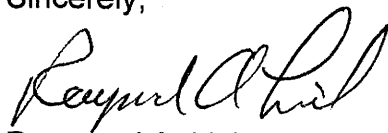


Raymond A. Lieb  
Vice President, Nuclear419-321-7676  
Fax: 419-321-7582April 18, 2014  
L-14-107ATTN: Document Control Desk  
U.S. Nuclear Regulatory Commission  
Washington, DC 20555-0001SUBJECT:  
Davis-Besse Nuclear Power Station  
Docket No. 50-346, License No. NPF-3  
Core Operating Limits Report, Cycle 19

Pursuant to the requirements of Davis-Besse Nuclear Power Station (DBNPS) Technical Specification 5.6.3, "CORE OPERATING LIMITS REPORT (COLR)," FirstEnergy Nuclear Operating Company hereby submits the DBNPS Cycle 19 COLR, Revision 0.

There are no regulatory commitments contained in this submittal. If there are any questions or if additional information is required, please contact Mr. Thomas A. Lentz, Manager - Fleet Licensing, at (330) 315-6810.

Sincerely,



Raymond A. Lieb

Enclosure:  
FirstEnergy Nuclear Operating Company, Davis-Besse Unit 1, Cycle 19,  
Core Operating Limits Report, Revision 0cc: NRC Region III Administrator  
NRC Resident Inspector  
NRC Project Manager  
Utility Radiological Safety Board

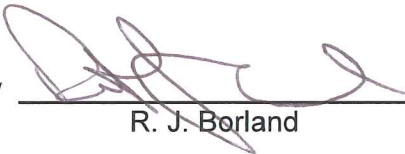
Enclosure  
L-14-107

FirstEnergy Nuclear Operating Company, Davis-Besse Unit 1, Cycle 19,  
Core Operating Limits Report, Revision 0  
(Twenty-Three Pages Follow)

FIRSTENERGY NUCLEAR OPERATING COMPANY  
DAVIS-BESSE UNIT 1  
CYCLE 19  
CORE OPERATING LIMITS REPORT

Prepared by  3/20/14  
D. B. Kelley

Reviewed by  3/28/2014  
P. R. Gilles

Approved by  3/31/2014  
R. J. Borland

LIST OF EFFECTIVE PAGES

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## 1.0 Core Operating Limits

This CORE OPERATING LIMITS REPORT for DB-1 Cycle 19 has been prepared in accordance with the requirements of Technical Specification 5.6.3. The Core Operating Limits have been developed using the methodology provided in Reference 2.0 (1). The licensed length of Cycle 19 is 700 EFPDs.

The following cycle-specific core Operating Limits, Protective Limit and Flux - $\Delta$  Flux -Flow Reactor Protection System Allowable Values are included in this report:

1. SL 2.1.1.1 Reactor Core Safety Limits
2. LCO 3.1.1 SHUTDOWN MARGIN (SDM)
3. LCO 3.1.3 Moderator Temperature Coefficient (MTC)
4. LCO 3.1.7 Position Indicator Channels
5. LCO 3.1.8 PHYSICS TESTS Exceptions – MODE 1
6. LCO 3.1.9 PHYSICS TESTS Exceptions – MODE 2
7. LCO 3.2.1 Regulating Rod Insertion Limits
8. LCO 3.2.2 AXIAL POWER SHAPING ROD (APSR) Insertion Limits
9. LCO 3.2.3 AXIAL POWER IMBALANCE Operating Limits
10. LCO 3.2.4 QUADRANT POWER TILT (QPT)
11. LCO 3.2.5 Power Peaking Factors
12. LCO 3.3.1 Reactor Protection Systems (RPS) Instrumentation  
Function 8: (Flux -  $\Delta$ Flux – Flow) Allowable Values
13. LCO 3.9.1 Boron Concentration
14. TRM 8.1.3 Rod Program

## 2.0 References

- 1) BAW-10179P-A, Rev. 8, "Safety Criteria and Methodology for Acceptable Cycle Reload Analyses", May 2010.

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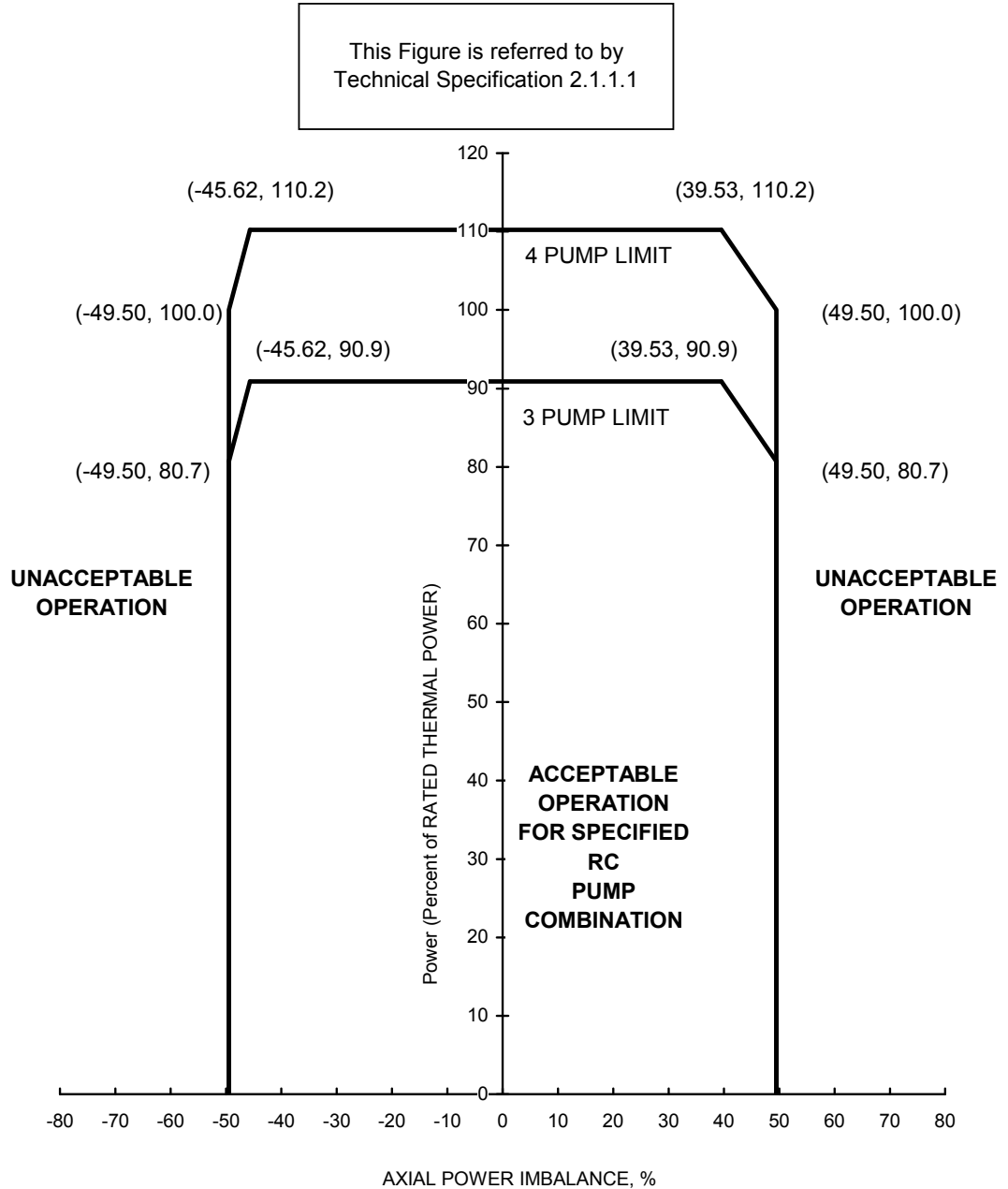
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Figure 1 AXIAL POWER IMBALANCE Protective Limits  
 2817 MWt RTP, Davis-Besse 1, Cycle 19



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

Table 1 Shutdown Margin Requirements

Verify SHUTDOWN MARGIN per the table below.

