



Crystal River Nuclear Plant
Docket No. 50-302
Operating License No. DPR-72

Ref: ITS 5.6.2.18(d)

November 28, 2007
3F1107-07

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

Subject: Crystal River Unit 3 – Core Operating Limits Report, Cycle 16, Revision 0 and
Revision 1

Dear Sir:

Florida Power Corporation, doing business as Progress Energy Florida, Inc., hereby submits the
Crystal River - Unit 3 Core Operating Limits Report, Cycle 16, Revisions 0 and 1, as required by
Improved Technical Specifications (ITS) 5.6.2.18(d).

No new regulatory commitments are made in this letter.

If you have any questions regarding this submittal, please contact Mr. Dennis Herrin, Acting
Supervisor, Licensing and Regulatory Programs at (352) 563-4633.

Sincerely,

Stephen J. Cahill
Manager Engineering

SJC/dar

Attachment A: Cycle 16, Core Operating Limits Report, Revision 0
Attachment B: Cycle 16, Core Operating Limits Report, Revision 1

xc: NRR Project Manager
Regional Administrator, Region II
Senior Resident Inspector

Progress Energy Florida, Inc.
Crystal River Nuclear Plant
15760 W. Powerline Street
Crystal River, FL 34428

ADD
NRR

PROGRESS ENERGY FLORIDA, INC.

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50 - 302 / LICENSE NUMBER DPR - 72

ATTACHMENT A

**Cycle 16
Core Operating Limits Report
Revision 0**

Progress Energy - Florida
Crystal River Unit 3

Cycle 16
Core Operating Limits Report
Revision 0

Referencing
Improved Technical Specifications

1.0 Core Operating Limits

The analytical methods used to determine the core protective and operating limits shall be those previously reviewed and approved by the NRC. These methods are documented in the following topical reports and Technical Specification Amendments:

Safety Criteria and Methodology for Acceptable Cycle Reload Analyses, BAW-10179P-A, Rev. 6, Framatome-ANP, Lynchburg, Virginia, August 2005.

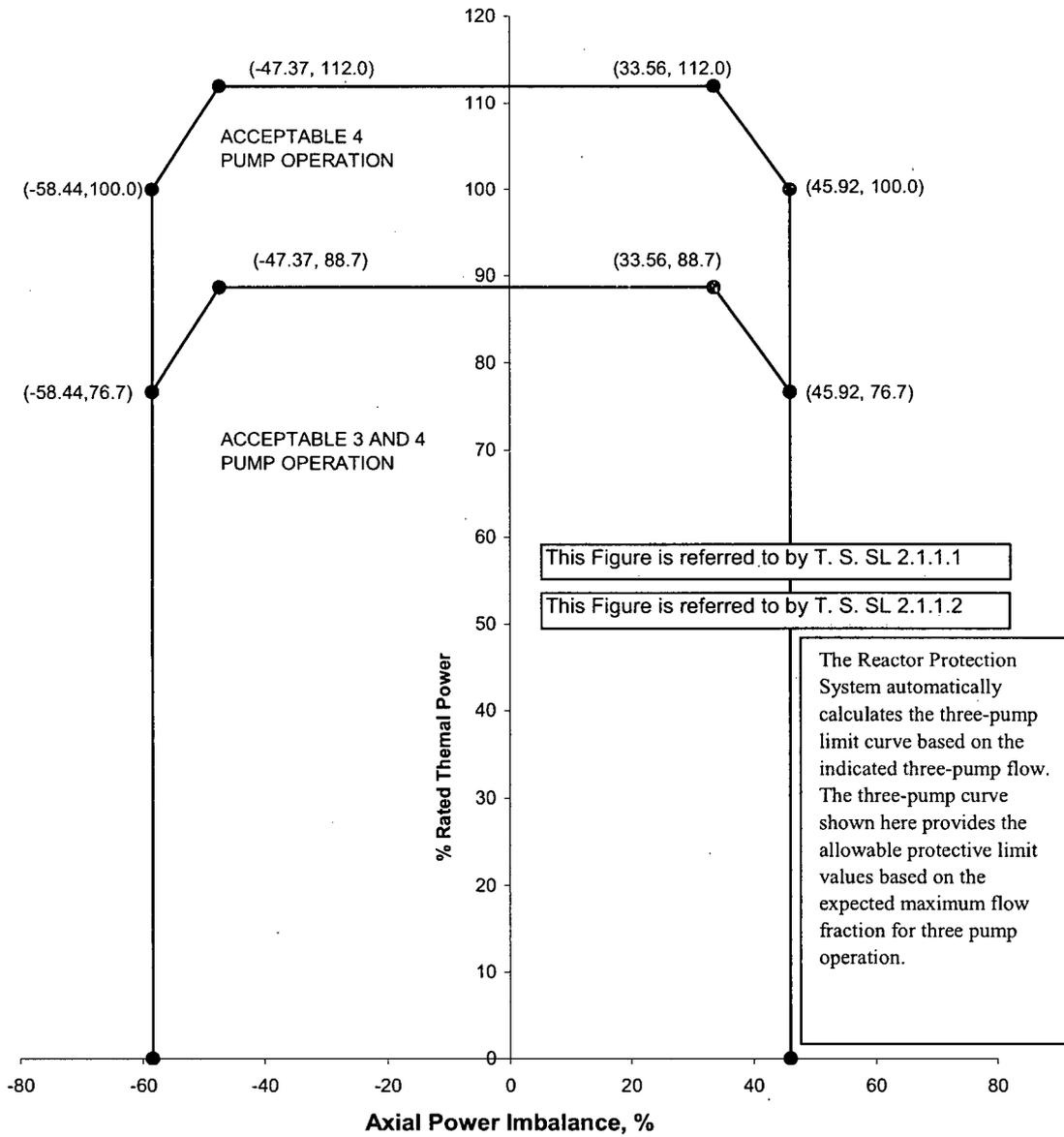
"Crystal River Unit 3 - Issuance of Amendment Re Dual Channel Control Rod Position Indication (TAC No M82990)," Licensing Amendment No 144, letter from H Silver to P M Beard, June 25, 1992.

The Cycle 16 limits generated using the methodologies above are documented in ANP-2651 Rev. 0, "Crystal River Unit 3 Cycle 16 Reload Report", dated August 2007.

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 (MTC)
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 (APSR) 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 (RPS) Instrumentation
SR 3.4.1.1	Reactor Coolant System Pressure DNB Limits
SR 3.4.1.2	Reactor Coolant System Temperature DNB Limits
SR 3.4.1.3	Reactor Coolant System Flow DNB Limits
LCO 3.9.1	Boron Concentration

AXIAL POWER IMBALANCE Protective Limits – 2568 MWt



SHUTDOWN MARGIN

Normal operating procedures require RCS boration to 1.0% $\Delta k/k$ Subcritical at 73°F prior to bypassing EFIC actuation on low steam generator pressure, or when high steam generator levels exist during secondary system chemistry control and steam generator cleaning in MODES 3, 4, and 5, therefore

Mode 3,4,5 $SDM \geq 1.0\% \Delta k/k$

These limits are
referred to by
Technical
Specification
LCO 3.1.1

Reference: Improved Technical Specification Bases B3.1.1.

