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Fax: 419-321-7582July 14, 2008  
L-08-228ATTN: Document Control Desk  
U. S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001SUBJECT:  
Davis-Besse Nuclear Power Station, Unit 1  
Docket Number 50-346, License No. NPF-3  
Core Operating Limits Report, Revision 1

Enclosed please find the Davis-Besse Nuclear Power Station, Unit 1 Core Operating Limits Report for Cycle 16, Revision 1, which supports the implementation of License Amendment 278, Measurement Uncertainty Recapture (MUR) Power Uprate. Submittal of this report is in accordance with Davis-Besse Nuclear Power Station, Unit 1 Technical Specification 6.9.1.7.

There are no regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Thomas A. Lentz, Manager – Fleet Licensing, at (330) 761-6071.

Sincerely,



Barry S. Allen

Enclosure:

FirstEnergy Nuclear Operating Company, Davis-Besse Unit 1, Cycle 16,  
Core Operating Limits Report, Revision 1cc: NRC Region III Administrator  
NRC Resident Inspector  
NRR Project Manager  
Executive Director, Ohio Emergency Management Agency,  
State of Ohio (NRC Liaison)  
Utility Radiological Review BoardA001  
NRR

FIRSTENERGY NUCLEAR OPERATING COMPANY  
DAVIS-BESSE UNIT 1  
CYCLE 16  
CORE OPERATING LIMITS REPORT

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Reviewed by *Paul W. Gilles* 7/2/08  
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Approved by *[Signature]* 7/3/08  
R. J. Borland

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FIRSTENERGY NUCLEAR OPERATING COMPANY

DAVIS-BESSE UNIT 1

CYCLE 16

CORE OPERATING LIMITS REPORT

1.0 Core Operating Limits

This CORE OPERATING LIMITS REPORT for DB-1 Cycle 16 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 16 is 741.8 EFPDs (based on a reactor thermal rating of 2772 MWt which is equivalent to 730 EFPDs at 2817 MWt).

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) 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- $\Delta$ Flux/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,  $F_{\Delta H}^N$

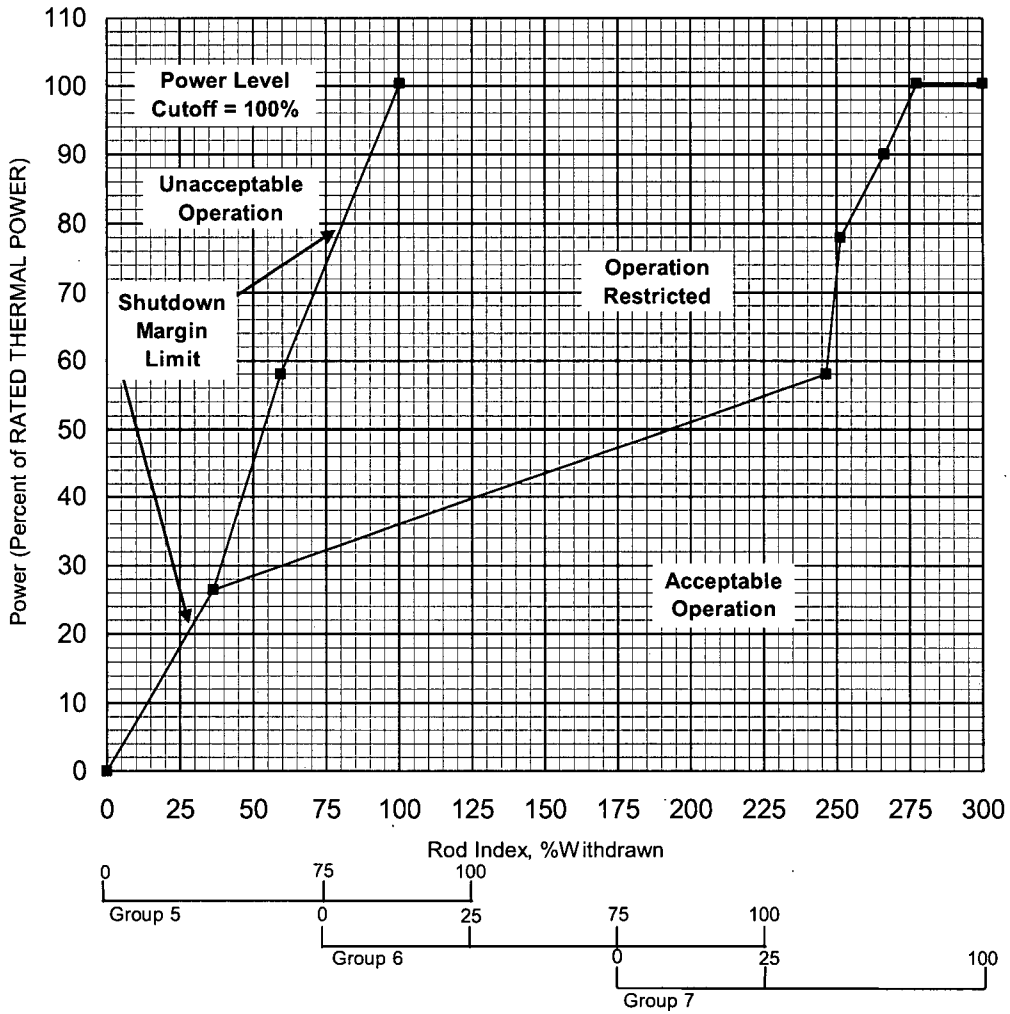
2.0 References

- 1) BAW-10179P-A, Rev. 6, "Safety Criteria and Methodology For Acceptable Cycle Reload Analyses", August, 2001.
- 2) BAW-10164P-A, Rev. 6, "RELAP5/MOD2-B&W – An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analysis", June, 2007.

- 3) BAW-10243P-A, "Statistical Fuel Assembly Hold Down Methodology",  
September, 2005.

Figure 1a Regulating Group Position Operating Limits  
 0 to 300  $\pm$ 10 EFPD, Four RC Pumps--2817MWt RTP  
 Davis-Besse 1, Cycle 16

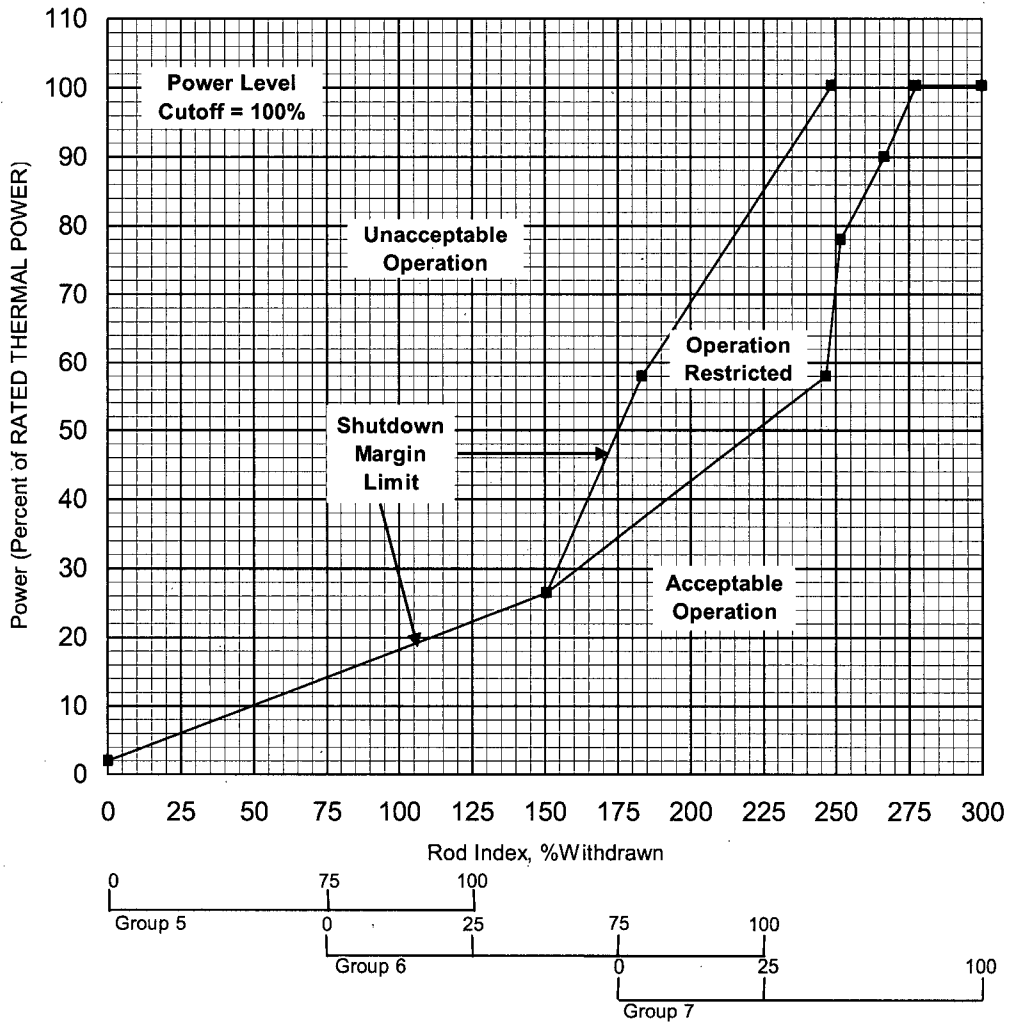
This Figure is referred to by Technical Specifications 3.1.3.6 and 3.1.3.8



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--2817MWt RTP  
 Davis-Besse 1, Cycle 16