APPLICABILITY	REQUIRED SHUTDOWN MARGIN	TECHNICAL SPECIFICATIONS REFERENCE
MODE 1*	$\geq 1\% \Delta k/k$	3.1.4, 3.1.5
MODE 2*	$\geq 1\% \Delta k/k$	3.1.4, 3.1.5, 3.3.9
MODE 3	$\geq 1\% \Delta k/k$	3.1.1, 3.3.9
MODE 4	$\geq 1\% \Delta k/k$	3.1.1, 3.3.9
MODE 5	$\geq 1\% \Delta k/k$	3.1.1, 3.3.9
MODE 1 PHYSICS TESTS Exceptions**	$\geq 1\% \Delta k/k$	3.1.8
MODE 2 PHYSICS TESTS Exceptions	$\geq 1\% \Delta k/k$	3.1.9

\* The required Shutdown Margin capability of  $1\% \Delta k/k$  in MODE 1 and MODE 2 is preserved by the Regulating Rod Insertion Limits specified in Figures 2a through 2d as required by Technical Specification 3.2.1.

\*\* Entry into Mode 1 Physics Tests Exceptions is not supported by existing analyses. For example, Regulating Rod Shutdown Margin Insertion Limits assumptions may not be met and as such requires actual shutdown margin to be  $\geq 1\% \Delta k/k$  via alternate verification or calculation.



Table 2 Moderator Temperature Coefficient Limit

These limits are referred to by Technical Specifications 3.1.3

1. Lower Limit:  
MTC at HFP  $\geq -3.54 \times 10^{-4} \Delta k/k/^{\circ}F$
2. The following Upper Limits may not be exceeded without prior NRC approval:  
MTC  $< 0.9 \times 10^{-4} \Delta k/k/^{\circ}F$  when Thermal Power  $< 95\%$  RTP  
MTC  $< 0.0 \times 10^{-4} \Delta k/k/^{\circ}F$  when Thermal Power  $\geq 95\%$  RTP
3. The following Upper Limits may not be exceeded for operation in Modes 1 and 2:

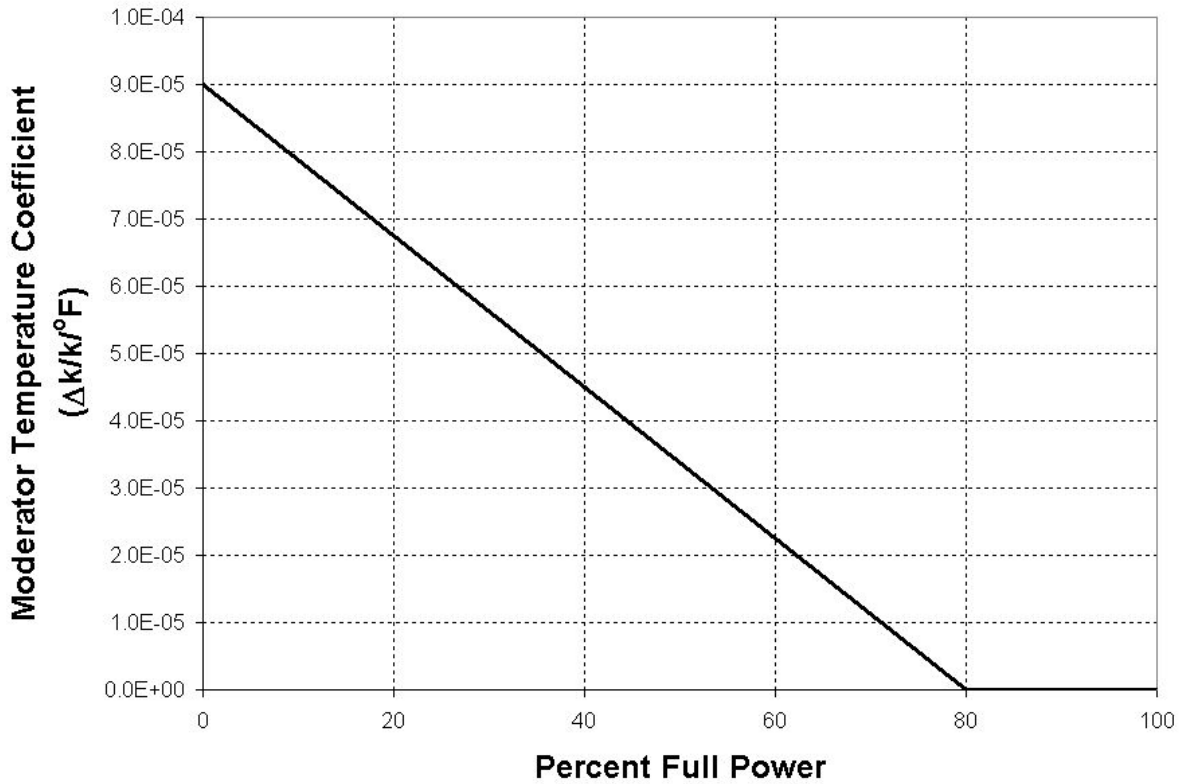


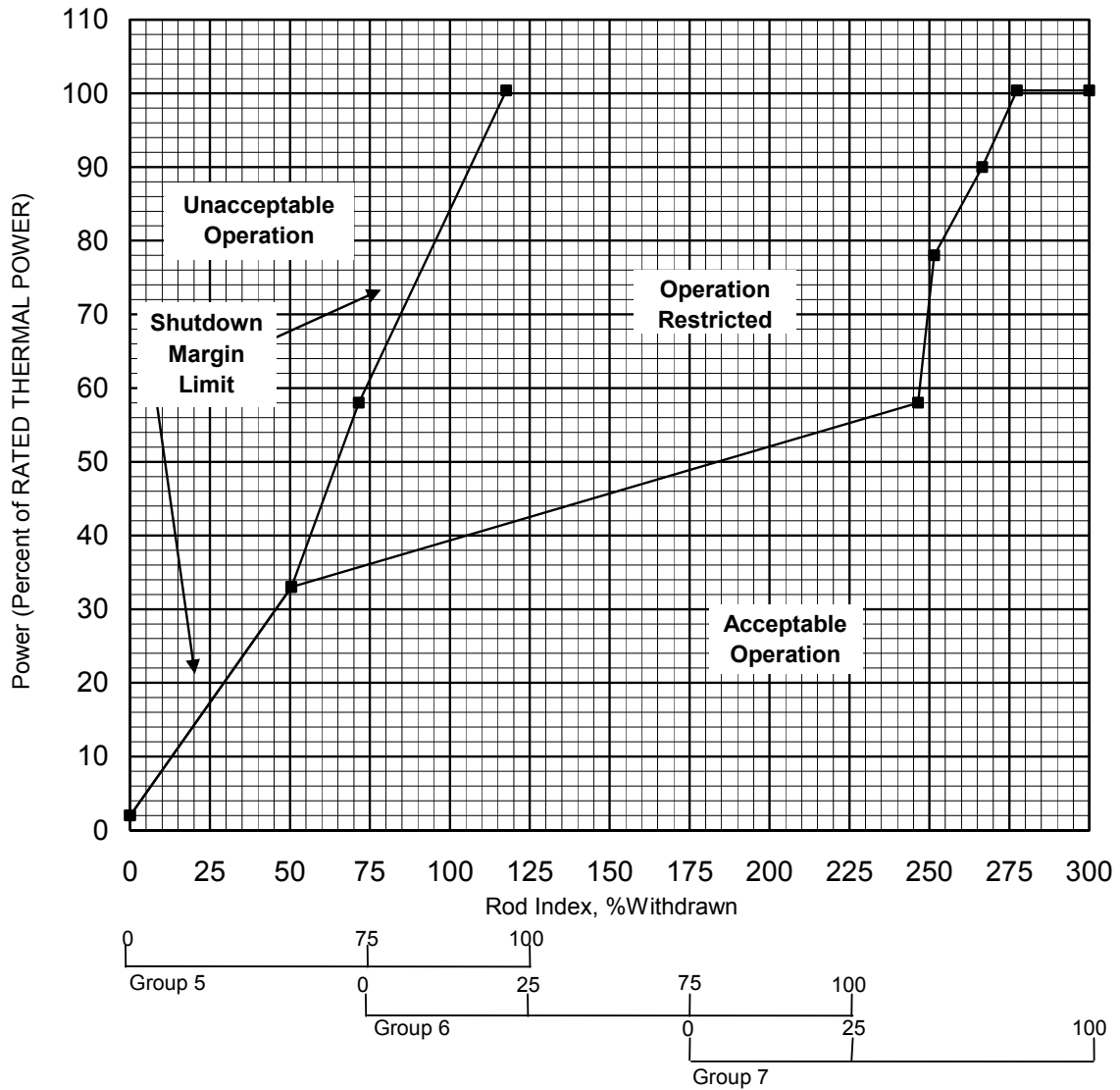
Table 3 Absolute Position Indicator (API) / Relative Position Indicator (RPI)  
Agreement Limit