Moderator Temperature Coefficient Limit (MTC)

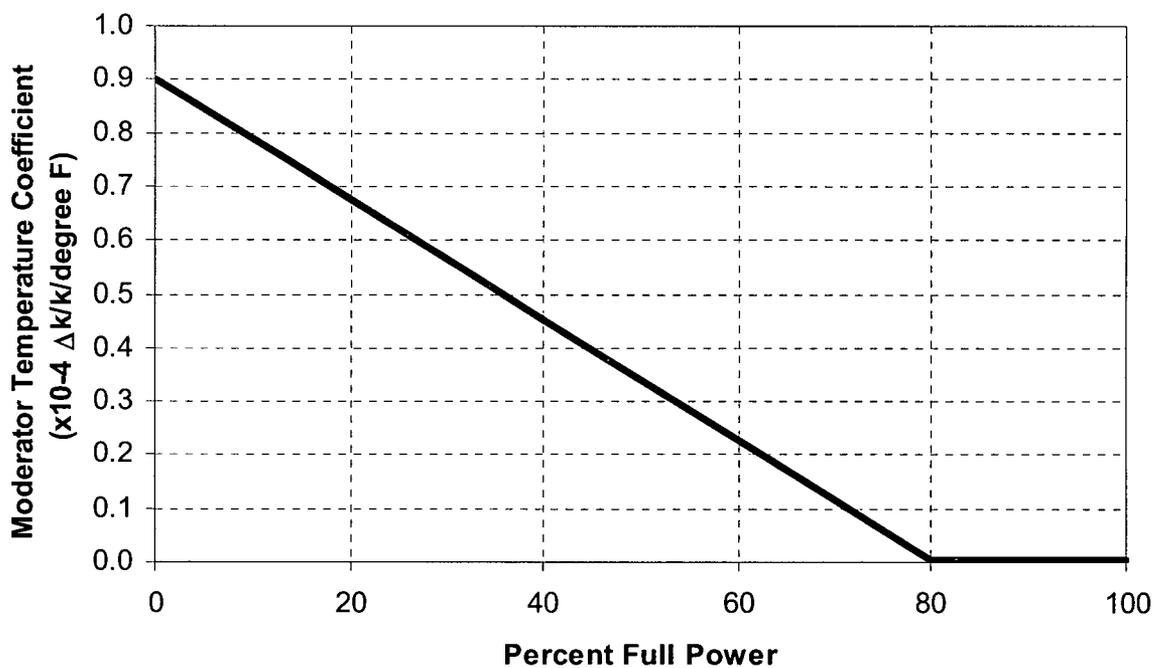
Lower Limit

MTC at HFP > $-3.58 \times 10^{-4} \Delta k/k/^\circ F$

Upper Limit

MTC \leq The curve below:

The following Upper Limits may not be exceeded (limits ensure the validity of the ECCS analysis is preserved) for operation in MODES 1 and 2:



These limits are referred to by Technical Specification LCO 3.1.3

Absolute Position Indicator (API)/ Relative Position Indicator (RPI) 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
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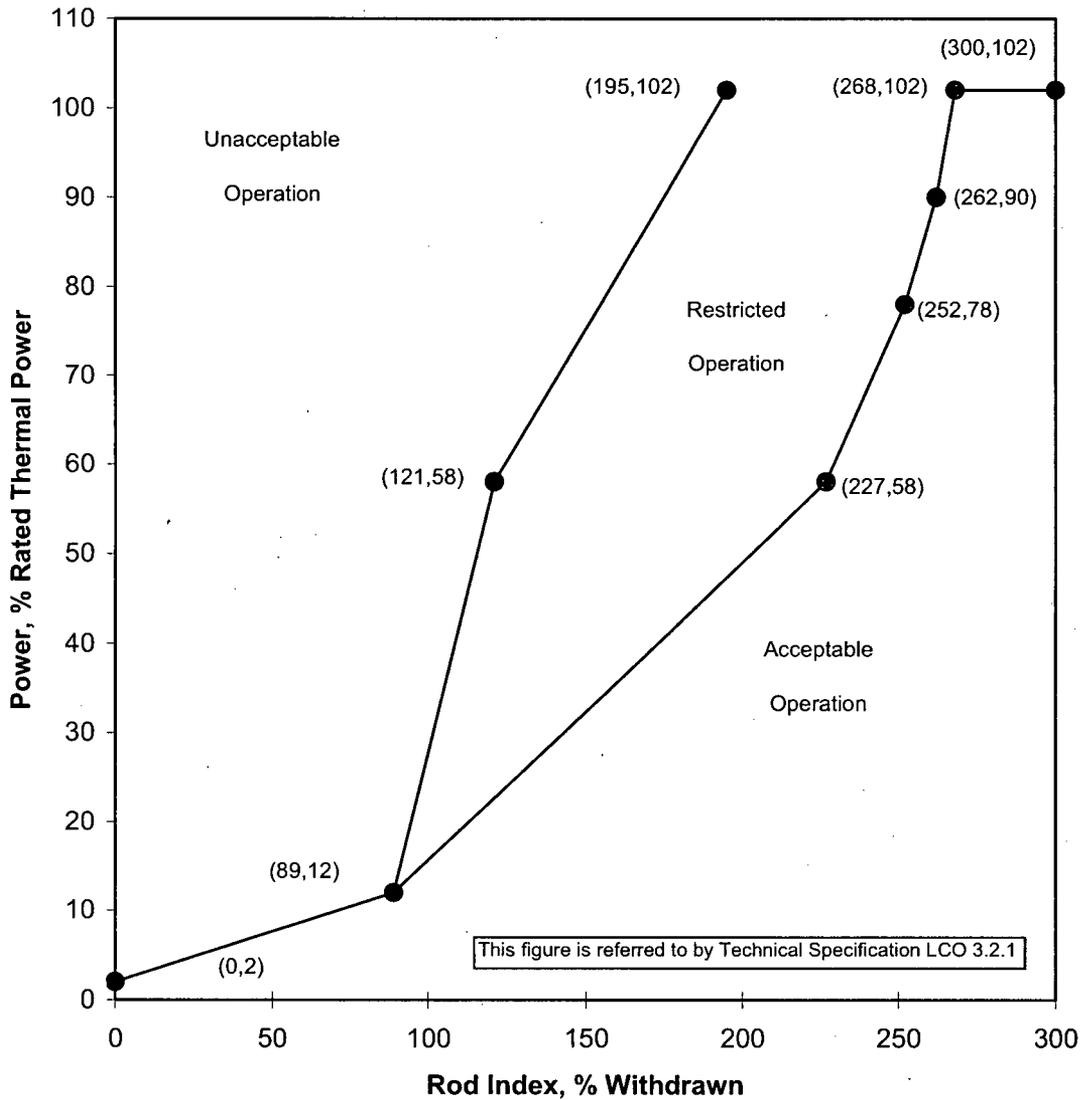
Reference: "Crystal River Unit 3 – Issuance of Amendment Re: Dual Channel Control Rod Position Indication (TAC No. M82990)", Licensing Amendment No. 144, Letter from H.S. Silver to P.M. Beard, June 25, 1992.