This Figure is referred to by Technical Specifications 3.1.3.6 and 3.1.3.8

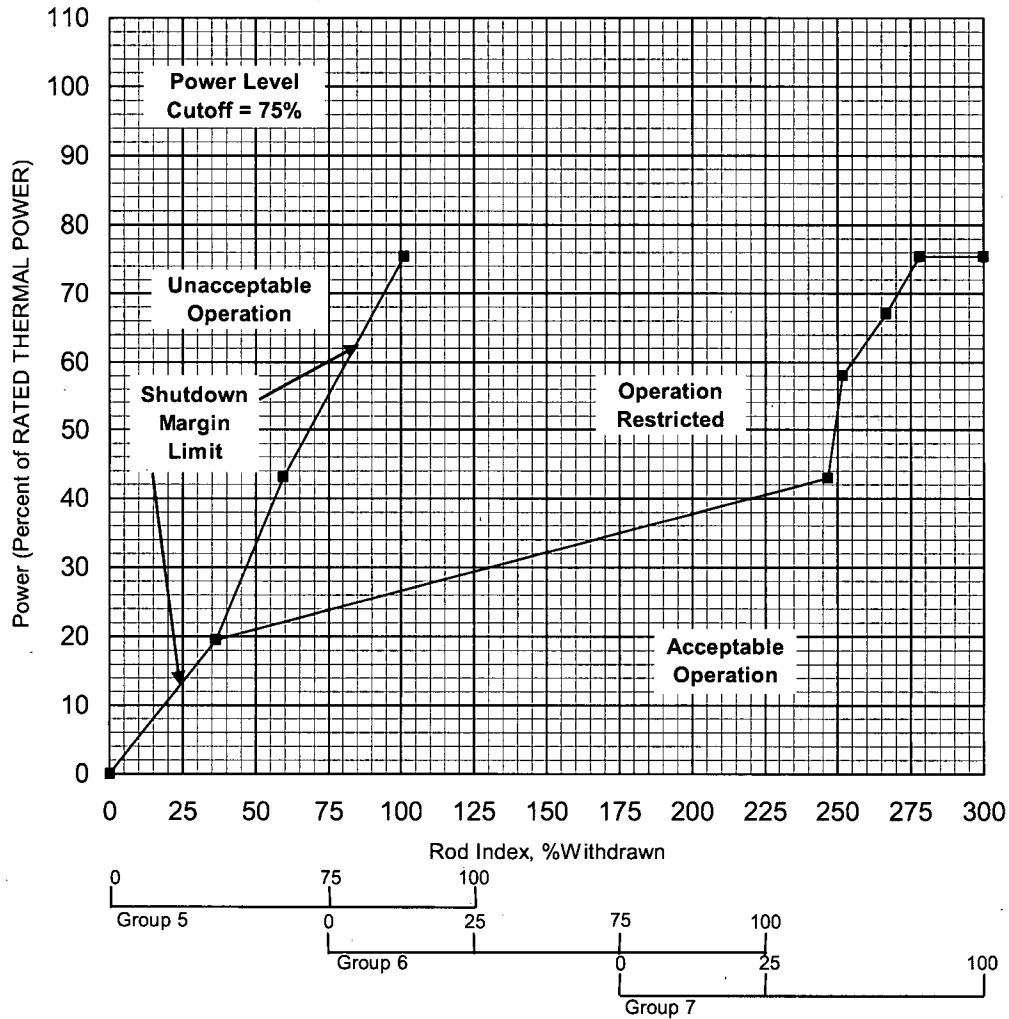


Note 1: A Rod Group overlap of 25 ±5% between sequential withdrawn groups 5 and 6, and 6 and 7, shall be maintained.  
 Note 2: Instrument error is accounted for in these Operating Limits.



Figure 1c Regulating Group Position Operating Limits  
 0 to 300  $\pm$ 10 EFPD, Three RC Pumps--2817 MWt RTP  
 Davis-Besse 1, Cycle 16

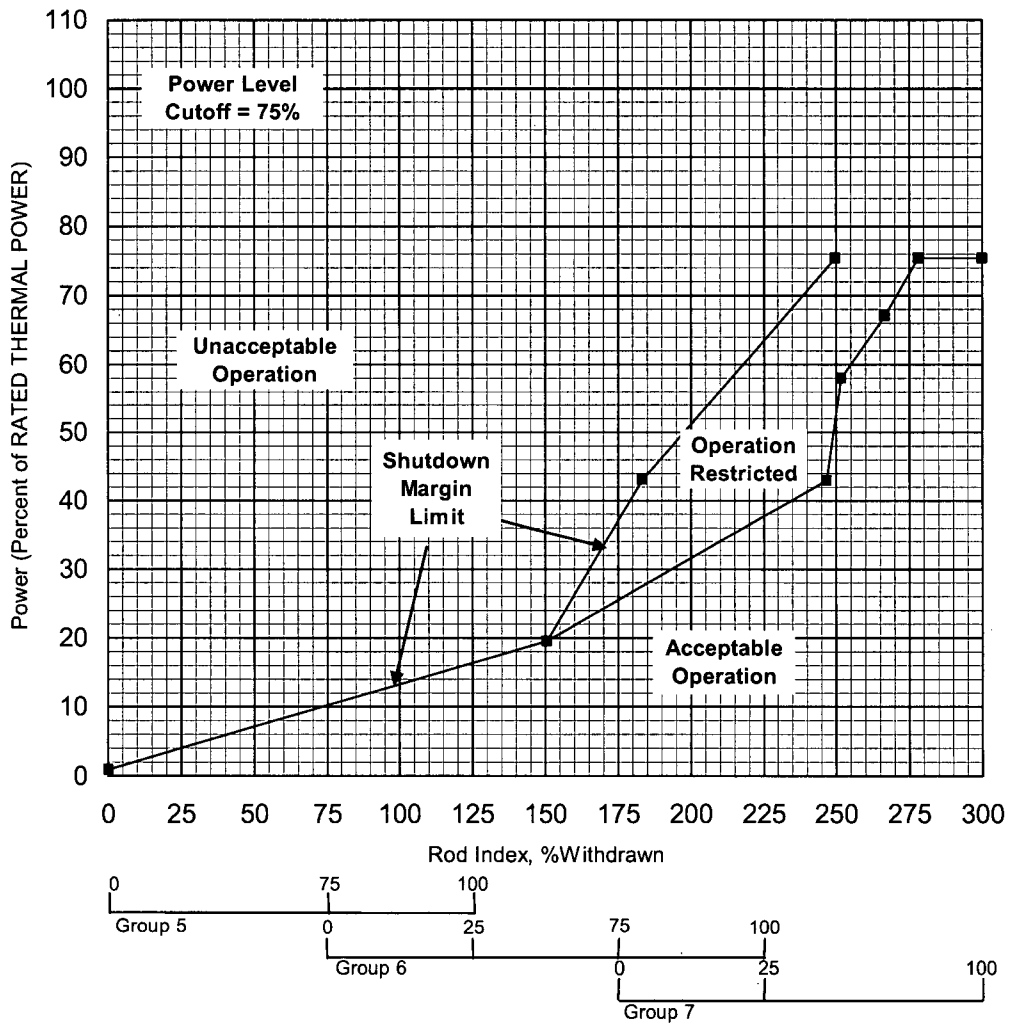
This Figure is referred to by Technical Specifications 3.1.3.6 and 3.1.3.8



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  $300 \pm 10$  EFPD, Three RC Pumps--2817MWt RTP  
 Davis-Besse 1, Cycle 16

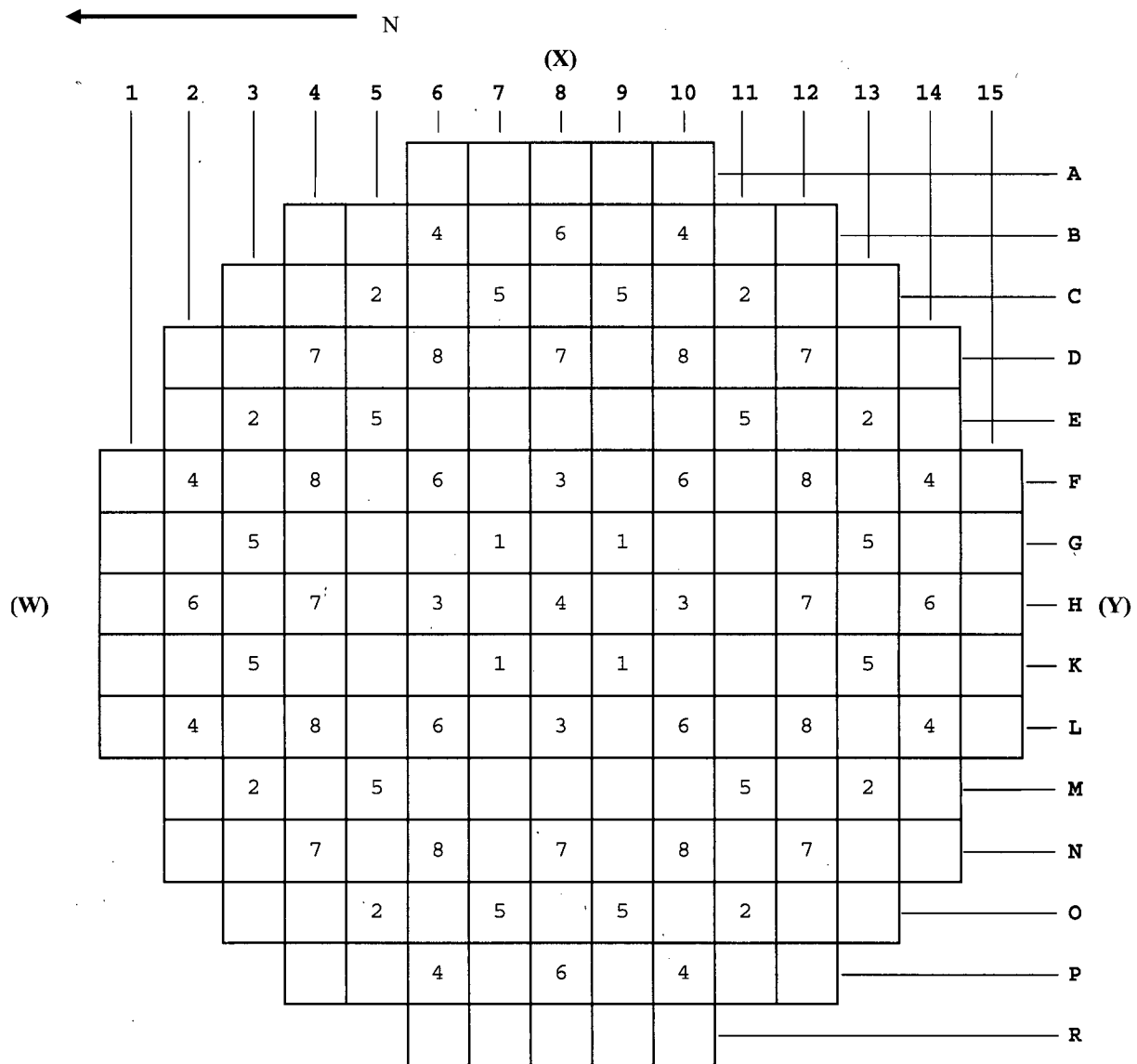
This Figure is referred to by Technical Specifications 3.1.3.6 and 3.1.3.8



Note 1: A Rod Group overlap of  $25 \pm 5\%$  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 16

This Figure is referred to by  
 Technical Specification 3.1.3.7



| Group Number | 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—2817 MWt RTP

