Exelon Generation.

Three Mile Island Unit 1
Route 441 South, P.O. Box 480
Middletown, PA 17057
Telephone 717-948-8000

TS 6.9.5.4

October 6, 2017

TMI-17-103

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Three Mile Island Nuclear Station, Unit 1
Renewed Facility Operating License No. DPR-50
NRC Docket No. 50-289

Subject: Cycle 22 Core Operating Limits Report, COLR TMI-1, Revision 12

Enclosed is a copy of the Cycle 22 Core Operating Limits Report, COLR TMI-1, Revision 12. The Cycle 22 Core Operating Limits Report, COLR TMI-1, Revision 12, provides the cycle-specific limits established to support operations of Cycle 22 up to 720 Effective Full Power Days. The cycle-specific core operating limits contained in the report have been determined in accordance with Technical Specification 6.9.5.

The COLR is being submitted to the NRC in accordance with the TMI Unit 1 Technical Specification Section 6.9.5.4.

If you have any questions or require further information, please contact Michael Fitzwater at (717) 948-8228.

Respectfully,

JA Goldman

Jeffrey A. Goldman
Regulatory Assurance Manager, Three Mile Island Unit 1
Exelon Generation Co., LLC

Attachment: 1) Cycle 22 Core Operating Limits Report, COLR TMI-1, Revision 12

cc: USNRC Administrator, Region I
USNRC Senior Resident Inspector, TMI-1
USNRC Project Manager, TMI-1
Director, Bureau of Radiation Protection – PA Department of Environmental Resources

ATTACHMENT

Three Mile Island Nuclear Station, Unit 1
Docket No. 50-289

<u>TMI-1 Cycle 22 Core Operating Limits Report Revision 12</u>

Exelon Generation

TMI-1 Cycle 22
Core Operating Limits Report

COLR TMI 1
Rev. 12

Preparer	Date 8/18/17
Robert Jaffa Review/SQR	Date 8-18-2017
Tyrone L Stevens NF Approver	Date 8/22/17
Reactor Engineering Manager	Date 8/24/17
BK Wunderly Director, Site Engineering	Date 8/24/17

1.0 Core Operating Limits

This CORE OPERATING LIMITS REPORT for TMI-1 Cycle 22 has been prepared in accordance with the requirements of Technical Specification 6.9.5. The Core Operating Limits have been developed using the methodology provided in the references. The following cycle-specific Core Operating Limits are included in this report:

SL 2.1.2	Axial Power Imbalance Protective Limits
SL 2.3.1	Reactor Protection System Maximum Allowable Setpoints for Axial Power Imbalance
LCO 3.5.2	Full Incore System Operability Requirements
LCO 3.5.2	Quadrant Power Tilt Limits
LCO 3.5.2	Power Peaking Factors - $F_Q(Z)$
LCO 3.5.2	Power Peaking Factors - $F^N_{\Delta H}$
LCO 3.5.2	Regulating Rod Insertion Limits
LCO 3.5.2	Axial Power Imbalance Operating Limits
SL 2.1.1 Bases	Nuclear Power Peaking Factors
SL 2.1.2 Bases	Maximum Allowable Local Linear Heat Rates
SL 2.3.1 Bases	Power-to-Flow Trip Setpoints
LCO 3.5.2 Bases	Allowable Moderator Temperature Coefficient (MTC)

Alternate Minimum Boron Requirements for Cold Shutdown

2.0 References

2.1 Methodology References

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

2.2 Other References

ANP-3599, Rev. 0, "Three Mile Island Unit 1 Cycle 22 Reload Report," July 2017.

TABLE OF CONTENTS

ABSTRACT

This Core Operating Limits Report (COLR) has been prepared in accordance with the requirements of TMI-1 Technical Specification 6.9.5. The core operating limits were generated using the methodologies described in the Section 2.1 reference and were documented in the Section 2.2 reference. The core operating limits and reactor protection system limits and setpoints in this report have been analyzed for a maximum end-of-cycle (EOC) length of 720 EFPD.

COLR Figure 1 provides the Axial Power Imbalance Protective Limits (APIPL) that preserve the steady state DNBR, Centerline Fuel Melt, and Cladding Transient Strain design criteria.

COLR Figure 2 provides the Reactor Protection System Maximum Allowable Setpoints for Axial Power Imbalance which combine the power/flow and error-adjusted axial imbalance trip setpoints that ensure the APIPL of Figure 1 are not exceeded.

The Full Incore System (FIS) operability requirements contained in Table 1 describe the number and location of Self-Powered Neutron Detector (SPND) strings that must be operable in order to monitor imbalance and quadrant tilt using the FIS.

Quadrant power tilt limits for FIS, out-of-core detector [OCD] system and minimum incore system [MIS] are given in Table 2. Technical Specification requirements related to quadrant tilt, including operator actions that must be taken in the event quadrant tilt limits are exceeded, are stated in T.S. 3.5.2.4.

Table 3 contains the total peaking hot channel factor $F_Q(Z)$ limits (i.e., ECCS power peaking limits) for core monitoring. Table 4 contains the nuclear enthalpy rise hot channel factor $F^N_{\Delta H}$ limits (i.e., initial condition DNB peaking) for core monitoring. During normal conditions, operation within quadrant tilt (Table 2), rod insertion (Figures 3-5), and imbalance (Figures 6-10) limits ensure $F_Q(Z)$ and $F^N_{\Delta H}$ limits are met. However, verification that positive margin to $F_Q(Z)$ and $F^N_{\Delta H}$ limits exists may be required during the following abnormal conditions:

T.S. 3.5.2.2.e (operation with an inoperable rod)
T.S. 3.5.2.4.e (operation with quadrant tilt in excess of steady-state limits)
T.S. 3.5.2.5.b (operation with control rods in the Restricted Region)
T.S. 3.5.2.7.d (operation with imbalance in the Restricted Region)

Display 1 of the Core Monitoring System provides the minimum margin to $F_Q(Z)$ and $F^N_{\Delta H}$ limits on the Summary Core Related Tech Specs page.

Rod insertion limits are provided in Figures 3 to 5 to ensure that the safety criteria for DNBR protection, LOCA kw/ft limits, shutdown margin and ejected rod worth are met. Technical Specification requirements related to control rod positions, including operator actions that must be taken in the event control rod positions enter Restricted or Not Allowed Regions, are stated in T.S. 3.5.2.5.

Imbalance limits for FIS, OCD and MIS are given in Figures 6 to 10. Technical Specification requirements related to axial power imbalance, including operator actions that must be taken in the event imbalance enters the Restricted Region, are stated in T.S. 3.5.2.7.

COLR Figures 3 through 10 may have three distinctly defined regions:

1. Permissible Region
2. Restricted Region
3. Not Allowed Region (Operation in this region is not allowed)

The limiting criteria within the Restricted Region are ECCS power peaking and initial condition DNB peaking. Since the probability of accidents related to these criteria is very low, especially in a twenty-four (24) hour time frame, inadvertent operation within the Restricted Region for a period not exceeding twenty-four (24) hours is allowed [T.S. 3.5.2.5.b and 3.5.2.7.e], provided that hot channel factors are within the limits given in Tables 3 and 4. Similarly, continued operation with quadrant tilt greater than the steady-state tilt limit for a period not exceeding twenty-four (24) hours is allowed [T.S. 3.5.2.4.e] provided that hot channel factors are within the limits given in Tables 3 and 4, with the added requirement that reactor power must be reduced 2% for each 1% tilt in excess of the tilt limit [T.S. 3.5.2.4.d]. (Note that continued operation with quadrant tilt greater than the steady-state tilt limit is also permitted without hot channel factor verification as long as the alternate guidance in T.S. 3.5.2.4.e is followed).

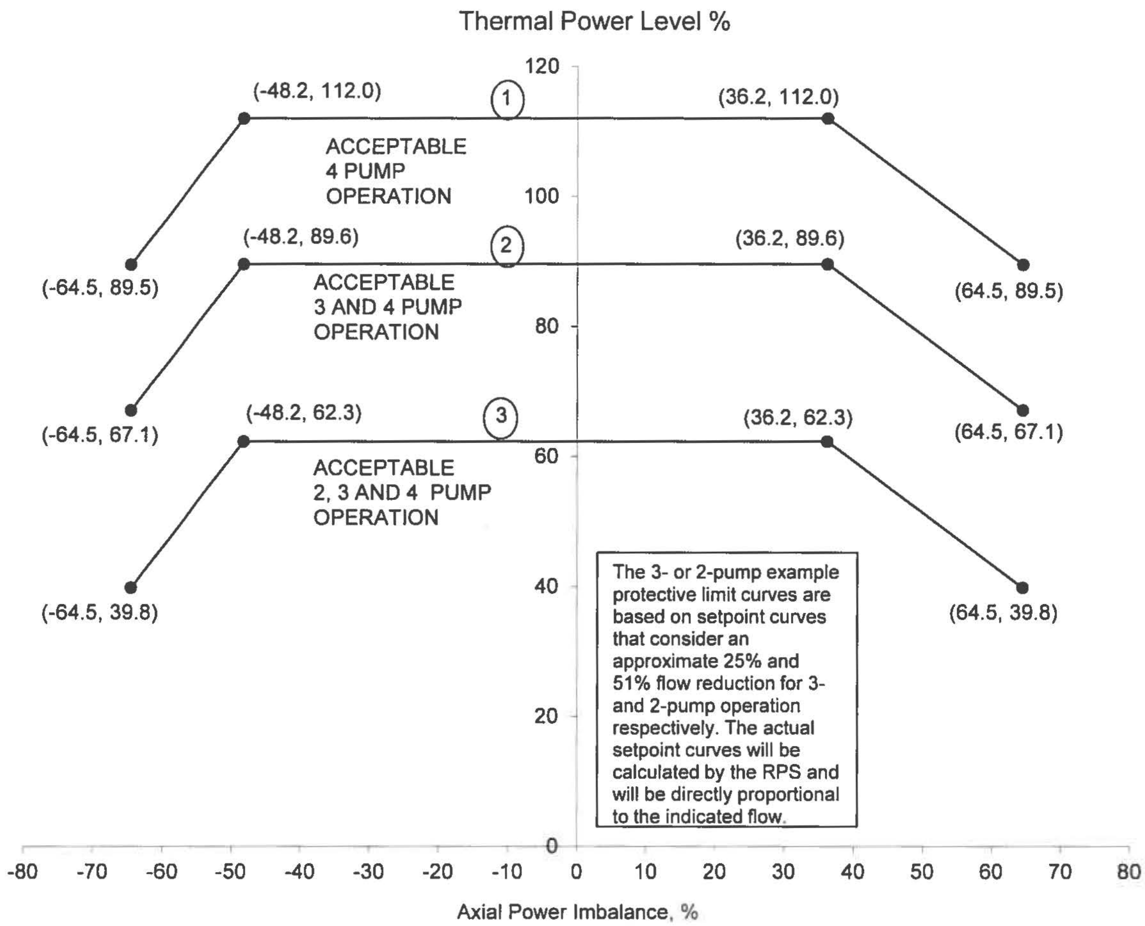
The limiting criteria within the Not Allowed Region are the shutdown margin limit and potential ejected rod worth. Inadvertent operation in this region is not permitted and requires immediate action to exit the region. Acceptable control rod positions shall be attained within two (2) hours [T.S. 3.5.2.5.b.2].

Enclosure 1 contains descriptions of limits and factors related to core operating limit TS bases. The Nuclear Power Peaking Factors for axial flux shape (F^N_Z) and hot channel nuclear enthalpy rise ($F^N_{\Delta H}$) define the reference design peaking condition in the core. The Maximum Allowable Local Linear Heat Rate limits for centerline fuel melt and cladding transient strain are the basis for the imbalance portions of the Axial Power Imbalance Protective Limits and Setpoints. The Power-to-Flow Trip Setpoint, in combination with the axial power imbalance trip, protects against violation of steady-state DNBR criteria.

The Allowable Moderator Temperature Coefficient (MTC) as a function of power level preserves the LOCA Limited Maximum Allowable Linear Heat Rate limits in COLR Table 3 for partial power and three pump operation.