This limit is referred to by Technical  
Specifications 3.1.7

The absolute position indicator channels and the relative position indicator channels agree within 3.46%.

Figure 2a Regulating Group Position Operating Limits  
 0 to 300 ±10 EFPD, Four RC Pumps--2817 MWt RTP  
 Davis-Besse 1, Cycle 19

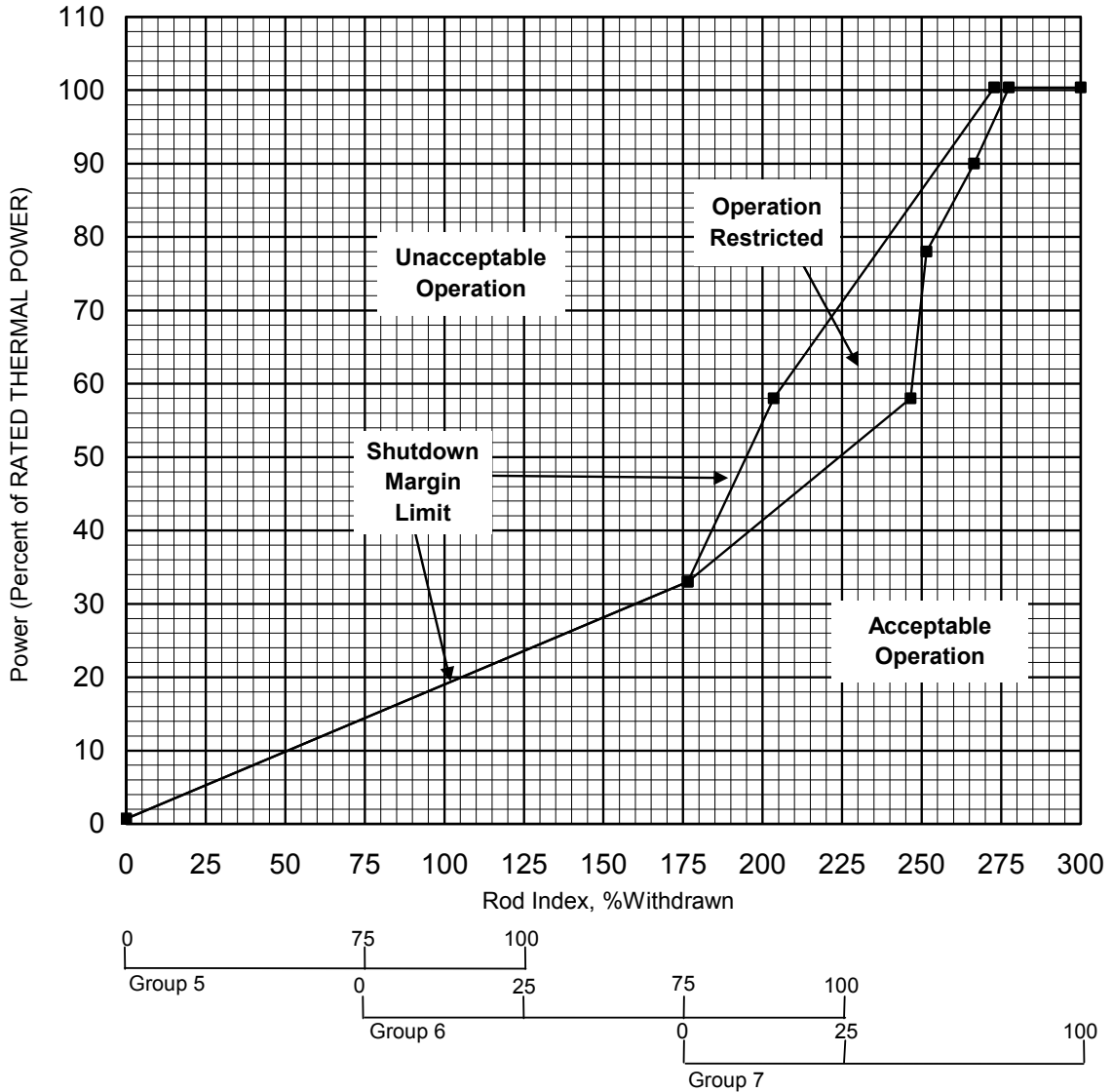
This Figure is referred to by Technical Specifications 3.2.1



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.  
 Note 3: Maximum plotted power level is 100.37 %RTP.

Figure 2b Regulating Group Position Operating Limits  
 After 300 ±10 EFPD, Four RC Pumps--2817 MWt RTP  
 Davis-Besse 1, Cycle 19