Note 1 If the plant computer is not available, then the following meter models are approved for use: Keithley 2001, Keithley 197, Keithley 197A (Ref. EC 61264).

Regulating Rod Insertion Limits

**Regulating Rod Group Insertion
 Error Adjusted Limits**

Four Pump Operation
 0 EFPD to EOC
 100% RTP = 2568MWt

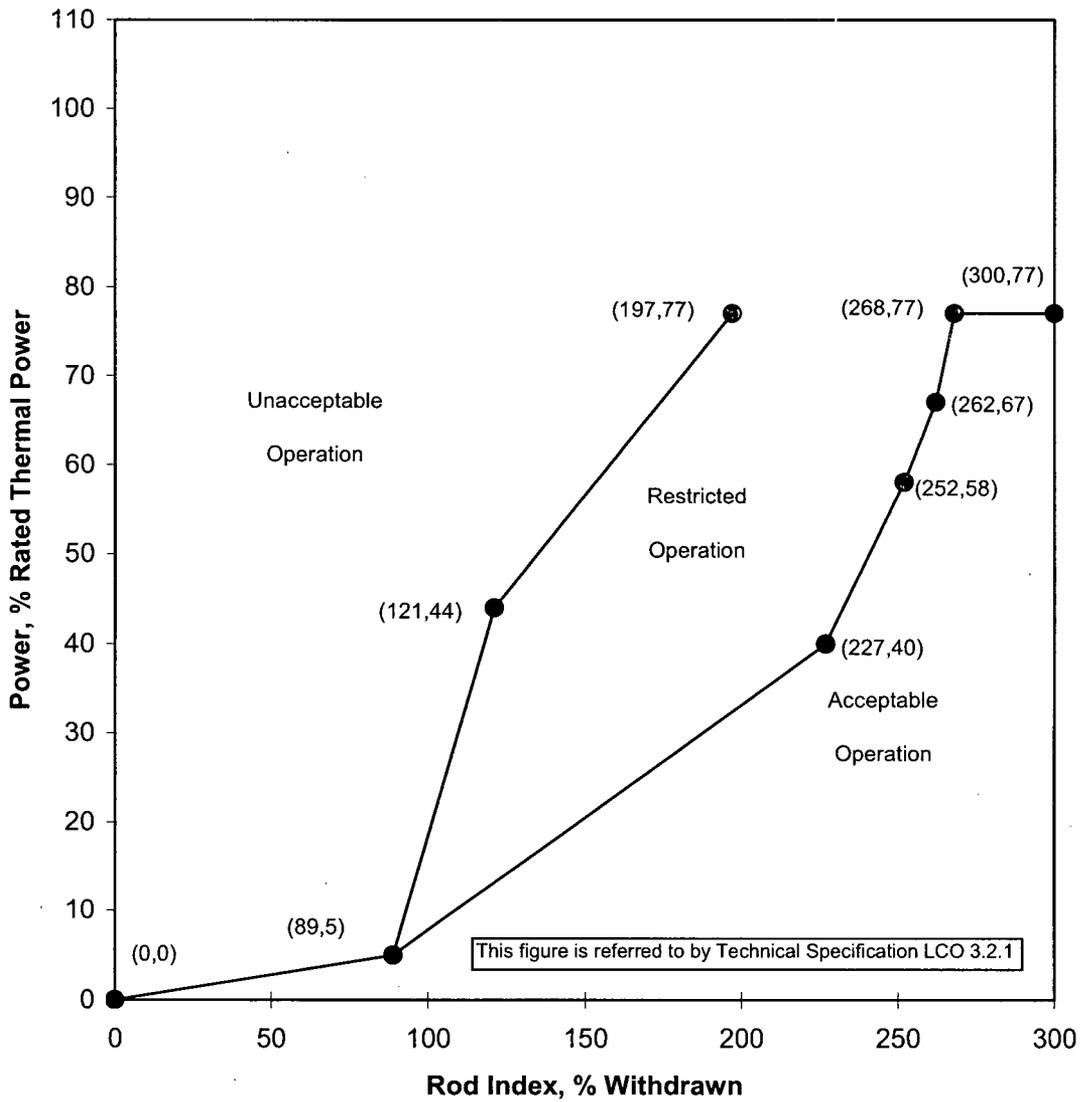


Note 1: A Rod group overlap of 25 ±5% between sequential groups 5 and 6, and 6 and 7 shall be maintained.

Regulating Rod Insertion Limits (Continued)

**Regulating Rod Group Insertion
 Error Adjusted Limits**

Three Pump Operation
 0 EFPD to EOC
 100% RTP = 2568 MWt



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

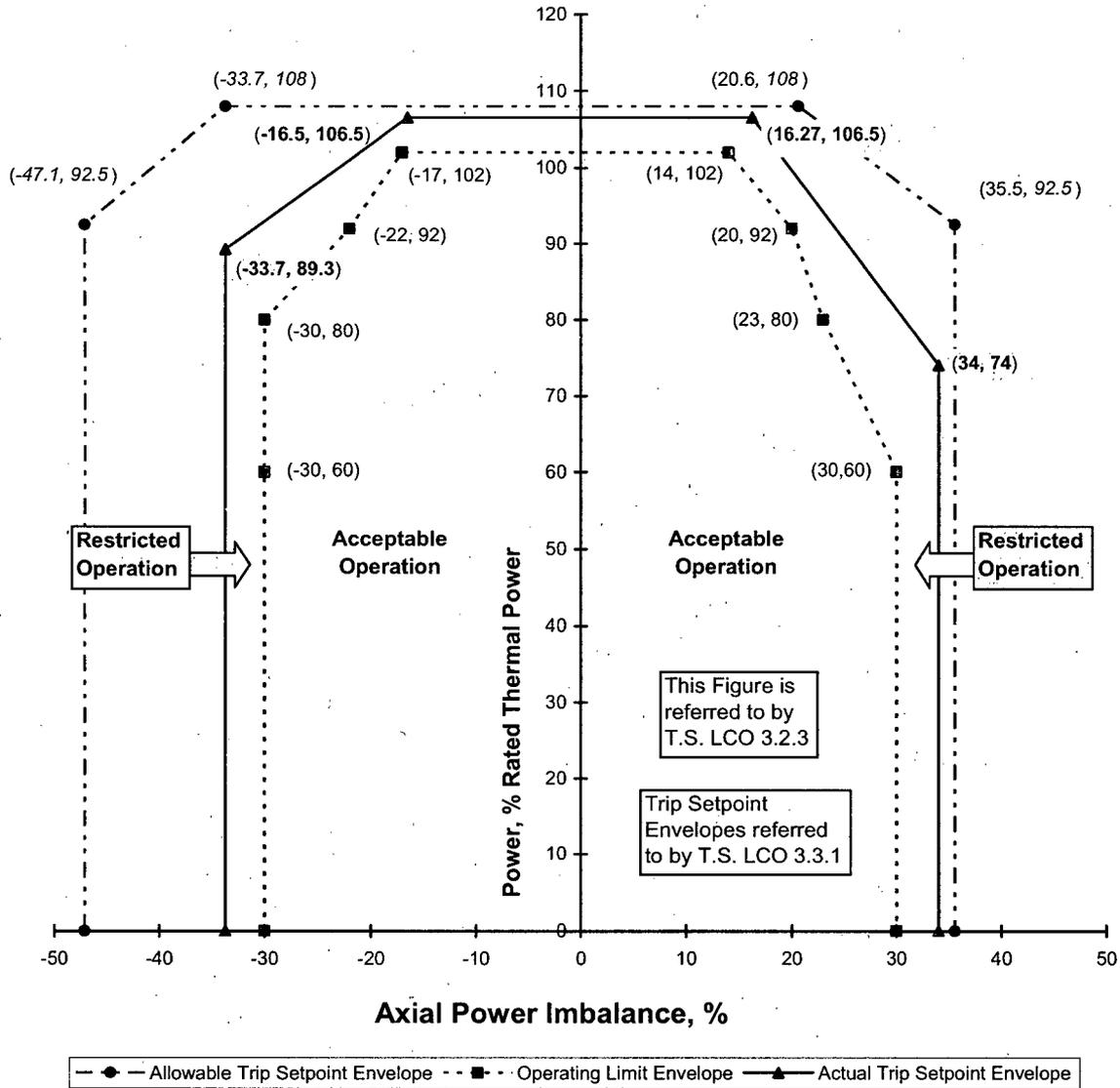
AXIAL POWER SHAPING ROD (APSR) Insertion Limits

