Florida Power Corporation
Crystal River Unit 3

Cycle 10
**Core Operating Limits Report**
Revision 0

Referencing Revised
Standard Technical Specifications

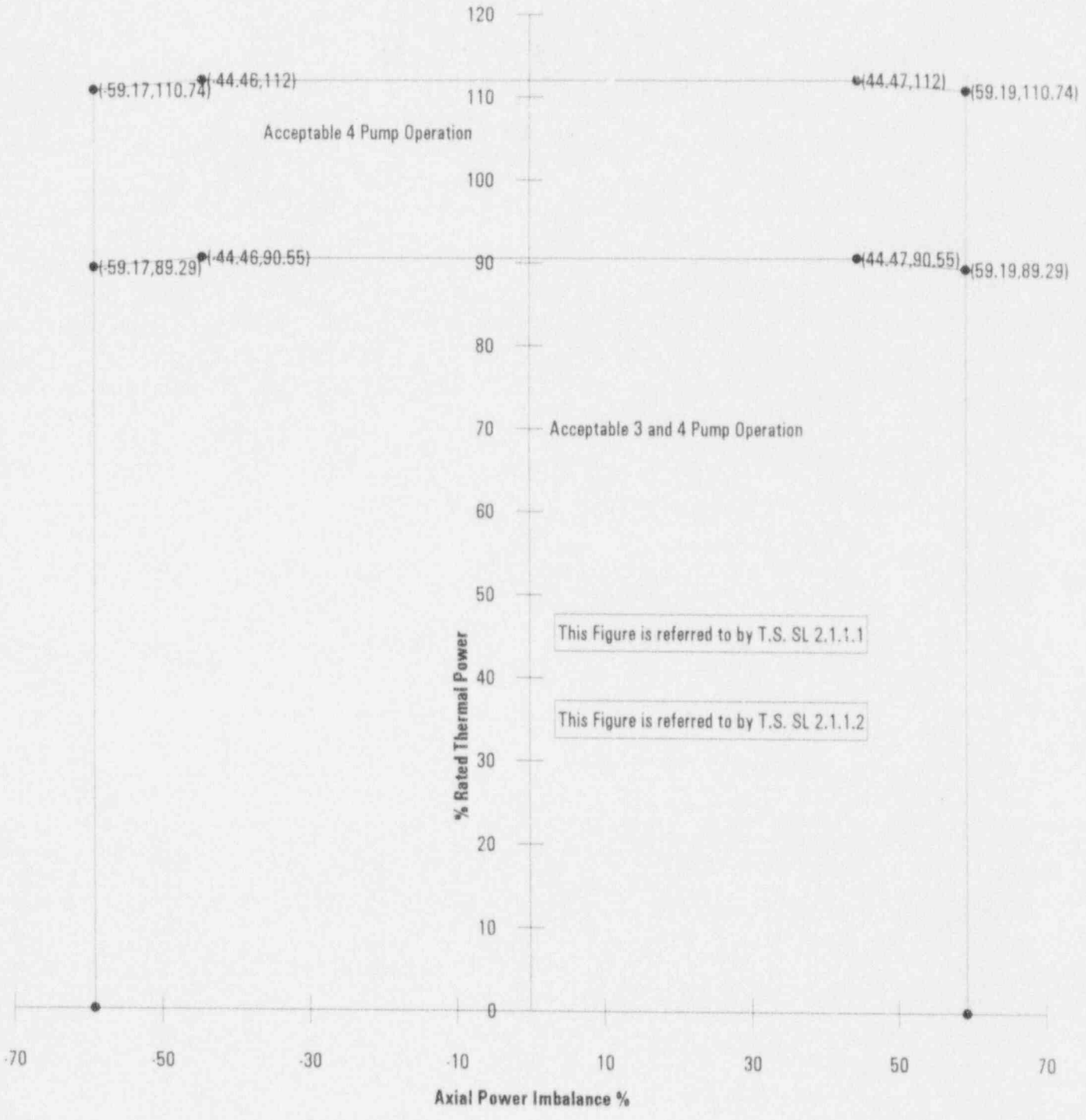
## 1.0 Core Operating Limits

This Core Operating Limits Report for CR3 Cycle 10 has been prepared in accordance with the requirements of Technical Specification Section 1.1 and 5.6.2.18. The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC. These methods are documented in BAW-10179PA, "Safety Critera and Methodology for Acceptable Cycle Reload Analyses", SER dated 3/16/93. BAW-10187P, "Statistical Core Design for B&W Designed 177 FA Plants", SER dated 3/24/93. BAW-2149-A, "Evaluation of Replacement Rods in BWFC Fuel Assemblies", dated September 1993. Application of the methodology for API and RPI position indication agreement was approved in SER dated June 25,1992.

The following limits are included in this report.

| | |
|---|---|
| SL 2.1.1.1 | AXIAL POWER IMBALANCE PROTECTIVE LIMITS |
| SL 2.1.1.2 | AXIAL POWER IMBALANCE PROTECTIVE LIMITS |
| LCO 3.1.1 | SHUTDOWN MARGIN |
| LCO 3.1.3 | MODERATOR TEMPERATURE COEFFICIENT |
| SR 3.1.7.1 | API/RPI POSITION INDICATION AGREEMENT |
| LCO 3.2.1 | REGULATING ROD INSERTION LIMITS |
| LCO 3.2.2 | AXIAL POWER SHAPING ROD INSERTION LIMITS |
| LCO 3.2.3 | AXIAL POWER IMBALANCE OPERATING LIMITS |
| LCO 3.2.4 | QUADRANT POWER TILT |
| LCO 3.2.5 | POWER PEAKING FACTORS |
| LCO 3.3.1 | REACTOR PROTECTION SYSTEM INSTRUMENTAION |
| LCO 3.9.1 | REFUELING BORON CONCENTRATION |

## Axial Power Imbalance Protective Limits



Shutdown Margin (SDM)

No special Evolutions are expected during Cycle 10 therefore
SDM $\geq$ 1.0% $\Delta k/k$

| These limits are referred to by Technical Specification LCO 3.1.1 |
|---|

Moderator Temperature Coefficient Limit

Lower Limit
MTC at HFP > $-3.68 \times 10^{-4}$ $\Delta$ k/k/°F

Upper Limit
MTC $\leq$ $0.9 \times 10^{-4}$ $\Delta$ k/k/°F when Thermal Power < 95% RTP
MTC $\leq$ 0.0 when Thermal Power $\geq$ 95% RTP

