683 EFPDs.

The following cycle-specific core Operating Limits, Protective Limit and Flux -Δ Flux/Flow

Reactor Protection System Allowable Values are included in this report:

1) Regulating Group Position Alarm Setpoints (error adjusted Operating Limits) and Xenon reactivity "power level cutoff"

2) Rod program group positions (Control Rod Core locations and group assignments)

3) Axial Power Shaping Rod Alarm Setpoints (error adjusted Operating Limits)

4) AXIAL POWER IMBALANCE Alarm Setpoints (error adjusted Operating Limits)

5) AXIAL POWER IMBALANCE Protective Limits

6) Flux-ΔFlux/Flow (or Power/Imbalance/Flow) Allowable Values

7) QUADRANT POWER TILT limits

8) Negative Moderator Temperature Coefficient limit

9) Nuclear Heat Flux Hot Channel Factor, F_Q and

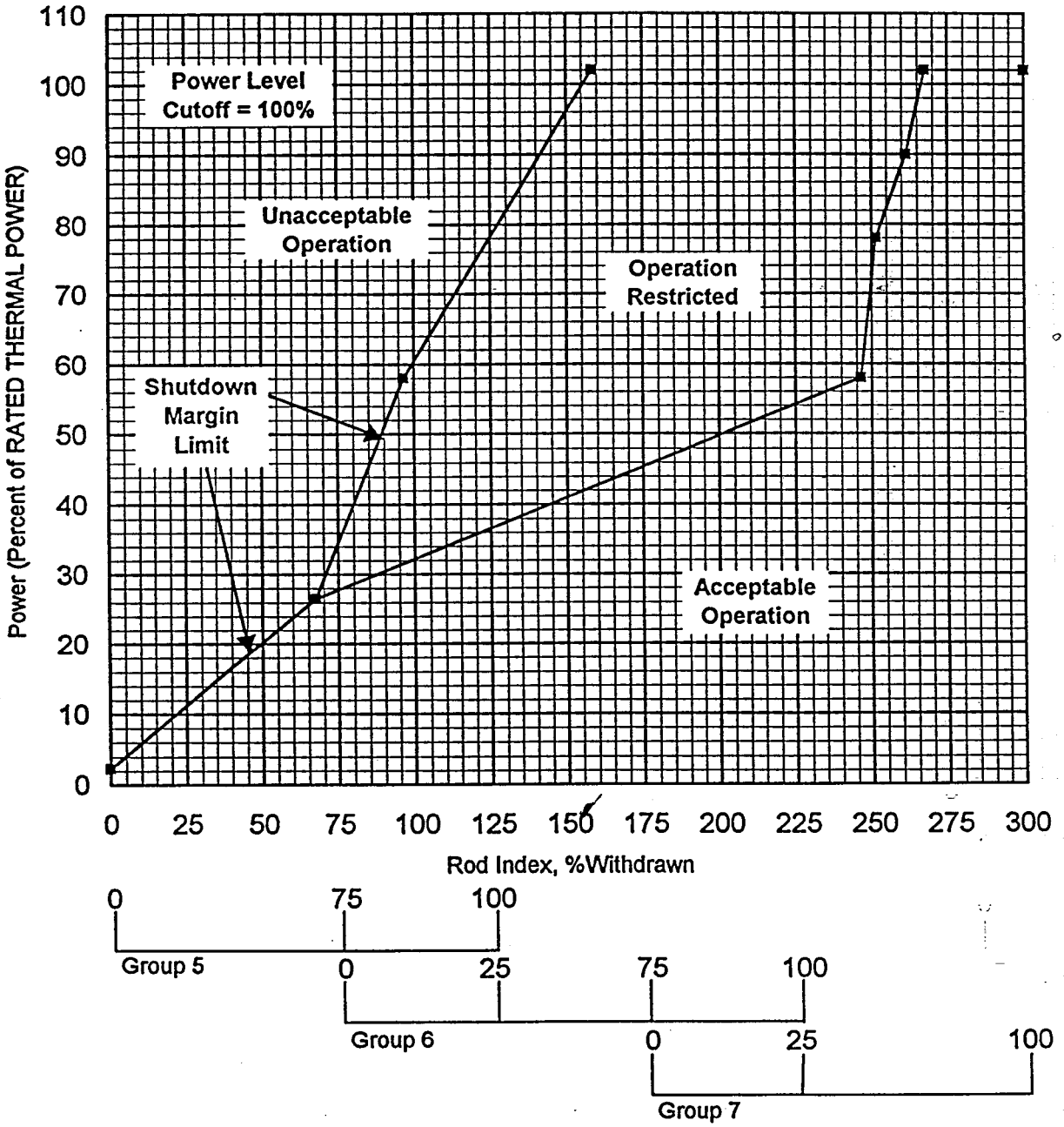
10) Nuclear Enthalpy Rise Hot Channel Factor, $F^N_{\Delta H}$

2.0 References

(1) BAW-10179P-A, Revision 3, "Safety Criteria and Methodology of Acceptable Cycle Reload Analysis.", dated October 1999.
(2) BAW-10227P-A, Revision 0, " Evaluation of Advanced Cladding and Structural Material (M5™) in PWR Reactor Fuel, dated February 2000.

Figure 1a Regulating Group Position Operating Limits
0 to 300 ±10 EFPD, Four RC Pumps --
Davis-Besse 1, Cycle 13

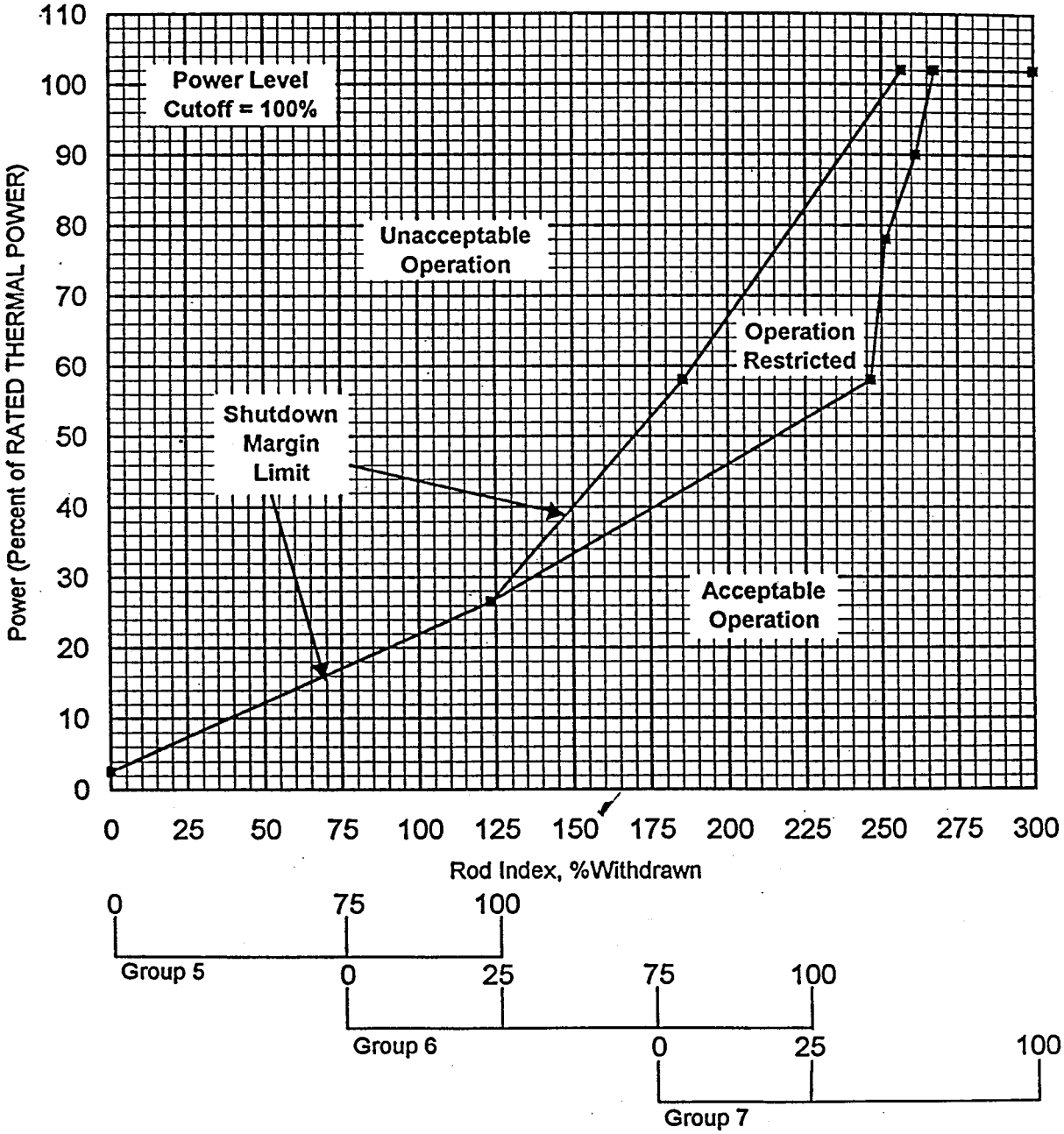
This Figure is referred to by Technical Specifications 3.1.3.6 and 3.1.3.8



Note 1: A Rod Group overlap of 25 ±5% between sequential withdrawn groups 5 and 6, and 6 and 7, shall be maintained.
Note 2: Instrument error is accounted for in these Operating Limits.