The Axial Power Shaping Rods (APSRs) shall be inserted at the initial startup following fuel reload and may be positioned as necessary during the Power Imbalance Detector Correlation (PIDC) test. The APSRs shall be fully withdrawn from the core before exceeding 4 EFPD and prior to thermal power escalation above 80% RTP. Once the APSR pull maneuver has been completed, the APSRs shall not be inserted for the remainder of the fuel cycle during normal operation.

These limits are
referred to by
Technical
Specification
LCO 3.2.2

AXIAL POWER IMBALANCE Operating Limits

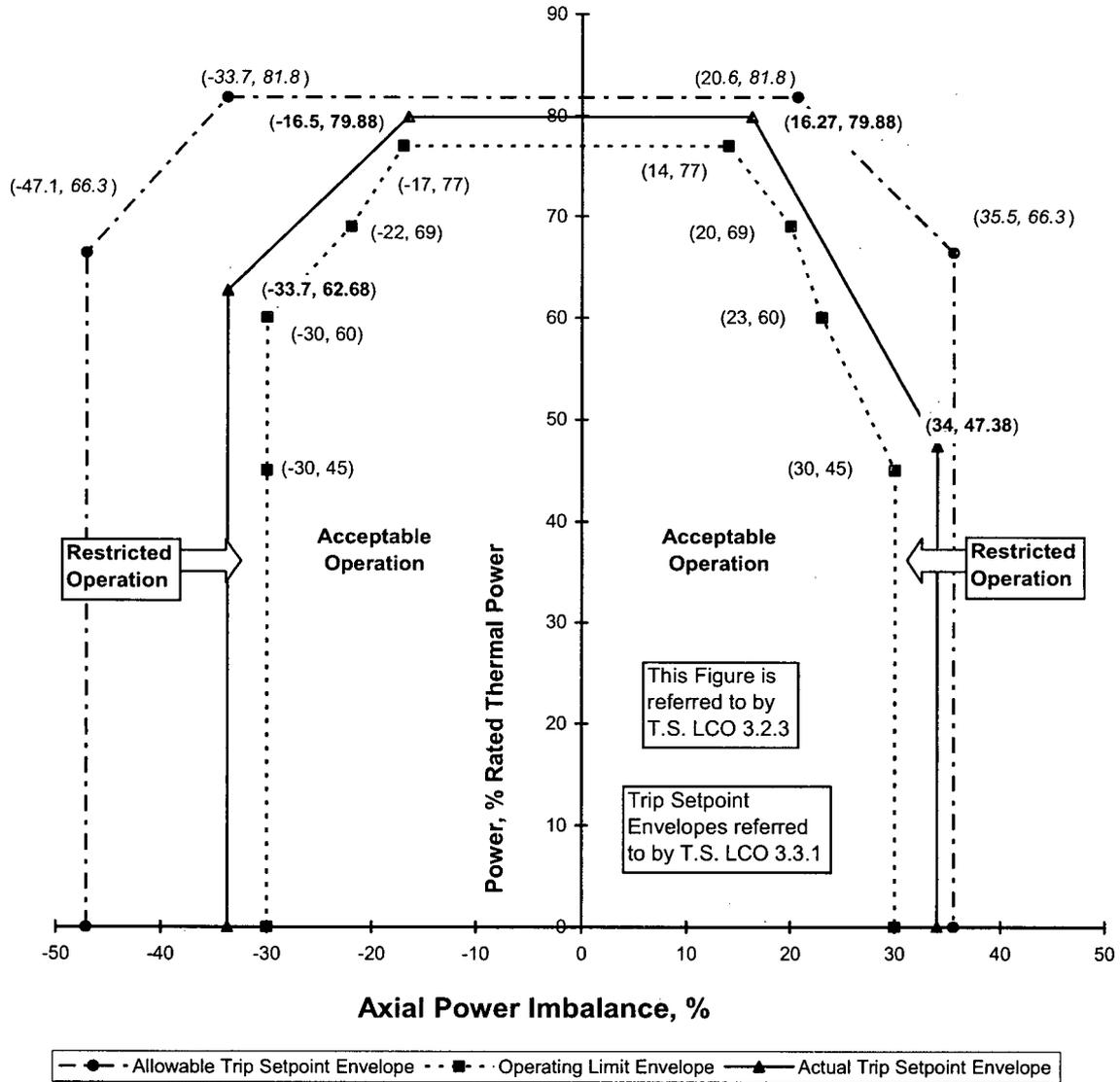
**Axial Power Imbalance Error Adjusted
 Operating Limit and Trip Setpoint Envelopes**
 Four Pump Operation
 0 EFPD to EOC
 100% RTP = 2568 MWt



AXIAL POWER IMBALANCE Operating Limits (Continued)