These limits are referred to by Technical Specification LCO 3.1.3

Absolute Position Indicator / Relative Position Indicator Agreement Limits

2.7% when the comparison is performed using the plant computer, or

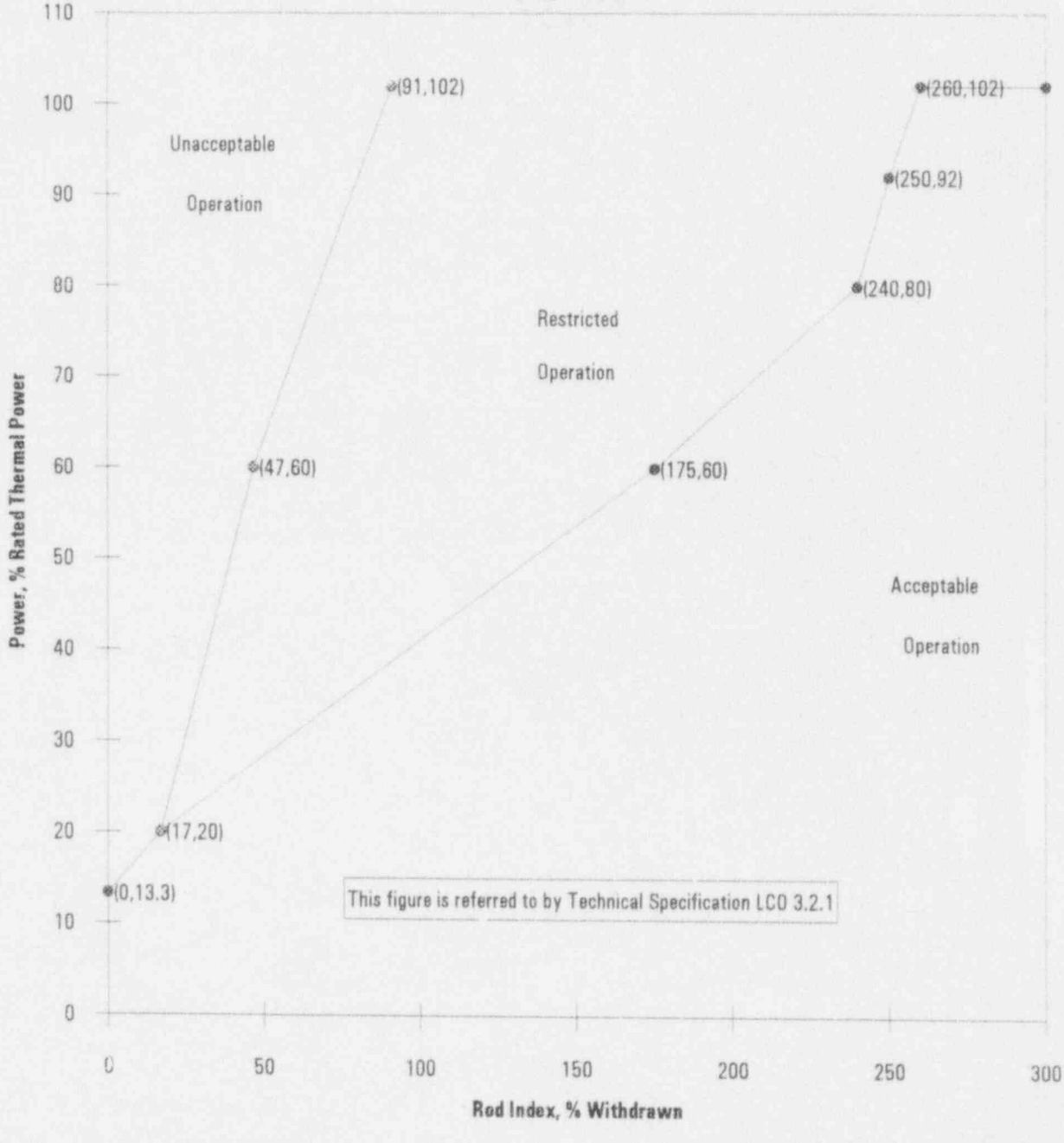
3.5% when the comparison is performed using the panel meters on the main control board.