Figure 1b Regulating Group Position Operating Limits
After 300 ±10 EFPD, Four RC Pumps --
Davis-Besse 1, Cycle 13

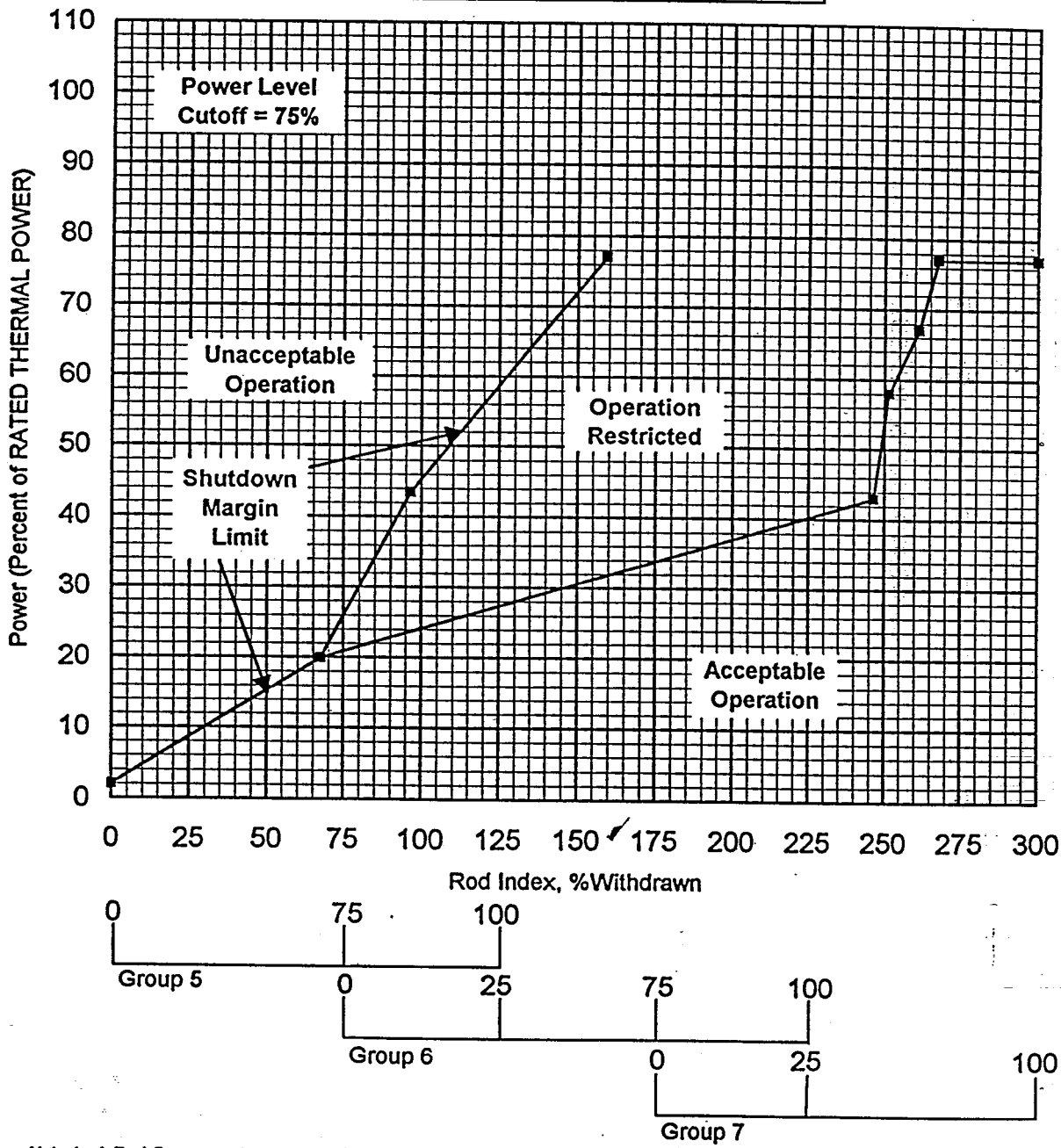
This Figure is referred to by Technical Specifications 3.1.3.6 and 3.1.3.8



Note 1: A Rod Group overlap of 25 ±5% between sequential withdrawn groups 5 and 6, and 6 and 7, shall be maintained.
Note 2: Instrument error is accounted for in these Operating Limits.

Figure 1c Regulating Group Position Operating Limits
0 to 300 ±10 EFPD, Three RC Pumps –
Davis-Besse 1, Cycle 13

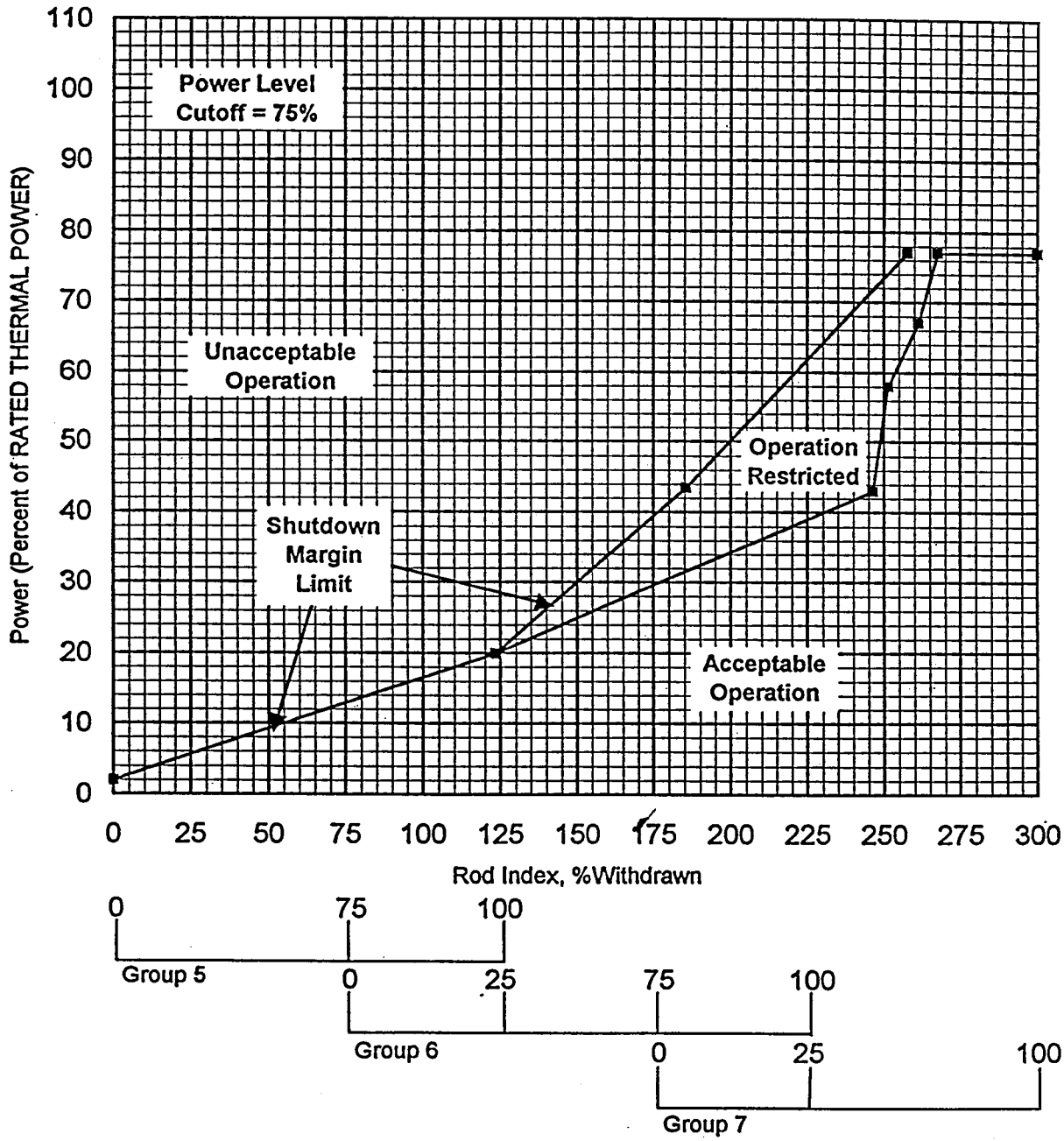
This Figure is referred to by Technical Specifications 3.1.3.6 and 3.1.3.8



Note 1: A Rod Group overlap of 25 ±5% between sequential withdrawn groups 5 and 6, and 6 and 7, shall be maintained.
Note 2: Instrument error is accounted for in these Operating Limits.