This Figure is referred to by Technical  
Specification 3.1.3.9

**Before APSR Pull: 0 EFPD to  $675 \pm 10$  EFPD,  
Three or Four RC pumps operation\***

**Lower Limit: 0 %WD**

**Upper Limit: 100 %WD**

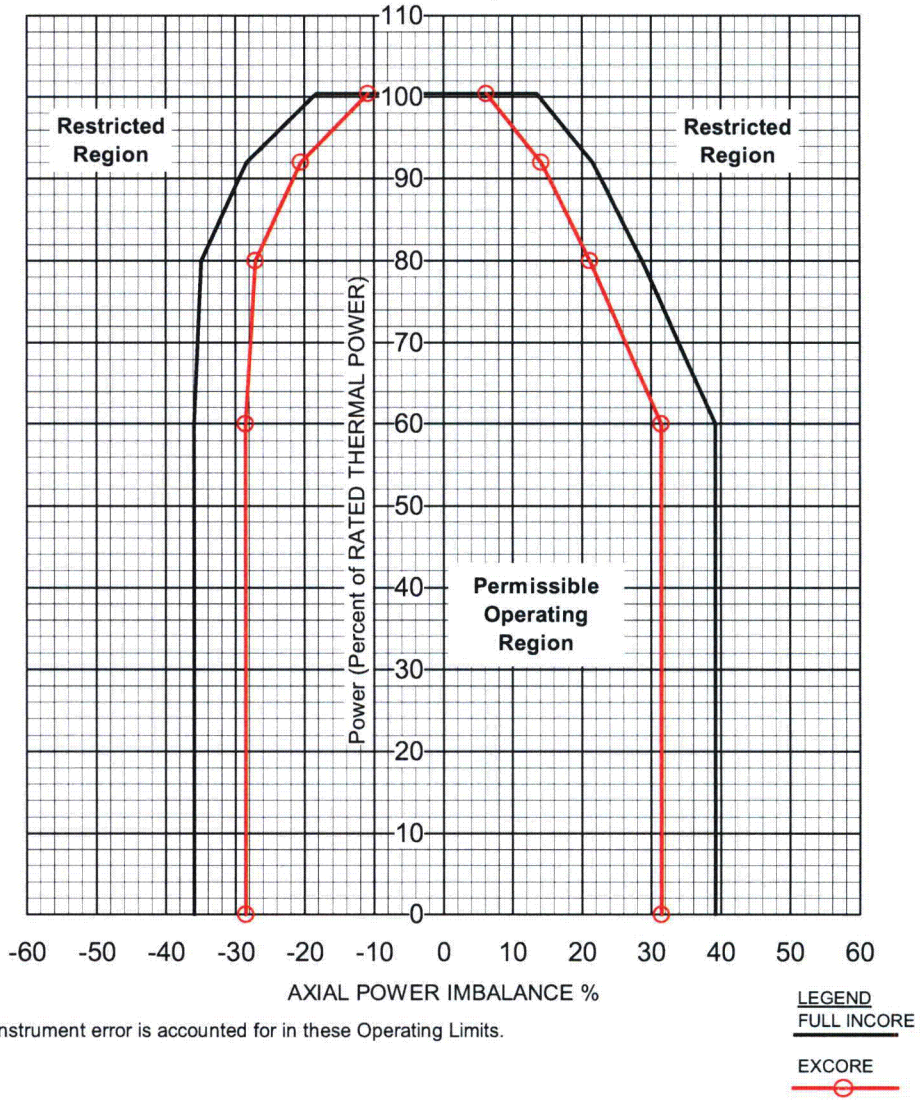
**After APSR Pull:  $675 \pm 10$  EFPD to End-of-Cycle  
Three or Four RC pumps operation\***

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

**\* Power restricted to 75.37% for 3-pump operation.**

Figure 4a AXIAL POWER IMBALANCE Operating Limits  
 0 to 350 ±10 EFPD, Four RC Pumps--2817 MWt RTP  
 Davis-Besse 1, Cycle 16

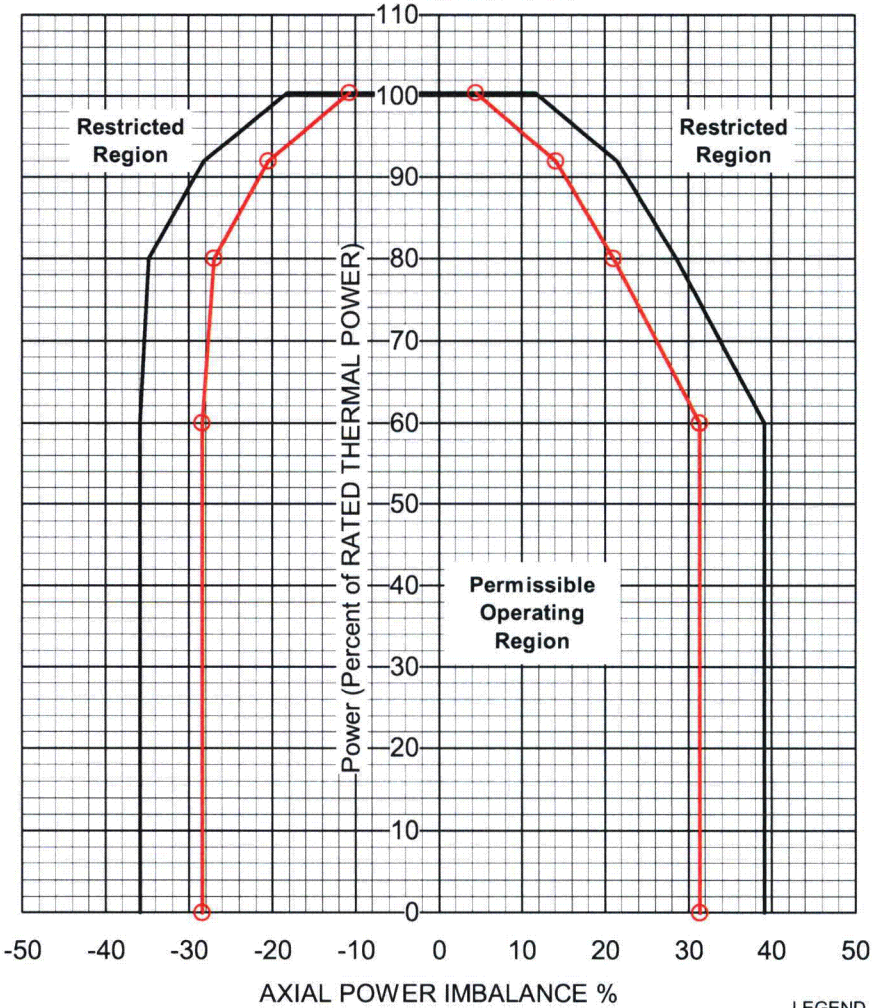
This Figure is referred to by  
 Technical Specification 3.2.1



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

Figure 4b AXIAL POWER IMBALANCE Operating Limits  
 350  $\pm$ 10 to 600  $\pm$ 10 EFPD, Four RC Pumps--2817MWt RTP  
 Davis-Besse 1, Cycle 16

This Figure is referred to by  
 Technical Specification 3.2.1

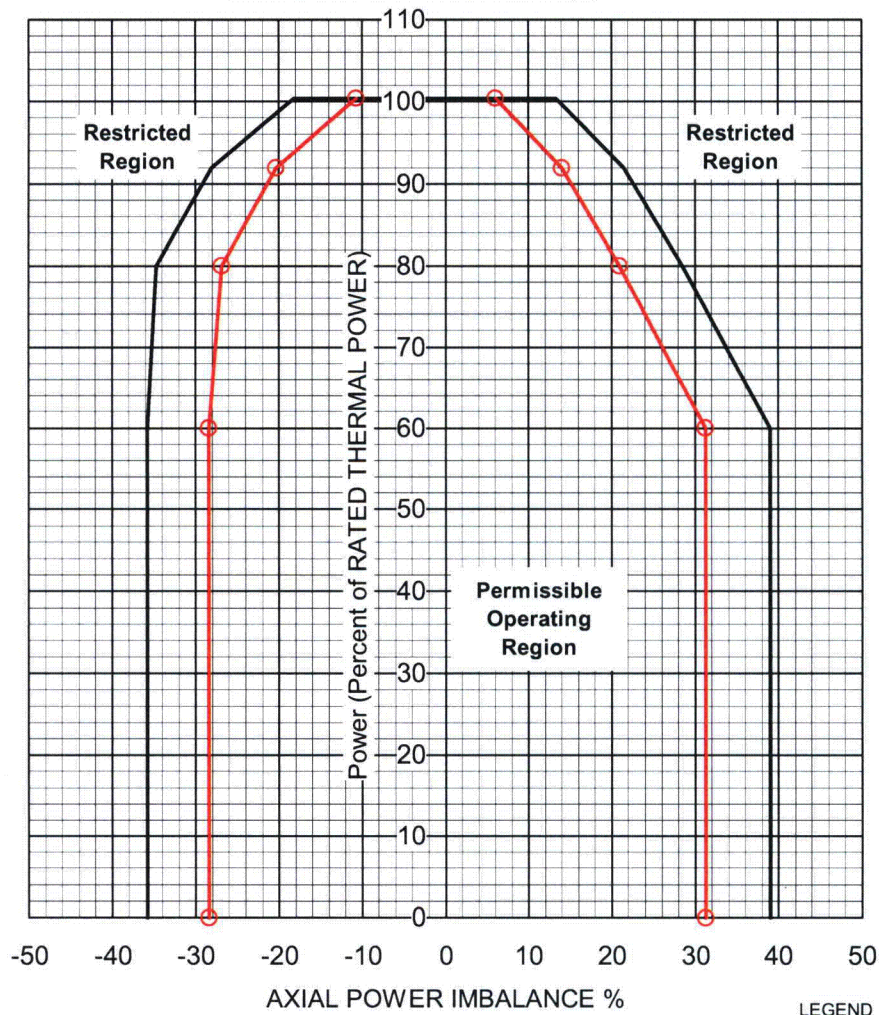


Note 1: Instrument error is accounted for in these Operating Limits.

LEGEND  
 FULL INCORE  
 EXCORE

Figure 4c AXIAL POWER IMBALANCE Operating Limits  
 After 600  $\pm$ 10 EFPD, Four RC Pumps--2817MWt RTP  
 Davis-Besse 1, Cycle 16

This Figure is referred to by  
 Technical Specification 3.2.1

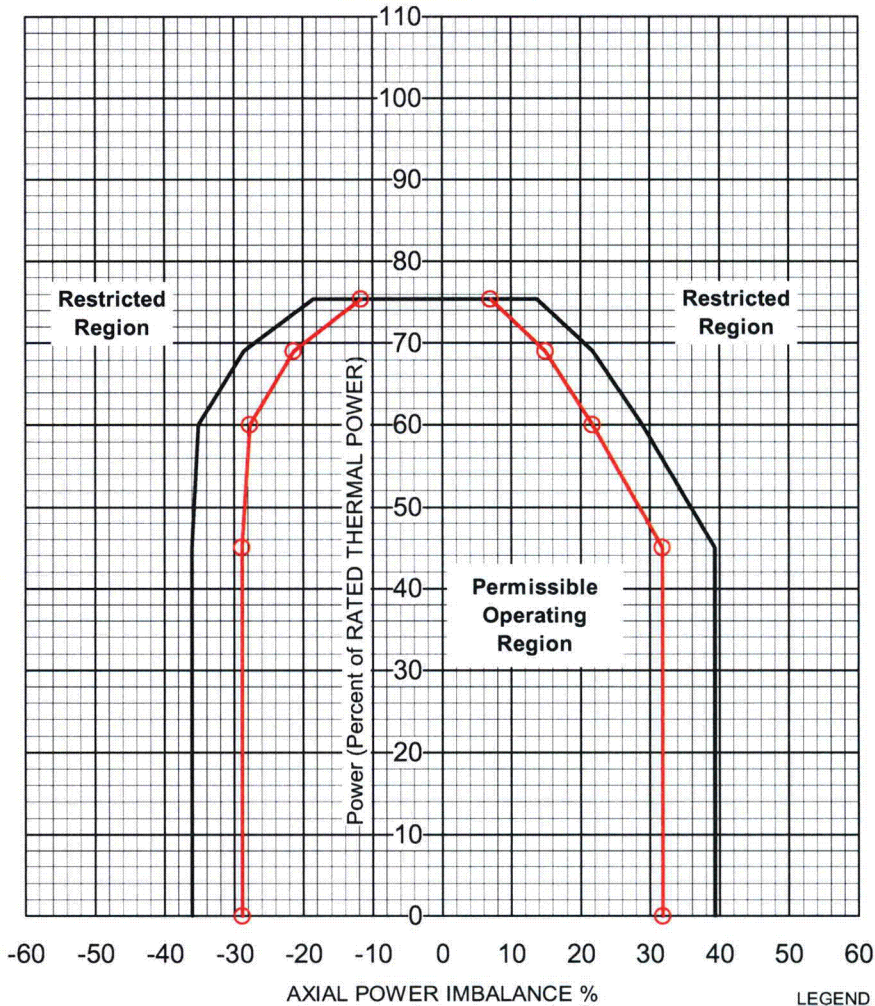


Note 1: Instrument error is accounted for in these Operating Limits.