Enclosure 2 contains operating limits not required by TS. The minimum boron volumes and concentrations for the Boric Acid Mix Tank (BAMT) and Reclaimed Boric Acid Storage Tanks (RBAT) are the boron levels needed to achieve cold shutdown conditions throughout the cycle using these tanks.

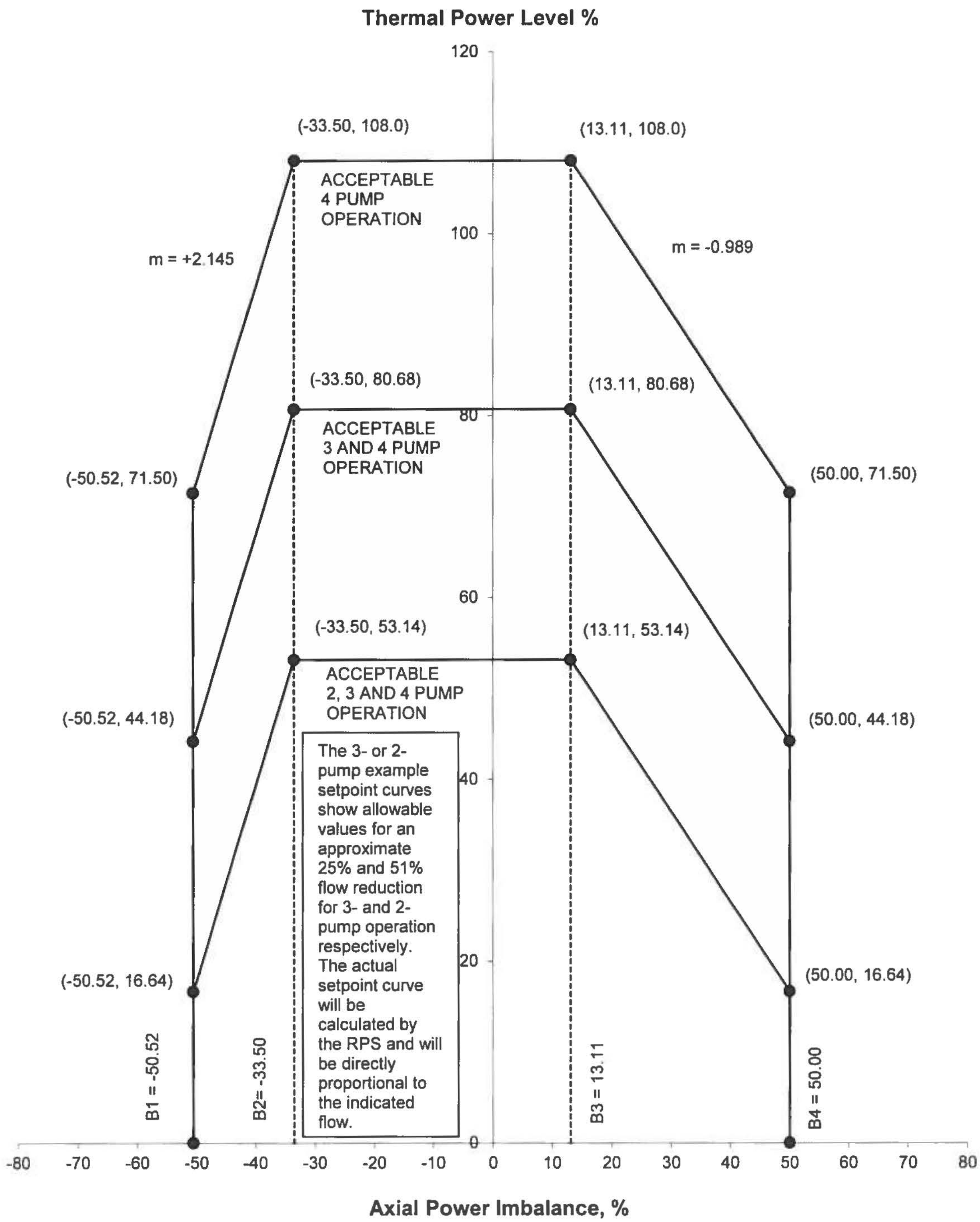
Figure 1
SL 2.1.2 Axial Power Imbalance Protective Limits



CURVE	EXPECTED MINIMUM REACTOR COOLANT FLOW (gpm)
1	376.64×10^3
2	281.35×10^3
3	185.31×10^3

Referred to by Technical Specification 2.1.2

Figure 2
SL 2.3.1 Reactor Protection System Maximum Allowable Setpoints for Axial Power Imbalance



Referred to by Technical Specification 2.3.1

Table 1
LCO 3.5.2 Full Incore System (FIS) Operability Requirements

- The Full Incore System (FIS) is operable for monitoring axial power imbalance provided the number of valid Self Powered Neutron Detector (SPND) signals in any one quadrant is not less than 75% of the total number of SPNDs in the quadrant.

Quadrant	SPNDs	75%
WX	85.75	64.5
XY	99.75	75.0
YZ	89.25	67.0
ZW	89.25	67.0

Referred to by Technical Specification 3.5.2.4.a

- The Full Incore System (FIS) is operable for monitoring quadrant tilt provided the number of valid symmetric string individual SPND signals in any one quadrant is not less than 75% (21) of the total number of SPNDs in the quadrant (28).

Quadrant	Symmetric Strings
WX	7, 9, 32, 35
XY	5, 23, 25, 28
YZ	16, 19, 47, 50
ZW	11, 13, 39, 43

Referred to by Technical Specification 3.5.2.7.a

TABLE 2
LCO 3.5.2 Quadrant Power Tilt Limits

	Steady State Limit[(a)] 15 < Power ≤ 60%	**Steady State Limit[(a)] Power > 60%**	**Maximum Limit Power > 15%**
Full Incore System (FIS)	**6.83**	**4.31**	**16.8**
Minimum Incore System (MIS)[(b)]	**2.78**	**1.90**	**9.5**

Referred to by Technical Specification 3.5.2.4

(a) The Steady State Limits apply during power operation above 15% power, including power and xenon transients.

(b) No individual long emitter detector affecting the minimum incore tilt calculation exceeds 73% sensitivity depletion; therefore, reduced limits are not applicable and are not shown.

Note: If the Full Incore System (FIS) is inoperable, FIS tilt limits are applicable to the Out-of-Core (OCD) Detector System following the guidance in OP-TM-300-202, Quadrant Power Tilt and Axial Power Imbalance using the Out-of-Core Detector System.

TABLE 3
LCO 3.5.2 Power Peaking Factors - $F_Q(Z)$

Core Monitoring System Bounding Values for LOCA Limited Maximum Allowable Linear Heat Rate (kW/ft [a])

Referred to by Technical Specification 3.5.2.2.e, 3.5.2.4.e, 3.5.2.5.b, 3.5.2.7.d, 3.5.2.8

UO_2 LOCA Limits

Batches 19, 22, 23 and 24

Core Elevation (feet)	0 MWd/mtU	34,000 MWd/mtU	62,000 MWd/mtU
0.000	15.5	13.5	11.6
2.506	16.5	14.5	11.7
4.264	16.6	14.6	11.8
6.021	17.0	15.0	12.0
7.779	17.0	15.0	12.0
9.536	16.8	14.8	12.0
12.000	15.9	13.9	12.0

Batch 20A

Core Elevation (feet)	0 MWd/mtU	34,000 MWd/mtU
0.000	15.0	13.0
2.506	16.0	14.0
4.264	16.1	14.1
6.021	16.5	14.5
7.779	16.5	14.5
9.536	16.2	14.2
12.000	15.3	13.3

(a) Linear interpolation for allowable linear heat rate limits between specified burnup points and core elevation points is valid for these tables. Linear heat rate limits at 0.000, 2.506, and 4.264 feet have been reduced by 0.4, 0.3, and 0.2 kW/ft, respectively, based on compliance with SER to the LOCA Evaluation Model for Once-Through Steam Generator Plants topical.

NOTE: LHR limits provided are based on nuclear power source.

Table 3 (Continued)

Gadolinia Fuel LOCA Limits

Batches 19, 22, 23 and 24 - 2 wt.% Gadolinia

Core Elevation (feet)	0 MWd/mtU	34,000 MWd/mtU	62,000 MWd/mtU
0.000	14.7	12.7	11.2
2.506	15.6	13.6	11.3
4.264	15.7	13.7	11.4
6.021	16.1	14.1	11.6
7.779	16.1	14.1	11.6
9.536	15.9	13.9	11.6
12.000	15.1	13.1	11.6

Batches 22, 23 and 24 - 3 wt.% Gadolinia

Core Elevation (feet)	0 MWd/mtU	34,000 MWd/mtU	62,000 MWd/mtU
0.000	14.0	12.0	10.9
2.506	14.9	12.9	11.0
4.264	15.0	13.0	11.1
6.021	15.4	13.4	11.3
7.779	15.4	13.4	11.3
9.536	15.2	13.2	11.3
12.000	14.4	12.4	11.3

Batch 23 - 6 wt.% Gadolinia

Core Elevation (feet)	0 MWd/mtU	34,000 MWd/mtU	62,000 MWd/mtU
0.000	13.1	11.1	10.2
2.506	13.9	11.9	10.3
4.264	14.0	12.0	10.4
6.021	14.4	12.4	10.6
7.779	14.4	12.4	10.6
9.536	14.2	12.2	10.6
12.000	13.5	11.5	10.6

(a) Linear interpolation for allowable linear heat rate limits between specified burnup points and core elevation points is valid for these tables. Linear heat rate limits at 0.000, 2.506, and 4.264 feet have been reduced by 0.4, 0.3, and 0.2 kW/ft, respectively, based on compliance with SER to the LOCA Evaluation Model for Once-Through Steam Generator Plants topical.

NOTE: LHR limits provided are based on nuclear power source.

Table 3 (Continued)

Gadolinia Fuel LOCA Limits

Batches 22, 23 and 24 - 8 wt.% Gadolinia

Core Elevation (feet)	0 MWd/mtU	34,000 MWd/mtU	62,000 MWd/mtU
0.000	13.1	11.1	10.2
2.506	13.9	11.9	10.3
4.264	14.0	12.0	10.4
6.021	14.4	12.4	10.6
7.779	14.4	12.4	10.6
9.536	14.2	12.2	10.6
12.000	13.5	11.5	10.6

(a) Linear interpolation for allowable linear heat rate limits between specified burnup points and core elevation points is valid for these tables. Linear heat rate limits at 0.000, 2.506, and 4.264 feet have been reduced by 0.4, 0.3, and 0.2 kW/ft, respectively, based on compliance with SER to the LOCA Evaluation Model for Once-Through Steam Generator Plants topical.

NOTE: LHR limits provided are based on nuclear power source.

The maximum linear heat rate for each CMS level, as measured with the FIDMS Thermal Hydraulic Package, should not be greater than the corresponding bounding value from Table 3 above. CMS Display 1, Summary Core Related Tech Specs, shows the minimum margin to $F_Q(Z)$ limits.

Notes: The LHR limits above are equivalent to the total peaking hot channel factor limits, $F_Q(Z)$, referred to in T.S. 3.5.2 by dividing the LHR limits by the product of the core average linear heat rate and the current fraction of rated power. The core average linear heat rate for $F_Q(Z)$ calculations is fuel batch specific and is based on nuclear source power to be consistent with the LHR limits above.

TABLE 4
LCO 3.5.2 Power Peaking Factors - $F^N_{\Delta H}$

LCO DNB Maximum Allowable Radial Peaking (MARP) Limits

Referred to by Technical Specification 3.5.2.2.e, 3.5.2.4.e, 3.5.2.5.b, 3.5.2.7.d, 3.5.2.8

The maximum radial peak for each fuel assembly, as measured with the Core Monitoring System (CMS) at the elevation where the assembly axial peak occurs, should not be greater than the corresponding bounding value from the table below. CMS Display 1, Summary Core Related Tech Specs, shows the minimum margin to $F^N_{\Delta H}$ limits for the fuel assembly with the smallest (or negative) margin.