Figure 1d Regulating Group Position Operating Limits
After 300 ±10 EFPD, Three RC Pumps --
Davis-Besse 1, Cycle 13

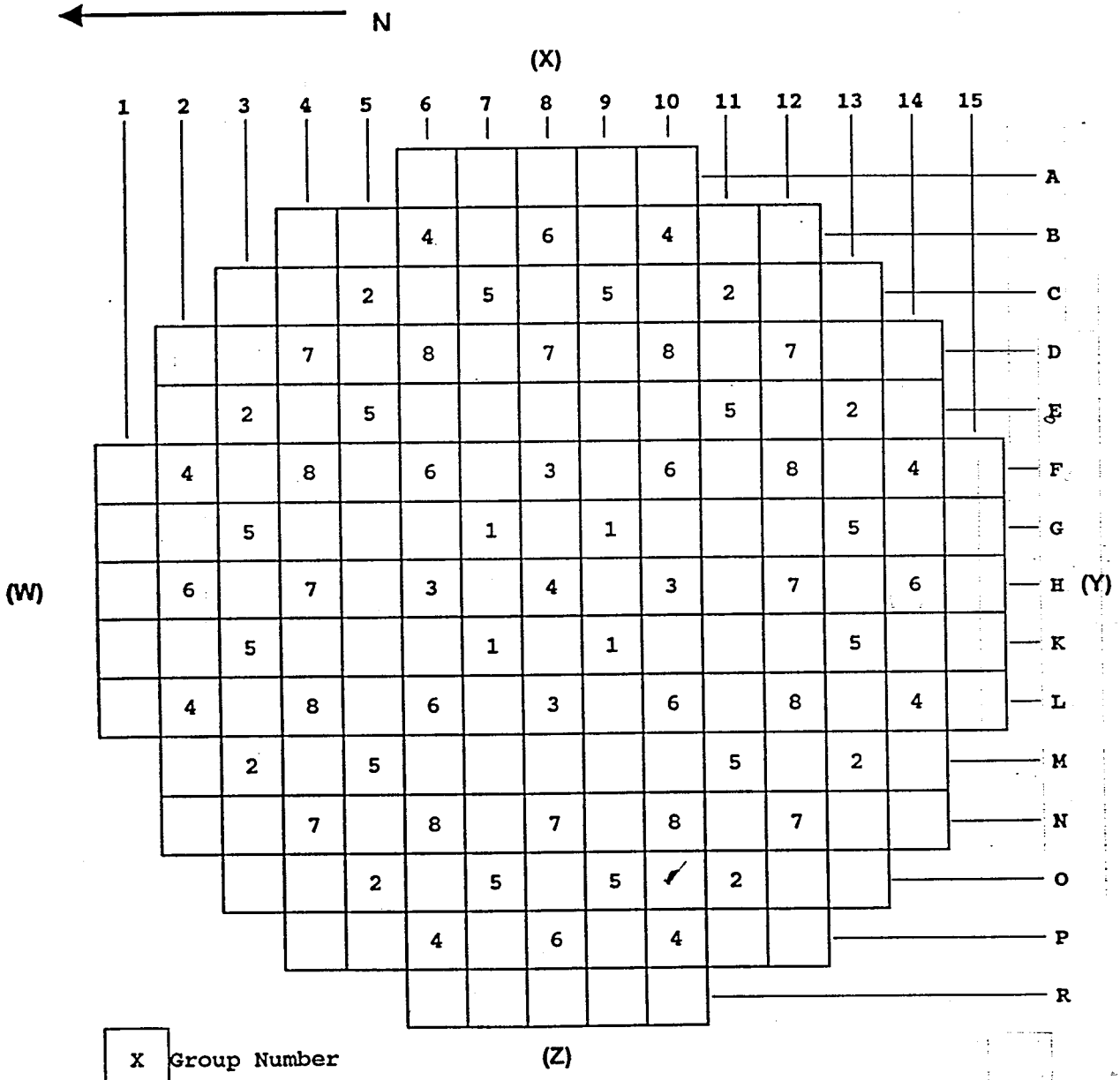
This Figure is referred to by Technical Specifications 3.1.3.6 and 3.1.3.8



Note 1: A Rod Group overlap of 25 ±5% between sequential withdrawn groups 5 and 6, and 6 and 7, shall be maintained.
Note 2: Instrument error is accounted for in these Operating Limits.

Figure 2 Control Rod Core Locations
and Group Assignments
Davis-Besse 1, Cycle 13

This Figure is referred to by
Technical Specification 3.1.3.7



Group	No. of Rods	Function	Group	No. of Rods	Function
1	4	Safety	5	12	Control
2	8	Safety	6	8	Control
3	4	Safety	7	8	Control
4	9	Safety	8	8	APSRs
			Total	61	

Figure 3 APSR Position Operating Limits

This Figure is referred to by Technical Specification 3.1.3.9

Before APSR Pull: 0 EFPD to 626 ±10 EFPD,
Three or Four RC pumps operation*

Lower Limit: 0 %WD

Upper Limit: 100 %WD

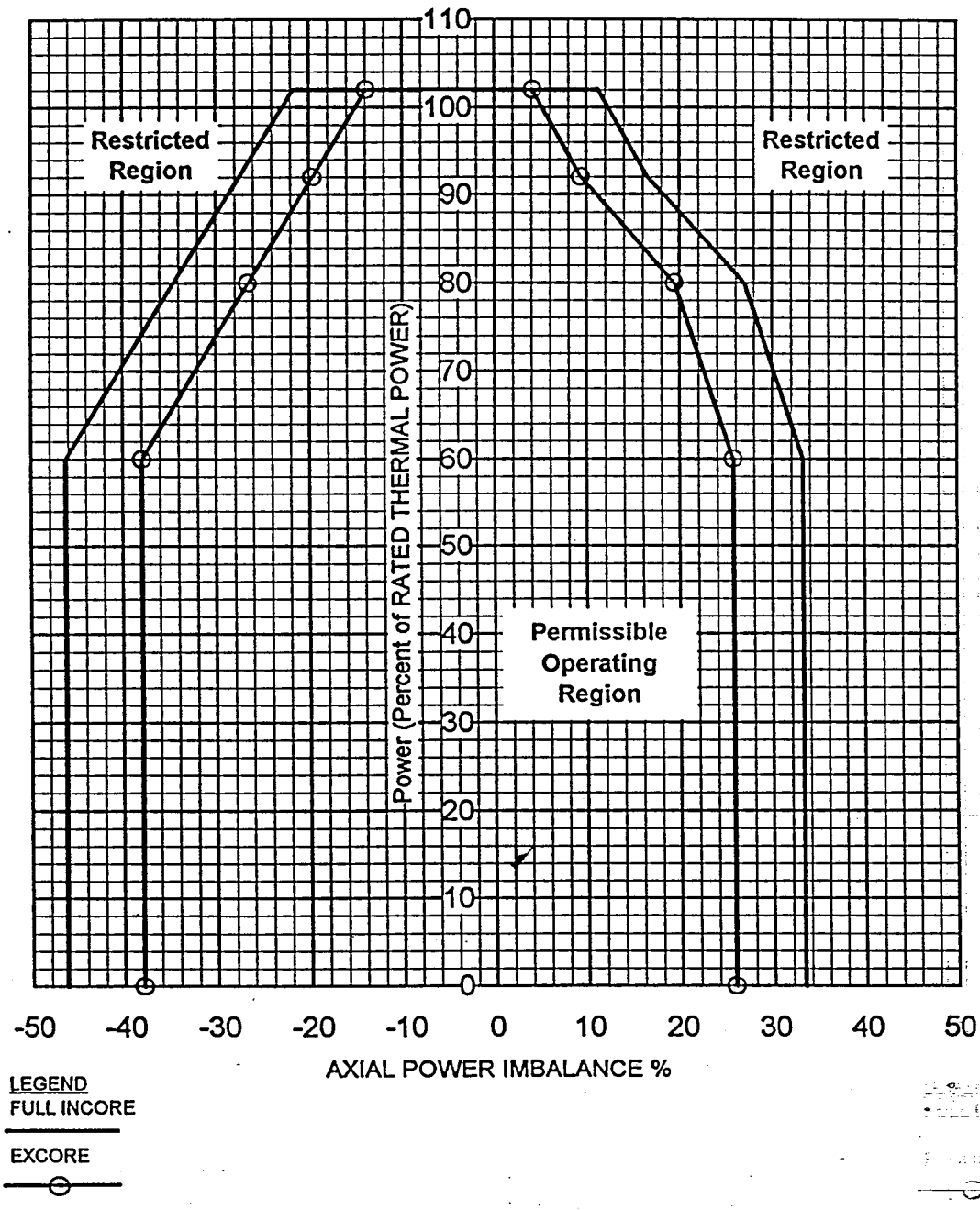
After APSR Pull: 626 ±10 EFPD to End-of-Cycle
Three or Four RC pumps operation*