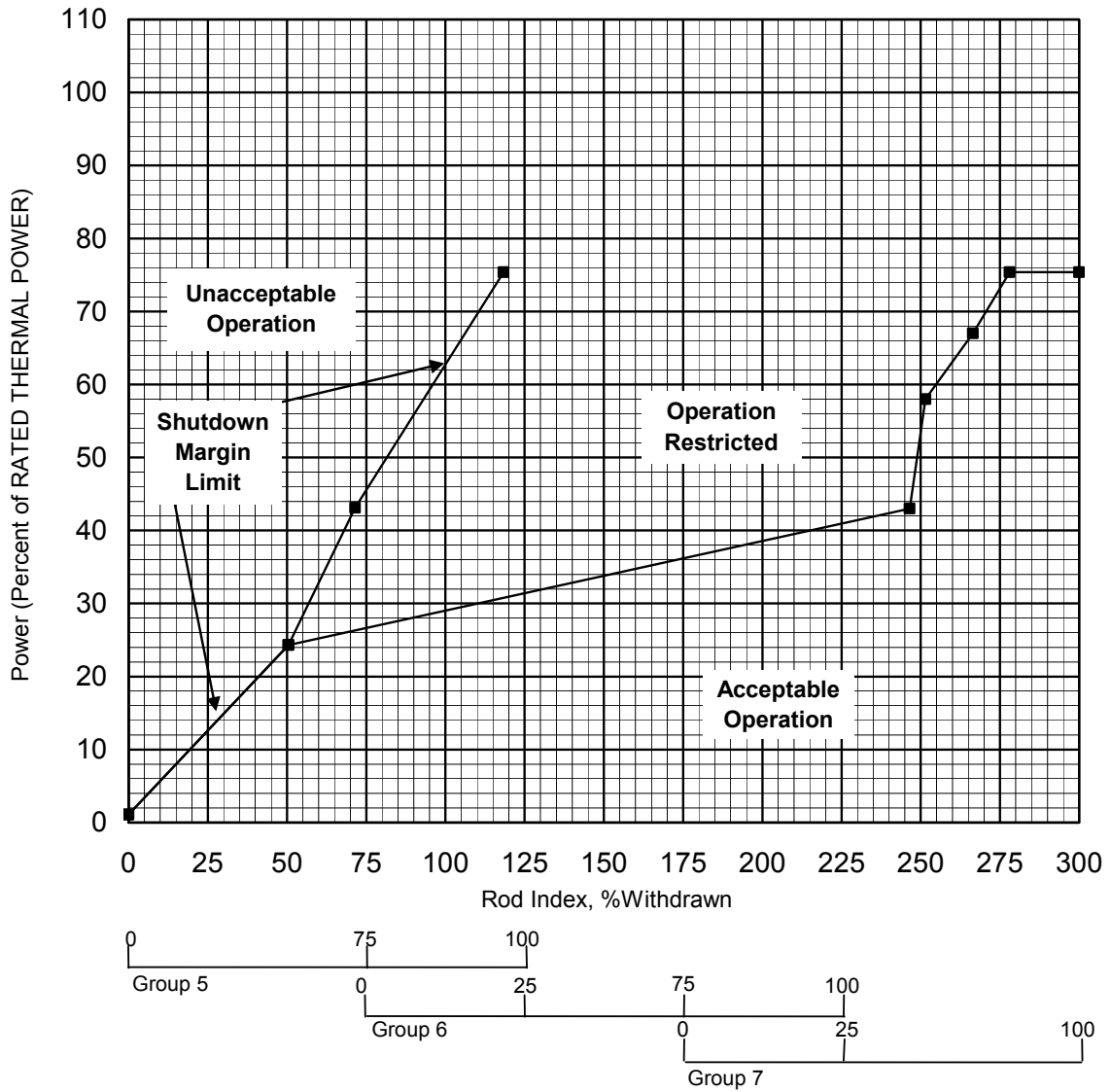
This Figure is referred to by Technical Specifications 3.2.1



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.  
 Note 3: Maximum plotted power level is 100.37 %RTP.

Figure 2c Regulating Group Position Operating Limits  
 0 to 300 ±10 EFPD, Three RC Pumps--2817 MWt RTP  
 Davis-Besse 1, Cycle 19

This Figure is referred to by Technical Specifications 3.2.1



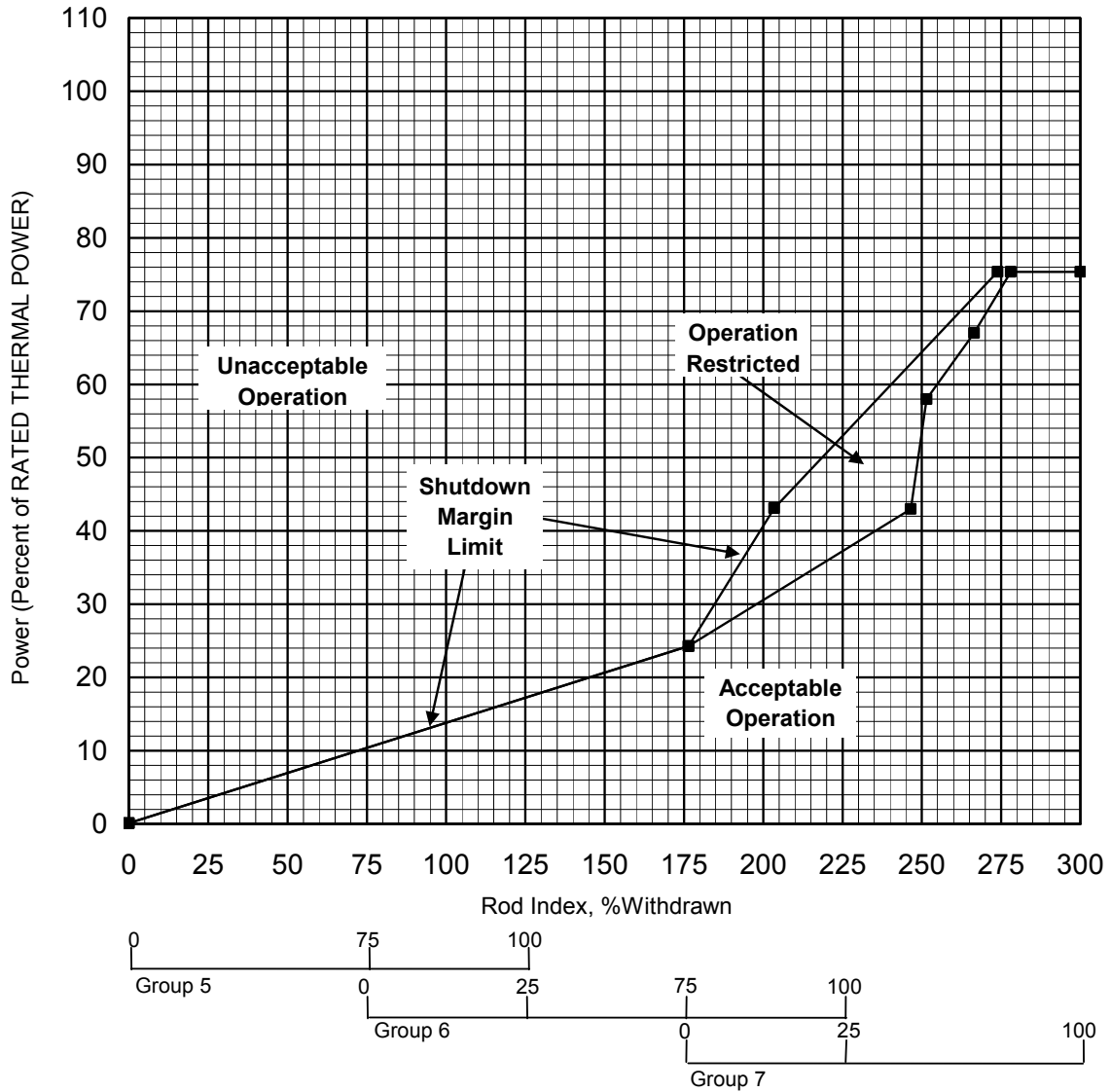
Note 1: A Rod Group overlap of 25 +/- 5% between sequential withdrawn groups 5 and 6, and 6 and 7, shall be maintained.

Note 2: Instrument error is accounted for in these Operating Limits.

Note 3: Maximum plotted power level is 75.37 %RTP.

Figure 2d Regulating Group Position Operating Limits  
 After 300 ±10 EFPD, Three RC Pumps--2817 MWt RTP  
 Davis-Besse 1, Cycle 19

This Figure is referred to by Technical Specifications 3.2.1



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.  
 Note 3: Maximum plotted power level is 75.37 %RTP.