| These limits are referred to by Technical Specification SR 3.1.7.1 |
|---|

**Regulating Rod Group Insertion Limits**

Four Pump Operation

0 to 300 + 10 EFPD

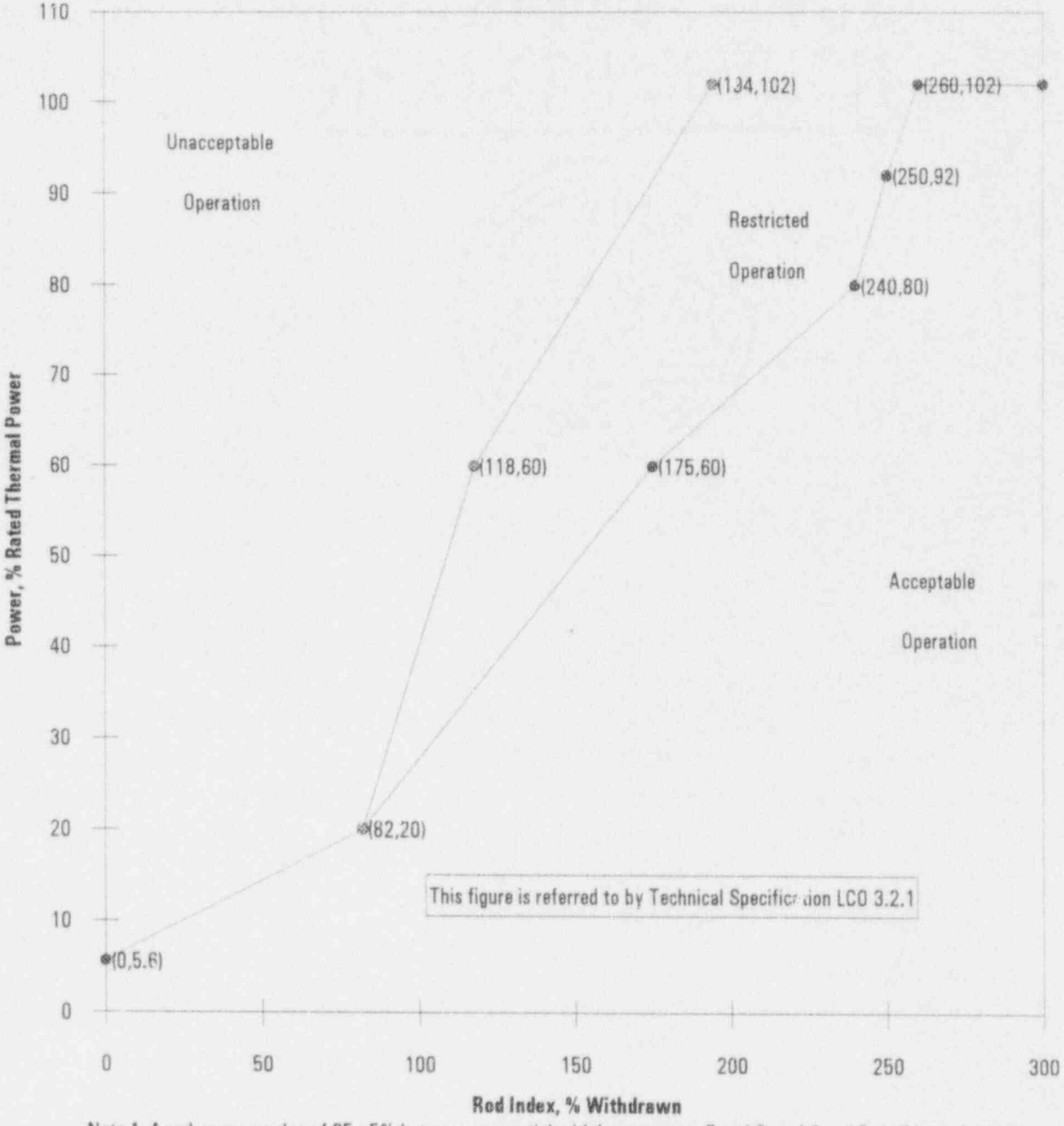



Note 1: A rod group overlap of 25 ± 5% between sequential withdrawn groups 5 and 6, and 6 and 7 shall be maintained

**Regulating Rod Group Insertion Limits**

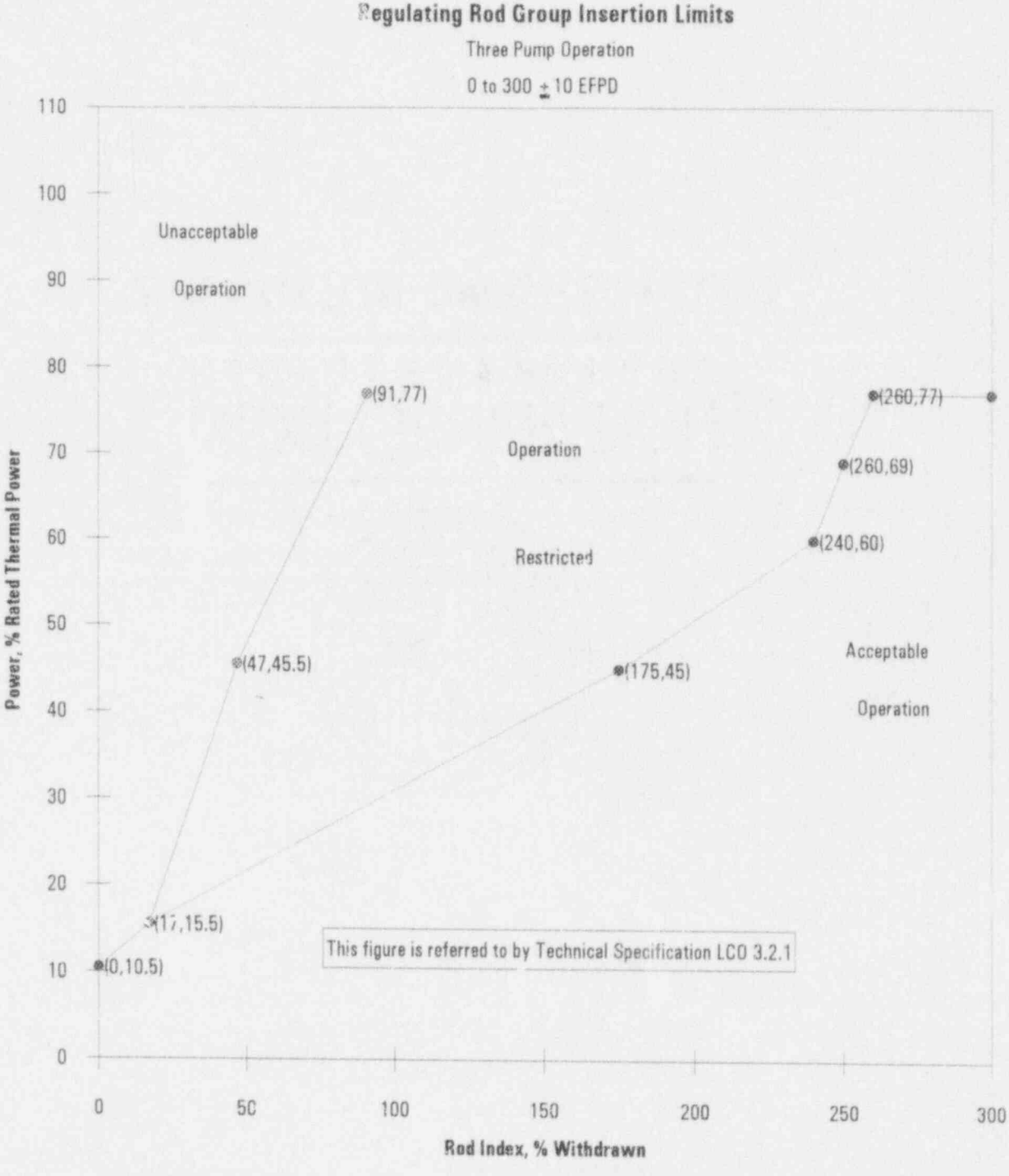
Four Pump Operation

after 300 ± 10 EFPD




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: This figure shall be used up to, during, after APSR withdrawal per LCO 3.2.2