Insertion Prohibited (maintain ≥99 %WD)

* Power restricted to 77% for 3 pump operation

Figure 4a AXIAL POWER IMBALANCE Operating Limits
0 to 300 ±10 EFPD, Four RC Pumps --
Davis-Besse 1, Cycle 13

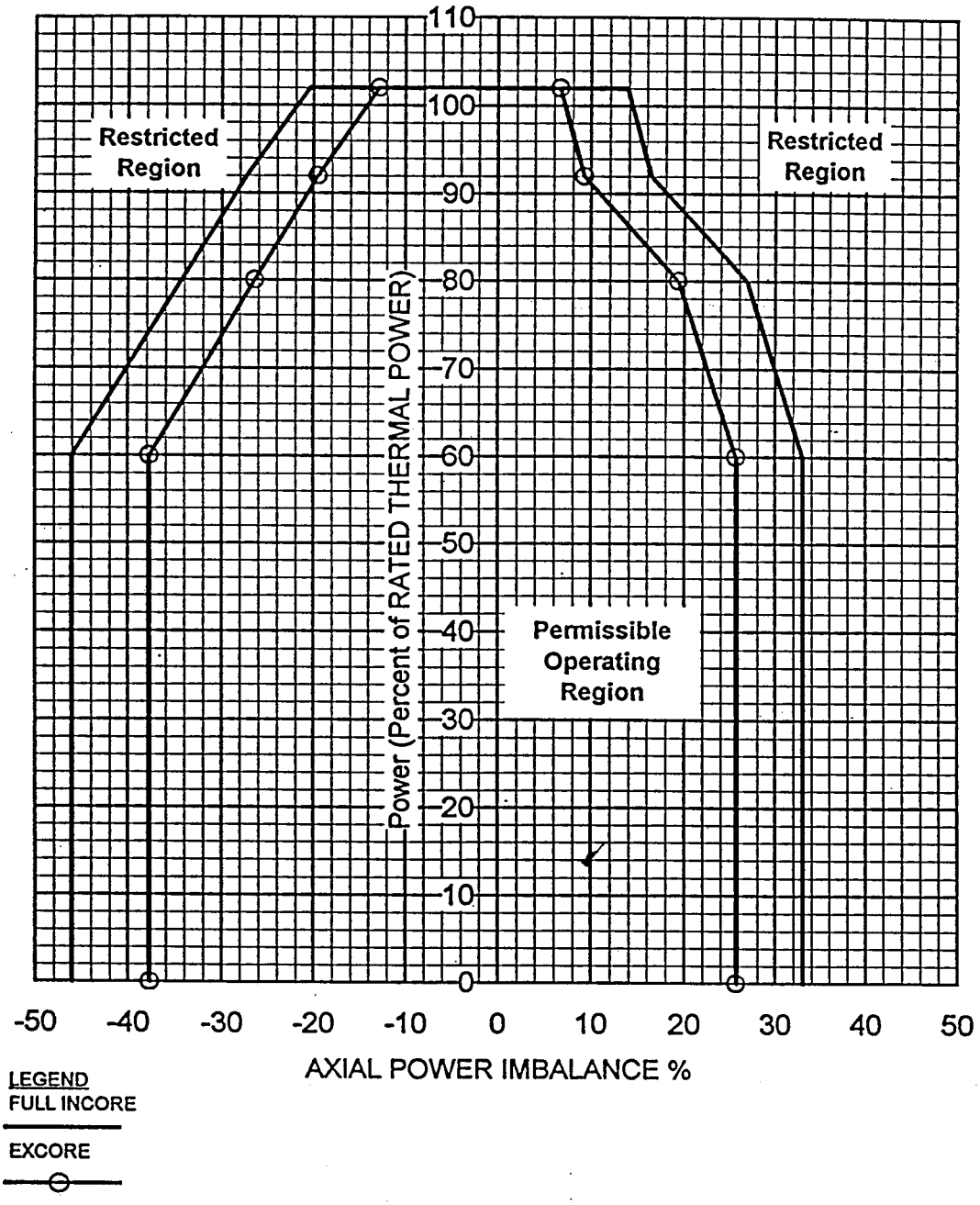
This Figure is referred to by
Technical Specification 3.2.1



Note 1: Instrument error is accounted for in these Operating Limits.

Figure 4b AXIAL POWER IMBALANCE Operating Limits
300 ±10 to 626 ±10 EFPD, Four RC Pumps --
Davis-Besse 1, Cycle 13

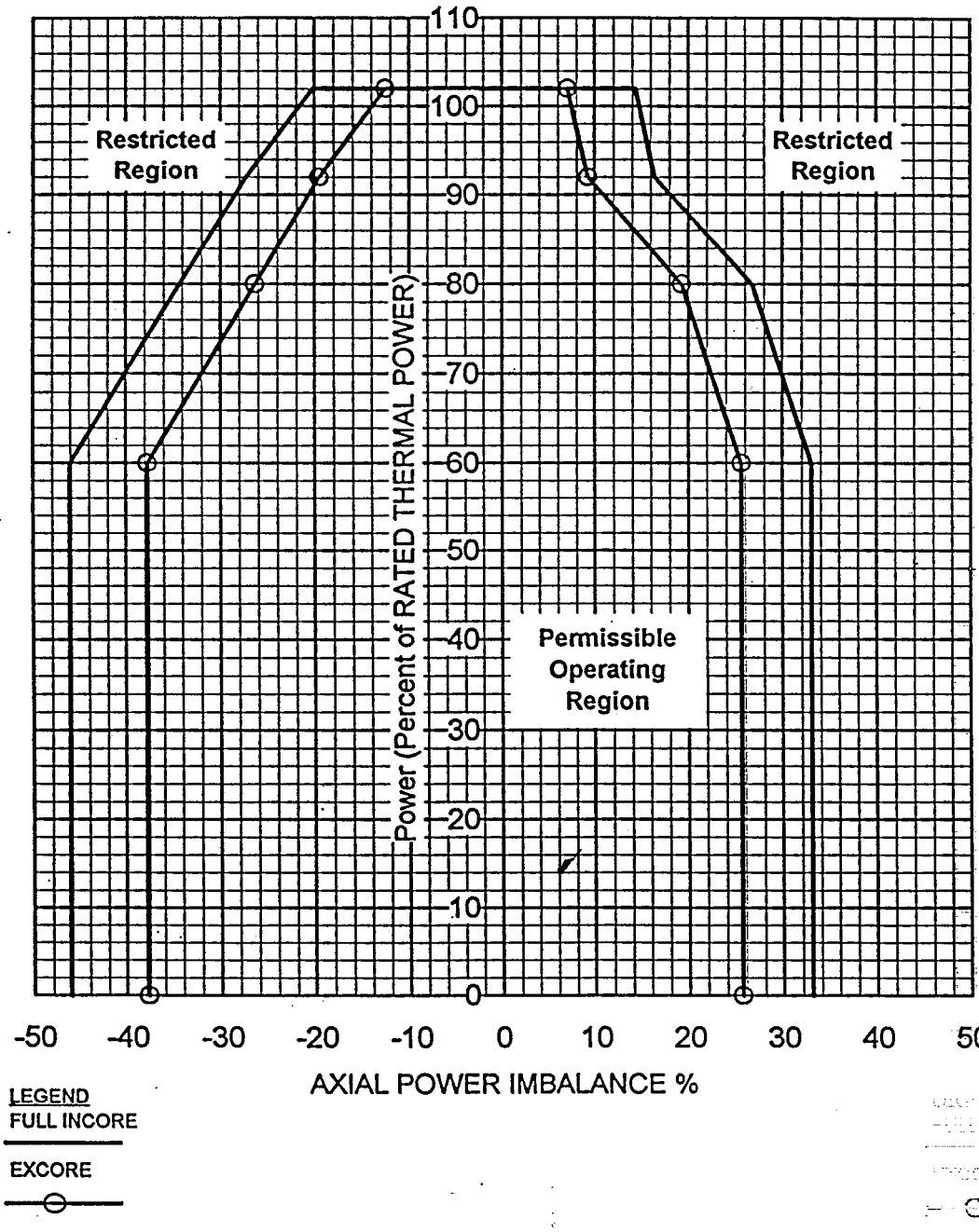
This Figure is referred to by
Technical Specification 3.2.1