Notes: The LCO DNB Maximum Allowable Radial Peaking (MARP) limits below are equivalent to nuclear enthalpy rise hot channel factor limits, $F^N_{\Delta H}$, referred to in T.S. 3.5.2 by using the following conversion:

$$F^N_{\Delta H} \text{ limit} = (\text{LCO DNB MARP}) * [1 + 0.3 * (1 - P/P_m)]$$

where: P = current fraction of power and,
P_m = power adjustment factor for RC Pump combination
(1.0 for 4 pump, 0.75 for 3 pump)

These limits are applicable to all fuel in the core for 3 and 4 RC pump operation.

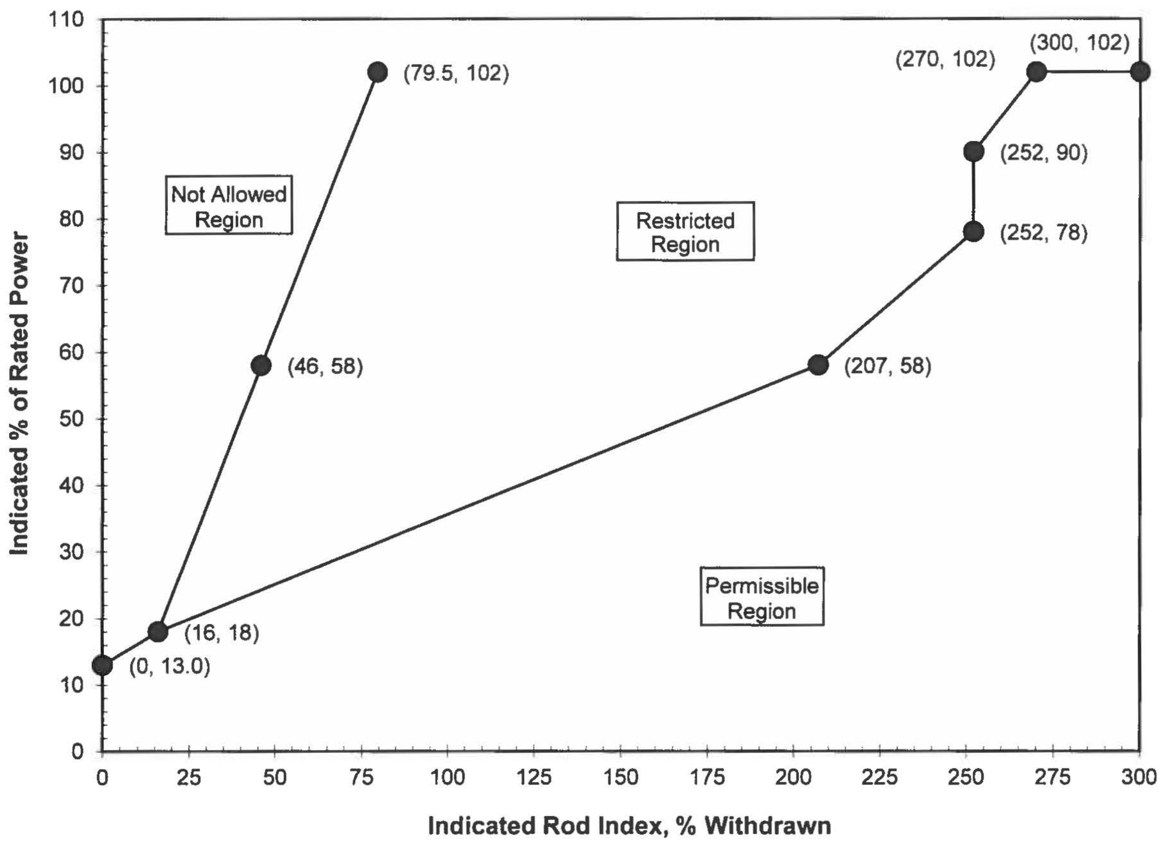
These limits have been increased to reflect the 3.8% peaking uncertainty treated by Statistical Core Design (SCD) methodology.

TABLE 4 (Continued)
MARP Limits – Mark-B-HTP Assemblies

Axial Peak	x/L	Maximum Allowable Radial Peak	Axial Peak	x/L	Maximum Allowable Radial Peak	Axial Peak	x/L	Maximum Allowable Radial Peak
	0.01	1.92149		0.01	2.17980		0.01	2.04944
	0.14	1.92080		0.14	2.17980		0.14	1.97141
	0.20	1.92040		0.20	2.17980		0.20	1.93753
	0.30	1.91958		0.30	2.11538		0.30	1.88636
	0.40	1.91885		0.40	2.04869		0.40	1.82062
1.1	0.50	1.91833	1.4	0.50	1.97877	1.7	0.50	1.76522
	0.60	1.91766		0.60	1.89956		0.60	1.69761
	0.70	1.91739		0.70	1.82744		0.70	1.63401
	0.80	1.91696		0.80	1.74222		0.80	1.56668
	0.89	1.88255		0.89	1.68344		0.89	1.51767
	0.99	1.80206		0.99	1.62376		0.99	1.47619
	0.01	2.00638		0.01	2.17980		0.01	1.95940
	0.14	2.00471		0.14	2.14346		0.14	1.89208
	0.20	2.00393		0.20	2.10932		0.20	1.86073
	0.30	2.00232		0.30	2.03998		0.30	1.81433
	0.40	2.00097		0.40	1.96913		0.40	1.75302
1.2	0.50	1.99966	1.5	0.50	1.90702	1.8	0.50	1.69943
	0.60	1.99860		0.60	1.82932		0.60	1.63696
	0.70	1.95423		0.70	1.76040		0.70	1.57725
	0.80	1.87113		0.80	1.67984		0.80	1.51627
	0.89	1.81351		0.89	1.62369		0.89	1.46966
	0.99	1.73614		0.99	1.57357		0.99	1.43130
	0.01	2.09686		0.01	2.13561		0.01	1.87531
	0.14	2.09445		0.14	2.05463		0.14	1.81763
	0.20	2.09300		0.20	2.02055		0.20	1.78748
	0.30	2.09129		0.30	1.96229		0.30	1.74390
	0.40	2.08973		0.40	1.89306		0.40	1.68924
1.3	0.50	2.04596	1.6	0.50	1.83577	1.9	0.50	1.63873
	0.60	1.96946		0.60	1.76136		0.60	1.58064
	0.70	1.89528		0.70	1.69541		0.70	1.52546
	0.80	1.80831		0.80	1.62108		0.80	1.46766
	0.89	1.74678		0.89	1.56920		0.89	1.42427
	0.99	1.67928		0.99	1.52433		0.99	1.38821

Figure 3 (Page 1 of 2)
LCO 3.5.2 Regulating Rod Insertion Limits

(0 to 400 ±10 EFPD; 4 Pump Operation)

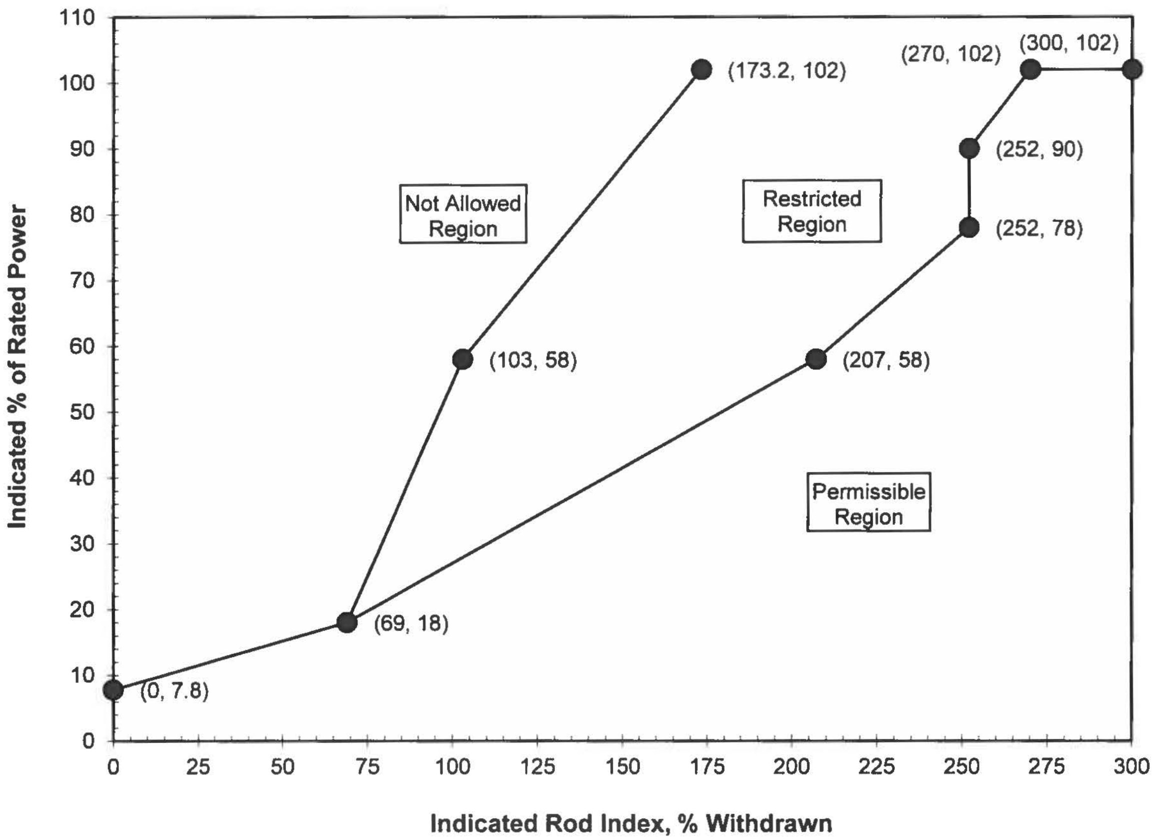


A Rod group overlap of 25 ±5% between sequential groups 5 and 6, and 6 and 7 shall be maintained.

This figure is referred to by
TS 3.5.2.5.b & 3.5.2.4.e.3

Figure 3 (Page 2 of 2)
LCO 3.5.2 Regulating Rod Insertion Limits

(400 ±10 EFPD to EOC; 4 Pump Operation)

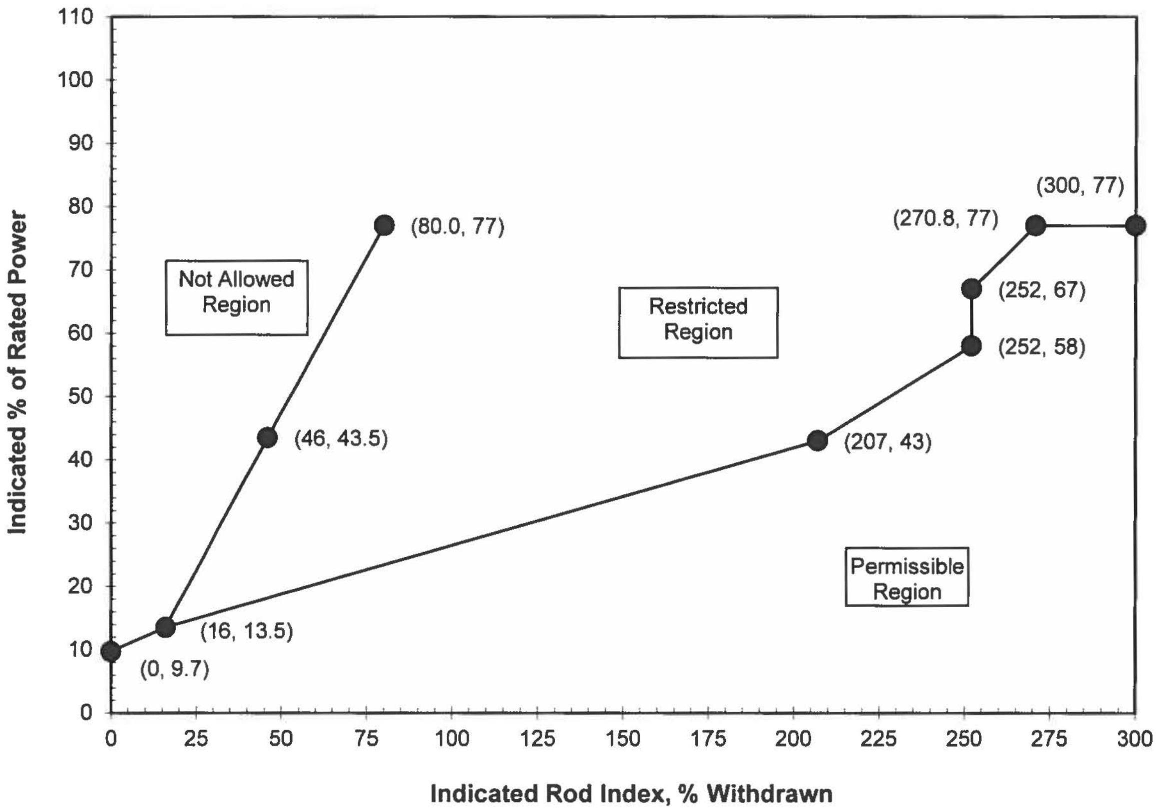


A Rod group overlap of 25 ±5% between sequential groups 5 and 6, and 6 and 7 shall be maintained.