**Axial Power Imbalance Error Adjusted
 Operating Limit and Trip Setpoint Envelopes**

Three Pump Operation
 0 EFPD to EOC
 100% RTP = 2568 MWt



QUADRANT POWER TILT

QUADRANT POWER TILT Limits For Thermal Power \leq 60%

For Operation from 0 EFPD to EOC
 100%RTP = 2568 MWt

QUADRANT POWER TILT As Measured By:	STEADY-STATE <u>LIMIT(%)</u>	TRANSIENT <u>LIMIT(%)</u>	MAXIMUM <u>LIMIT(%)</u>
Symmetrical Incore Detector System	7.50	10.03	20.0
Power Range Channels	4.94	6.96	20.0
Minimum Incore Detector System	3.07	4.40	20.0
Measurement System Independent	8.58	11.07	20.0

QUADRANT POWER TILT Limits For Thermal Power $>$ 60%

For Operation from 0 EFPD to EOC
 100%RTP = 2568 MWt

QUADRANT POWER TILT As Measured By:	STEADY-STATE <u>LIMIT(%)</u>	TRANSIENT <u>LIMIT(%)</u>	MAXIMUM <u>LIMIT(%)</u>
Symmetrical Incore Detector System	4.29	10.03	20.0
Power Range Channels	1.96	6.96	20.0
Minimum Incore Detector System	1.90	4.40	20.0
Measurement System Independent	4.92	11.07	20.0

<p>These limits are referred to by Technical Specification LCO 3.2.4</p>

Power Peaking Factors for FIDMS

These Limits are referred to by Technical Specification LCO 3.2.5

Heat Flux Hot Channel Factor FQ

100% RTP = 2568 MWt

F_Q shall be limited by the following relationships:

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

LHR^{allow} (Bu) = See the following table

LHR^{avg} = 5.8533 kW/ft for Batch 16 E2,F2 Mark-B-HTP fuel

LHR^{avg} = 5.8636 kW/ft for Batch 17 Mark-B-HTP fuel

LHR^{avg} = 5.8533 kW/ft for Batch 18 Mark-B-HTP fuel

P = ratio of THERMAL POWER / RATED THERMAL POWER

Bu = fuel burnup (MWd/mtU)

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 16E2,F2 (Mark-B-HTP) UO₂ Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	16.0	16.0	14.3
2.506	16.9	16.9	14.3
4.264	17.0	16.5	14.3
6.021	17.3	17.3	14.3
7.779	17.3	17.3	14.3
9.536	17.0	17.0	14.3
12.000	16.1	16.1	14.3

This table is referred to
 by Technical Specification
 LCO 3.2.5

Power Peaking Factors (Continued)

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 17A,B,C,D,E (Mark-B-HTP) UO₂ Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	16.0	16.0	14.3
2.506	16.9	16.9	14.3
4.264	17.0	16.5	14.3
6.021	17.3	17.3	14.3
7.779	17.3	17.3	14.3
9.536	17.0	17.0	14.3
12.000	16.1	16.1	14.3

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 17F (Mark-B-HTP) UO₂ Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup Range, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	15.7	15.7	13.9
2.506	16.6	16.6	13.9
4.264	16.7	16.2	13.9
6.021	17.0	17.0	13.9
7.779	17.0	17.0	13.9
9.536	16.7	16.7	13.9
12.000	15.8	15.8	13.9

These tables are referred to
 by Technical Specification.
 LCO 3.2.5

Power Peaking Factors (Continued)

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 18 (Mark-B-HTP) UO₂ Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	15.9	15.9	14.3
2.506	16.8	16.8	14.3
4.264	16.9	16.4	14.3
6.021	17.3	17.3	14.3
7.779	17.3	17.3	14.3
9.536	17.0	17.0	14.3
12.000	16.1	16.1	14.3

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 16E2,F2 (Mark-B-HTP) 3 wt% Gadolinia Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup Range, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	14.9	14.9	12.2
2.506	15.7	15.7	12.2
4.264	15.8	15.4	12.2
6.021	16.0	16.0	12.2
7.779	16.0	16.0	12.2
9.536	15.8	15.8	12.2
12.000	15.0	15.0	12.2

These tables are referred to
 by Technical Specification.
 LCO 3.2.5

Power Peaking Factors (Continued)

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 16F2 (Mark-B-HTP) 8 wt% Gadolinia Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	13.5	13.5	11.1
2.506	14.3	14.3	11.1
4.264	14.4	14.0	11.1
6.021	14.7	14.7	11.1
7.779	14.7	14.7	11.1
9.536	14.4	14.4	11.1
12.000	13.6	13.6	11.1

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 17 (Mark-B-HTP) 3 wt% Gadolinia Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup Range, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	14.9	14.9	12.2
2.506	15.7	15.7	12.2
4.264	15.8	15.4	12.2
6.021	16.0	16.0	12.2
7.779	16.0	16.0	12.2
9.536	15.8	15.8	12.2
12.000	15.0	15.0	12.2

These tables are referred to
 by Technical Specification.
 LCO 3.2.5

Power Peaking Factors (Continued)

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 17 (Mark-B-HTP) 6 wt% Gadolinia Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	14.0	14.0	11.8
2.506	14.8	14.8	11.8
4.264	14.9	14.5	11.8
6.021	15.2	15.2	11.8
7.779	15.2	15.2	11.8
9.536	14.9	14.9	11.8
12.000	14.1	14.1	11.8

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 17 (Mark-B-HTP) 8 wt% Gadolinia Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup Range, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	13.5	13.5	11.1
2.506	14.3	14.3	11.1
4.264	14.4	14.0	11.1
6.021	14.7	14.7	11.1
7.779	14.7	14.7	11.1
9.536	14.4	14.4	11.1
12.000	13.6	13.6	11.1

These tables are referred to
 by Technical Specification.
 LCO 3.2.5

Power Peaking Factors (Continued)

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 18 (Mark-B-HTP) 3 wt% Gadolinia Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	14.8	14.8	12.2
2.506	15.6	15.6	12.2
4.264	15.7	15.3	12.2
6.021	16.0	16.0	12.2
7.779	16.0	16.0	12.2
9.536	15.8	15.8	12.2
12.000	15.0	15.0	12.2

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 18 (Mark-B-HTP) 6 wt% Gadolinia Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup Range, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	13.9	13.9	11.8
2.506	14.7	14.7	11.8
4.264	14.8	14.4	11.8
6.021	15.2	15.2	11.8
7.779	15.2	15.2	11.8
9.536	14.9	14.9	11.8
12.000	14.1	14.1	11.8

These tables are referred to
 by Technical Specification.
 LCO 3.2.5

Power Peaking Factors (Continued)

**CR-3 Cycle 16 Reload Allowable LHR Limits
Batch 18 (Mark-B-HTP) 8 wt% Gadolinia Fuel LHR^{allow}
Allowable Peak LHR for Specified Burnup, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	13.4	13.4	11.1
2.506	14.2	14.2	11.1
4.264	14.3	13.9	11.1
6.021	14.7	14.7	11.1
7.779	14.7	14.7	11.1
9.536	14.4	14.4	11.1
12.000	13.6	13.6	11.1

These tables are referred to
by Technical Specification.
LCO 3.2.5

Power Peaking Factors (Continued)