Note 1: Instrument error is accounted for in these Operating Limits.

Figure 4c AXIAL POWER IMBALANCE Operating Limits
After 626 ±10 EFPD, Four RC Pumps –
Davis-Besse 1, Cycle 13

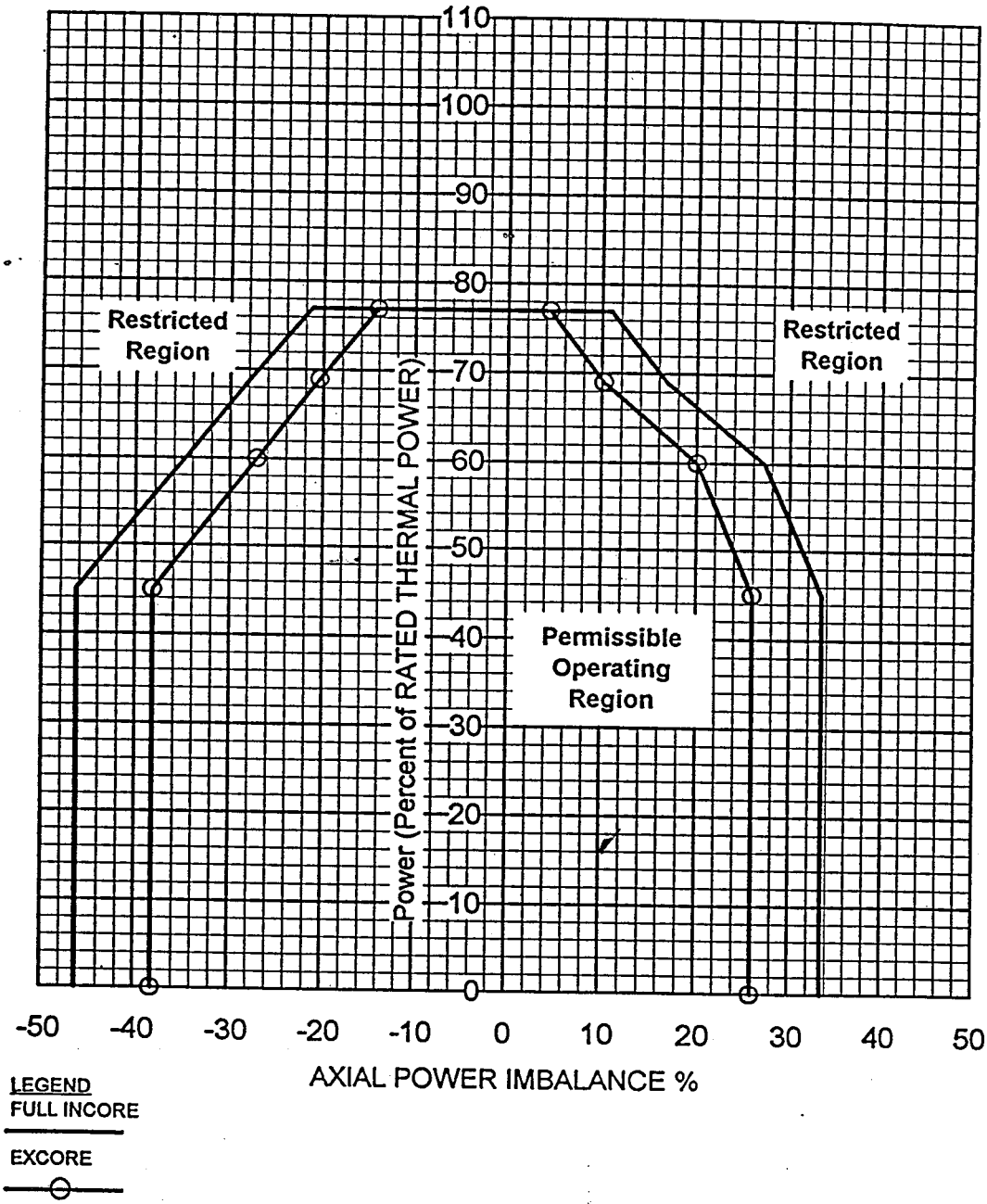
This Figure is referred to by
Technical Specification 3.2.1



Note 1: Instrument error is accounted for in these Operating Limits.

Figure 4d AXIAL POWER IMBALANCE Operating Limits
0 to 300 ±10 EFPD, Three RC Pumps --
Davis-Besse 1, Cycle 13

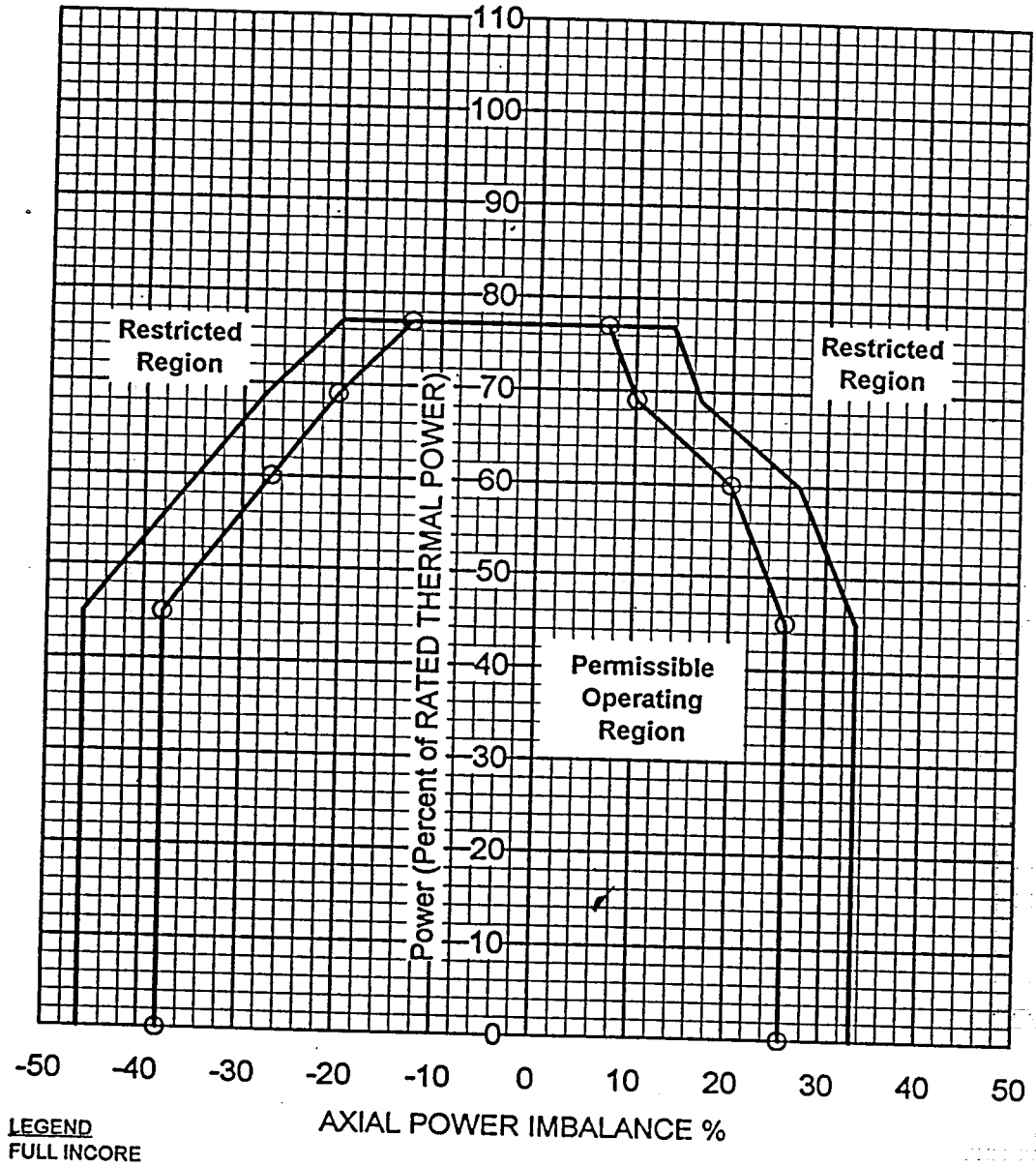
This Figure is referred to by
Technical Specification 3.2.1



Note 1: Instrument error is accounted for in these Operating Limits.