This figure is referred to by
TS 3.5.2.5.b & 3.5.2.4.e.3

Figure 4 (Page 1 of 2)
LCO 3.5.2 Regulating Rod Insertion Limits

(0 to 400 ±10 EFPD; 3 Pump Operation)

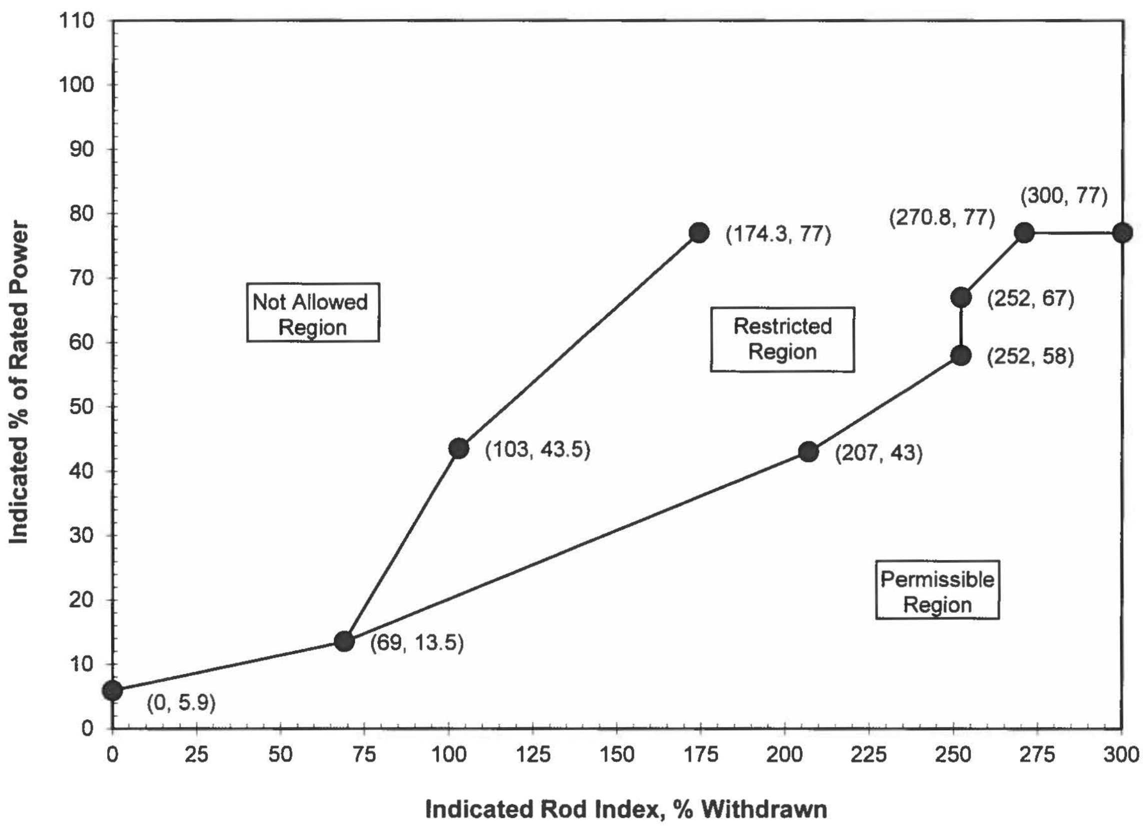


A Rod group overlap of 25 ±5% between sequential groups 5 and 6, and 6 and 7 shall be maintained.

This figure is referred to by TS 3.5.2.5.b & 3.5.2.4.e.3

Figure 4 (Page 2 of 2)
LCO 3.5.2 Regulating Rod Insertion Limits

(400 ±10 EFPD to EOC; 3 Pump Operation)

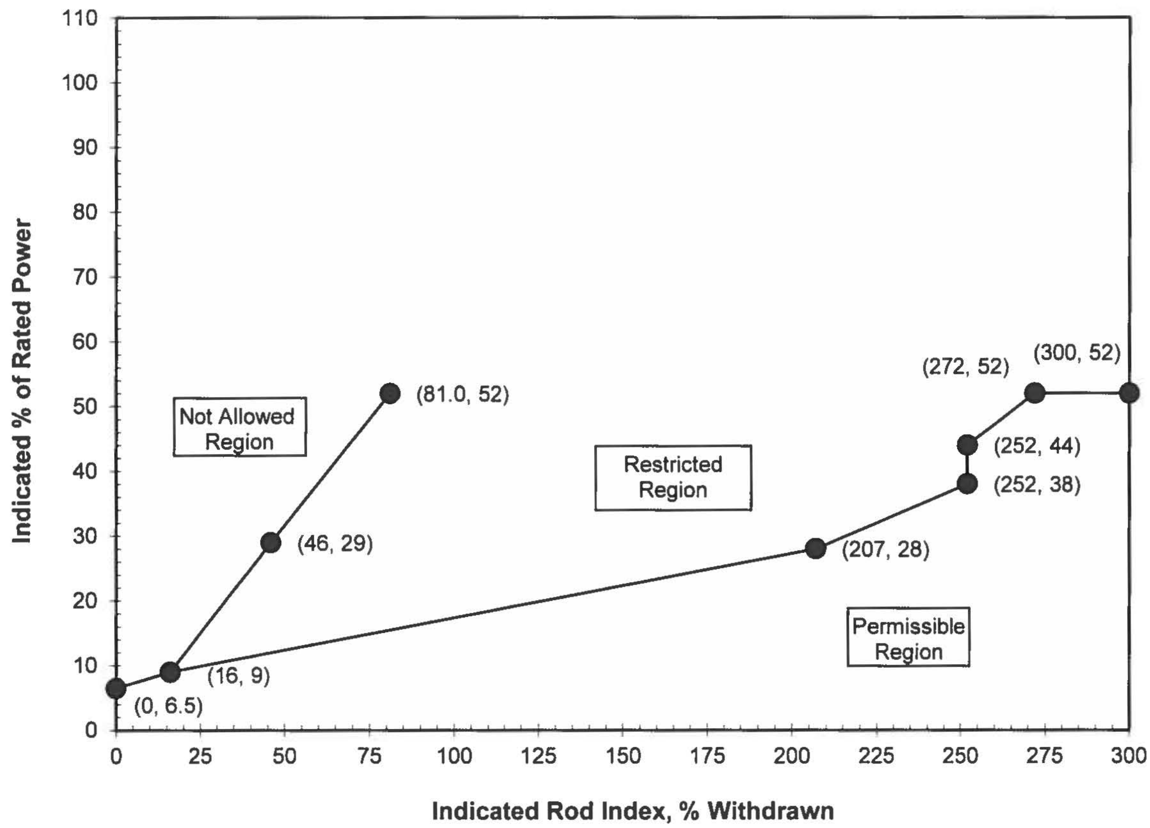


A Rod group overlap of 25 ±5% between sequential groups 5 and 6, and 6 and 7 shall be maintained.

This figure is referred to by
TS 3.5.2.5.b & 3.5.2.4.e.3

Figure 5 (Page 1 of 2)
LCO 3.5.2 Regulating Rod Insertion Limits

(0 to 400 ±10 EFPD; 2 Pump Operation)

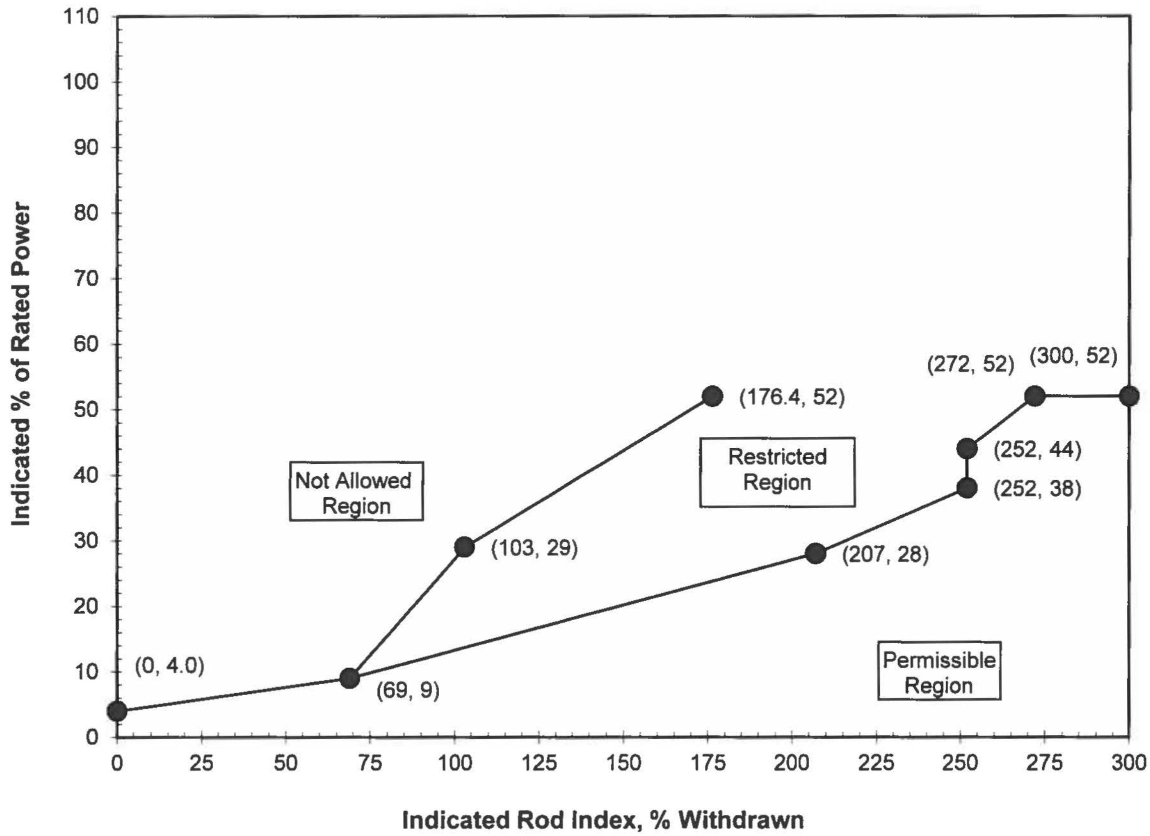


A Rod group overlap of 25 ±5% between sequential groups 5 and 6, and 6 and 7 shall be maintained.

This figure is referred to by TS 3.5.2.5.b & 3.5.2.4.e.3

Figure 5 (Page 2 of 2)
LCO 3.5.2 Regulating Rod Insertion Limits

(400 ±10 EFPD to EOC; 2 Pump Operation)



A Rod group overlap of 25 ±5% between sequential groups 5 and 6, and 6 and 7 shall be maintained.