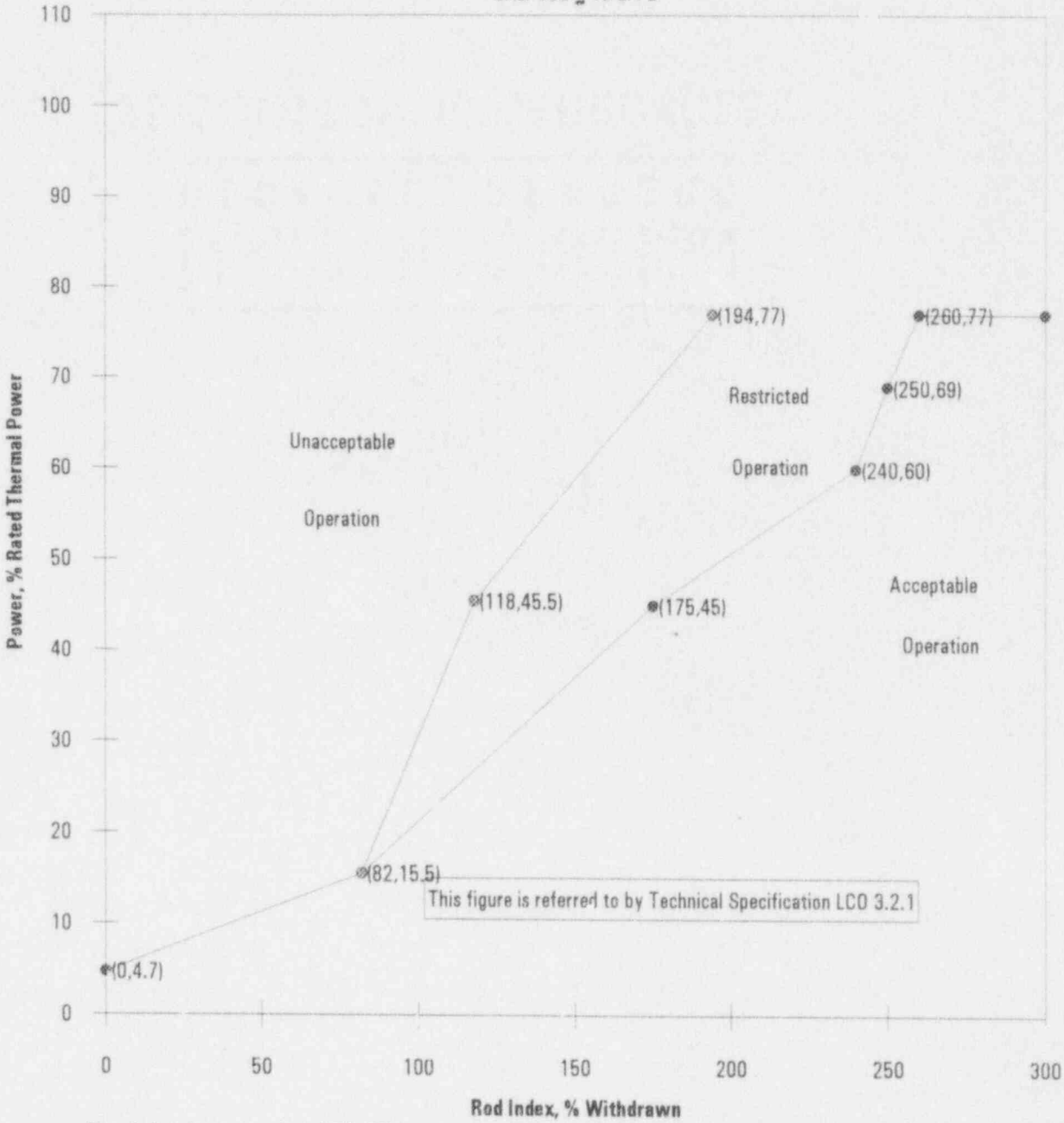



Note 1: A rod group overlap of 25 ± 5% between sequential withdrawn groups 5 and 6, and 6 and 7 shall be maintained