LEGEND  
 FULL INCORE  
 EXCORE

Figure 4d AXIAL POWER IMBALANCE Operating Limits  
 0 to 350 ±10 EFPD, Three RC Pumps--2817 MWt RTP  
 Davis-Besse 1, Cycle 16

This Figure is referred to by  
 Technical Specification 3.2.1



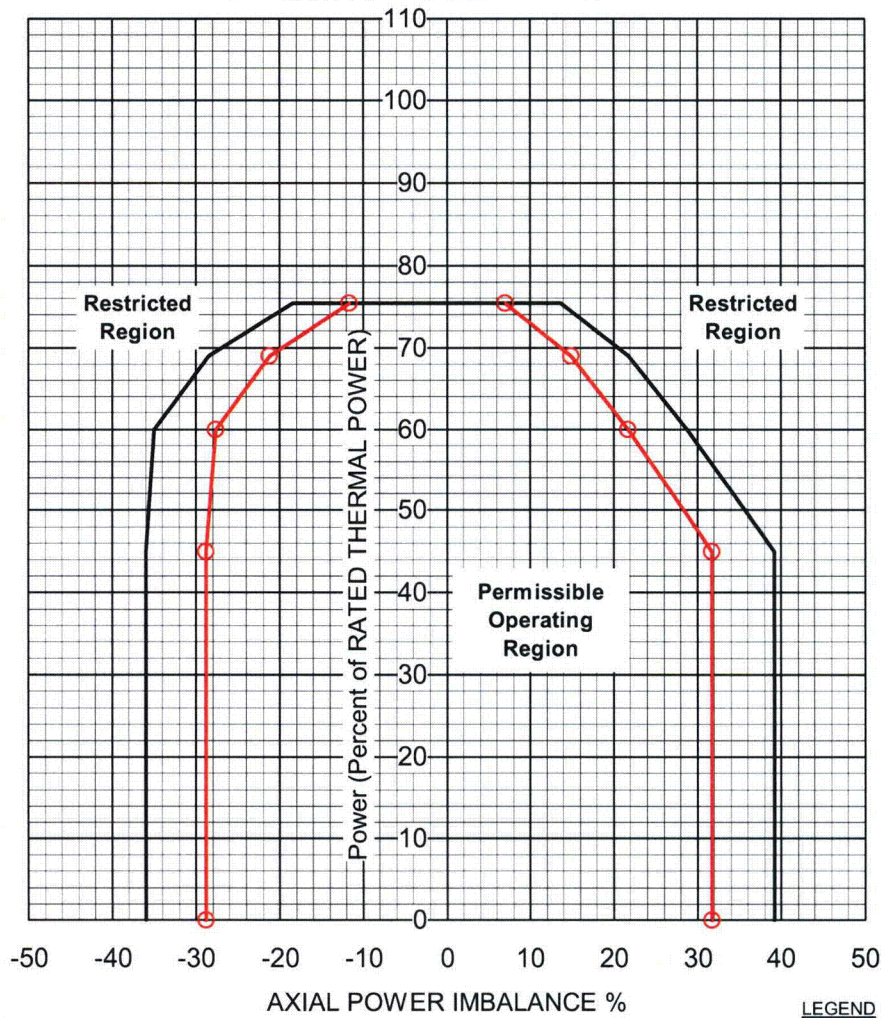
Note 1: Instrument error is accounted for in these Operating Limits.

LEGEND  
FULL INCORE  
 EXCORE



Figure 4e AXIAL POWER IMBALANCE Operating Limits  
 350 ±10 to 600 ±10 EFPD, Three RC Pumps--2817MWt RTP  
 Davis-Besse 1, Cycle 16

This Figure is referred to by  
 Technical Specification 3.2.1

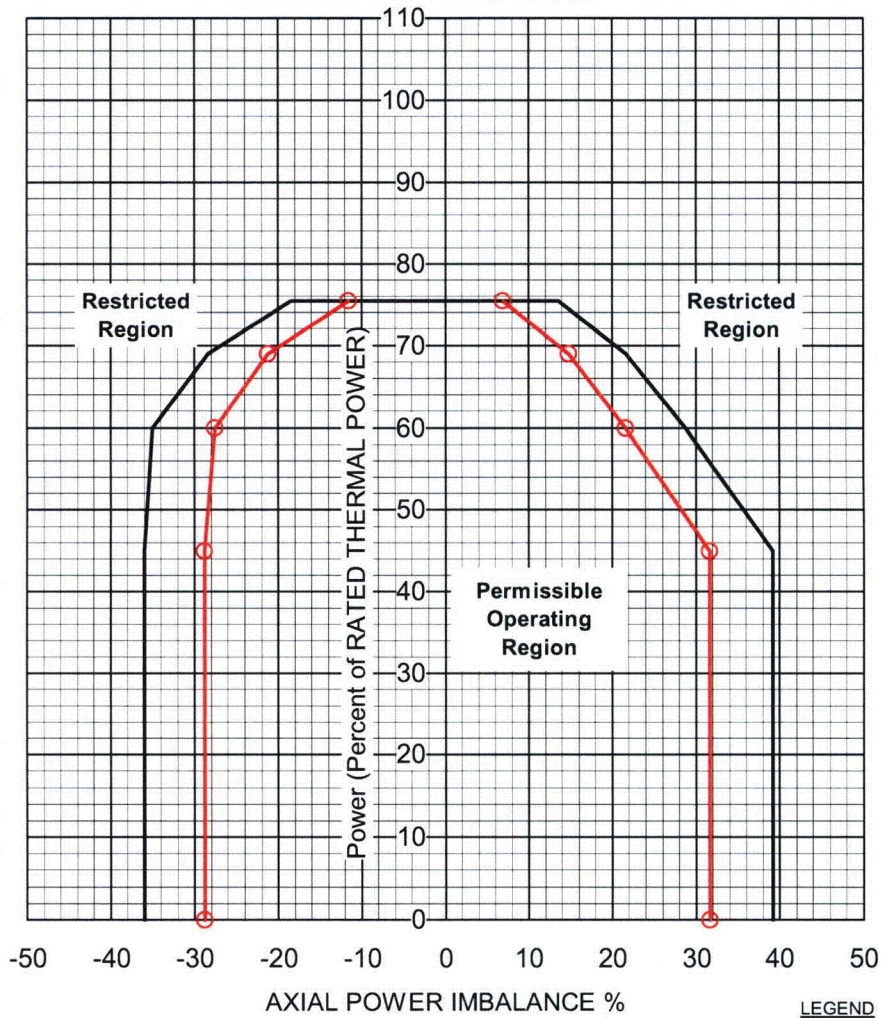


Note 1: Instrument error is accounted for in these Operating Limits.

LEGEND  
 FULL INCORE  
 EXCORE

Figure 4f AXIAL POWER IMBALANCE Operating Limits  
 After 600 ±10 EFPD, Three RC Pumps--2817MWt RTP  
 Davis-Besse 1, Cycle 16

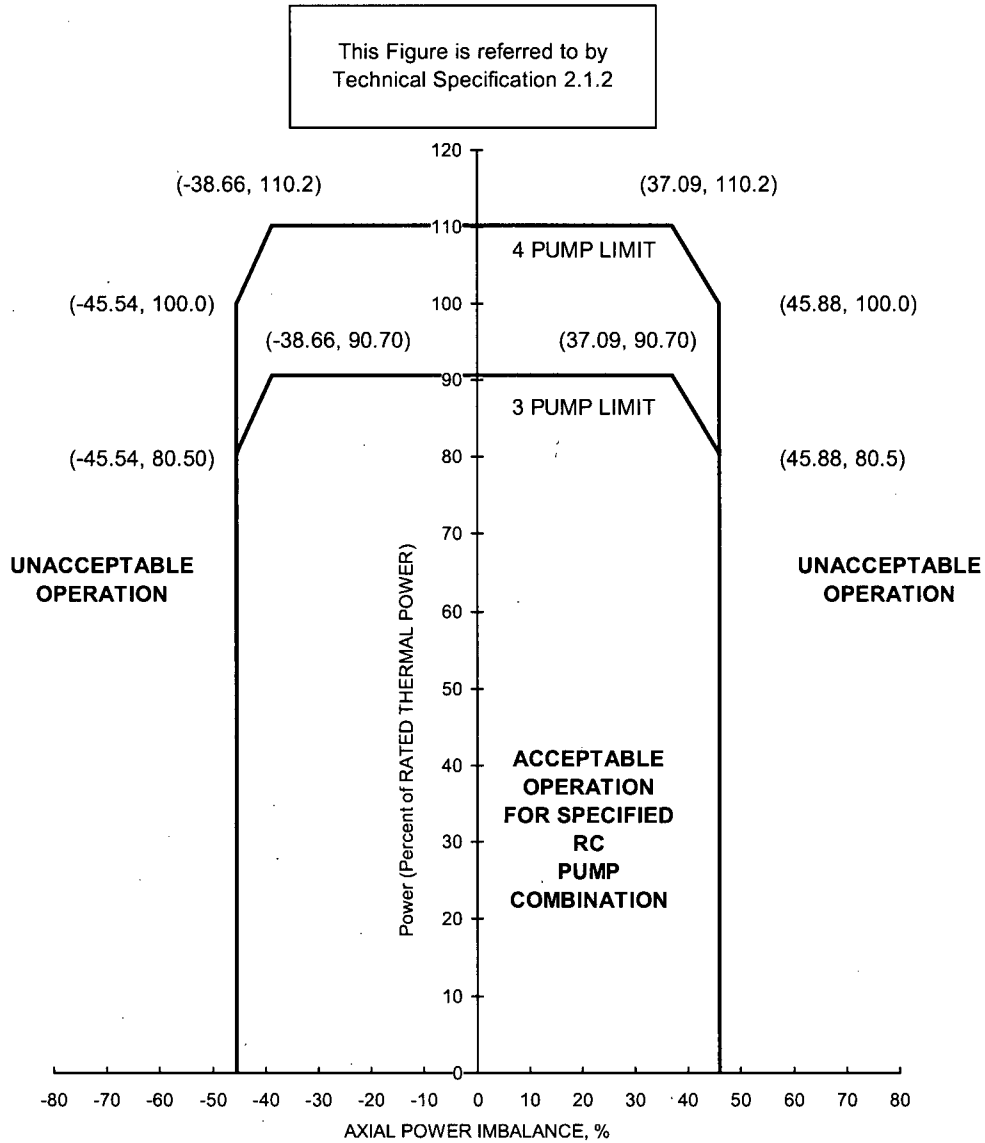
This Figure is referred to by  
 Technical Specification 3.2.1