Figure 4e AXIAL POWER IMBALANCE Operating Limits
300 ±10 to 626 ±10 EFPD, Three RC Pumps –
Davis-Besse 1, Cycle 13

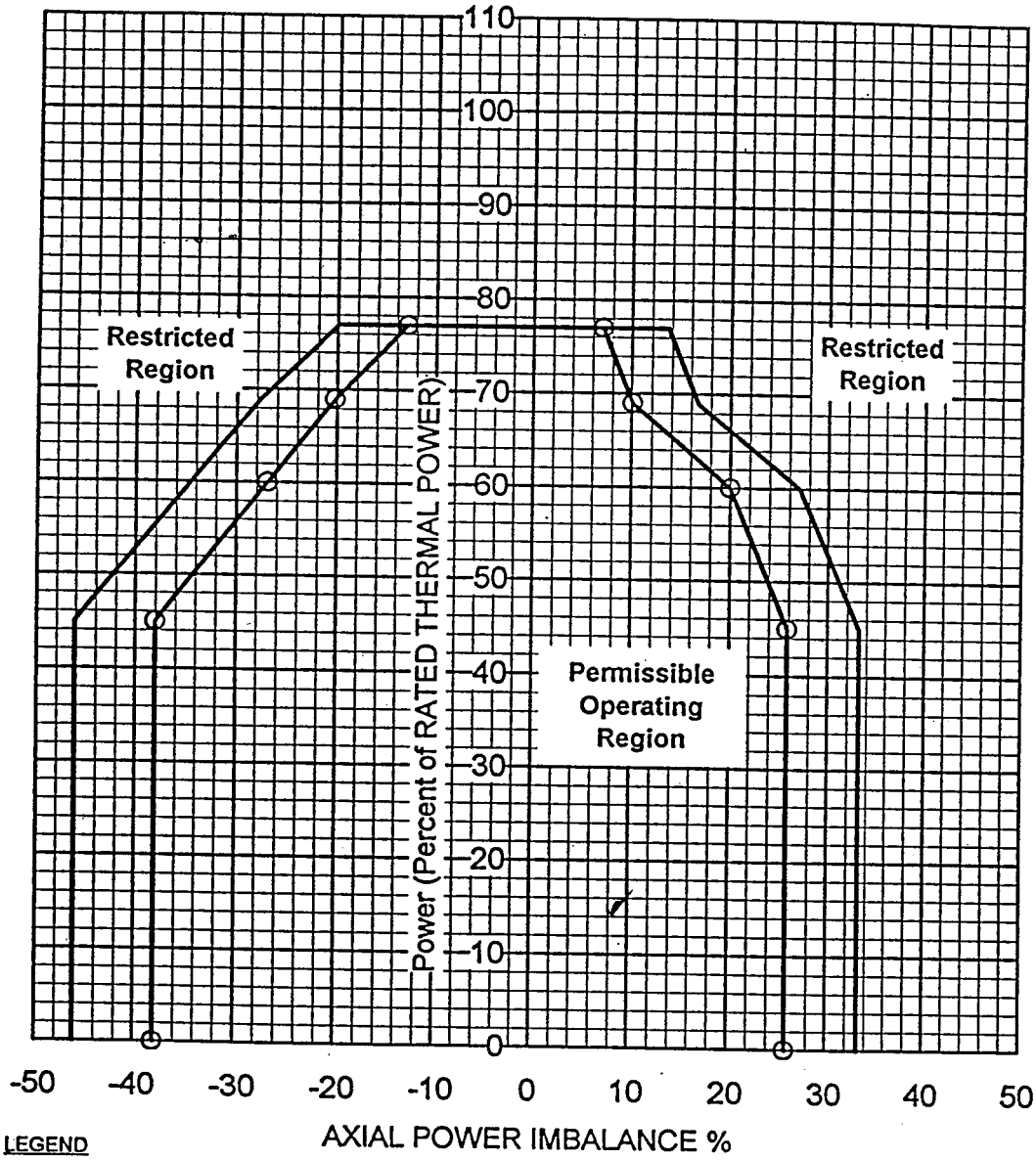
This Figure is referred to by
Technical Specification 3.2.1



Note 1: Instrument error is accounted for in these Operating Limits.

Figure 4f AXIAL POWER IMBALANCE Operating Limits
After 626 ±10 EFPD, Three RC Pumps --
Davis-Besse 1, Cycle 13

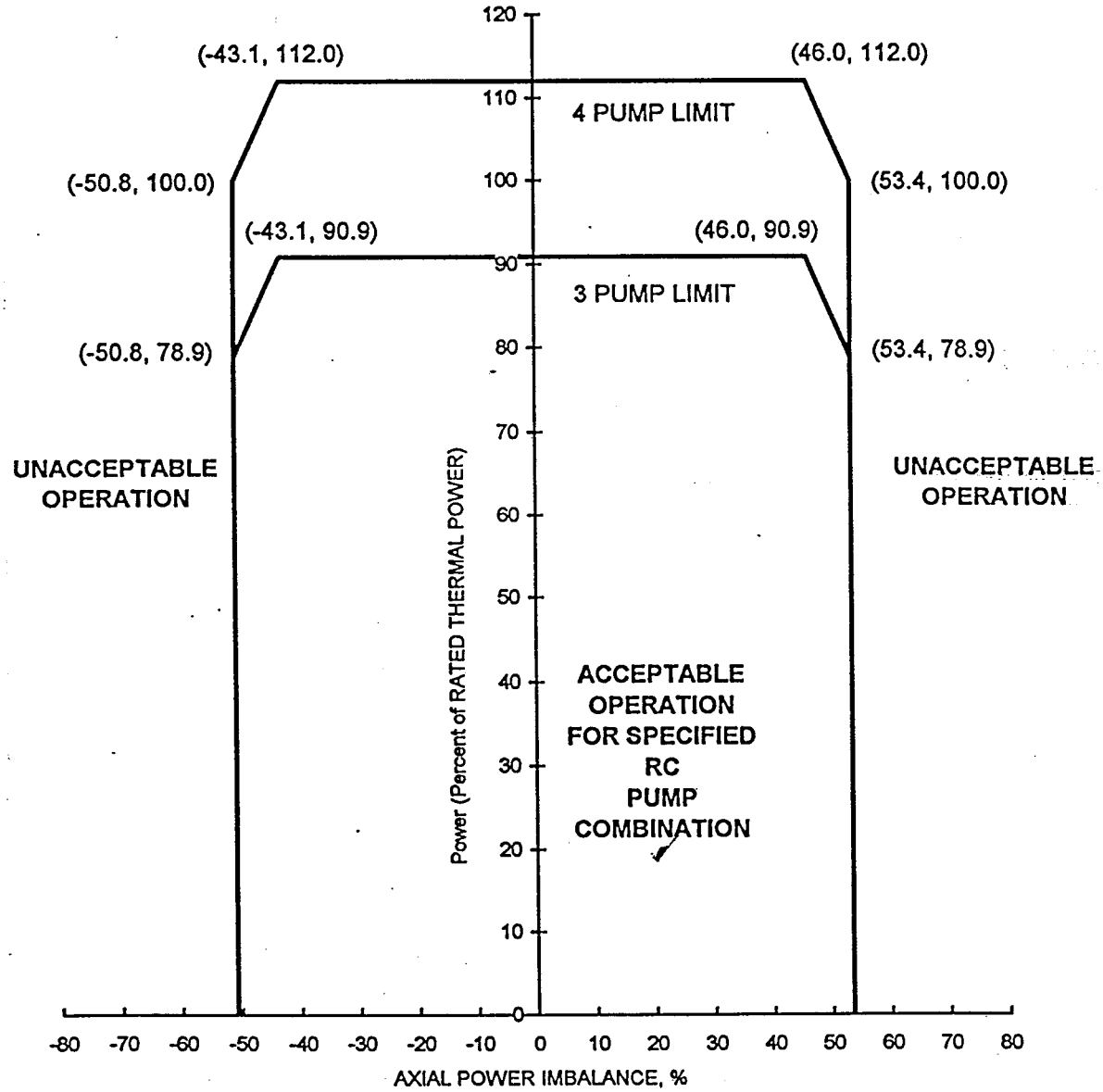
This Figure is referred to by
Technical Specification 3.2.1



Note 1: Instrument error is accounted for in these Operating Limits.