This Limit is referred to by Technical Specification LCO 3.2.5

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

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

ARP = Allowable Radial Peak, See the following table

P = ratio of 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

$1/\text{RH} = 0.3$

Cycle 16 Allowable Radial Peaks (ARP)

Axial Peak	Axial Location (X/L)	ARP ⁽¹⁾	Axial Peak	Axial Location (X/L)	ARP ⁽¹⁾	Axial Peak	Axial Location (X/L)	ARP ⁽¹⁾
1.1	0.01	1.9292	1.4	0.01	2.2106	1.7	0.01	2.1194
1.1	0.14	1.9287	1.4	0.14	2.2079	1.7	0.14	1.9723
1.1	0.2	1.9284	1.4	0.2	2.1840	1.7	0.2	1.9392
1.1	0.3	1.9278	1.4	0.3	2.1162	1.7	0.3	1.8853
1.1	0.4	1.9271	1.4	0.4	2.0509	1.7	0.4	1.8194
1.1	0.5	1.9266	1.4	0.5	1.9779	1.7	0.5	1.7658
1.1	0.6	1.9258	1.4	0.6	1.8969	1.7	0.6	1.6942
1.1	0.7	1.9254	1.4	0.7	1.8263	1.7	0.7	1.6361
1.1	0.8	1.9248	1.4	0.8	1.7407	1.7	0.8	1.5606
1.1	0.89	1.8866	1.4	0.89	1.6847	1.7	0.89	1.5170
1.1	0.99	1.7941	1.4	0.99	1.6141	1.7	0.99	1.4608
1.2	0.01	2.0160	1.5	0.01	2.2223	1.8	0.01	2.1130
1.2	0.14	2.0148	1.5	0.14	2.1467	1.8	0.14	1.8927
1.2	0.2	2.0141	1.5	0.2	2.1100	1.8	0.2	1.8598
1.2	0.3	2.0128	1.5	0.3	2.0385	1.8	0.3	1.8142
1.2	0.4	2.0109	1.5	0.4	1.9680	1.8	0.4	1.7524
1.2	0.5	2.0103	1.5	0.5	1.9053	1.8	0.5	1.7012
1.2	0.6	2.0092	1.5	0.6	1.8262	1.8	0.6	1.6346
1.2	0.7	1.9600	1.5	0.7	1.7594	1.8	0.7	1.5792
1.2	0.8	1.8745	1.5	0.8	1.6766	1.8	0.8	1.5092
1.2	0.89	1.8191	1.5	0.89	1.6259	1.8	0.89	1.4683
1.2	0.99	1.7304	1.5	0.99	1.5625	1.8	0.99	1.4148
1.3	0.01	2.1110	1.6	0.01	2.1352	1.9	0.01	2.0497
1.3	0.14	2.1091	1.6	0.14	2.0562	1.9	0.14	1.8163
1.3	0.2	2.1082	1.6	0.2	2.0239	1.9	0.2	1.7858
1.3	0.3	2.1062	1.6	0.3	1.9604	1.9	0.3	1.7424
1.3	0.4	2.1045	1.6	0.4	1.8919	1.9	0.4	1.6880
1.3	0.5	2.0476	1.6	0.5	1.8341	1.9	0.5	1.6395
1.3	0.6	1.9701	1.6	0.6	1.7578	1.9	0.6	1.5789
1.3	0.7	1.8954	1.6	0.7	1.6952	1.9	0.7	1.5276
1.3	0.8	1.8068	1.6	0.8	1.6166	1.9	0.8	1.4620
1.3	0.89	1.7499	1.6	0.89	1.5695	1.9	0.89	1.4230
1.3	0.99	1.6713	1.6	0.99	1.5100	1.9	0.99	1.3725

⁽¹⁾These limits have been increased to reflect the 3.8% peaking uncertainty treated by SCD.

Reactor Protection System (RPS) Instrumentation

RCS Variable Low Pressure Setpoint Equation

$$P_{\text{Trip}} \geq (11.59 * T_{\text{HOT}} - 5037.8) \text{ psig}$$

This limit is referred to by ITS
Table 3.3.1-1, Item 5

Reactor Coolant System DNB Pressure Limits

RCS loop pressure \geq 2064 psig

(Assumes 20% tube plugging and bounds either four or three RCPs operating).

These limits are
referred to by
SR 3.4.1.1

Reactor Coolant System DNB Temperature Limit

RCS Hot Leg Temperature $\leq 605.8^{\circ}\text{F}$

(Assumes 20% OTSG tube plugging).

These limits are
referred to by
SR 3.4.1.2

Reactor Coolant System DNB Flow Rate Limits

RCS total flow rate ≥ 133.5 E6 lb/hr with four RCPs operating, or ≥ 99.7 E6 lb/hr with three RCPs operating.

(Assumes 20% OTSG tube plugging).

These limits are
referred to by
SR 3.4.1.3

Refueling Boron Concentration

The Mode 6 refueling boron concentration must be greater than **2714 ppmB** prior to core alterations that include the introduction of any fuel assemblies not present in the cycle 15 core, subject to the following:

- 1) 2 ppm/EFPD shall be added for each EFPD that the cycle 15 length is less than 653 EFPD (based on 2568 MWt), while 1.0 ppm/EFPD may be deducted for each EFPD that the cycle 15 length is more than 653 EFPD (based on 2568 MWt);
- 2) must be corrected for the actual expected ^{10}B isotopic atom percent if less than the basis of 19.8 ^{10}B isotopic atom percent;
- 3) no allowance is included for intermediate core locations;
- 4) control rod assemblies and APSRs do not affect the required refueling boron concentration.

This limit is referred to by
Technical Specification
LCO 3.9.1

Revision History

Revision 0 – November 2007; Original Cycle 16 COLR.

PROGRESS ENERGY FLORIDA, INC.

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50 - 302 / LICENSE NUMBER DPR - 72

ATTACHMENT B

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The analytical methods used to determine the core protective and operating limits shall be those previously reviewed and approved by the NRC. These methods are documented in the following topical reports and Technical Specification Amendments:

Safety Criteria and Methodology for Acceptable Cycle Reload Analyses, BAW-10179P-A, Rev. 6, Framatome-ANP, Lynchburg, Virginia, August 2005.