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

LEGEND  
 FULL INCORE  
 EXCORE

Figure 5 AXIAL POWER IMBALANCE Protective Limits  
 2817MWt RTP



| <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   |

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

This Figure is referred to by  
 Technical Specification 2.2.1

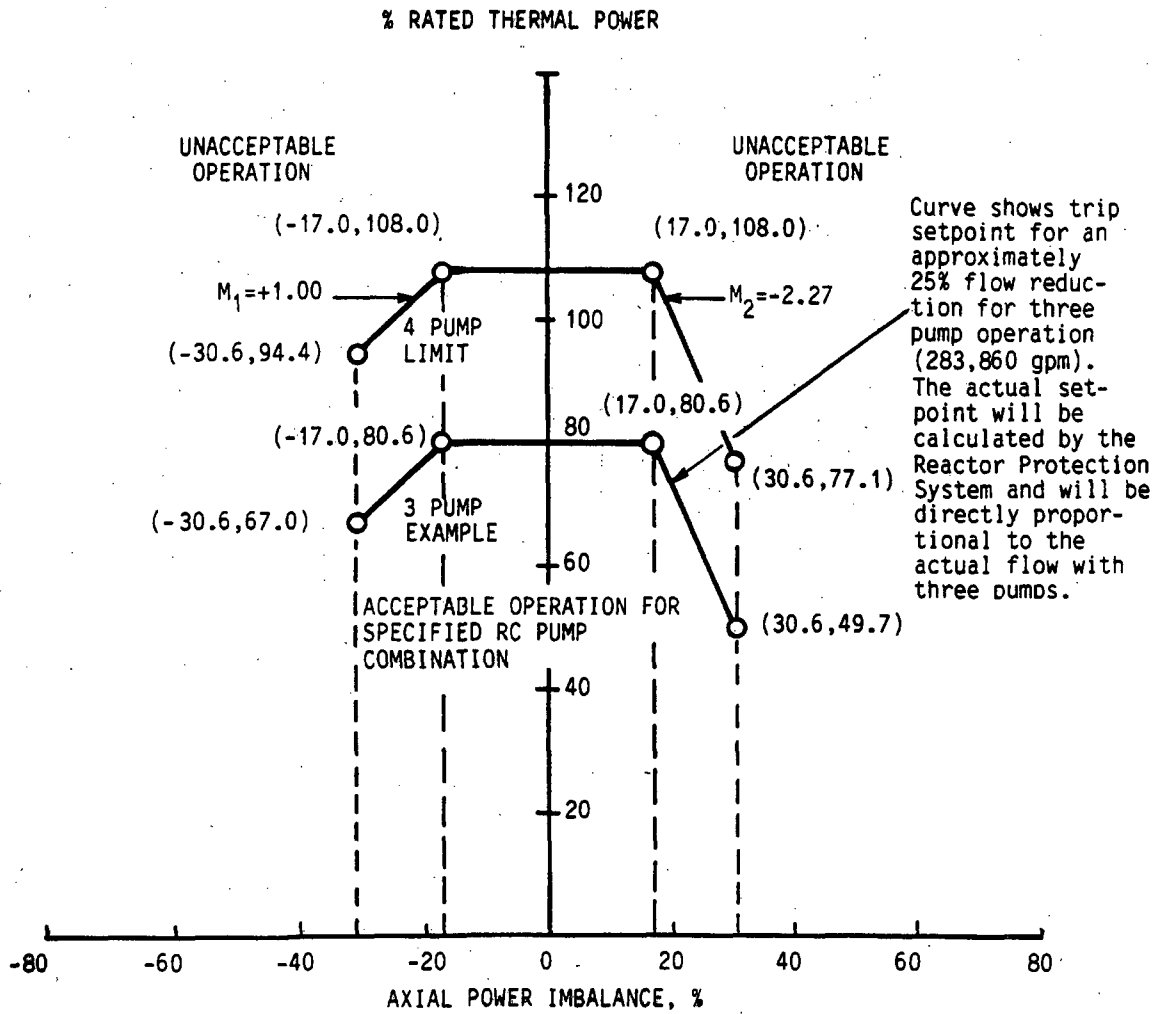


Table 1 QUADRANT POWER TILT Limits

2817 MWt RTP

This Table is referred to by Technical Specification 3.2.4

| QUADRANT POWER TILT as measured by: | From 0 EFPD to EOC-16                          |  |                     |                   |
|-------------------------------------|--|--|---------------------|-------------------|
|                                     | Steady-state Limit for THERMAL POWER ≤ 60% (%) | Steady-state Limit for THERMAL POWER > 60% (%) | Transient Limit (%) | Maximum Limit (%) |
| Symmetric Incore Detector System    | 7.90   | 4.25   | 10.03               | 20.00             |

Table 2 Negative Moderator Temperature Coefficient Limit

This Table is referred to by Technical Specification 3.1.1.3c

Negative Moderator Temperature Coefficient Limit (@ RATED THERMAL POWER)  $-3.76 \times 10^{-4} \Delta k/k/^{\circ}F$

Table 3 Power To Melt Limits

|   |
|---|
| <p>This Table is referred to by Technical<br/> Specification Bases B2.1</p> |
|---|

|   | <u>Batch 9K</u> | <u>Batch 15</u>  | <u>Batch 16</u>  | <u>Batch 17</u>  | <u>Batch 18</u>  |
|---|-----------------|--|--|--|--|
| Fuel Assembly Type                      | Mark-B8A        | Mark-B10K  | Mark-B12   | Mark-B-HTP   | Mark-B-HTP   |
| Minimum linear heat rate to melt, kW/ft | 20.5            | 22.1<br>(21.1) <sup>(a)</sup><br>(19.3) <sup>(b)</sup> | 22.1<br>(20.3) <sup>(c)</sup><br>(19.3) <sup>(d)</sup> | 22.1<br>(20.1) <sup>(e)</sup><br>(19.1) <sup>(f)</sup> | 22.1<br>(20.1) <sup>(e)</sup><br>(19.1) <sup>(f)</sup> |

- (a) Limit for 2 wt% Gd<sub>2</sub>O<sub>3</sub> rods – Batch 15
- (b) Limit for 8 wt% Gd<sub>2</sub>O<sub>3</sub> rods – Batch 15
- (c) Limit for 4 wt% Gd<sub>2</sub>O<sub>3</sub> rods – Batch 16
- (d) Limit for 8 wt% Gd<sub>2</sub>O<sub>3</sub> rods – Batch 16
- (e) Limit for 4 wt% Gd<sub>2</sub>O<sub>3</sub> rods – Batches 17 and 18
- (f) Limit for 8 wt% Gd<sub>2</sub>O<sub>3</sub> rods – Batches 17 and 18

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

**2817 MWt RTP**

This Table is referred  
to by Technical Specification 3.2.2

Heat Flux Hot Channel Factor  $F_Q$

$F_Q$  shall be limited by the following relationships:

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

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

$\text{LHR}^{\text{avg}} = 6.4119$  kW/ft at 2817 MWt for Batch 9K Mark-B8A fuel

$\text{LHR}^{\text{avg}} = 6.4209$  kW/ft at 2817 MWt for Batches 15C3 and 15E Mark-B10K fuel

$\text{LHR}^{\text{avg}} = 6.4209$  kW/ft at 2817 MWt for Batches 16C2, 16D2 and 16E2 Mark-B12 fuel

$\text{LHR}^{\text{avg}} = 6.4321$  kW/ft at 2817 MWt for Batch 17A-E Mark-B-HTP fuel

$\text{LHR}^{\text{avg}} = 6.4209$  kW/ft at 2817 MWt for Batch 18A-C Mark-B-HTP fuel

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

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

Batch 9K UO2 Fuel(Mark-B8A)  $\text{LHR}^{\text{ALLOW}}$  kW/ft<sup>(a)</sup>

| <u>Axial Segment</u> | <u>0<br/>MWd/mtU</u> | <u>24,500<br/>MWd/mtU</u> | <u>52,000<br/>MWd/mtU</u> | <u>60,000<br/>MWd/mtU</u> |
|----------------------|----------------------|---------------------------|---------------------------|---------------------------|
| 1                    | 16.1                 | 16.1                      | 12.0                      | 10.2                      |
| 2                    | 15.8                 | 15.8                      | 12.0                      | 10.2                      |
| 3                    | 15.0                 | 15.0                      | 12.0                      | 10.2                      |
| 4                    | 15.0                 | 15.0                      | 12.0                      | 10.2                      |
| 5                    | 15.4                 | 15.4                      | 12.0                      | 10.2                      |
| 6                    | 15.4                 | 15.4                      | 12.0                      | 10.2                      |
| 7                    | 14.6                 | 14.6                      | 12.0                      | 10.2                      |
| 8                    | 14.3                 | 14.3                      | 12.0                      | 10.2                      |

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

Table 4a . (Continued)

Batch 15C3 and 15E UO2 Fuel (Mark-B10K) LHR<sup>ALLOW</sup> kW/ft<sup>(a)</sup>

| <u>Axial Segment</u> | <u>0</u><br><u>MWd/mtU</u> | <u>35,000</u><br><u>MWd/mtU</u> | <u>58,000</u><br><u>MWd/mtU</u> | <u>59,000</u><br><u>MWd/mtU</u> | <u>60,000</u><br><u>MWd/mtU</u> | <u>62,000</u><br><u>MWd/mtU</u> |
|----------------------|----------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| 1                    | 17.6                       | 16.8                            | 14.7                            | 14.4                            | 14.1                            | 13.5                            |
| 2                    | 17.5                       | 16.7                            | 14.7                            | 14.4                            | 14.1                            | 13.5                            |
| 3                    | 17.0                       | 15.6                            | 14.6                            | 14.4                            | 14.1                            | 13.5                            |
| 4                    | 16.6                       | 15.3                            | 14.4                            | 14.4                            | 14.1                            | 13.5                            |
| 5                    | 16.0                       | 15.3                            | 14.2                            | 14.1                            | 14.1                            | 13.5                            |
| 6                    | 15.3                       | 15.3                            | 13.7                            | 13.7                            | 13.6                            | 13.5                            |
| 7                    | 14.7                       | 14.7                            | 13.2                            | 13.1                            | 13.1                            | 13.0                            |
| 8                    | 14.5                       | 14.5                            | 13.0                            | 12.9                            | 12.9                            | 12.8                            |