**Regulating Rod Group Insertion Limits**

Three Pump Operation

after 300 ± 10 EFPD



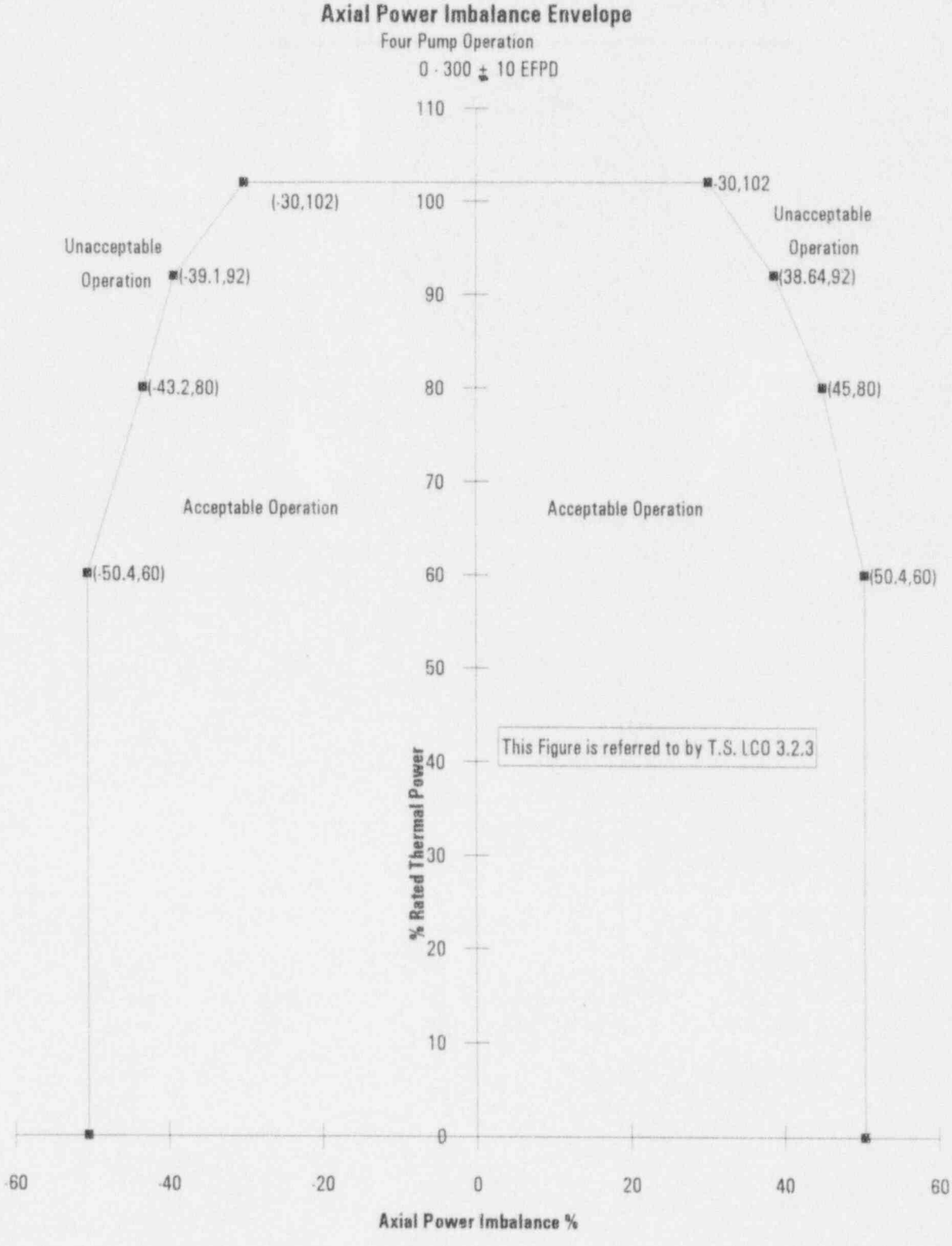

Note 1: A rod group overlap of 25 ± 5% between sequential withdrawn groups 5 and 6, and 6 and 7 shall be maintained

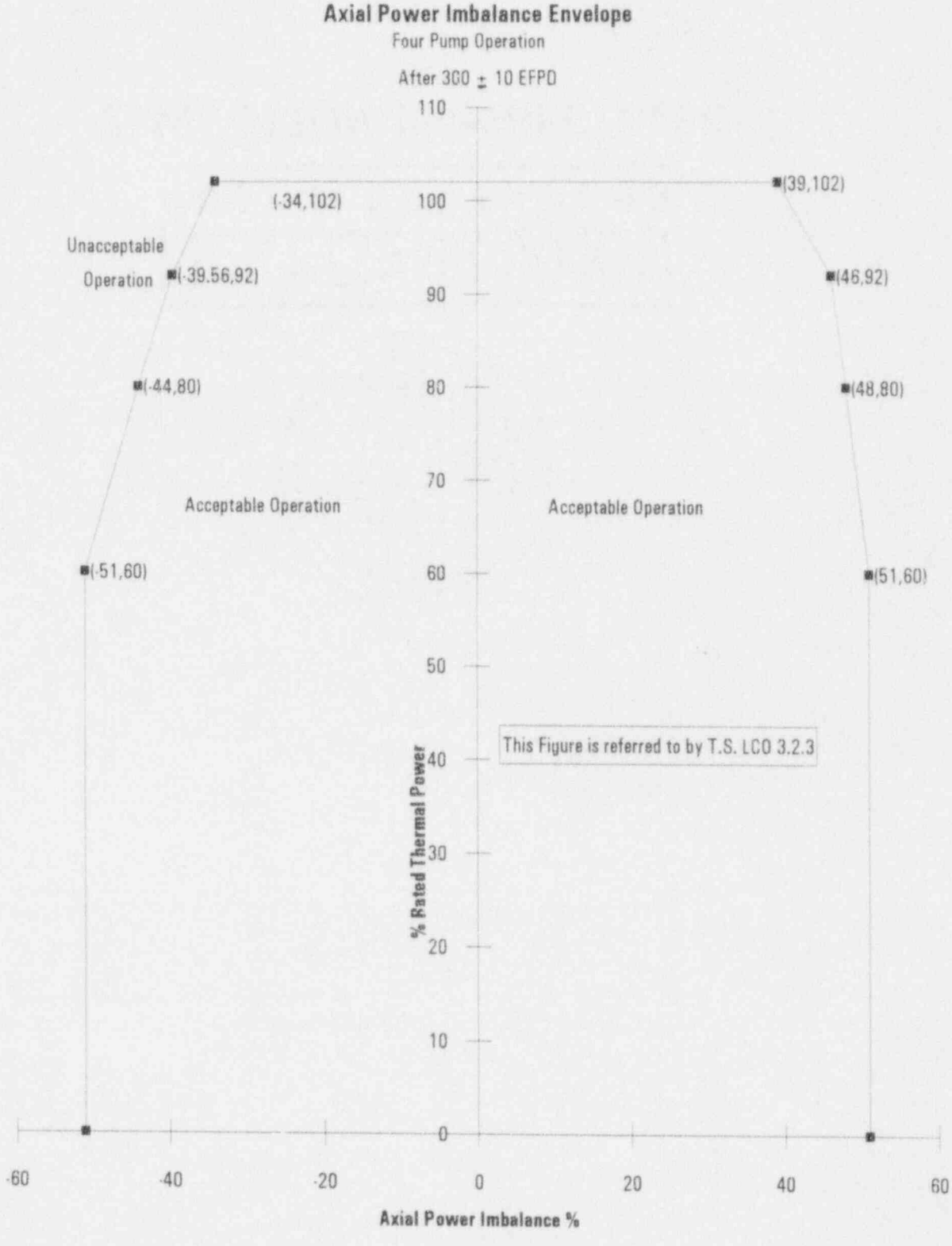
Note 2: This figure shall be used up to, during,and after APSR withdrawal per LCO 3.2.2