Figure 3 APSR Position Operating Limits

This Figure is referred to by Technical  
Specifications 3.2.2

**Before APSR Pull: 0 EFPD to  $600 \pm 10$  EFPD,  
Three or Four RC pumps operation\***

Lower Limit: 0 %WD

Upper Limit: 100 %WD

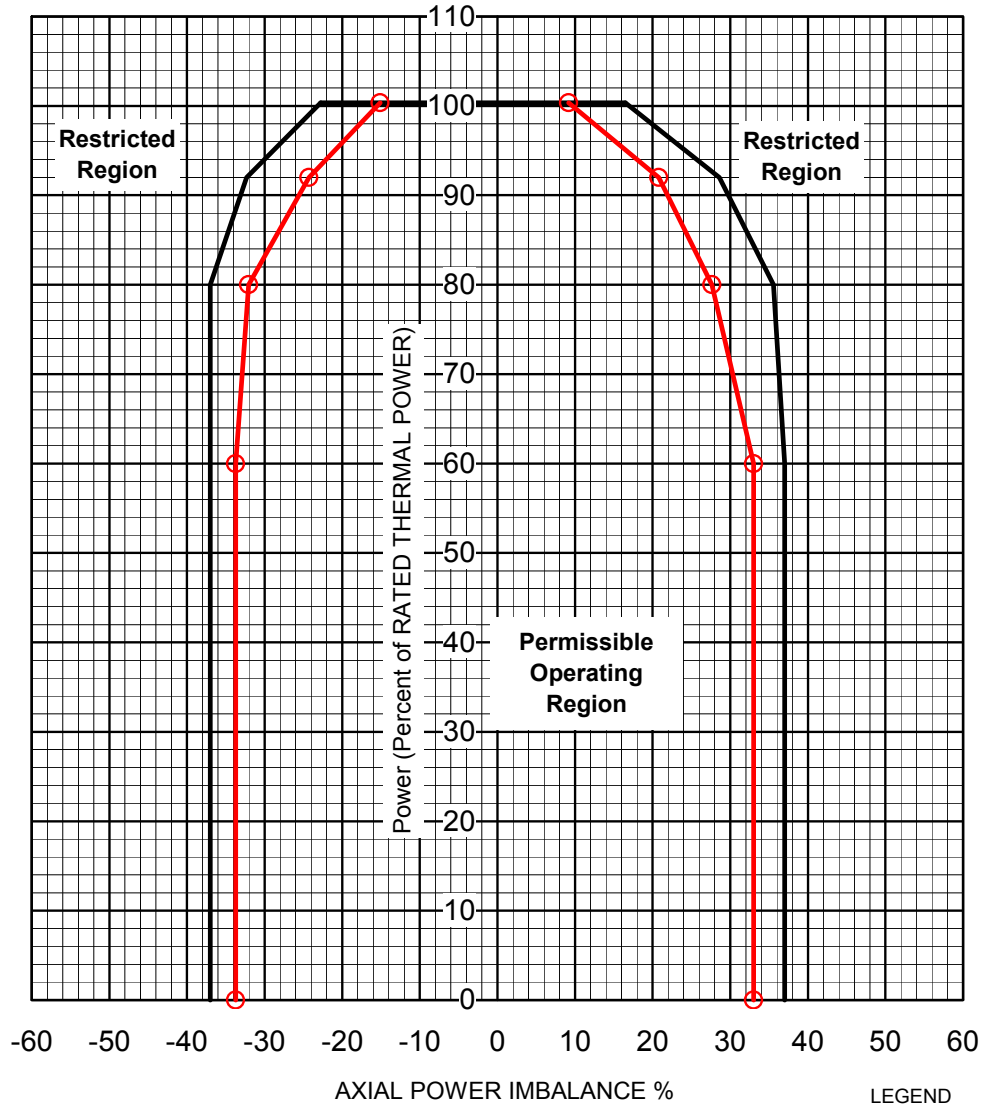
**After APSR Pull:  $600 \pm 10$  EFPD to End-of-Cycle  
Three or Four RC pumps operation\***

Insertion Prohibited (maintain  $\geq 99\%$ WD) \*\*

- \* Power restricted to 75.37% for 3-pump operation.
- \*\* Reinsertion is allowed only during the end of cycle shutdown when the reactor power is equal to, or less than, 30%RTP.

Figure 4a AXIAL POWER IMBALANCE Operating Limits  
 0 EFPD to EOC, Four RC Pumps--2817 MWt RTP  
 Davis-Besse 1, Cycle 19

This Figure is referred to by  
 Technical Specification 3.2.3



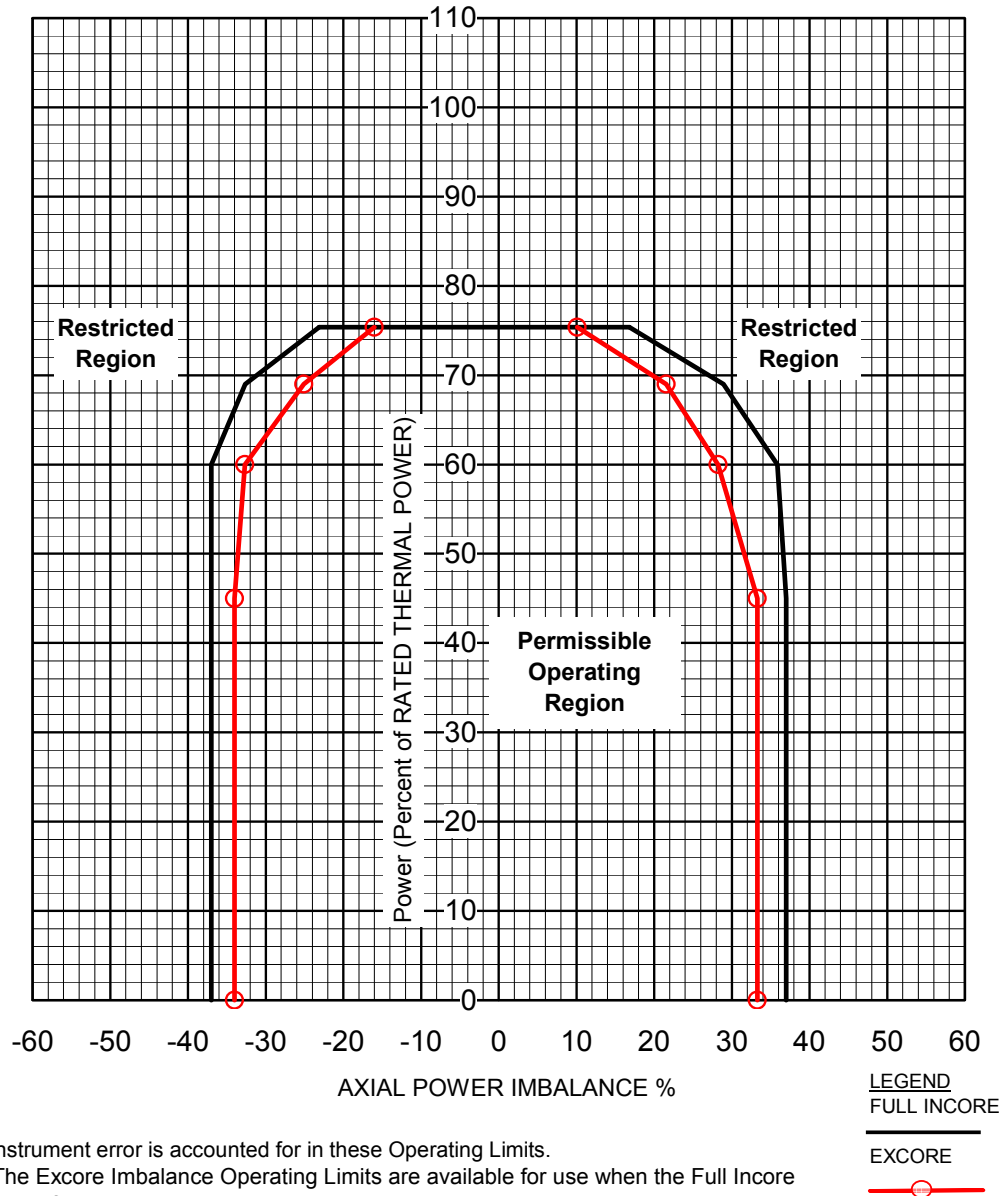
Note 1: Instrument error is accounted for in these Operating Limits.  
 Note 2: The Excore Imbalance Operating Limits are available for use when the Full Incore system is non-functional.  
 Note 3: Maximum plotted power level is 100.37 %RTP.