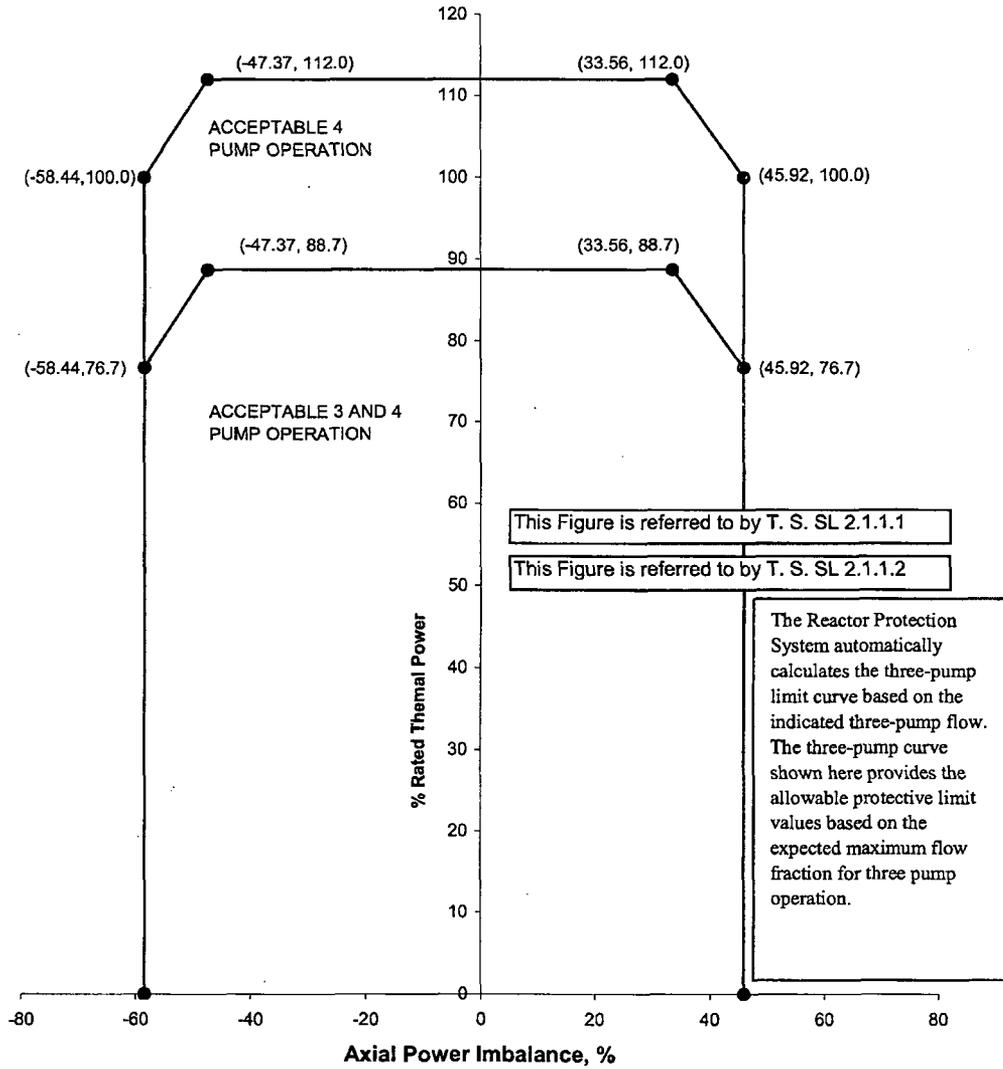
"Crystal River Unit 3 - Issuance of Amendment Re Dual Channel Control Rod Position Indication (TAC No M82990)," Licensing Amendment No 144, letter from H Silver to P M Beard, June 25, 1992.

The Cycle 16 limits generated using the methodologies above are documented in ANP-2651 Rev. 0, "Crystal River Unit 3 Cycle 16 Reload Report", dated August 2007.

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 (MTC)
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 (APSR) 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 (RPS) Instrumentation
SR 3.4.1.1	Reactor Coolant System Pressure DNB Limits
SR 3.4.1.2	Reactor Coolant System Temperature DNB Limits
SR 3.4.1.3	Reactor Coolant System Flow DNB Limits
LCO 3.9.1	Boron Concentration

AXIAL POWER IMBALANCE Protective Limits – 2568 MWt



SHUTDOWN MARGIN

Normal operating procedures require RCS boration to 1.0% $\Delta k/k$ Subcritical at 73°F prior to bypassing EFIC actuation on low steam generator pressure, or when high steam generator levels exist during secondary system chemistry control and steam generator cleaning in MODES 3, 4, and 5, therefore

Mode 3,4,5 $SDM \geq 1.0\% \Delta k/k$

These limits are
referred to by
Technical
Specification
LCO 3.1.1

Reference: Improved Technical Specification Bases B3.1.1.

Moderator Temperature Coefficient Limit (MTC)

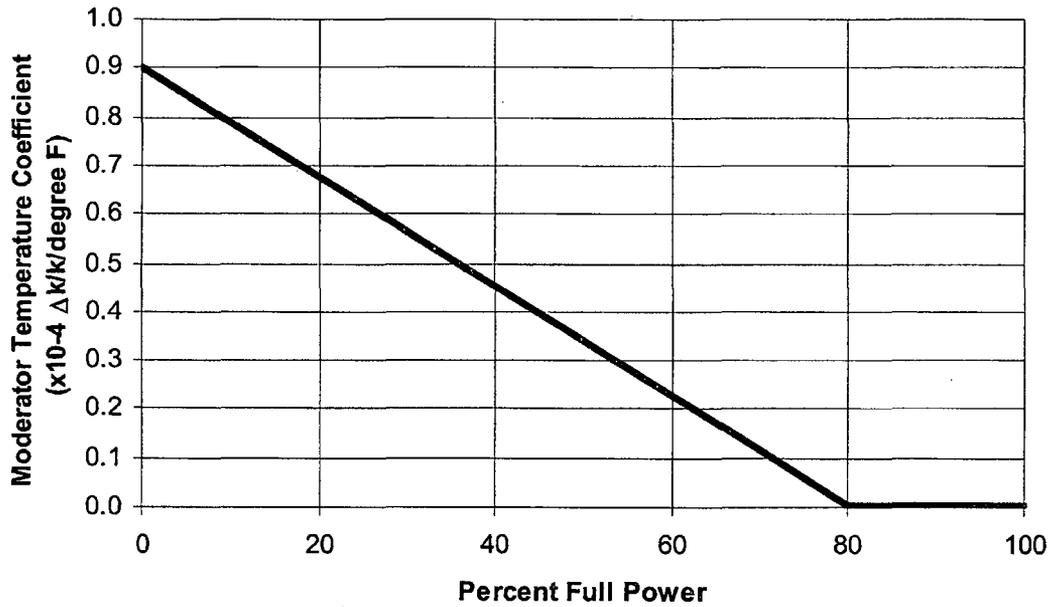
Lower Limit

MTC at HFP > $-3.58 \times 10^{-4} \Delta k/k/^\circ F$

Upper Limit

MTC ≤ The curve below:

The following Upper Limits may not be exceeded (limits ensure the validity of the ECCS analysis is preserved) for operation in MODES 1 and 2:



These limits are
referred to by
Technical
Specification
LCO 3.1.3

Absolute Position Indicator (API)/ Relative Position Indicator (RPI) 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