Batch 16C2, 16D2, and 16E2 UO2 Fuel (Mark-B12) LHR<sup>ALLOW</sup> kW/ft<sup>(a)</sup>

| <u>Axial Segment</u> | <u>0</u><br><u>MWd/mtU</u> | <u>35,000</u><br><u>MWd/mtU</u> | <u>58,000</u><br><u>MWd/mtU</u> | <u>59,000</u><br><u>MWd/mtU</u> | <u>60,000</u><br><u>MWd/mtU</u> | <u>62,000</u><br><u>MWd/mtU</u> |
|----------------------|----------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| 1                    | 17.6                       | 16.8                            | 14.7                            | 14.4                            | 14.1                            | 13.5                            |
| 2                    | 17.5                       | 16.7                            | 14.7                            | 14.4                            | 14.1                            | 13.5                            |
| 3                    | 17.0                       | 15.6                            | 14.6                            | 14.4                            | 14.1                            | 13.5                            |
| 4                    | 16.6                       | 15.3                            | 14.4                            | 14.4                            | 14.1                            | 13.5                            |
| 5                    | 16.0                       | 15.3                            | 14.2                            | 14.1                            | 14.1                            | 13.5                            |
| 6                    | 15.3                       | 15.3                            | 13.7                            | 13.7                            | 13.6                            | 13.5                            |
| 7                    | 14.7                       | 14.7                            | 13.2                            | 13.1                            | 13.1                            | 13.0                            |
| 8                    | 14.5                       | 14.5                            | 13.0                            | 12.9                            | 12.9                            | 12.8                            |

Batch 17A-17E UO2 Fuel (Mark-B-HTP) LHR<sup>ALLOW</sup> kW/ft<sup>(a)</sup>

| <u>Axial Segment</u> | <u>0</u><br><u>MWd/mtU</u> | <u>40,000</u><br><u>MWd/mtU</u> | <u>62,000</u><br><u>MWd/mtU</u> |
|----------------------|----------------------------|---------------------------------|---------------------------------|
| 1                    | 17.6                       | 17.2                            | 13.6                            |
| 2                    | 17.5                       | 17.1                            | 13.5                            |
| 3                    | 17.1                       | 16.7                            | 13.2                            |
| 4                    | 17.0                       | 16.7                            | 13.2                            |
| 5                    | 16.5                       | 16.2                            | 13.1                            |
| 6                    | 15.9                       | 16.0                            | 13.1                            |
| 7                    | 15.3                       | 15.4                            | 12.8                            |
| 8                    | 15.1                       | 15.2                            | 12.6                            |

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



Table 4a , (Continued)

Batch 18A-18C UO2 Fuel (Mark-B-HTP) LHR<sup>ALLOW</sup> kW/ft<sup>(a)</sup>

|                      | 0              | 40,000         | 62,000         |
|----------------------|----------------|----------------|----------------|
| <u>Axial Segment</u> | <u>MWd/mtU</u> | <u>MWd/mtU</u> | <u>MWd/mtU</u> |
| 1                    | 17.6           | 17.2           | 13.6           |
| 2                    | 17.5           | 17.1           | 13.5           |
| 3                    | 17.1           | 16.7           | 13.2           |
| 4                    | 17.0           | 16.7           | 13.2           |
| 5                    | 16.5           | 16.2           | 13.1           |
| 6                    | 15.9           | 16.0           | 13.1           |
| 7                    | 15.3           | 15.4           | 12.8           |
| 8                    | 15.1           | 15.2           | 12.6           |

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

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

**2817 MWt RTP**

This Table is referred  
to by Technical Specification 3.2.2

Heat Flux Hot Channel Factor  $F_Q$

$F_Q$  shall be limited by the following relationships:

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

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

$\text{LHR}^{\text{avg}} = 6.4119$  kW/ft at 2817 MWt for Batch 9K Mark-B8A fuel

$\text{LHR}^{\text{avg}} = 6.4209$  kW/ft at 2817 MWt for Batches 15C3 and 15E Mark-B10K fuel

$\text{LHR}^{\text{avg}} = 6.4209$  kW/ft at 2817 MWt for Batches 16C2, 16D2 and 16E2 Mark-B12 fuel

$\text{LHR}^{\text{avg}} = 6.4321$  kW/ft at 2817 MWt for Batch 17A-E Mark-B-HTP fuel

$\text{LHR}^{\text{avg}} = 6.4209$  kW/ft at 2817 MWt for Batch 18A-C Mark-B-HTP fuel

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

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

| Core Elevation<br>(ft) | Batch 9K – UO2 Fuel $\text{LHR}^{\text{ALLOW}}$ kW/ft* |                   |                   |                   |
|------------------------|--|-------------------|-------------------|-------------------|
|                        | 0 MWd/mtU  | 24,500<br>MWd/mtU | 52,000<br>MWd/mtU | 60,000<br>MWd/mtU |
| 0.000                  | 16.3   | 16.3              | 12.0              | 10.2              |
| 2.506                  | 15.9   | 15.9              | 12.0              | 10.2              |
| 4.264                  | 15.1   | 15.1              | 12.0              | 10.2              |
| 6.021                  | 15.5   | 15.5              | 12.0              | 10.2              |
| 7.779                  | 16.0   | 16.0              | 12.0              | 10.2              |
| 9.536                  | 15.4   | 15.4              | 12.0              | 10.2              |
| 12.000                 | 14.3   | 14.3              | 12.0              | 10.2              |

\* Linear interpolation for allowable LHR between specified burnup points is valid for these tables.

| Core<br>Elevation (ft) | Batches 15C3 and 15E – UO2 Fuel $\text{LHR}^{\text{ALLOW}}$ kW/ft* |                   |                   |                   |                   |                   |
|------------------------|--|-------------------|-------------------|-------------------|-------------------|-------------------|
|                        | 0 MWd/mtU  | 35,000<br>MWd/mtU | 58,000<br>MWd/mtU | 59,000<br>MWd/mtU | 60,000<br>MWd/mtU | 62,000<br>MWd/mtU |
| 0.000                  | 17.6   | 16.8              | 14.7              | 14.4              | 14.1              | 13.5              |
| 2.506                  | 17.6   | 16.8              | 14.7              | 14.4              | 14.1              | 13.5              |
| 4.264                  | 17.1   | 15.7              | 14.7              | 14.4              | 14.1              | 13.5              |
| 6.021                  | 16.6   | 15.3              | 14.4              | 14.4              | 14.1              | 13.5              |
| 7.779                  | 16.0   | 15.8              | 14.2              | 14.1              | 14.1              | 13.5              |
| 9.536                  | 15.3   | 15.3              | 13.7              | 13.7              | 13.6              | 13.5              |
| 12.000                 | 14.5   | 14.5              | 13.0              | 12.9              | 12.9              | 12.8              |

\* Linear interpolation for allowable LHR between specified burnup points is valid for these tables.

Table 4b, (Continued)

| Core<br>Elevation (ft) | Batch 16C2, 16D2, and 16E2 – UO <sub>2</sub> Fuel LHR <sup>ALLOW</sup> kW/ft* |                   |                   |                   |                   |                   |
|------------------------|---|-------------------|-------------------|-------------------|-------------------|-------------------|
|                        | 0 MWd/mtU   | 35,000<br>MWd/mtU | 58,000<br>MWd/mtU | 59,000<br>MWd/mtU | 60,000<br>MWd/mtU | 62,000<br>MWd/mtU |
| 0.000                  | 17.6  | 16.8              | 14.7              | 14.4              | 14.1              | 13.5              |
| 2.506                  | 17.6  | 16.8              | 14.7              | 14.4              | 14.1              | 13.5              |
| 4.264                  | 17.1  | 15.7              | 14.7              | 14.4              | 14.1              | 13.5              |
| 6.021                  | 16.6  | 15.3              | 14.4              | 14.4              | 14.1              | 13.5              |
| 7.779                  | 16.0  | 15.8              | 14.2              | 14.1              | 14.1              | 13.5              |
| 9.536                  | 15.3  | 15.3              | 13.7              | 13.7              | 13.6              | 13.5              |
| 12.000                 | 14.5  | 14.5              | 13.0              | 12.9              | 12.9              | 12.8              |

\* Linear interpolation for allowable LHR between specified burnup points is valid for these tables.

| Core Elevation (ft) | Batch 17A-E – UO <sub>2</sub> Fuel LHR <sup>ALLOW</sup> kW/ft* |                |                |
|---------------------|--|----------------|----------------|
|                     | 0 MWd/mtU  | 40,000 MWd/mtU | 62,000 MWd/mtU |
| 0.000               | 17.6   | 17.2           | 13.6           |
| 2.506               | 17.6   | 17.2           | 13.6           |
| 4.264               | 17.2   | 16.8           | 13.3           |
| 6.021               | 17.0   | 16.7           | 13.2           |
| 7.779               | 16.5   | 16.2           | 13.1           |
| 9.536               | 15.9   | 16.0           | 13.3           |
| 12.000              | 15.1   | 15.2           | 12.6           |

\* Linear interpolation for allowable LHR between specified burnup points is valid for these tables.

| Core Elevation (ft) | Batch 18A-C – UO <sub>2</sub> Fuel LHR <sup>ALLOW</sup> kW/ft* |                |                |
|---------------------|--|----------------|----------------|
|                     | 0 MWd/mtU  | 40,000 MWd/mtU | 62,000 MWd/mtU |
| 0.000               | 17.6   | 17.2           | 13.6           |
| 2.506               | 17.6   | 17.2           | 13.6           |
| 4.264               | 17.2   | 16.8           | 13.3           |
| 6.021               | 17.0   | 16.7           | 13.2           |
| 7.779               | 16.5   | 16.2           | 13.1           |
| 9.536               | 15.9   | 16.0           | 13.3           |
| 12.000              | 15.1   | 15.2           | 12.6           |

\* Linear interpolation for allowable LHR between specified burnup points is valid for these tables.

| Core<br>Elevation (ft) | Batch 15 – 2 wt% Gadolinia Fuel LHR <sup>ALLOW</sup> kW/ft* |                   |                   |                   |                   |                   |
|------------------------|---|-------------------|-------------------|-------------------|-------------------|-------------------|
|                        | 0 MWd/mtU   | 35,000<br>MWd/mtU | 58,000<br>MWd/mtU | 59,000<br>MWd/mtU | 60,000<br>MWd/mtU | 62,000<br>MWd/mtU |
| 0.000                  | 16.5  | 15.7              | 13.9              | 13.6              | 13.3              | 12.8              |
| 2.506                  | 16.5  | 15.7              | 13.9              | 13.6              | 13.3              | 12.8              |
| 4.264                  | 16.0  | 14.7              | 13.9              | 13.6              | 13.3              | 12.8              |
| 6.021                  | 15.5  | 14.3              | 13.6              | 13.6              | 13.3              | 12.8              |
| 7.779                  | 15.0  | 14.8              | 13.4              | 13.3              | 13.3              | 12.8              |
| 9.536                  | 14.3  | 14.3              | 13.0              | 12.9              | 12.9              | 12.8              |
| 12.000                 | 13.6  | 13.6              | 12.4              | 12.3              | 12.3              | 12.2              |

\* Linear interpolation for allowable LHR between specified burnup points is valid for these tables.