LEGEND  
FULL INCORE  
 EXCORE



Figure 4b AXIAL POWER IMBALANCE Operating Limits  
 0 EFPD to EOC, Three RC Pumps--2817 MWt RTP  
 Davis-Besse 1, Cycle 19

This Figure is referred to by  
 Technical Specification 3.2.3



Note 1: Instrument error is accounted for in these Operating Limits.  
 Note 2: The Excore Imbalance Operating Limits are available for use when the Full Incore system is non-functional.  
 Note 3: Maximum plotted power level is 75.37 %RTP.

Table 4 QUADRANT POWER TILT Limits

<p>This Table is referred to by Technical Specifications 3.2.4</p>
--------------------------------------------------------------------

QUADRANT POWER TILT as measured by:	From 0 EFPD to EOC			
	Steady-state Limit for THERMAL POWER $\leq$ 60% (%)	Steady-state Limit for THERMAL POWER $>$ 60% (%)	Transient Limit (%)	Maximum Limit (%)
Symmetric Incore Detector System	7.90	3.90	10.03	20.00

Table 5 Power Peaking Factors -  $F_Q$

This Table is referred to by Technical Specifications 3.2.5

The measured  $F_Q$  shall be increased by 1.4% to account for manufacturing tolerances and further increased by 7.5% to account for measurement uncertainty before comparing to the limits.

Heat Flux Hot Channel Factor  $F_Q$

$F_Q$  shall be limited by the following relationships:

$$F_Q \leq \text{LHR}^{\text{allow}} (\text{Bu}) / [\text{LHR}^{\text{avg}} * P] \text{ (for } P \leq 1.0\text{)}$$

$\text{LHR}^{\text{allow}} (\text{Bu}) =$  See the following tables

$\text{LHR}^{\text{avg}} = 6.4209 \text{ kW/ft}$  at 2817 MWt for Batches 18, 19, 20 and 21 Mark-B-HTP fuel

$P =$  ratio of THERMAL POWER / RATED THERMAL POWER

$\text{Bu} =$  fuel burnup (MWd/mtU)

$\text{UO}_2$  Fuel (Mark-B-HTP) – All Batches  $\text{LHR}^{\text{ALLOW}}$  kW/ft<sup>(a)</sup>

<u>Core Elevation (ft)</u>	0	34,000	62,000
	<u>MWd/mtU</u>	<u>MWd/mtU</u>	<u>MWd/mtU</u>
0	17.6	17.2	13.1
2.506	17.6	17.2	13.1
4.264	17.5	17.1	13.1
6.021	16.8	16.8	13.1
7.779	17.0	16.7	13.1
9.536	16.2	16.3	13.1
12.000	15.4	15.5	12.4

<sup>(a)</sup> Linear interpolation for allowable LHR between specified burnup points is valid for these tables.

Table 5 (continued)

4 wt% Gad Fuel (Mark-B-HTP) – All Batches except 21B LHR<sup>ALLOW</sup> kW/ft<sup>(a)</sup>

<u>Core Elevation (ft)</u>	0	34,000	62,000
	<u>MWd/mtU</u>	<u>MWd/mtU</u>	<u>MWd/mtU</u>
0	15.8	15.7	11.8
2.506	15.8	15.7	11.8
4.264	15.7	15.5	11.8
6.021	15.1	15.2	11.8
7.779	15.3	15.2	11.8
9.536	14.6	14.8	11.8
12.000	13.8	14.1	11.2

6 wt% Gad Fuel (Mark-B-HTP) – Batch 20C and 21B LHR<sup>ALLOW</sup> kW/ft<sup>(a)</sup>

<u>Core Elevation (ft)</u>	0	34,000	62,000
	<u>MWd/mtU</u>	<u>MWd/mtU</u>	<u>MWd/mtU</u>
0	15.3	15.4	11.4
2.506	15.3	15.4	11.4
4.264	15.2	15.4	11.4
6.021	14.5	15.1	11.4
7.779	14.8	15.0	11.4
9.536	14.1	14.7	11.4
12.000	13.3	14.0	10.8

8 wt% Gad Fuel (Mark-B-HTP) – Batches 18A5, 19C2, 20A, 21A, 21B and 21E LHR<sup>ALLOW</sup> kW/ft<sup>(a)</sup>

<u>Core Elevation (ft)</u>	0	34,000	62,000
	<u>MWd/mtU</u>	<u>MWd/mtU</u>	<u>MWd/mtU</u>
0	14.9	14.9	11.0
2.506	14.9	14.9	11.0
4.264	14.8	14.9	11.0
6.021	14.2	14.5	11.0
7.779	14.4	14.5	11.0
9.536	13.7	14.2	11.0
12.000	13.0	13.5	10.4

<sup>(a)</sup> Linear interpolation for allowable LHR between specified burnup points is valid for these tables.

Table 6 Power Peaking Factors -  $F_{\Delta H}^N$

This Table is referred to by Technical Specifications 3.2.5

Enthalpy Rise Hot Channel Factors -  $F_{\Delta H}^N$

$F_{\Delta H}^N \leq \text{MARP} [1 + (1/\text{RH}) (1 - P/P_m)]$  (see note below)