Figure 5 AXIAL POWER IMBALANCE Protective Limits

This Figure is referred to by
Technical Specification 2.1.2



Pumps Operating	Reactor Coolant Flow, gpm	Required Measured Flow to Ensure Compliance, gpm
4	380,000	389,500
3	283,860	290,957

Figure 6 Flux--ΔFlux/Flow
(or Power/Imbalance/Flow)
Allowable Values

This Figure is referred to by
Technical Specification 2.2.1

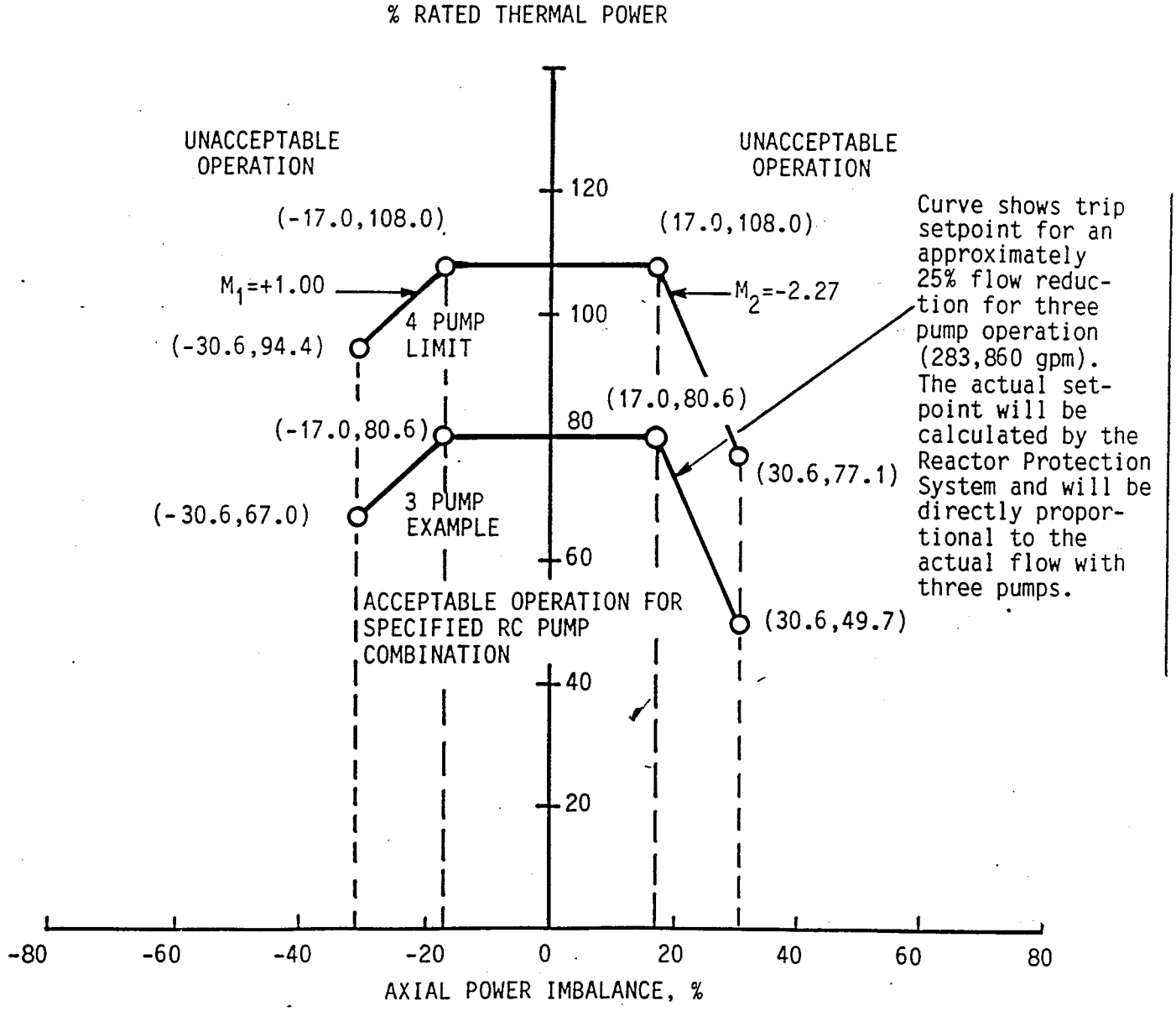


Table 1 QUADRANT POWER TILT Limits

This Table is referred to by Technical Specification 3.2.4

QUADRANT POWER TILT as measured by:	From 0 EFPD to EOC-13			
	Steady-state Limit for THERMAL POWER ≤ 60% (%)	Steady-state Limit for THERMAL POWER > 60% (%)	Transient Limit (%)	Maximum Limit (%)
Symmetrical Incore detector system	7.90	4.00	10.03	20.0

Table 2 Negative Moderator Temperature Coefficient Limit

This Table is referred to by Technical Specification 3.1.1.3c

Negative Moderator Temperature Coefficient Limit (at RATED THERMAL POWER)	-4.00×10^{-4} $\Delta k/k/°F$

Table 3 Power to Melt Limits

This Table is referred to by Technical Specification Bases B2.1

	Batch 9G	Batch 10A2	Batch 13	Batch 14	Batch 15
Fuel Assembly Type	Mark-B8A	Mark-B8A	Mark-B10A	Mark-B10M	Mark-B10K
Minimum linear heat rate to melt, kW/ft	20.5	20.5	22.3	22.3 (20.8) (a) (20.8) (b)	22.1 (21.1) (c) (20.7) (d) (20.3) (e)

(a) Limit for 3 wt% Gd rods - Batch 14
(b) Limit for 6 wt% Gd rods - Batch 14
(c) Limit for 2 wt% Gd rods - Batch 15
(d) Limit for 3 wt% Gd rods - Batch 15
(e) Limit for 8 wt% Gd rods - Batch 15

Table 4a Nuclear Heat Flux Hot Channel Factor - F_Q (NAS)

This Table is referred to by Technical Specification 3.2.2

Nuclear Heat Flux Hot Channel Factor - F_Q

F_Q shall be limited by the following relationships:

$F_Q \leq LHR^{ALLOW}(Bu)/[LHR^{AVG} * P]$ (for $P \leq 1.0$)

$LHR^{ALLOW}(Bu)$: See Tables below
LHR^{AVG} = 6.139 kW/ft for Mark-B8A fuel
LHR^{AVG} = 6.426 kW/ft for Mark-B10A fuel
LHR^{AVG} = 6.420 kW/ft for Mark-B10M fuel
LHR^{AVG} = 6.318 kW/ft for Mark-B10K fuel
P = ratio of THERMAL POWER/RATED THERMAL POWER
Bu = Fuel Burnup (MWd/mtU)

Batch 9G (Mark-B8A) LHR^{ALLOW} kW/ft(a)

Axial Segment	0 MWd/mtU	24,500 MWd/mtU	52,000 MWd/mtU	60,000 MWd/mtU
1	15.6	15.6	11.8	10.3
2	15.3	15.3	11.8	10.3
3	14.5	14.5	11.8	10.3
4	14.5	14.5	11.8	10.3
5	14.9	14.9	11.8	10.3
6	14.9	14.9	11.8	10.3
7	14.2	14.2	11.4	9.9
8	13.9	13.9	11.2	9.7

Batch 10A2 (Mark-B8A) LHR^{ALLOW} kW/ft(a)

Axial Segment	0 MWd/mtU	24,500 MWd/mtU	52,000 MWd/mtU
1	15.6	15.6	11.8
2	15.3	15.3	11.8
3	14.5	14.5	11.8
4	14.5	14.5	11.8
5	14.9	14.9	11.8
6	14.9	14.9	11.8
7	14.2	14.2	11.4
8	13.9	13.9	11.2