This figure is referred to by
TS 3.5.2.5.b & 3.5.2.4.e.3

Figure 6 (Page 1 of 2)
LCO 3.5.2 Axial Power Imbalance Operating Limits

Full Incore System - 4 Pump
(0 EFPD to 400 ±10 EFPD)

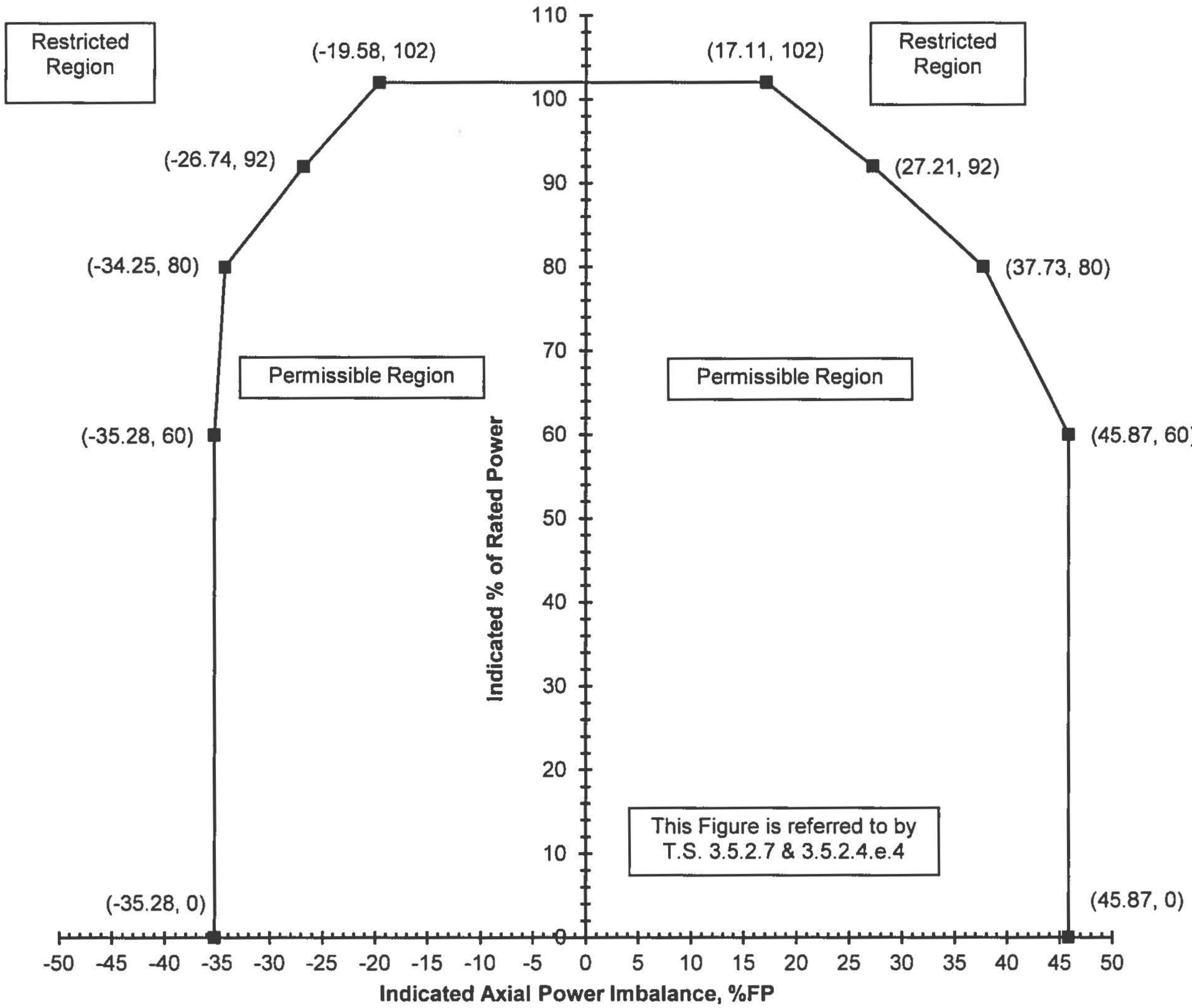


Figure 6 (Page 2 of 2)
LCO 3.5.2 Axial Power Imbalance Operating Limits

Full Incore System - 4 Pump
(400 ±10 EFPD to EOC)

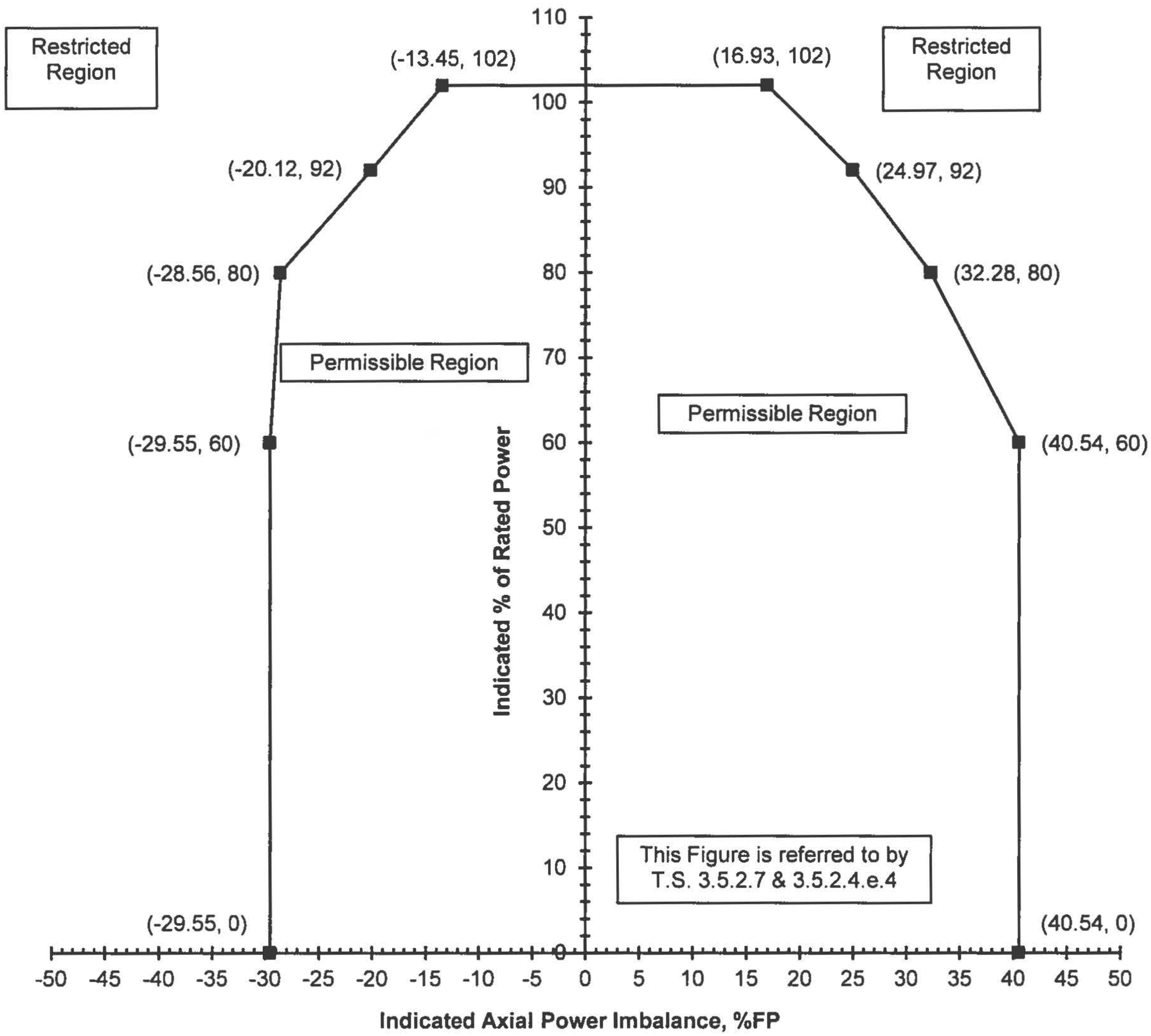


Figure 7 (Page 1 of 2)
LCO 3.5.2 Axial Power Imbalance Operating Limits

Full Incore System - 3 Pump
(0 EFPD to 400 ±10 EFPD)

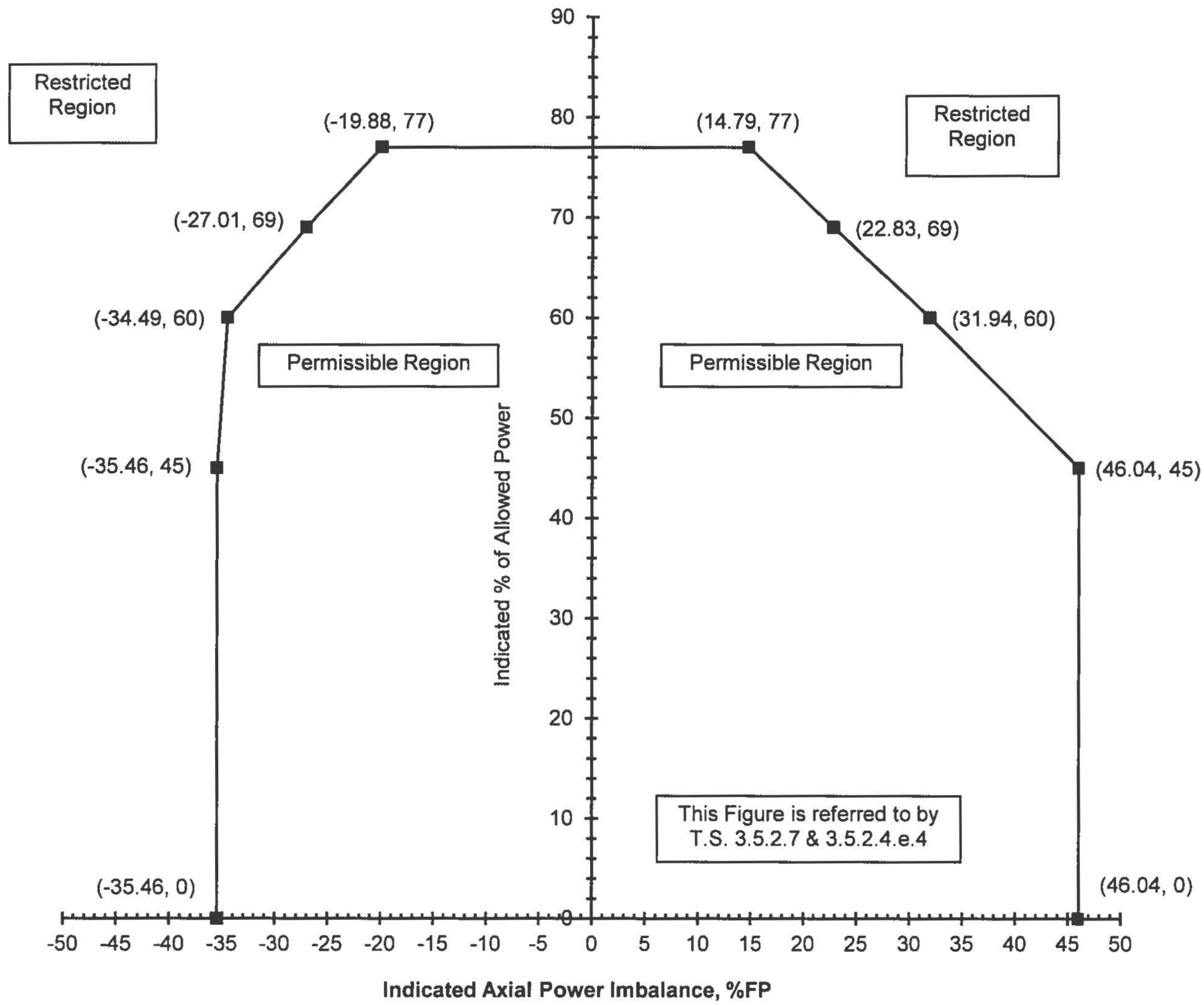


Figure 7 (Page 2 of 2)
LCO 3.5.2 Axial Power Imbalance Operating Limits

Full Incore System - 3 Pump
(400 ±10 EFPD to EOC)