Table 4b. (Continued)

| Core Elevation (ft) | Batch 16 – 4 wt% Gadolinia Fuel LHR <sup>ALLOW</sup> kW/ft* |                |                |                |                |                |
|---------------------|---|----------------|----------------|----------------|----------------|----------------|
|                     | 0 MWd/mtU   | 35,000 MWd/mtU | 58,000 MWd/mtU | 59,000 MWd/mtU | 60,000 MWd/mtU | 62,000 MWd/mtU |
| 0.000               | 15.8  | 15.1           | 13.3           | 13.0           | 12.7           | 12.2           |
| 2.506               | 15.8  | 15.1           | 13.3           | 13.0           | 12.7           | 12.2           |
| 4.264               | 15.3  | 14.1           | 13.3           | 13.0           | 12.7           | 12.2           |
| 6.021               | 14.9  | 13.7           | 13.0           | 13.0           | 12.7           | 12.2           |
| 7.779               | 14.3  | 14.2           | 12.9           | 12.8           | 12.8           | 12.2           |
| 9.536               | 13.7  | 13.7           | 12.4           | 12.3           | 12.3           | 12.2           |
| 12.000              | 13.0  | 13.0           | 11.8           | 11.7           | 11.7           | 11.6           |

\* Linear interpolation for allowable LHR between specified burnup points is valid for these tables.

| Core Elevation (ft) | Batches 15 and 16 – 8 wt% Gadolinia Fuel LHR <sup>ALLOW</sup> kW/ft* |                |                |                |                |                |
|---------------------|--|----------------|----------------|----------------|----------------|----------------|
|                     | 0 MWd/mtU  | 35,000 MWd/mtU | 58,000 MWd/mtU | 59,000 MWd/mtU | 60,000 MWd/mtU | 62,000 MWd/mtU |
| 0.000               | 14.9   | 14.2           | 12.4           | 12.1           | 11.9           | 11.4           |
| 2.506               | 14.9   | 14.2           | 12.4           | 12.1           | 11.9           | 11.4           |
| 4.264               | 14.5   | 13.3           | 12.4           | 12.1           | 11.9           | 11.4           |
| 6.021               | 14.0   | 12.9           | 12.2           | 12.2           | 11.9           | 11.4           |
| 7.779               | 13.5   | 13.4           | 12.0           | 11.9           | 11.9           | 11.4           |
| 9.536               | 12.9   | 12.9           | 11.6           | 11.5           | 11.5           | 11.4           |
| 12.000              | 12.2   | 12.2           | 11.0           | 10.9           | 10.9           | 10.8           |

\* Linear interpolation for allowable LHR between specified burnup points is valid for these tables.

| Core Elevation (ft) | Batches 17 and 18 – 4 wt% Gadolinia Fuel LHR <sup>ALLOW</sup> kW/ft* |                |                |
|---------------------|--|----------------|----------------|
|                     | 0 MWd/mtU  | 40,000 MWd/mtU | 62,000 MWd/mtU |
| 0.000               | 15.8   | 15.7           | 12.3           |
| 2.506               | 15.8   | 15.7           | 12.3           |
| 4.264               | 15.4   | 15.2           | 12.0           |
| 6.021               | 15.2   | 15.1           | 11.9           |
| 7.779               | 14.8   | 14.7           | 11.8           |
| 9.536               | 14.3   | 14.5           | 12.0           |
| 12.000              | 13.6   | 13.8           | 11.4           |

\* Linear interpolation for allowable LHR between specified burnup points is valid for these tables.

| Core Elevation (ft) | Batches 17 and 18 – 8 wt% Gadolinia Fuel LHR <sup>ALLOW</sup> kW/ft* |                |                |
|---------------------|--|----------------|----------------|
|                     | 0 MWd/mtU  | 40,000 MWd/mtU | 62,000 MWd/mtU |
| 0.000               | 14.9   | 14.9           | 11.5           |
| 2.506               | 14.9   | 14.9           | 11.5           |
| 4.264               | 14.5   | 14.6           | 11.2           |
| 6.021               | 14.4   | 14.5           | 11.1           |
| 7.779               | 13.9   | 14.0           | 11.0           |
| 9.536               | 13.4   | 13.9           | 11.2           |
| 12.000              | 12.7   | 13.2           | 10.6           |

\* Linear interpolation for allowable LHR between specified burnup points is valid for these tables.

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

This Table is referred  
 to by Technical Specification 3.2.3

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

$$F_{\Delta H}^N \leq \text{MARP} [1 + 0.3 (1 - P/P_m)]$$

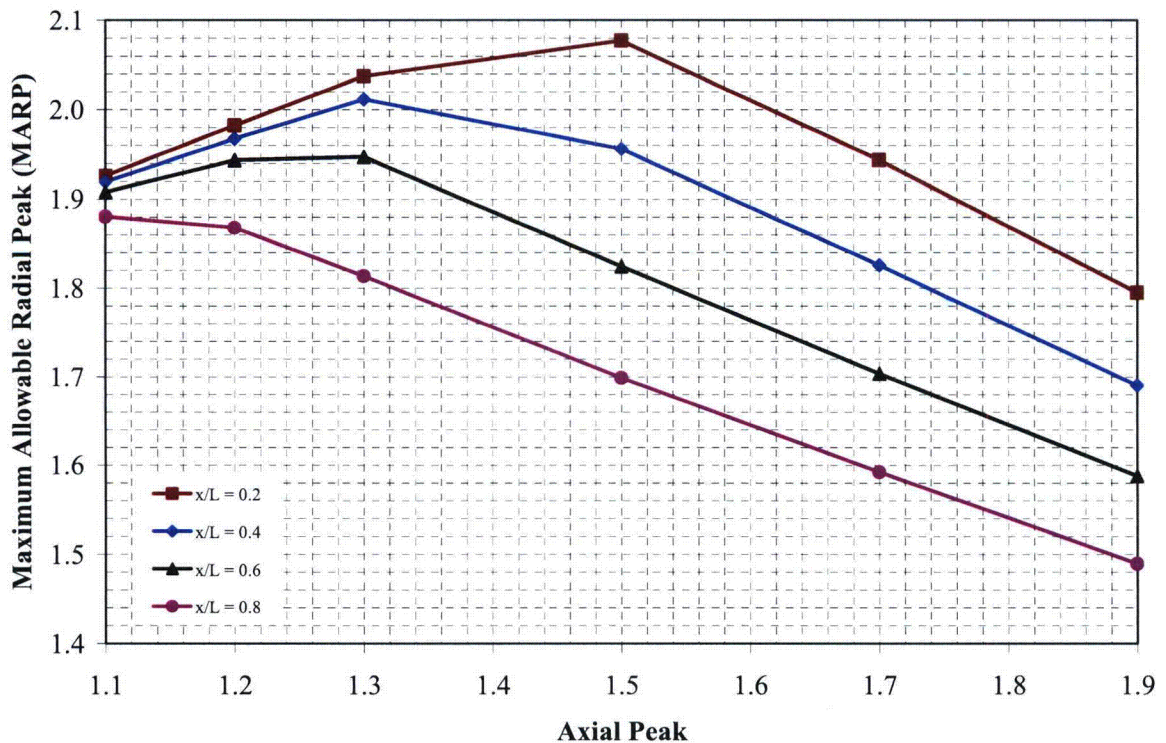
MARP = Maximum Allowable Radial Peak, see MARP Figures and data Tables

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

$P_m = 1.0$  for 4-RCP operation

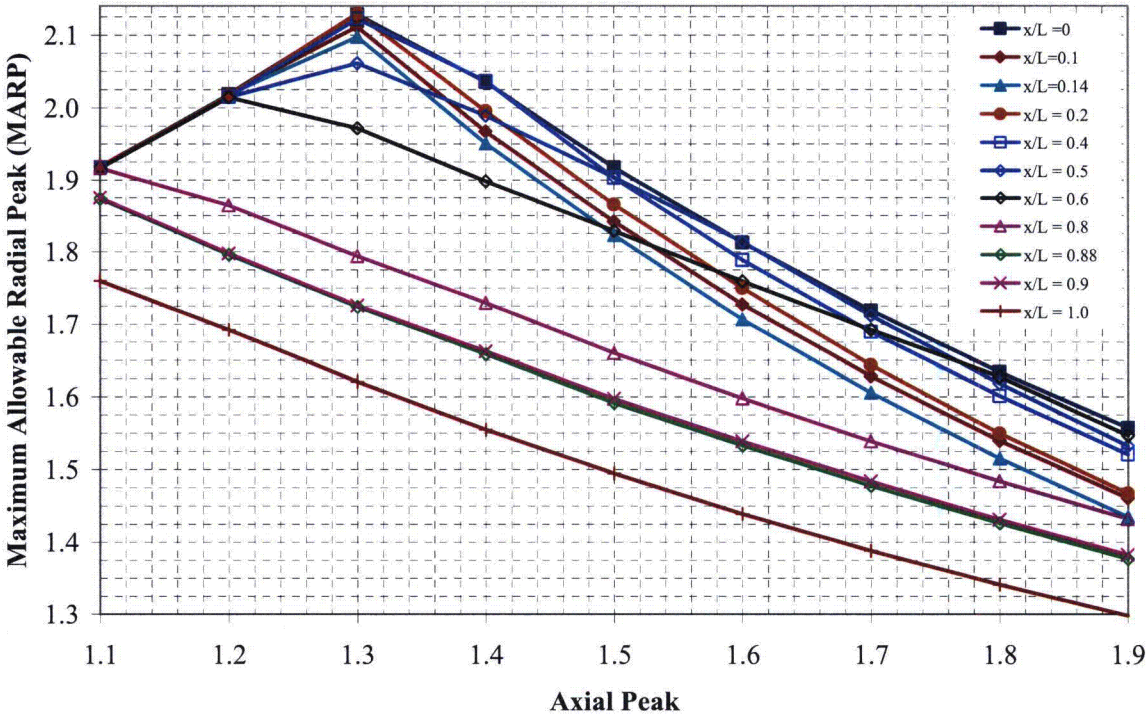
$P_m = 0.75$  for 3-RCP operation

Figure 7 Maximum Allowable Radial Peak for  $F_{\Delta H}^N$  in Mark-B Fuel Assemblies\*



\* This figure is applicable to all Mark-B fuel in the core. Linear interpolation and extrapolation above x/L of 0.8 are acceptable. For axial heights < x/L of 0.2, the value at x/L 0.2 will be used.