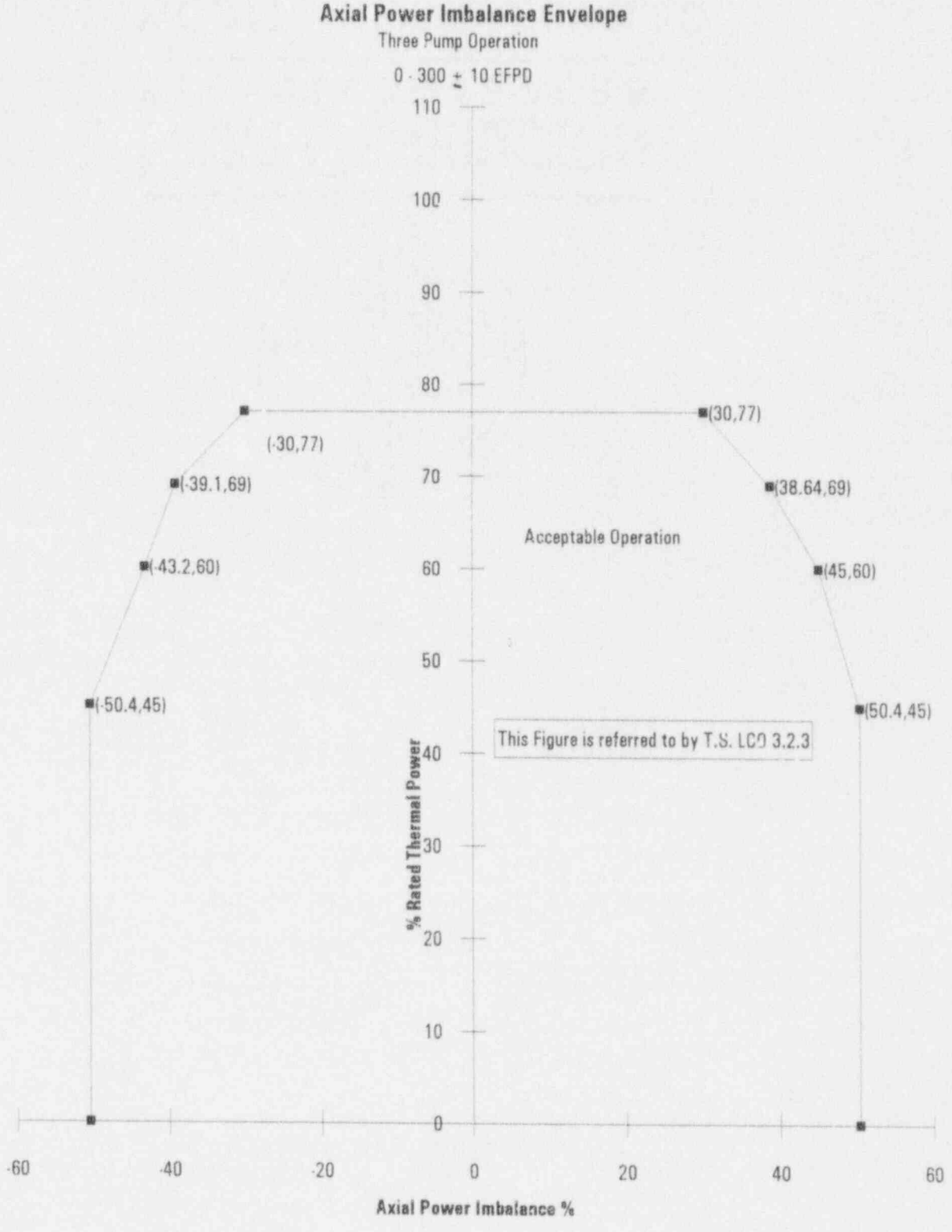
Axial Power Shaping Rod Insertion Limits

Up to 540 EFPD the APSRs may be positioned as necessary. The APSRs shall be completely withdrawn (100%) by 560 EFPD. Once withdrawn during this period, 540EFPD to 560EFPD the APSRs shall not be reinserted for the remainer of the cycle.

These limits are referred to by Technical Specification LCO 3.2.2


Axial Power Imbalance Envelope
Four Pump Operation
0 - 300 ± 10 EFPD
110
100
90
80
70
60
50
40
30
20
10
0
(-30,102)
(30,102
(-39.1,92)
(38.64,92)
(-43.2,80)
(45,80)
(-50.4,60)
(50.4,60)
Unacceptable Operation
Unacceptable Operation
Acceptable Operation
Acceptable Operation
This Figure is referred to by T.S. LCO 3.2.3
% Rated Thermal Power
-60
-40
-20
0
20
40
60
Axial Power Imbalance %