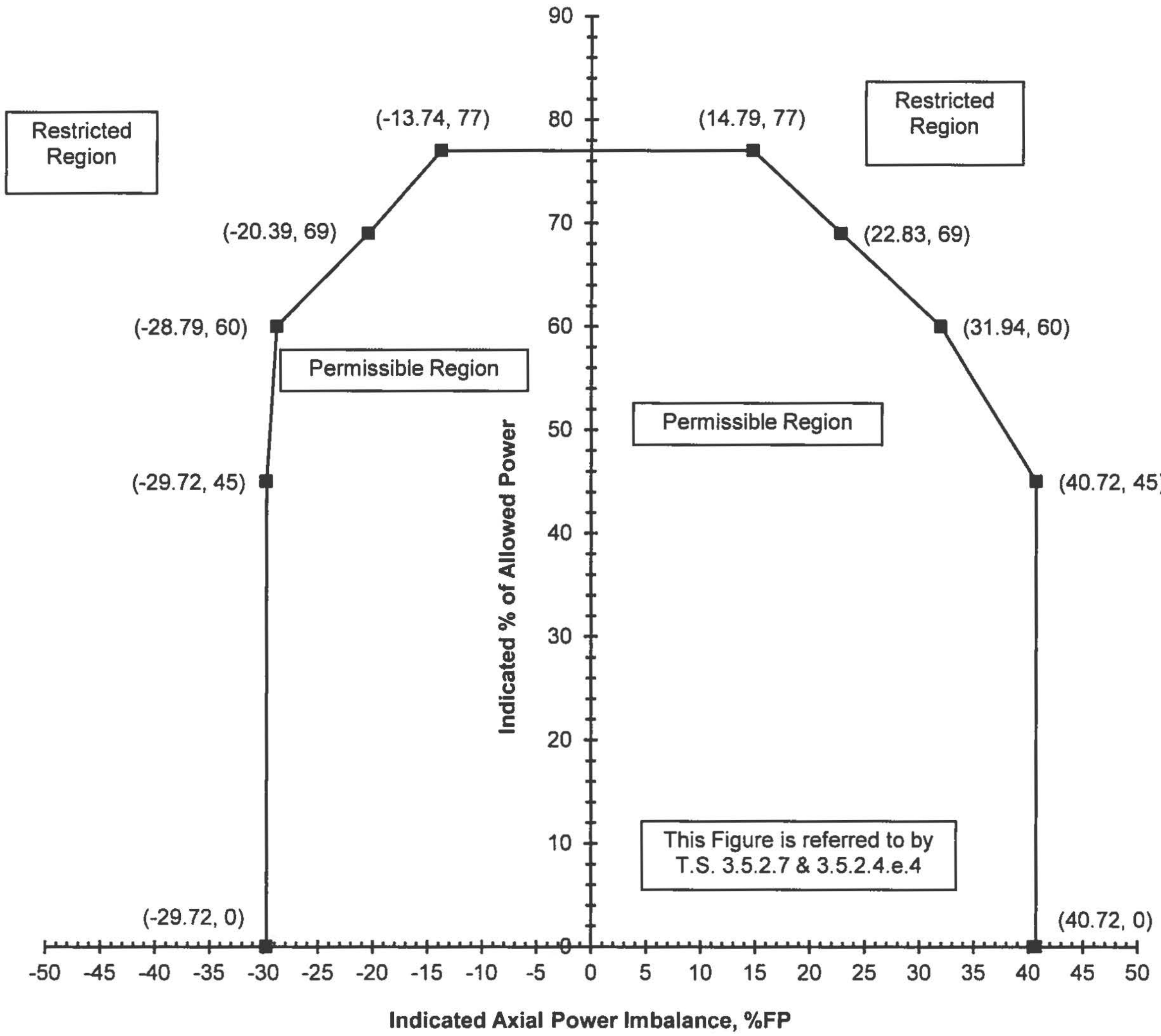


Figure 8 (Page 1 of 2)
LCO 3.5.2 Axial Power Imbalance Operating Limits

Full Incore System - 2 Pump
(0 EFPD to 400 ±10 EFPD)

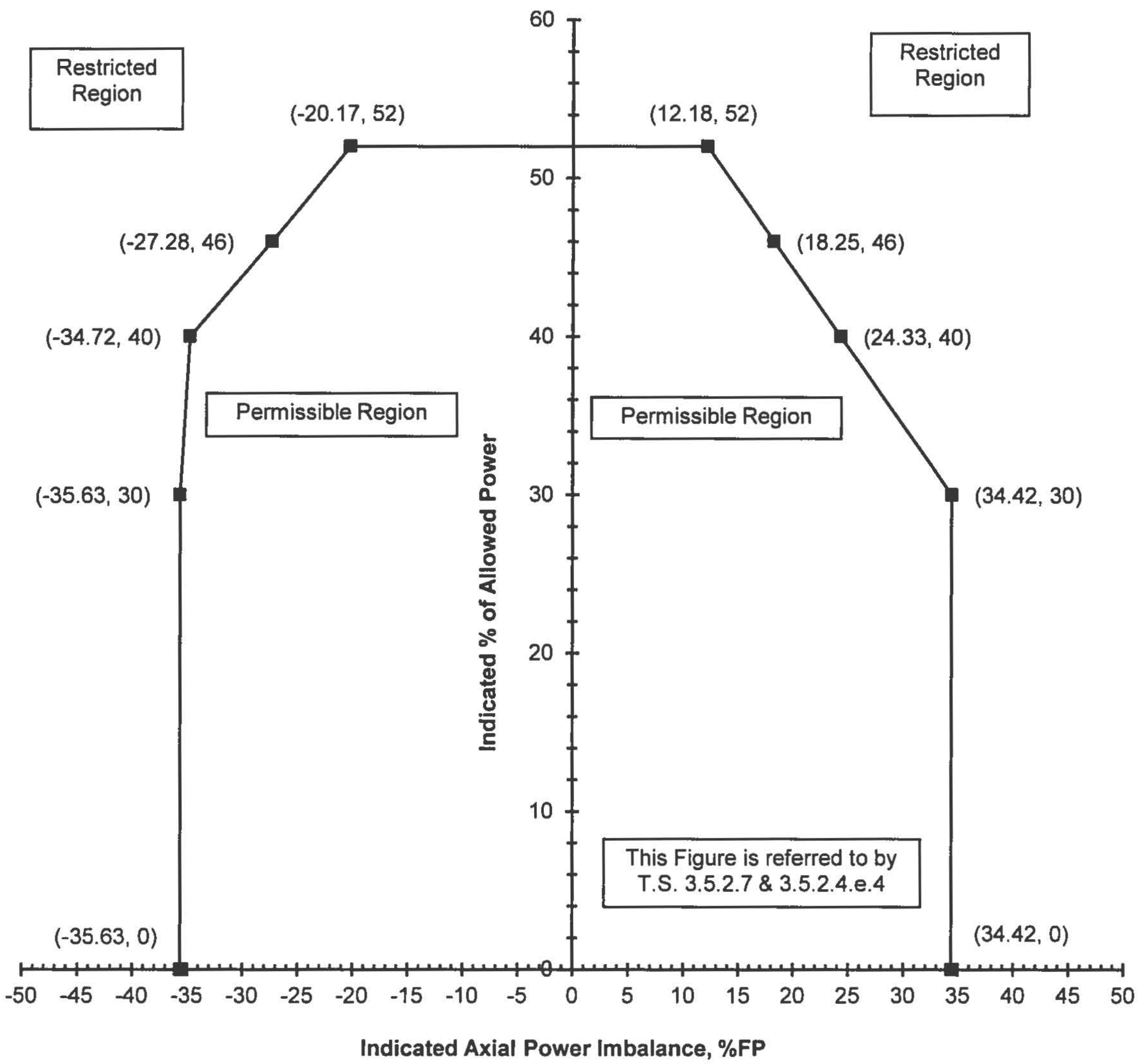


Figure 8 (Page 2 of 2)
LCO 3.5.2 Axial Power Imbalance Operating Limits

Full Incore System - 2 Pump
(400 ±10 EFPD to EOC)

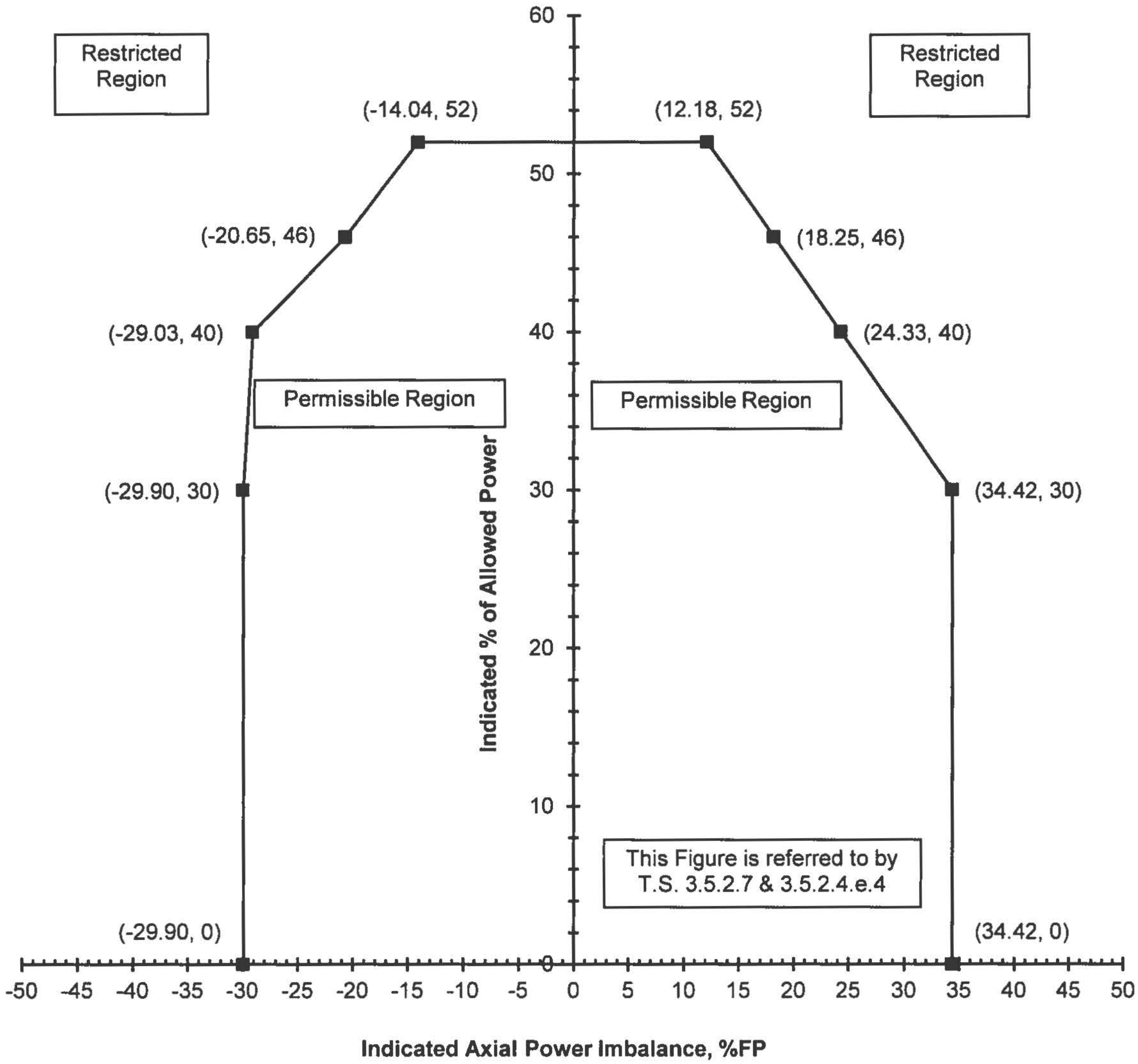
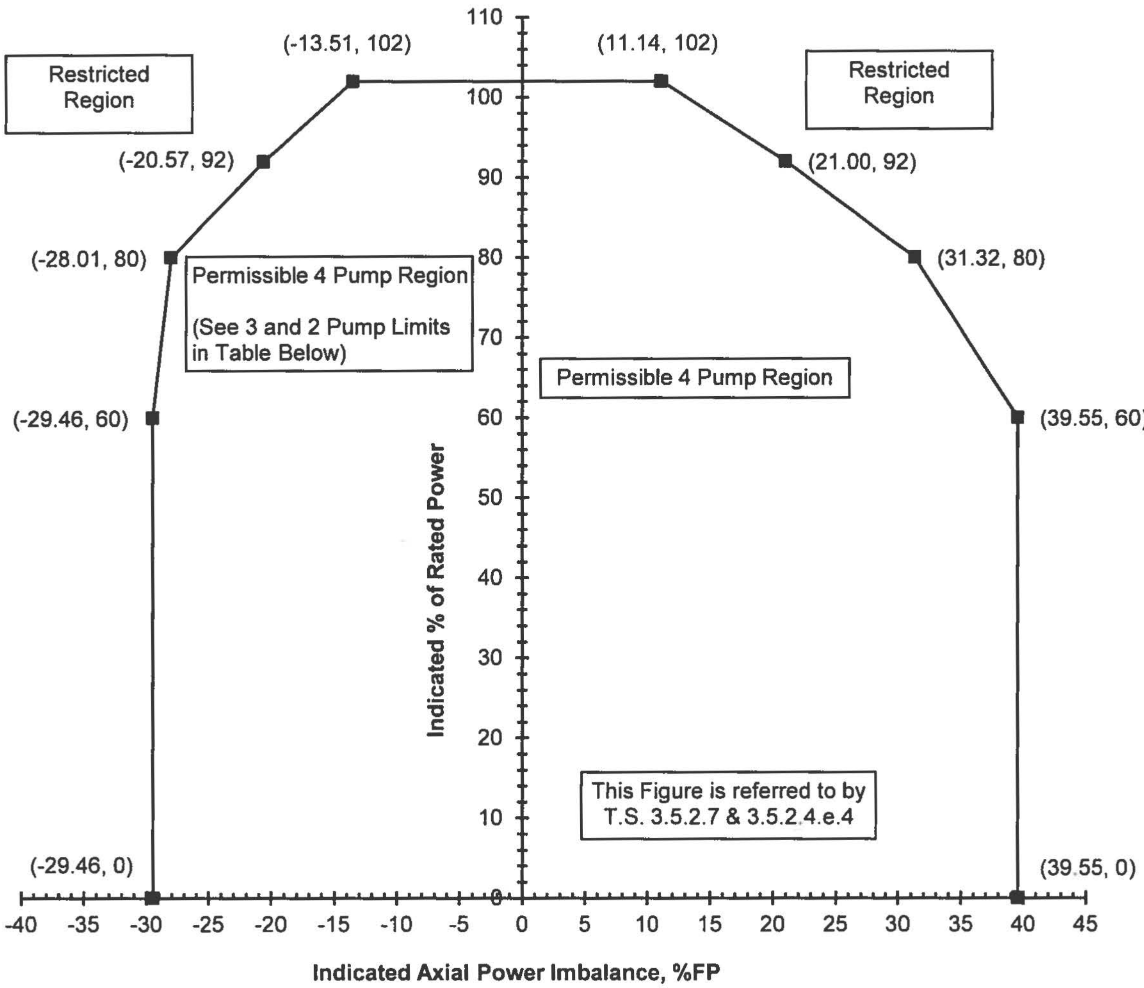