TABLE 4a continued

Batch 13 (Mark-B10A) LHR^{ALLOW} kW/ft(a)

Axial Segment	0 MWd/mtU	35,000 MWd/mtU	62,000 MWd/mtU
1	17.6	16.8	12.8
2	17.5	16.7	12.8
3	17.0	15.6	12.8
4	16.6	15.3	12.8
5	16.0	15.3	12.8
6	15.3	15.3	12.8
7	14.7	14.7	12.8
8	14.5	14.5	12.8

Batch 14 (Mark-B10M) LHR^{ALLOW} kW/ft(a)

Axial Segment	0 MWd/mtU	35,000 MWd/mtU	62,000 MWd/mtU
1	17.6	16.8	12.8
2	17.5	16.7	12.8
3	17.0	15.6	12.8
4	16.6	15.3	12.8
5	16.0	15.3	12.8
6	15.3	15.3	12.8
7	14.7	14.7	12.8
8	14.5	14.5	12.8

Batch 15 (Mark-B10K) LHR^{ALLOW} kW/ft(a)

Axial Segment	0 MWd/mtU	35,000 MWd/mtU
1	17.6	16.8
2	17.5	16.7
3	17.0	15.6
4	16.6	15.3
5	16.0	15.3
6	15.3	15.3
7	14.7	14.7
8	14.5	14.5

(a) Linear interpolation for allowable linear heat rate between specified burnup points is valid for these tables.

Table 4b Nuclear Heat Flux Hot Channel Factor - F_Q (FIDMS)

This Table is referred to by Technical Specification 3.2.2

Nuclear Heat Flux Hot Channel Factor - F_Q

F_Q shall be limited by the following relationships:

$F_Q \leq LHR^{ALLOW}(Bu)/[LHR^{AVG} * P]$ (for $P \leq 1.0$)

$LHR^{ALLOW}(Bu)$: See Tables below
LHR^{AVG} = 6.377 kW/ft
P = ratio of THERMAL POWER/RATED THERMAL POWER
Bu = Fuel Burnup (MWd/mtU)

Batch 9G (Mark-B8A) LHR^{ALLOW} kW/ft(a)

Core Elevation ft.	0 MWd/mtU	24,500 MWd/mtU	52,000 MWd/mtU	60,000 MWd/mtU
0.000	16.2	16.2	12.1	10.6
2.506	15.8	15.8	12.1	10.6
4.264	15.0	15.0	12.1	10.6
6.021	15.4	15.4	12.1	10.6
7.779	15.9	15.9	12.1	10.6
9.536	15.3	15.3	12.1	10.6
12.000	14.3	14.3	11.5	10.0

Batch 10A2 (Mark-B8A) LHR^{ALLOW} kW/ft(a)

Core Elevation ft.	0 MWd/mtU	24,500 MWd/mtU	52,000 MWd/mtU
0.000	16.2	16.2	12.1
2.506	15.8	15.8	12.1
4.264	15.0	15.0	12.1
6.021	15.4	15.4	12.1
7.779	15.9	15.9	12.1
9.536	15.3	15.3	12.1
12.000	14.3	14.3	11.5

TABLE 4b continued

Batch 13 (Mark-B10A) LHR^{ALLOW} kW/ft(a)

Core Elevation ft.	0 MWd/mtU	35,000 MWd/mtU	62,000 MWd/mtU
0.000	17.6	16.8	12.8
2.506	17.6	16.8	12.8
4.264	17.1	15.7	12.8
6.021	16.6	15.3	12.8
7.779	16.0	15.8	12.8
9.536	15.3	15.3	12.8
12.000	14.5	14.5	12.8

Batch 14 (Mark-B10M) LHR^{ALLOW} kW/ft(a)

Core Elevation ft.	0 MWd/mtU	35,000 MWd/mtU	62,000 MWd/mtU
0.000	17.6	16.8	12.8
2.506	17.6	16.8	12.8
4.264	17.1	15.7	12.8
6.021	16.6	15.3	12.8
7.779	16.0	15.8	12.8
9.536	15.3	15.3	12.8
12.000	14.5	14.5	12.8

Batch 15 (Mark-B10K) LHR^{ALLOW} kW/ft(a)

Core Elevation ft.	0 MWd/mtU	35,000 MWd/mtU
0.000	17.6	16.8
2.506	17.6	16.8
4.264	17.1	15.7
6.021	16.6	15.3
7.779	16.0	15.8
9.536	15.3	15.3
12.000	14.5	14.5

(a) Linear interpolation for allowable linear heat rate between specified burnup points is valid for these tables.

Table 5 Nuclear Enthalpy Rise Hot Channel Factor - $F^N_{\Delta H}$

This Table is referred to by Technical Specification 3.2.3

Enthalpy Rise Hot Channel Factor $F^N_{\Delta H}$

$F^N_{\Delta H} \leq ARP\ [1 + 0.3(1 - P/P_m)]$

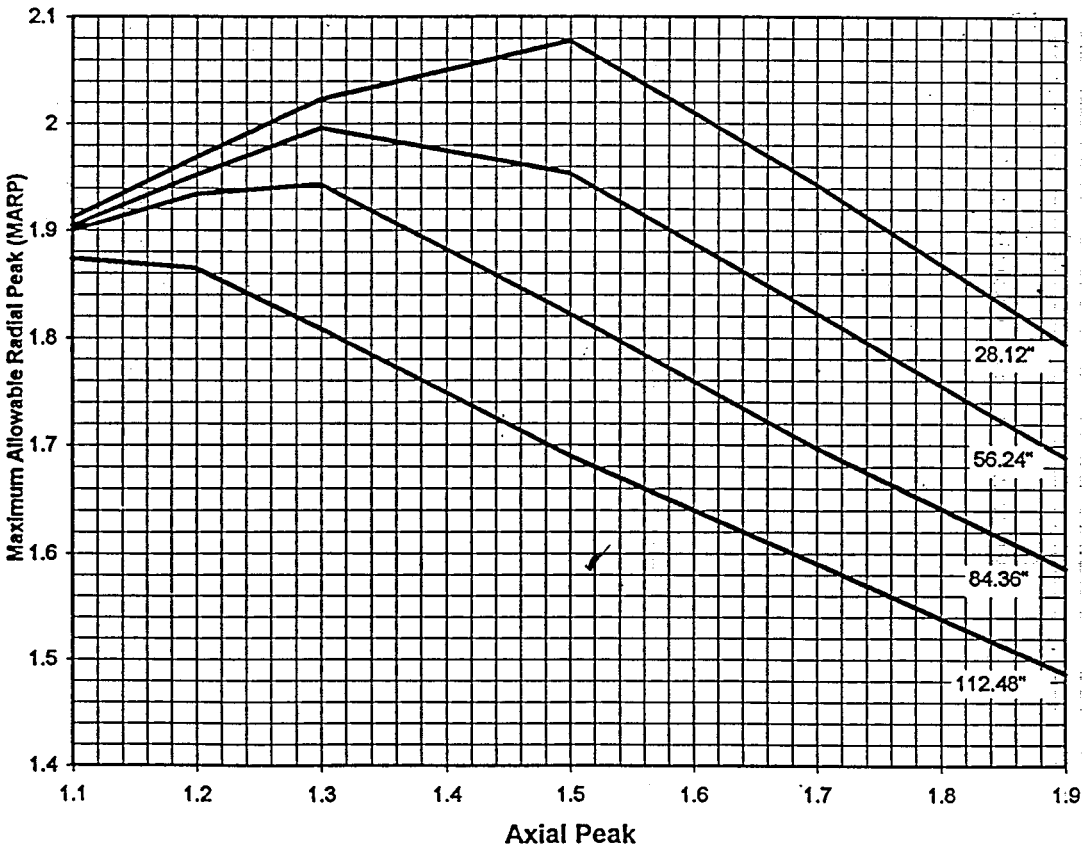
ARP = Allowable Radial Peak, see Figure

P = THERMAL POWER/RATED THERMAL POWER and $P \leq 1.0$

$P_m = 1.0$ for 4-RCP operation

$P_m = 0.75$ for 3-RCP operation

Figure 7 * Allowable Radial Peak for $F^N_{\Delta H}$



* This figure is applicable to all fuel in the core. Linear interpolation and extrapolation above 112.48 inches are acceptable. For axial heights <28.12 inches, the value at 28.12 inches will be used.