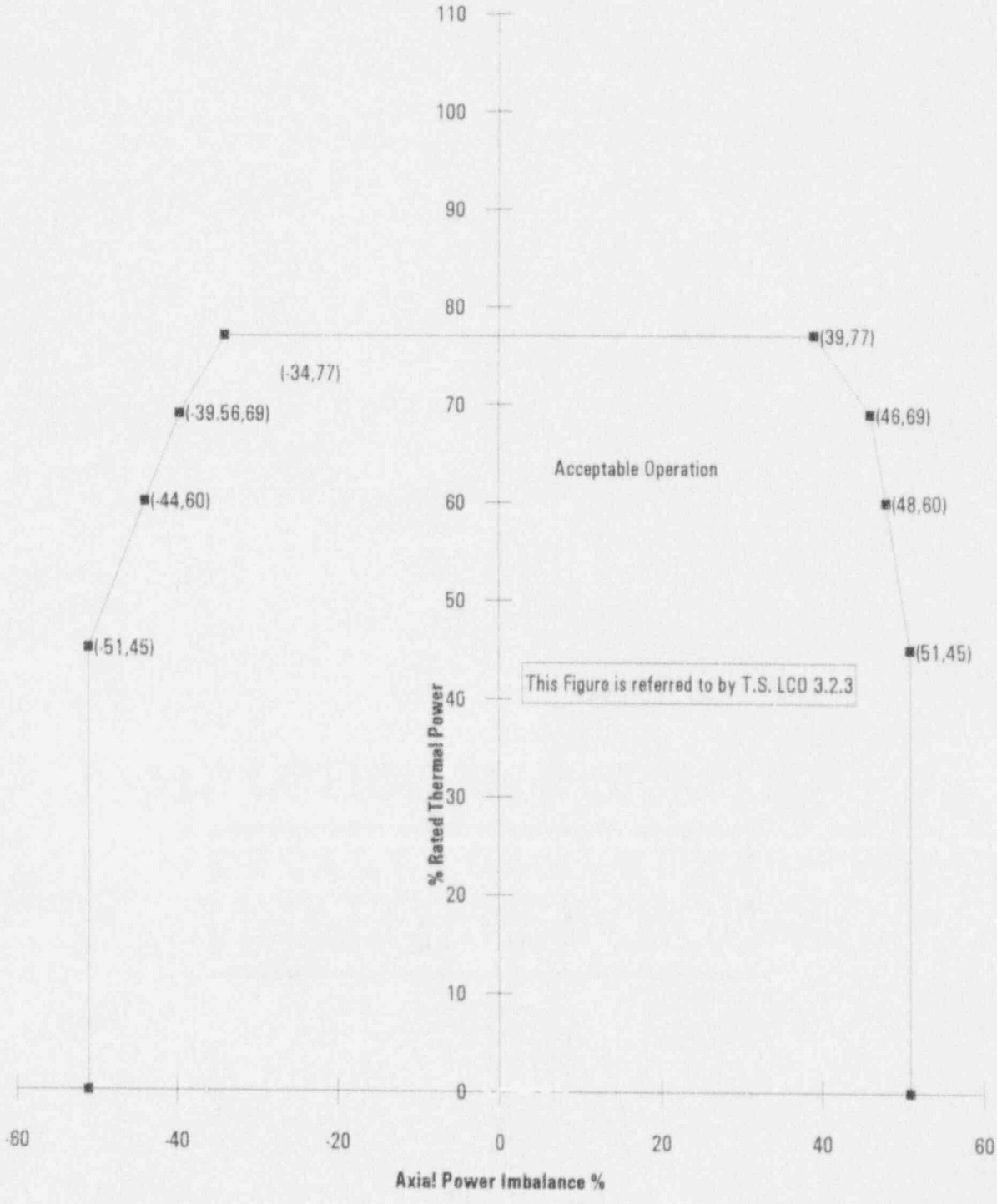

Axial Power Imbalance Envelope
Four Pump Operation
After 300 ± 10 EFPD
110
100
90
80
70
60
50
40
30
20
10
0
(-34,102)
(39,102)
Unacceptable
Operation
(-39.56,92)
(46,92)
(-44,80)
(48,80)
Acceptable Operation
Acceptable Operation
(-51,60)
(51,60)
This Figure is referred to by T.S. LCO 3.2.3
% Rated Thermal Power
-60
-40
-20
0
20
40
60
Axial Power Imbalance %


Axial Power Imbalance Envelope
Three Pump Operation
0 - 300 ± 10 EFPD
110
100
90
80
70
60
50
40
30
20
10
0
(-30,77)
(30,77)
(-39.1,69)
(38.64,69)
(-43.2,60)
(45,60)
(-50.4,45)
(50.4,45)
Acceptable Operation
This Figure is referred to by T.S. LCO 3.2.3
% Rated Thermal Power
-60
-40
-20
0
20
40
60
Axial Power Imbalance %

**Axial Power Imbalance Envelope**

Three Pump Operation

After 300 ± 10 EFPD



Quadrant Power Tilt Limits

**For Operation from 0 to 500 +0/-10 EFPD**

Thermal Power ≤ 60% RTP

| | Steady State | Transient | Maximum |
|---|---|---|---|
| Symmetrical Incore Detector System | 7.50 | 10.03 | 20.00 |
| Power Range Channels | 4.94 | 6.96 | 20.00 |
| Minimum Incore Detector System | 3.07 | 4.40 | 20.00 |
| Measurement System Independent | 8.58 | 11.07 | 20.00 |

Thermal Power > 60% RTP

| | Steady State | Transient | Maximum |
|---|---|---|---|
| Symmetrical Incore Detector System | 4.24 | 10.03 | 20.00 |
| Power Range Channels | 1.96 | 6.96 | 20.00 |
| Minimum Incore Detector System | 1.90 | 4.40 | 20.00 |
| Measurement System Independent | 4.92 | 11.07 | 20.00 |

**For Operation after 500 +0/-10 EFPD**

Thermal Power ≤ 60% RTP

| | Steady State | Transient | Maximum |
|---|---|---|---|
| Symmetrical Incore Detector System | 7.50 | 10.03 | 20.00 |
| Power Range Channels | 4.94 | 6.96 | 20.00 |
| Minimum Incore Detector System | 2.42 | 3.47 | 20.00 |
| Measurement System Independent | 8.58 | 11.07 | 20.00 |

Thermal Power > 60% RTP

| | Steady State | Transient | Maximum |
|---|---|---|---|
| Symmetrical Incore Detector System | 4.16 | 10.03 | 20.00 |
| Power Range Channels | 1.96 | 6.96 | 20.00 |
| Minimum Incore Detector System | 1.50 | 3.47 | 20.00 |
| Measurement System Independent | 4.92 | 11.07 | 20.00 |

These limits are referred to by Technical Specification LCO 3.2.4

Power Peaking Factors

This Limit is referred to by Technical Specfication LCO 3.2.5

Heat Flux Hot Channel Factor FQ

FQ 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 the following Table

$LHR^{avg}$ = 5.79 kW/ft for Mk-B9 fuel

$LHR^{avg}$ = 5.74 kW/ft for Mk-B4Z fuel

$LHR^{avg}$ = 5.79 kW/ft for Mk-B10ZL fuel

P = ratio of THERMAL POWER/ RATED THERMAL POWER

Bu = Fuel Burnup (MWd/mtU)

Mk-B9/Mk-B10ZL $LHR^{allow}$ kW/ft*

| Core Elevation, ft | 0 Mwd/mtU | 10650 Mwd/mtU | 43333 Mwd/mtU | 44000 MWd/mtU | 44667 MWd/mtU | 57000 MWd/mtU |
|---|---|---|---|---|---|---|
| 2 | 16.7 | 16.7 | 16.7 | 16.5 | 16.3 | 12.6 |
| 4 | 17.5 | 16.5 | 16.5 | 16.5 | 16.3 | 12.6 |
| 6 | 17.0 | 16.3 | 16.3 | 16.3 | 16.3 | 12.6 |
| 8 | 17.0 | 16.5 | 16.5 | 16.5 | 16.3 | 12.6 |
| 10 | 17.0 | 16.5 | 16.5 | 16.5 | 16.3 | 12.6 |