Figure 9 (Page 1 of 2)
LCO 3.5.2 Axial Power Imbalance Operating Limits

Out-of-Core Detector System
(0 EFPD to 400 ±10 EFPD)



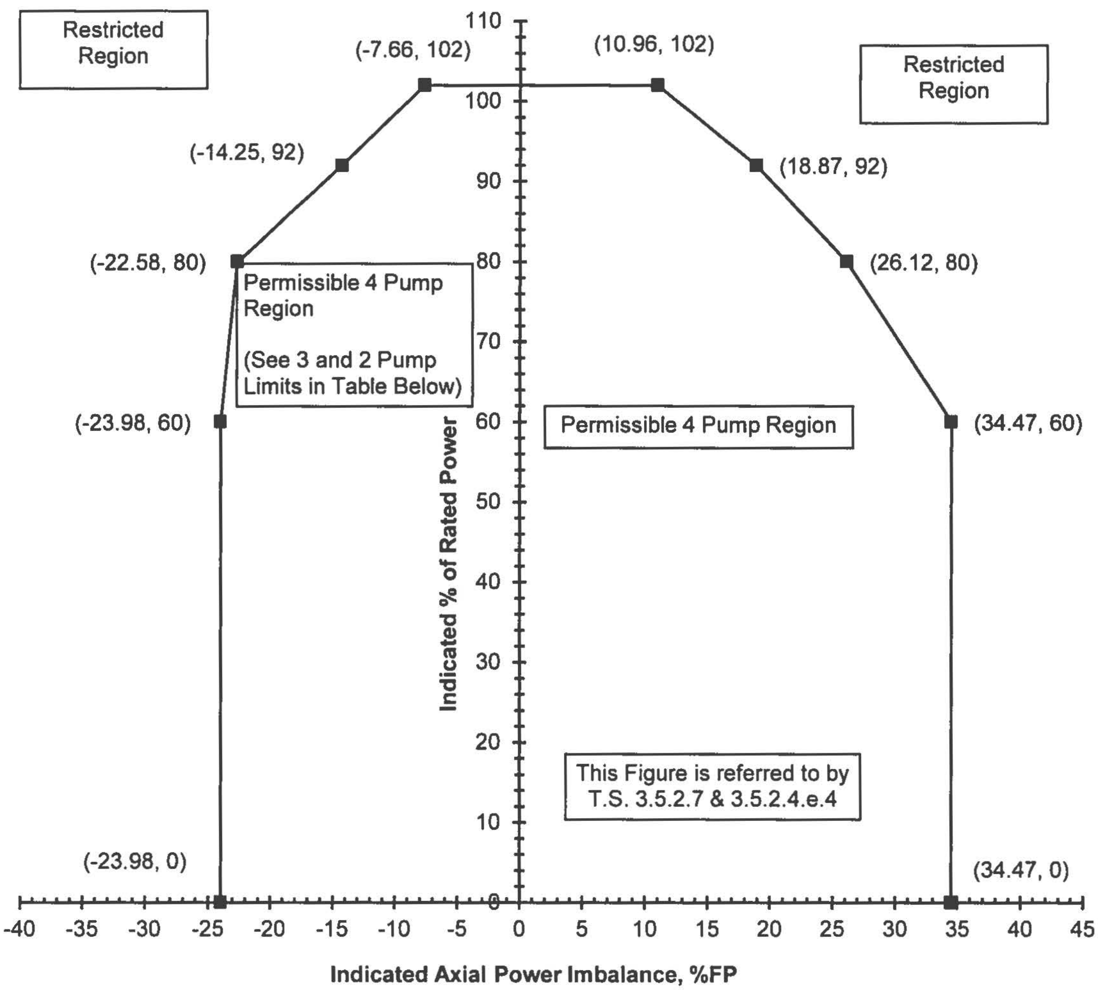
Out-of-Core Detector System Imbalance Limits (0 EFPD to 400 ±10 EFPD)
for 3 and 2 Pump Operation

Power (%FP)	Neg. Imb. (%FP)	Pos. Imb. (%FP)
	3 Pump Operation	
77	-14.36	9.48
69	-21.36	17.34
60	-28.70	26.26
45	-29.96	40.07
0	-29.96	40.07

Power (%FP)	Neg. Imb. (%FP)	Pos. Imb. (%FP)
	2 Pump Operation	
52	-15.19	7.50
46	-22.13	13.45
40	-29.37	19.40
30	-30.46	29.28
0	-30.46	29.28

Figure 9 (Page 2 of 2)
LCO 3.5.2 Axial Power Imbalance Operating Limits

Out-of-Core Detector System
(400 ±10 EFPD to EOC)



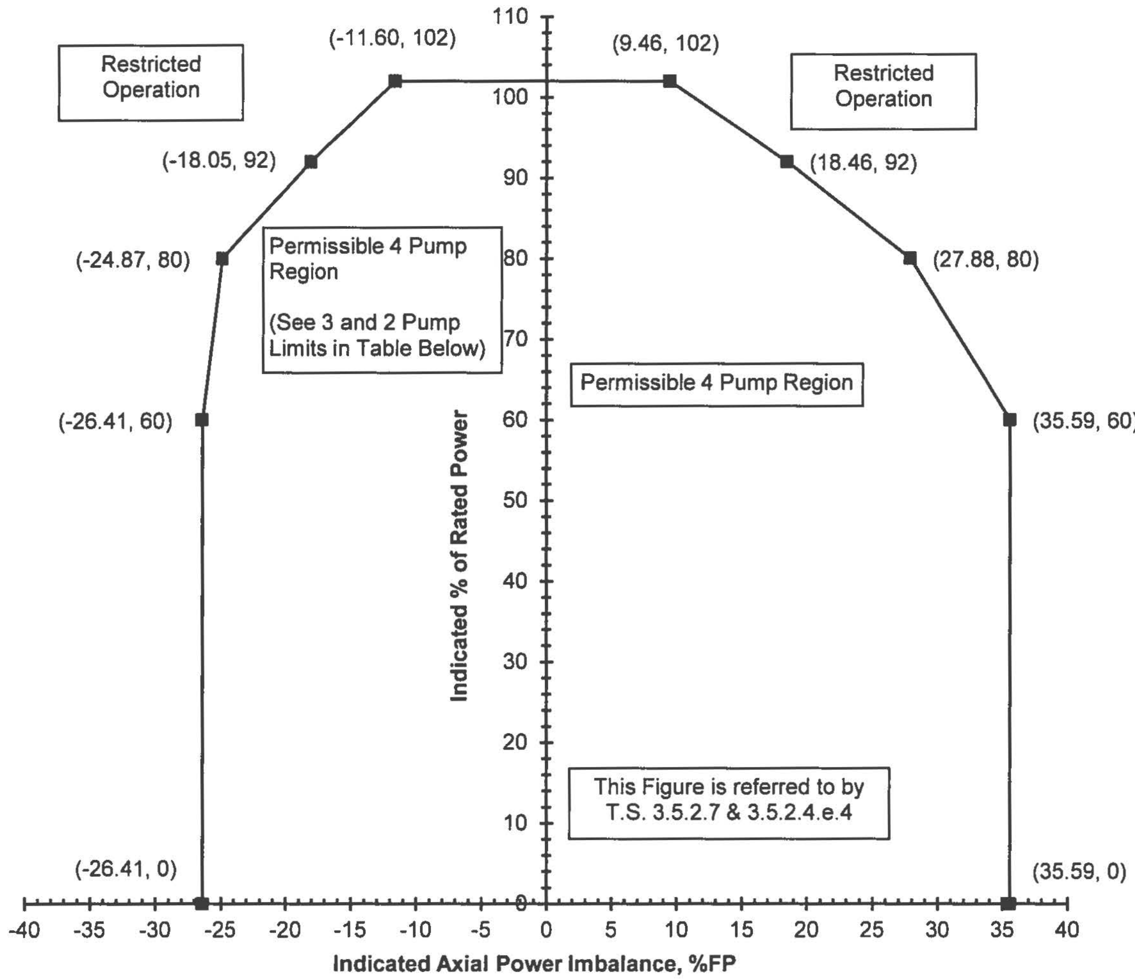
Out-of-Core Detector System Imbalance Limits (400 ±10 EFPD to EOC)
for 3 and 2 Pump Operation

Power (%FP)	Neg. Imb. (%FP)	Pos. Imb. (%FP)
	3 Pump Operation	
77	-8.50	9.48
69	-15.03	17.34
60	-23.26	26.26
45	-24.48	34.98
0	-24.48	34.98

Power (%FP)	Neg. Imb. (%FP)	Pos. Imb. (%FP)
	2 Pump Operation	
52	-9.32	7.50
46	-15.79	13.45
40	-23.93	19.40
30	-24.98	29.28
0	-24.98	29.28

Figure 10 (Page 1 of 2)
LCO 3.5.2 Axial Power Imbalance Operating Limits

Minimum Incore System
(0 EFPD to 400 ±10 EFPD)



Minimum Incore System Imbalance Limits (0 EFPD to 400 ±10 EFPD)
for 3 and 2 Pump Operation