Figure 8 Maximum Allowable Radial Peak for  $F_{\Delta H}^N$  in Mark-BHTP Fuel Assemblies



\* This figure is applicable to all Mark-B-HTP fuel in the core. Linear interpolation is acceptable. The MARP values are based on an active fuel height of 142.75 inches.

Table 6 Maximum Allowable Radial Peak for  $F_{\Delta H}^N$  in Mark-B Fuel Assemblies

| <u>Axial Peak</u> | <u>x/L</u> | <u>Axial Height (inches)</u> | <u>MAP Limit</u> | <u>MARP Limit</u> |
|-------------------|------------|------------------------------|------------------|-------------------|
| 1.1               | 0.2        | 28.12                        | 2.0415           | 1.9264            |
|                   | 0.4        | 56.24                        | 2.0345           | 1.9198            |
|                   | 0.6        | 84.36                        | 2.0221           | 1.9081            |
|                   | 0.8        | 112.48                       | 1.9934           | 1.8810            |
| 1.2               | 0.2        | 28.12                        | 2.2918           | 1.9824            |
|                   | 0.4        | 56.24                        | 2.2749           | 1.9678            |
|                   | 0.6        | 84.36                        | 2.2470           | 1.9437            |
|                   | 0.8        | 112.48                       | 2.1601           | 1.8685            |
| 1.3               | 0.2        | 28.12                        | 2.5521           | 2.0378            |
|                   | 0.4        | 56.24                        | 2.5197           | 2.0119            |
|                   | 0.6        | 84.36                        | 2.4387           | 1.9472            |
|                   | 0.8        | 112.48                       | 2.2719           | 1.8140            |
| 1.5               | 0.2        | 28.12                        | 3.0022           | 2.0775            |
|                   | 0.4        | 56.24                        | 2.8272           | 1.9564            |
|                   | 0.6        | 84.36                        | 2.6367           | 1.8246            |
|                   | 0.8        | 112.48                       | 2.4553           | 1.6991            |
| 1.7               | 0.2        | 28.12                        | 3.1839           | 1.9441            |
|                   | 0.4        | 56.24                        | 2.9911           | 1.8263            |
|                   | 0.6        | 84.36                        | 2.7902           | 1.7037            |
|                   | 0.8        | 112.48                       | 2.6084           | 1.5927            |
| 1.9               | 0.2        | 28.12                        | 3.2865           | 1.7955            |
|                   | 0.4        | 56.24                        | 3.0945           | 1.6906            |
|                   | 0.6        | 84.36                        | 2.9062           | 1.5877            |
|                   | 0.8        | 112.48                       | 2.7279           | 1.4903            |

Table 7 Maximum Allowable Radial Peak for  $F_{\Delta H}^N$  in Mark-BHTP Fuel Assemblies

| Axial Peak | x/L     | Axial Height (inches) | MAP Limit | MARP Limit | Axial Peak | x/L     | Axial Height (inches) | MAP Limit | MARP Limit |
|------------|---------|-----------------------|-----------|------------|------------|---------|-----------------------|-----------|------------|
| 1.1        | 0.0     | 0.000                 | 2.03286   | 1.91828    | 1.6        | 0.0     | 0.000                 | 2.79510   | 1.81332    |
|            | 0.1     | 14.275                | 2.03375   | 1.91912    |            | 0.1     | 14.275                | 2.66285   | 1.72752    |
|            | 0.14    | 19.985                | 2.03379   | 1.91916    |            | 0.14    | 19.985                | 2.63106   | 1.70690    |
|            | 0.2     | 28.550                | 2.03355   | 1.91893    |            | 0.2     | 28.550                | 2.69787   | 1.75024    |
|            | 0.4     | 57.100                | 2.03179   | 1.91727    |            | 0.4     | 57.100                | 2.75779   | 1.78912    |
|            | 0.5     | 71.375                | 2.03107   | 1.91659    |            | 0.5     | 71.375                | 2.79658   | 1.81428    |
|            | 0.6     | 85.650                | 2.03099   | 1.91652    |            | 0.6     | 85.650                | 2.71189   | 1.75934    |
|            | 0.8     | 114.200               | 2.03178   | 1.91726    |            | 0.8     | 114.200               | 2.46394   | 1.59848    |
|            | 0.88    | 125.620               | 1.98623   | 1.87428    |            | 0.88    | 125.620               | 2.36299   | 1.53299    |
|            | 0.9     | 128.475               | 1.98774   | 1.87570    |            | 0.9     | 128.475               | 2.37234   | 1.53906    |
| 1.0        | 142.750 | 1.86518               | 1.76005   | 1.0        | 142.750    | 2.21845 | 1.43922               |           |            |
| 1.2        | 0.0     | 0.000                 | 2.33414   | 2.01903    | 1.7        | 0.0     | 0.000                 | 2.81571   | 1.71924    |
|            | 0.1     | 14.275                | 2.33416   | 2.01905    |            | 0.1     | 14.275                | 2.66718   | 1.62855    |
|            | 0.14    | 19.985                | 2.33413   | 2.01902    |            | 0.14    | 19.985                | 2.63022   | 1.60598    |
|            | 0.2     | 28.550                | 2.33248   | 2.01760    |            | 0.2     | 28.550                | 2.69195   | 1.64367    |
|            | 0.4     | 57.100                | 2.33024   | 2.01566    |            | 0.4     | 57.100                | 2.76735   | 1.68971    |
|            | 0.5     | 71.375                | 2.32955   | 2.01506    |            | 0.5     | 71.375                | 2.80468   | 1.71250    |
|            | 0.6     | 85.650                | 2.32916   | 2.01472    |            | 0.6     | 85.650                | 2.77165   | 1.69234    |
|            | 0.8     | 114.200               | 2.15618   | 1.86510    |            | 0.8     | 114.200               | 2.52074   | 1.53913    |
|            | 0.88    | 125.620               | 2.07666   | 1.79631    |            | 0.88    | 125.620               | 2.42051   | 1.47793    |
|            | 0.9     | 128.475               | 2.07869   | 1.79807    |            | 0.9     | 128.475               | 2.43041   | 1.48398    |
| 1.0        | 142.750 | 1.95649               | 1.69236   | 1.0        | 142.750    | 2.27373 | 1.38831               |           |            |
| 1.3        | 0.0     | 0.000                 | 2.66591   | 2.12863    | 1.8        | 0.0     | 0.000                 | 2.83401   | 1.63428    |
|            | 0.1     | 14.275                | 2.64485   | 2.11181    |            | 0.1     | 14.275                | 2.66992   | 1.53965    |
|            | 0.14    | 19.985                | 2.62777   | 2.09817    |            | 0.14    | 19.985                | 2.62789   | 1.51542    |
|            | 0.2     | 28.550                | 2.66761   | 2.12998    |            | 0.2     | 28.550                | 2.68772   | 1.54992    |
|            | 0.4     | 57.100                | 2.65903   | 2.12313    |            | 0.4     | 57.100                | 2.7774    | 1.60163    |
|            | 0.5     | 71.375                | 2.58224   | 2.06182    |            | 0.5     | 71.375                | 2.80694   | 1.61867    |
|            | 0.6     | 85.650                | 2.46978   | 1.97202    |            | 0.6     | 85.650                | 2.82218   | 1.62746    |
|            | 0.8     | 114.200               | 2.24712   | 1.79424    |            | 0.8     | 114.200               | 2.57398   | 1.48433    |
|            | 0.88    | 125.620               | 2.15963   | 1.72438    |            | 0.88    | 125.620               | 2.47403   | 1.42669    |
|            | 0.9     | 128.475               | 2.16184   | 1.72615    |            | 0.9     | 128.475               | 2.48254   | 1.43160    |
| 1.0        | 142.750 | 2.02976               | 1.62069   | 1.0        | 142.750    | 2.32589 | 1.34126               |           |            |
| 1.4        | 0.0     | 0.000                 | 2.74599   | 2.03596    | 1.9        | 0.0     | 0.000                 | 2.85122   | 1.55767    |
|            | 0.1     | 14.275                | 2.65413   | 1.96785    |            | 0.1     | 14.275                | 2.67423   | 1.46097    |
|            | 0.14    | 19.985                | 2.63176   | 1.95126    |            | 0.14    | 19.985                | 2.62778   | 1.43560    |
|            | 0.2     | 28.550                | 2.69213   | 1.99602    |            | 0.2     | 28.550                | 2.68609   | 1.46745    |
|            | 0.4     | 57.100                | 2.74771   | 2.03723    |            | 0.4     | 57.100                | 2.78418   | 1.52104    |
|            | 0.5     | 71.375                | 2.68391   | 1.98993    |            | 0.5     | 71.375                | 2.80567   | 1.53278    |
|            | 0.6     | 85.650                | 2.56032   | 1.89829    |            | 0.6     | 85.650                | 2.83113   | 1.54669    |
|            | 0.8     | 114.200               | 2.33307   | 1.72980    |            | 0.8     | 114.200               | 2.62225   | 1.43258    |
|            | 0.88    | 125.620               | 2.23716   | 1.65869    |            | 0.88    | 125.620               | 2.52166   | 1.37762    |
|            | 0.9     | 128.475               | 2.24237   | 1.66256    |            | 0.9     | 128.475               | 2.53147   | 1.38298    |
| 1.0        | 142.750 | 2.09699               | 1.55477   | 1.0        | 142.750    | 2.37605 | 1.29807               |           |            |
| 1.5        | 0.0     | 0.000                 | 2.77184   | 1.91811    |            | 0.0     | 0.000                 | 2.77184   | 1.91811    |
|            | 0.1     | 14.275                | 2.66225   | 1.84228    |            | 0.1     | 14.275                | 2.66225   | 1.84228    |
|            | 0.14    | 19.985                | 2.63504   | 1.82345    |            | 0.14    | 19.985                | 2.63504   | 1.82345    |
|            | 0.2     | 28.550                | 2.69706   | 1.86637    |            | 0.2     | 28.550                | 2.69706   | 1.86637    |
|            | 0.4     | 57.100                | 2.75139   | 1.90396    |            | 0.4     | 57.100                | 2.75139   | 1.90396    |
|            | 0.5     | 71.375                | 2.75241   | 1.90467    |            | 0.5     | 71.375                | 2.75241   | 1.90467    |
|            | 0.6     | 85.650                | 2.64282   | 1.82883    |            | 0.6     | 85.650                | 2.64282   | 1.82883    |
|            | 0.8     | 114.200               | 2.39919   | 1.66024    |            | 0.8     | 114.200               | 2.39919   | 1.66024    |
|            | 0.88    | 125.620               | 2.30027   | 1.59179    |            | 0.88    | 125.620               | 2.30027   | 1.59179    |
|            | 0.9     | 128.475               | 2.30907   | 1.59788    |            | 0.9     | 128.475               | 2.30907   | 1.59788    |
| 1.0        | 142.750 | 2.15988               | 1.49464   | 1.0        | 142.750    | 2.15988 | 1.49464               |           |            |