MARP = Maximum Allowable Radial Peak, see MARP Figures and data Tables

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

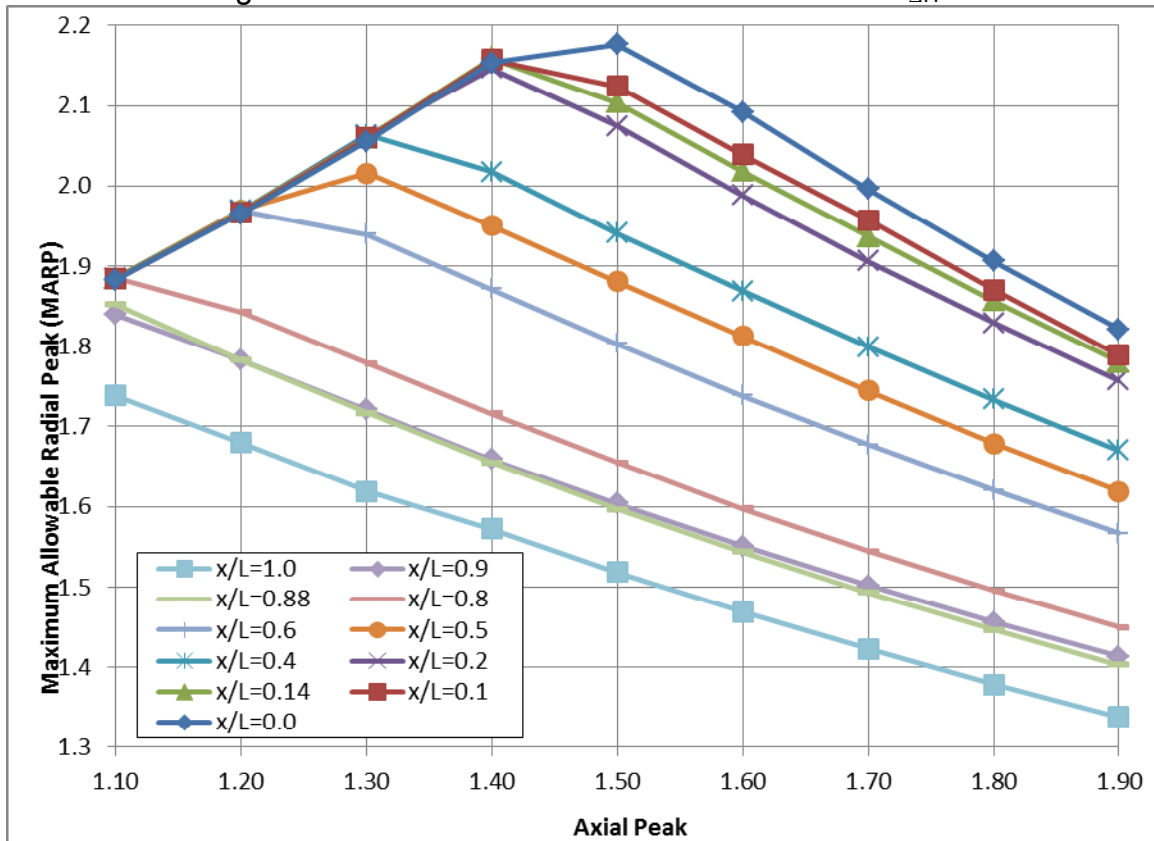
$P_m = 1.0$  for 4-RCP operation

$P_m = 0.75$  for 3-RCP operation

$1/\text{RH} = 0.3$

Note: The measured  $F_{\Delta H}^N$  shall be increased by 5.0% to account for measurement uncertainty prior to comparing to the limits.

Figure 5 Maximum Allowable Radial Peak for  $F_{\Delta H}^N$  \*



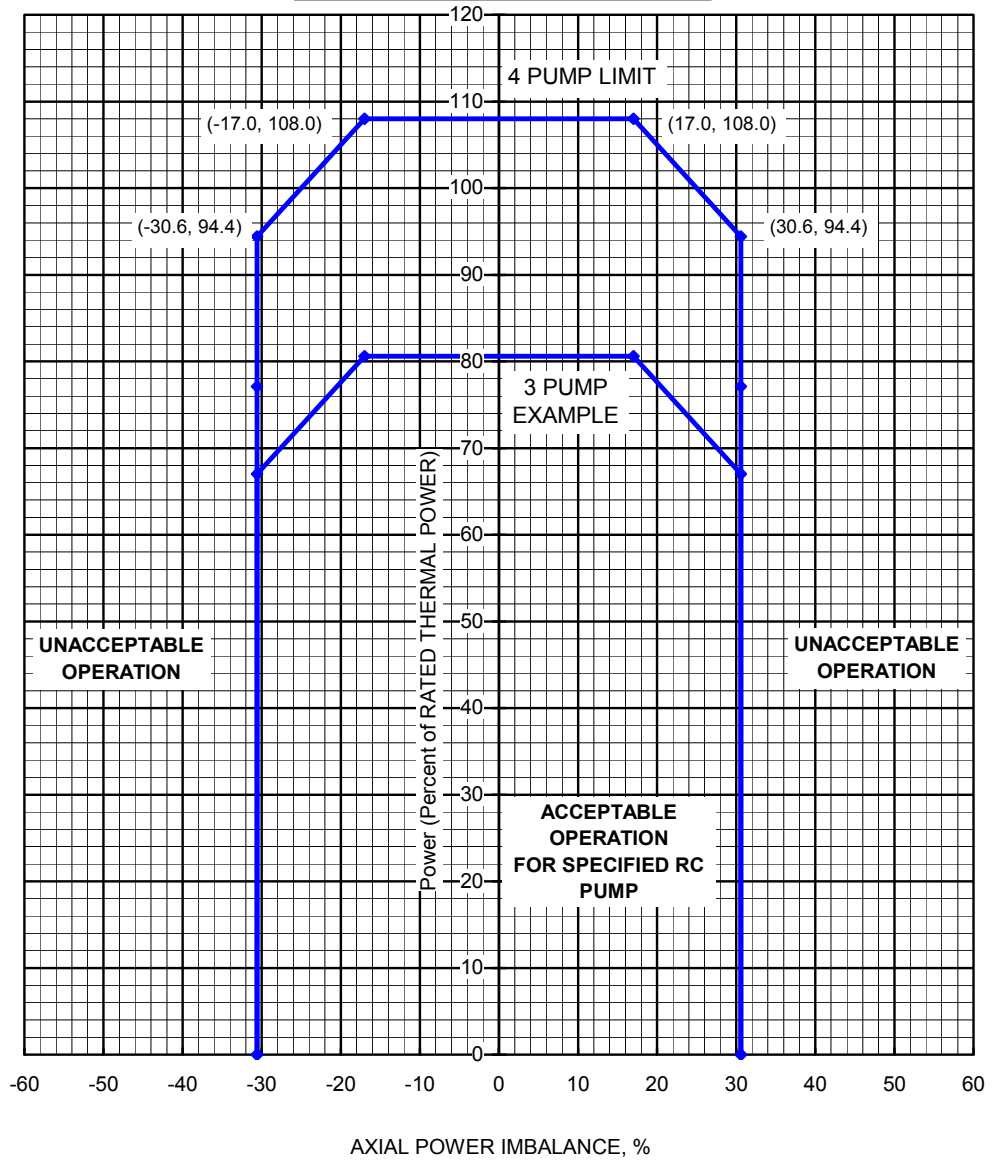
\* Linear interpolation is acceptable.