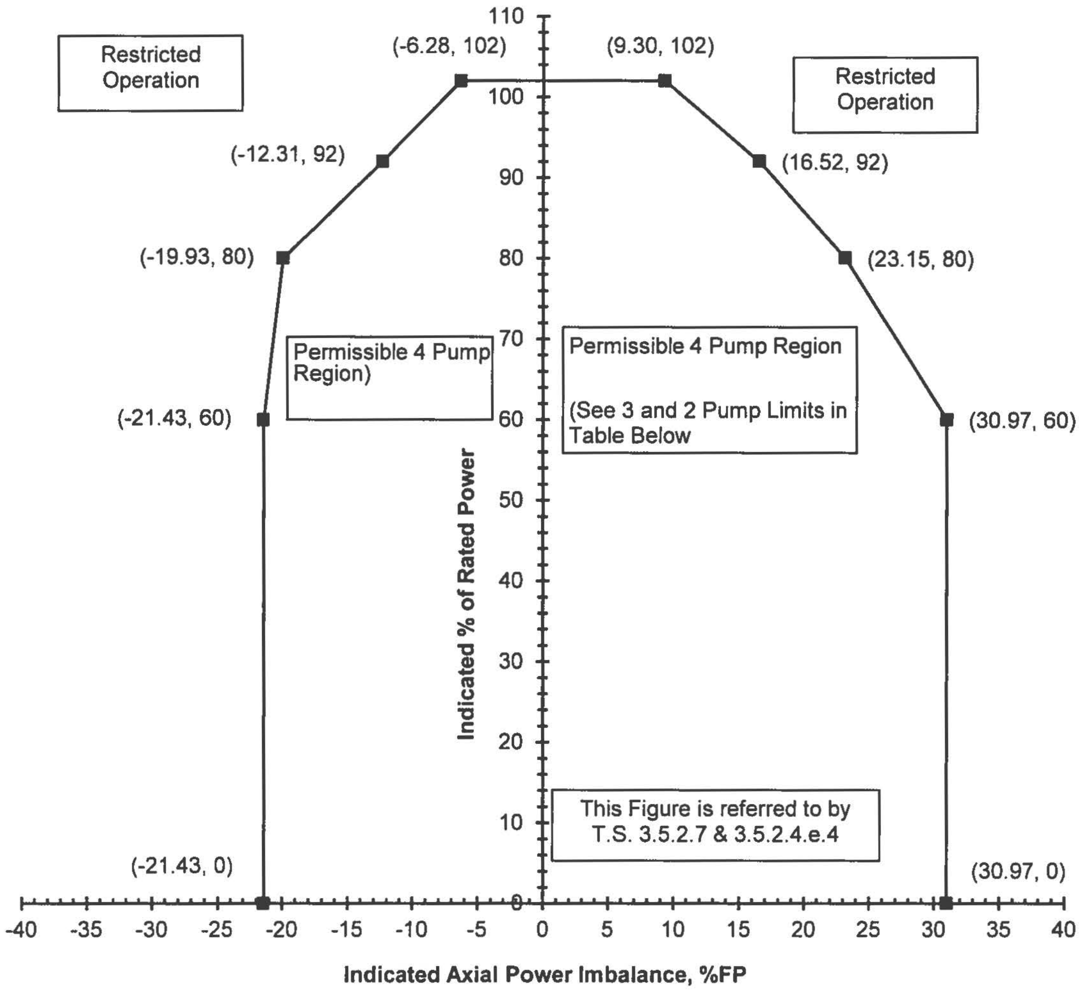
Power (%FP)	Neg. Imb. (%FP)	Pos. Imb. (%FP)
	3 Pump Operation	
77	-12.47	8.06
69	-18.86	15.23
60	-25.57	23.36
45	-26.93	35.96
0	-26.93	35.96

Power (%FP)	Neg. Imb. (%FP)	Pos. Imb. (%FP)
	2 Pump Operation	
52	-13.15	6.42
46	-19.46	11.84
40	-26.07	17.25
30	-27.46	26.26
0	-27.46	26.26

NOTE: No individual long emitter detector affecting the minimum incore system imbalance calculation exceeds 73% sensitivity depletion; therefore, reduced limits are not applicable and are not shown.

Figure 10 (Page 2 of 2)
LCO 3.5.2 Axial Power Imbalance Operating Limits

Minimum Incore System
(400 ±10 EFPD to EOC)



Minimum Incore System Imbalance Limits (400 ±10 EFPD to EOC)
for 3 and 2 Pump Operation

Power (%FP)	Neg. Imb. (%FP)	Pos. Imb. (%FP)
	3 Pump Operation	
77	-7.16	8.06
69	-13.11	15.23
60	-20.63	23.36
45	-21.96	31.34
0	-21.96	31.34

Power (%FP)	Neg. Imb. (%FP)	Pos. Imb. (%FP)
	2 Pump Operation	
52	-8.03	6.42
46	-13.72	11.84
40	-21.13	17.25
30	-22.48	26.26
0	-22.48	26.26

NOTE: No individual long emitter detector affecting the minimum incore system imbalance calculation exceeds 73% sensitivity depletion; therefore, reduced limits are not applicable and are not shown.

Enclosure 1

Core Operating Limit Technical Specification Bases Descriptions

SL 2.1.1 Bases Nuclear Power Peaking Factors

The design nuclear power peaking factors given below define the reference design peaking condition in the core for operation at the maximum overpower. These peaking factors serve as the basis for the pressure/temperature core protection safety limits and the power-to-flow limit that prevent cladding failure due to DNB overheating.

- Nuclear Enthalpy Rise Hot Channel Factor (Radial-Local Peaking Factor), $F^N_{\Delta H}$

  $F^N_{\Delta H} = 1.80$

- Axial Flux Shape Peaking Factor, F^N_Z

  $F^N_Z = 1.65$ (cosine with tails)

- Total Nuclear Power Peaking Factor, F^N_Q

  $F^N_Q = F^N_{\Delta H} \times F^N_Z$

  $F^N_Q = 2.97$

SL 2.1.2 Bases Maximum Allowable Local Linear Heat Rates

The maximum allowable local linear heat rate limit is the minimum LHR that will cause centerline fuel melt in the rod or cause the fuel rod cladding to exceed the 1.0% transient strain limit. These limits are the basis for the imbalance portions of the Axial Power Imbalance Protective Limits and Setpoints in Figures 1 and 2 of the COLR, respectively. The limits are fuel design-specific; the value for the most limiting fuel design in the current core is used for monitoring as given below:

- AREVA Mark-B-HTP

Burnup (MWd/mtU)	Linear Heat Rate to Melt (LHRTM) (kW/ft)	Linear Heat Rate to 1% Transient Strain (kW/ft)
0	25.16	23.86
50	25.16	
1000	25.36	
10000	25.24	
15000	24.54	
20000	24.09	23.86
25000	23.61	
30000	23.13	22.63
40000	22.17	21.51
50000	20.99	20.47
60000		17.33
62000	19.57	17.11

SL 2.3.1 Bases Power-to-Flow Trip Setpoints

The nuclear overpower trip setpoint based on RCS flow (power/flow or flux/flow trip) for the current cycle is 1.08. This setpoint applies to four-, three- and two-pump operation as described in T.S. Table 2.3-1 and Figure 2 of the COLR.

The power/flow trip, in combination with the axial power imbalance trip, provides steady-state DNB protection for the Axial Power Imbalance Protective Limit (Figure 1). A reactor trip is initiated when the core power, axial power peaking and reactor coolant flow conditions indicate an approach to the DNBR limit. The power/flow trip also provides transient protection for loss of reactor coolant flow events, such as loss of one RC pump from a four RC pump operating condition and a locked rotor accident.

Power level and reactor flow rate combinations for four-, three- and two-pump operating conditions are as follows:

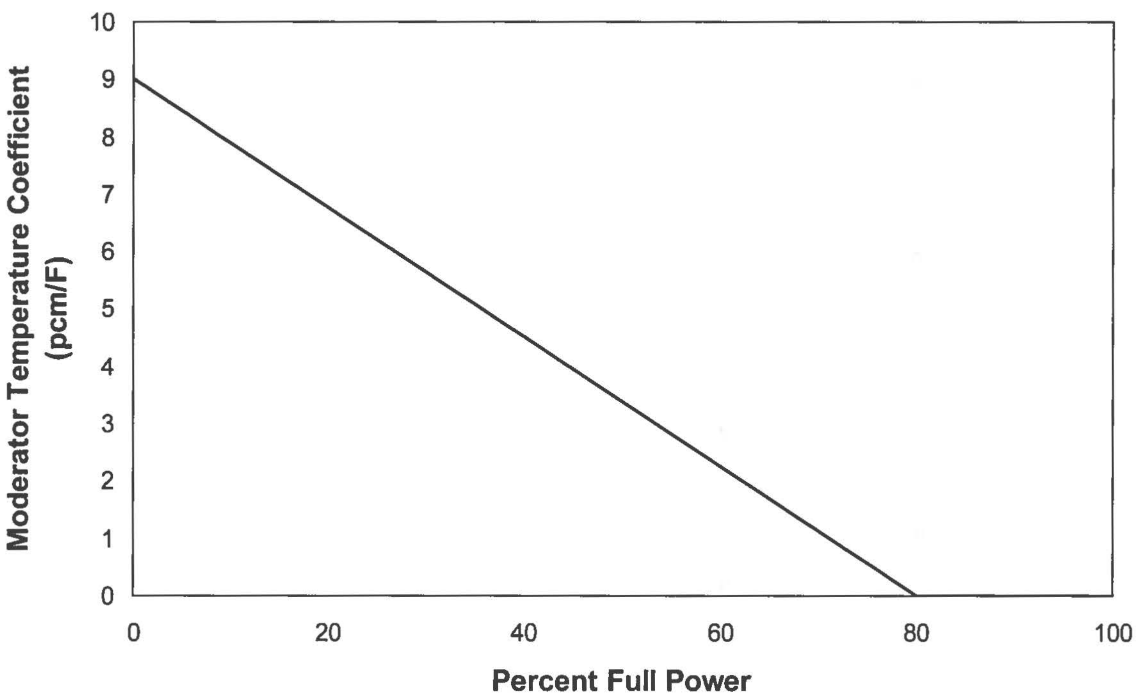
1. Trip would occur when four reactor coolant pumps are operating if power level is 108 percent and flow rate is 100 percent, or power level is 100 percent and flow rate is 92.5 percent.

2. Trip would occur when three reactor coolant pumps are operating if power level is 80.68 percent and flow rate is 74.7 percent or power level is 75 percent and flow rate is 69.4 percent.

3. Trip would occur when one reactor coolant pump is operating in each loop (total of two pumps operating) if power level is 53.14 percent and flow rate is 49.2 percent or power level is 49 percent and flow rate is 45.4 percent.

The power level trip and associated reactor power/axial power imbalance boundaries are reduced by the power-to-flow ratio as a percent (1.08 percent) for each one percent flow reduction.

LCO 3.5.2 Bases - Allowable MTC Limit vs. Power Level



The LOCA Limited Maximum Allowable Linear Heat Rate limits in COLR Table 3 can be maintained for partial power and three pump operation as long as the maximum allowable positive moderator temperature coefficient (MTC) as a function of power level shown above is preserved. Note that additional MTC limits are defined in TMI-1 Technical Specification 3.1.7.

Enclosure 2

Operating Limits Not Required by Technical Specifications

Alternate Minimum Boron Requirements for Cold Shutdown

(References: T.S. 3.3.1.1.a, T.S. 3.3. Bases, FSAR 9.2.1.2)

The Borated Water Storage Tank (BWST) is required by Technical Specifications 3.3.1.1.a to be available as a source of borated water to meet ECCS LOCA criteria. The T.S. 3.3.1.1.a requirements also ensure that there is a sufficient source of borated water available to bring the reactor to cold shutdown under normal operating conditions. Although not required by T.S., other sources of borated water can be used in lieu of the BWST for the purpose of achieving cold shutdown under normal operating conditions.

The alternate source of borated water shall contain the equivalent of at least 740 ft^3 of 12,500 ppm boron with B-10 content no less than 19.5 atom percent, or the equivalent of at least 780 ft^3 of 12,500 ppm boron with B-10 content no less than 18.5 atom percent, or the equivalent of at least 820 ft^3 of 12,500 ppm boron with B-10 content no less than 17.5 atom percent. There is no T.S. requirement to maintain an alternate source tank at this level, however out-of-service time for this tank should be minimized. The design bases for this tank are described in FSAR Section 9.2.1.2. The Boric Acid Mix Tank (BAMT) or one of the Reclaimed Boric Acid Tanks (RBAT) can be used as the alternate source of borated water.