Mk-B4Z $LHR^{allow}$ kw/ft*

| Core Elevation, ft | 0 MWd/mtU | 1600 MWd/mtU | 36375 MWd/mtU | 38125 MWd/mtU | 40312 MWd/mtU | 40750 MWd/mtU | 42937 MWd/mtU | 60000 MWd/mtU |
|---|---|---|---|---|---|---|---|---|
| 2 | 14.5 | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 | 11.6 |
| 4 | 16.1 | 16.6 | 16.6 | 16.6 | 16.1 | 16.0 | 15.5 | 11.6 |
| 6 | 16.1 | 16.1 | 16.1 | 16.1 | 16.1 | 16.0 | 15.5 | 11.6 |
| 8 | 17.0 | 17.0 | 17.0 | 16.6 | 16.1 | 16.0 | 15.5 | 11.6 |
| 10 | 16.0 | 16.0 | 16.0 | 16.0 | 16.0 | 16.0 | 15.5 | 11.6 |

*Linear interpolation is used to calculate the LHR limit to maintain the internal pin pressure below 2200 psia

Power Peaking Factors

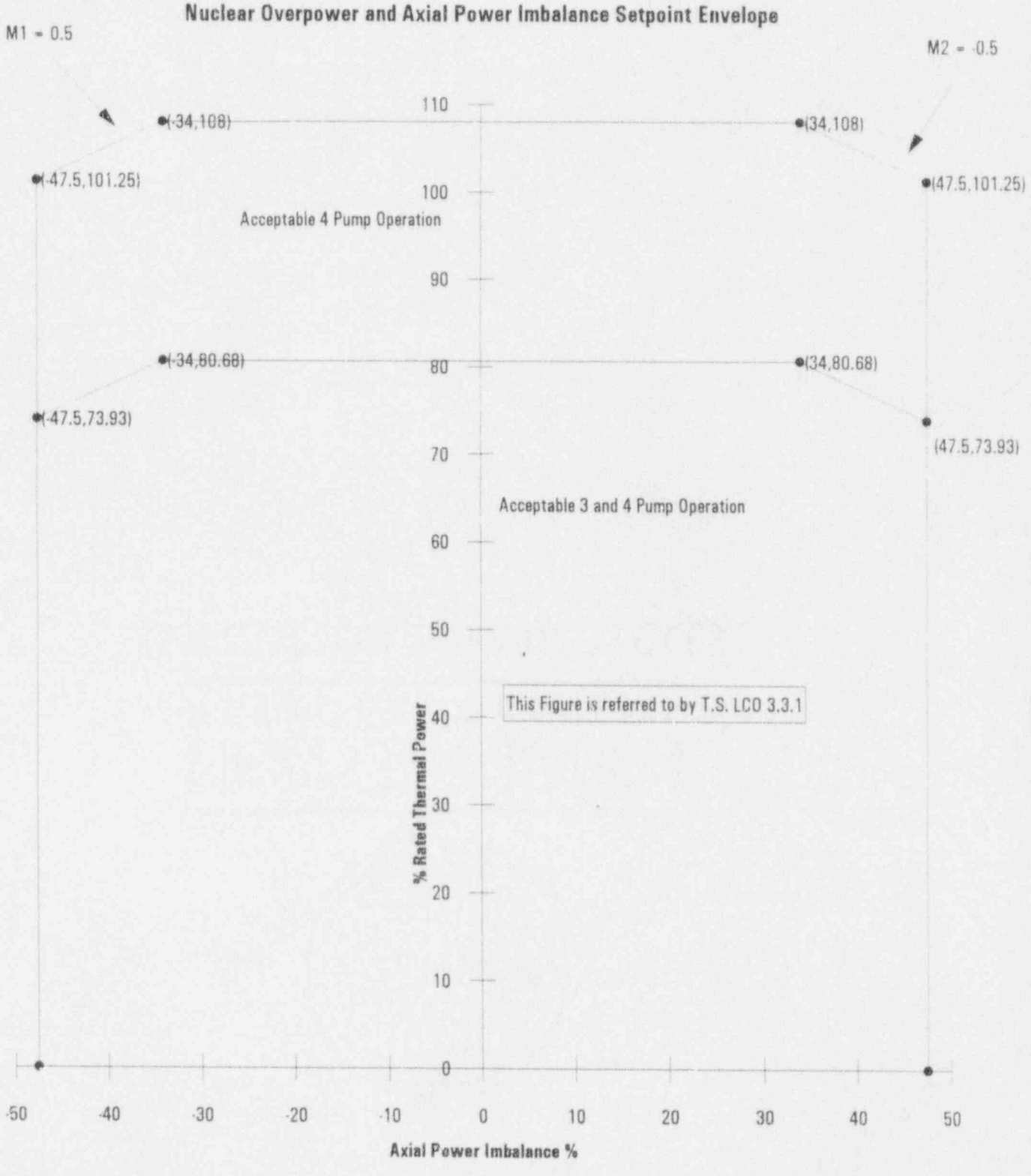
This Limit is referred to by Technical Specfication LCO 3.2.5

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

$F^N_{\Delta H} \leq 1.80\ [1 + (1\text{-}P)/RH]$

P = Thermal Power/RTP and $P \leq 1.0$

RH = 3.34


Nuclear Overpower and Axial Power Imbalance Setpoint Envelope
M1 = 0.5
M2 = -0.5
(-34,108)
(34,108)
(-47.5,101.25)
(47.5,101.25)
Acceptable 4 Pump Operation
(-34,80.68)
(34,80.68)
(-47.5,73.93)
(47.5,73.93)
Acceptable 3 and 4 Pump Operation
This Figure is referred to by T.S. LCO 3.3.1
% Rated Thermal Power
Axial Power Imbalance %
110
100
90
80
70
60
50
40
30
20
10
0
-50
-40
-30
-20
-10
0
10
20
30
40
50

Refueling Boron Concentration

The boron concentration must be greater than 2880 ppmb

Note: The refueling boron concentration must be increased by 2 ppmb for every EFPD the final Cycle 9 burnup is less than 545 EFPD. The refueling boron concentration can be reduced 1.4 ppmb for every EFPD that the final Cycle 9 burnup exceeds 545 EFPD. The 545 EFPD refueling concentration is 2897. The actual end of cycle 9 was 557.2264 EFPD. Using this value and the equation above the refueling boron reduces to 2880 ppmb.

| This limit is referred to by Technical Specification LCO 3.9.1 |
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