Table 7 Maximum Allowable Radial Peak for  $F_{\Delta H}^N$ 

<u>Axial Peak</u>	<u>x/L</u>	<u>Axial Height (inches)</u>	<u>MARP Limit</u>	<u>Axial Peak</u>	<u>x/L</u>	<u>Axial Height (inches)</u>	<u>MARP Limit</u>
1.1	0.0	0.00	1.88299	1.6	0.0	0.00	2.09189
	0.1	14.30	1.88398		0.1	14.30	2.03919
	0.14	20.02	1.88428		0.14	20.02	2.01827
	0.2	28.60	1.88461		0.2	28.60	1.98801
	0.4	57.20	1.88490		0.4	57.20	1.86840
	0.5	71.50	1.88439		0.5	71.50	1.81257
	0.6	85.80	1.88451		0.6	85.80	1.73794
	0.8	114.40	1.88421		0.8	114.40	1.59754
	0.88	125.84	1.85239		0.88	125.84	1.54331
	0.9	128.70	1.83969		0.9	128.70	1.55084
1.0	143.00	1.73842	1.0	143.00	1.46874		
1.2	0.0	0.00	1.96511	1.7	0.0	0.00	1.99604
	0.1	14.30	1.96705		0.1	14.30	1.95702
	0.14	20.02	1.96804		0.14	20.02	1.93661
	0.2	28.60	1.96825		0.2	28.60	1.90615
	0.4	57.20	1.96936		0.4	57.20	1.79933
	0.5	71.50	1.96984		0.5	71.50	1.74468
	0.6	85.80	1.96919		0.6	85.80	1.67736
	0.8	114.40	1.84278		0.8	114.40	1.54415
	0.88	125.84	1.78287		0.88	125.84	1.49299
	0.9	128.70	1.78220		0.9	128.70	1.50138
1.0	143.00	1.67994	1.0	143.00	1.42245		
1.3	0.0	0.00	2.05580	1.8	0.0	0.00	1.90606
	0.1	14.30	2.05912		0.1	14.30	1.87049
	0.14	20.02	2.06036		0.14	20.02	1.85710
	0.2	28.60	2.06155		0.2	28.60	1.82954
	0.4	57.20	2.06343		0.4	57.20	1.73365
	0.5	71.50	2.01583		0.5	71.50	1.67902
	0.6	85.80	1.93900		0.6	85.80	1.62023
	0.8	114.40	1.77864		0.8	114.40	1.49550
	0.88	125.84	1.71670		0.88	125.84	1.44607
	0.9	128.70	1.72105		0.9	128.70	1.45590
1.0	143.00	1.61890	1.0	143.00	1.37861		
1.4	0.0	0.00	2.15314	1.9	0.0	0.00	1.82131
	0.1	14.30	2.15758		0.1	14.30	1.78903
	0.14	20.02	2.15910		0.14	20.02	1.78024
	0.2	28.60	2.14648		0.2	28.60	1.75713
	0.4	57.20	2.01712		0.4	57.20	1.67040
	0.5	71.50	1.95015		0.5	71.50	1.61847
	0.6	85.80	1.87083		0.6	85.80	1.56653
	0.8	114.40	1.71630		0.8	114.40	1.44958
	0.88	125.84	1.65545		0.88	125.84	1.40281
	0.9	128.70	1.65903		0.9	128.70	1.41322
1.0	143.00	1.57207	1.0	143.00	1.33783		
1.5	0.0	0.00	2.17667	1.5	0.0	0.00	2.17667
	0.1	14.30	2.12413		0.1	14.30	2.12413
	0.14	20.02	2.10403		0.14	20.02	2.10403
	0.2	28.60	2.07451		0.2	28.60	2.07451
	0.4	57.20	1.94104		0.4	57.20	1.94104
	0.5	71.50	1.88067		0.5	71.50	1.88067
	0.6	85.80	1.80330		0.6	85.80	1.80330
	0.8	114.40	1.65555		0.8	114.40	1.65555
	0.88	125.84	1.59706		0.88	125.84	1.59706
	0.9	128.70	1.60415		0.9	128.70	1.60415
1.0	143.00	1.51859	1.0	143.00	1.51859		

Figure 6 Flux- $\Delta$ Flux-Flow  
 (or Power/Imbalance/Flow)  
 Allowable Values

This Figure is referred to by  
 Technical Specification 3.3.1



The 3 pump example curve shows allowable values for an approximately 25% flow reduction for three pump operation (283,860 gpm). The actual setpoint will be calculated by the Reactor Protection System and will be directly proportional to the actual RC flow with three pumps. These limits are based on Cycle 9 and are conservative relative to the actual Cycle 19 limits.

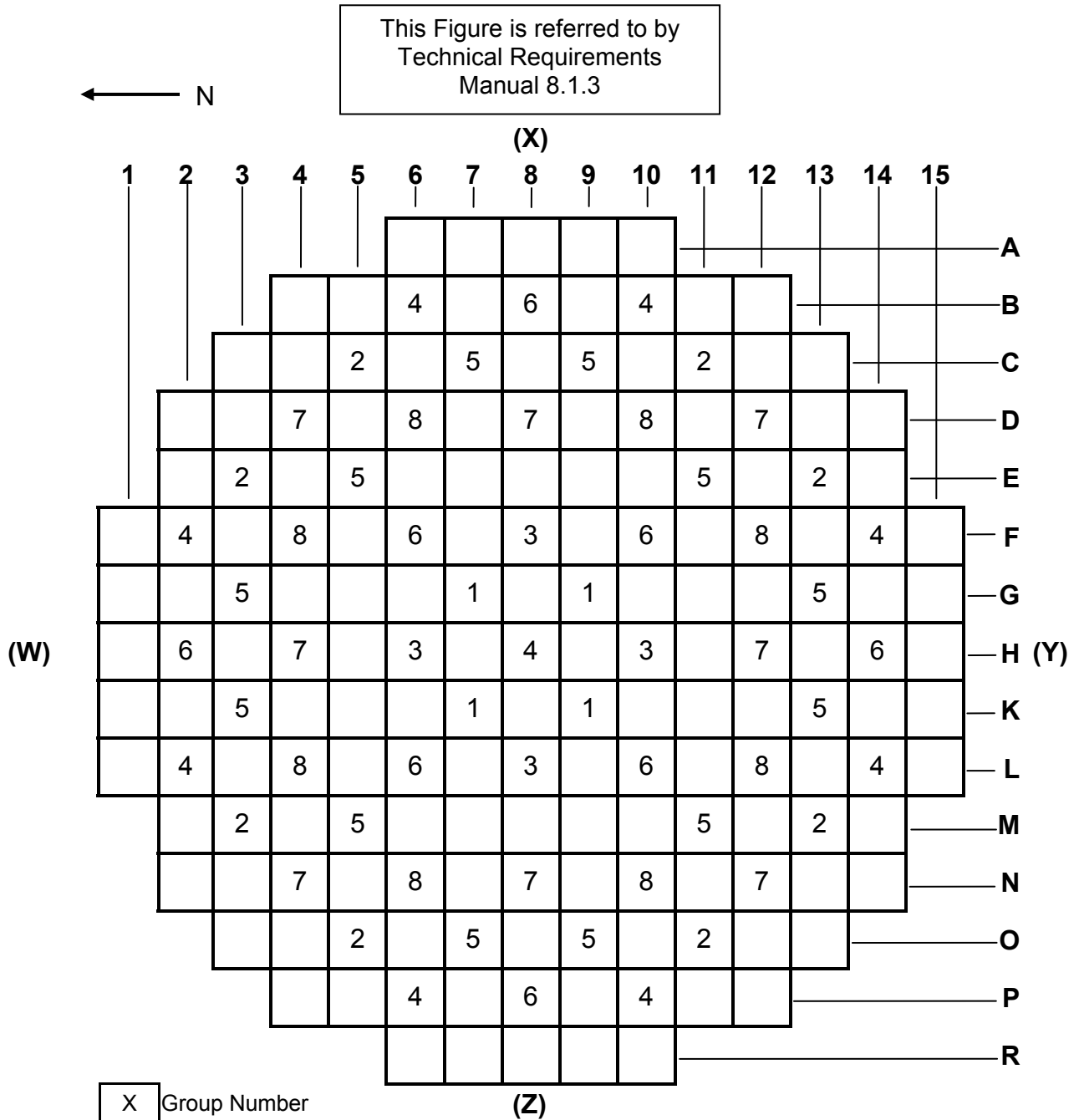
Table 8 Refueling Boron Concentration Limit

This limit is referred to by Technical Specifications 3.9.1
-------------------------------------------------------------

The minimum required boron concentration for Mode 6 shall be sufficient to ensure a  $K_{\text{eff}}$  of 0.95 or less, plus an additional 1%  $\Delta k/k$  conservatism allowance for uncertainties.



Figure 7 Control Rod Core Locations and Group Assignments



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	