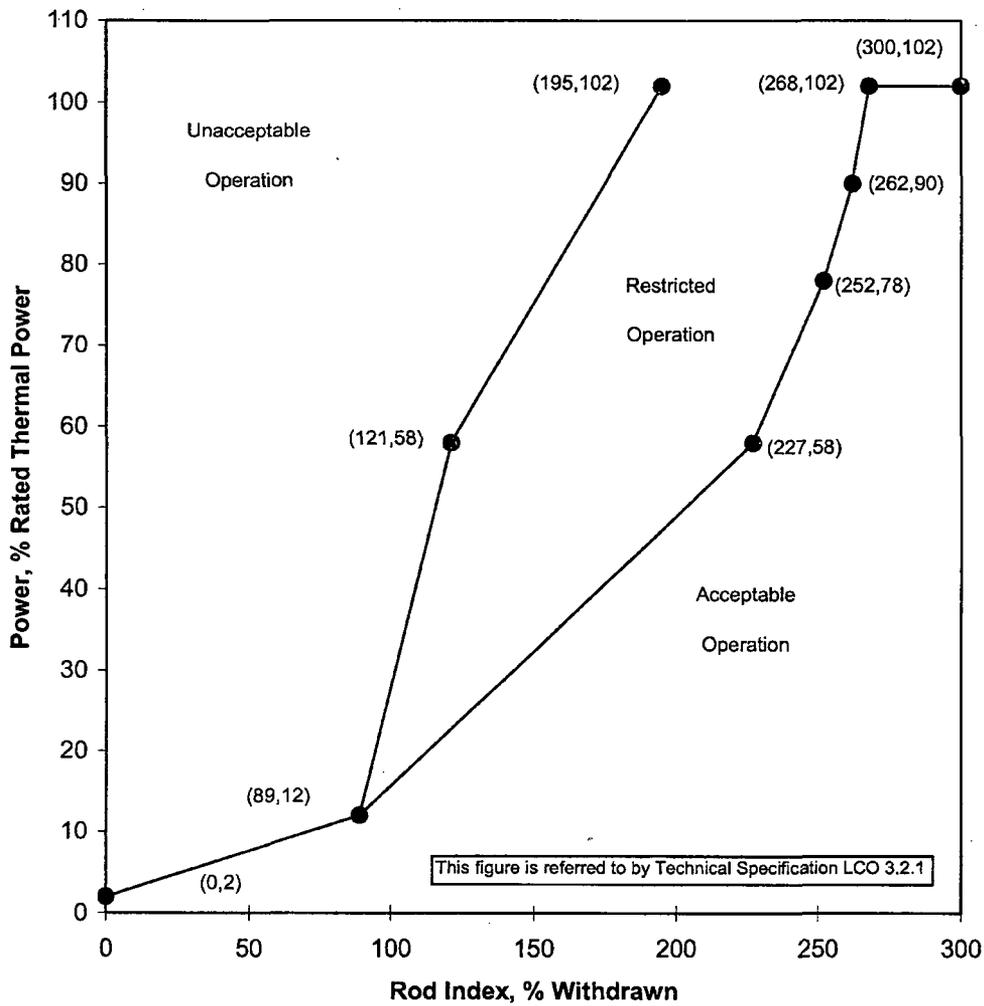
Reference: "Crystal River Unit 3 – Issuance of Amendment Re: Dual Channel Control Rod Position Indication (TAC No. M82990)", Licensing Amendment No. 144, Letter from H.S. Silver to P.M. Beard, June 25, 1992.

Note 1 If the plant computer is not available, then the following meter models are approved for use: Keithley 2001, Keithley 197, Keithley 197A (Ref. EC 61264).

Regulating Rod Insertion Limits

**Regulating Rod Group Insertion
 Error Adjusted Limits**

Four Pump Operation
 0 EFPD to EOC
 100% RTP = 2568MWt

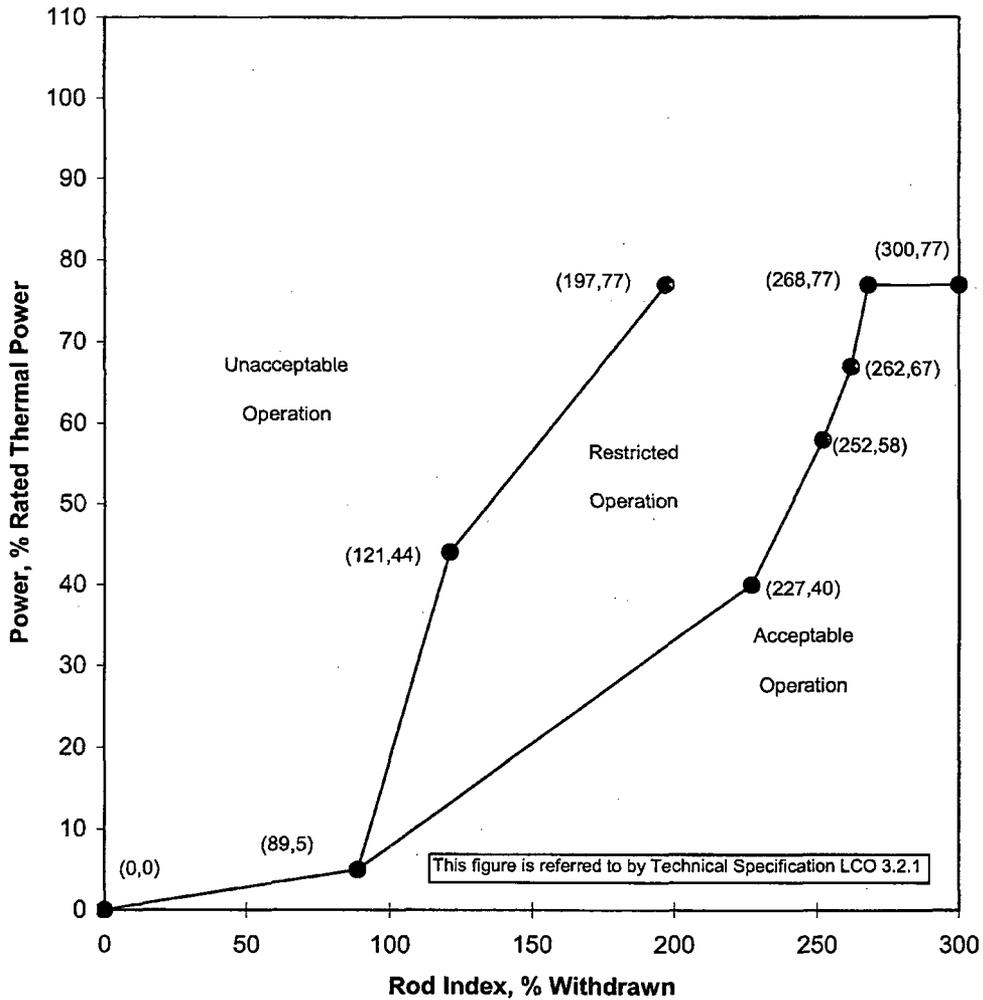


Note 1: A Rod group overlap of 25 ±5% between sequential groups 5 and 6, and 6 and 7 shall be maintained.

Regulating Rod Insertion Limits (Continued)

**Regulating Rod Group Insertion
 Error Adjusted Limits**

Three Pump Operation
 0 EFPD to EOC
 100% RTP = 2568 MWt



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

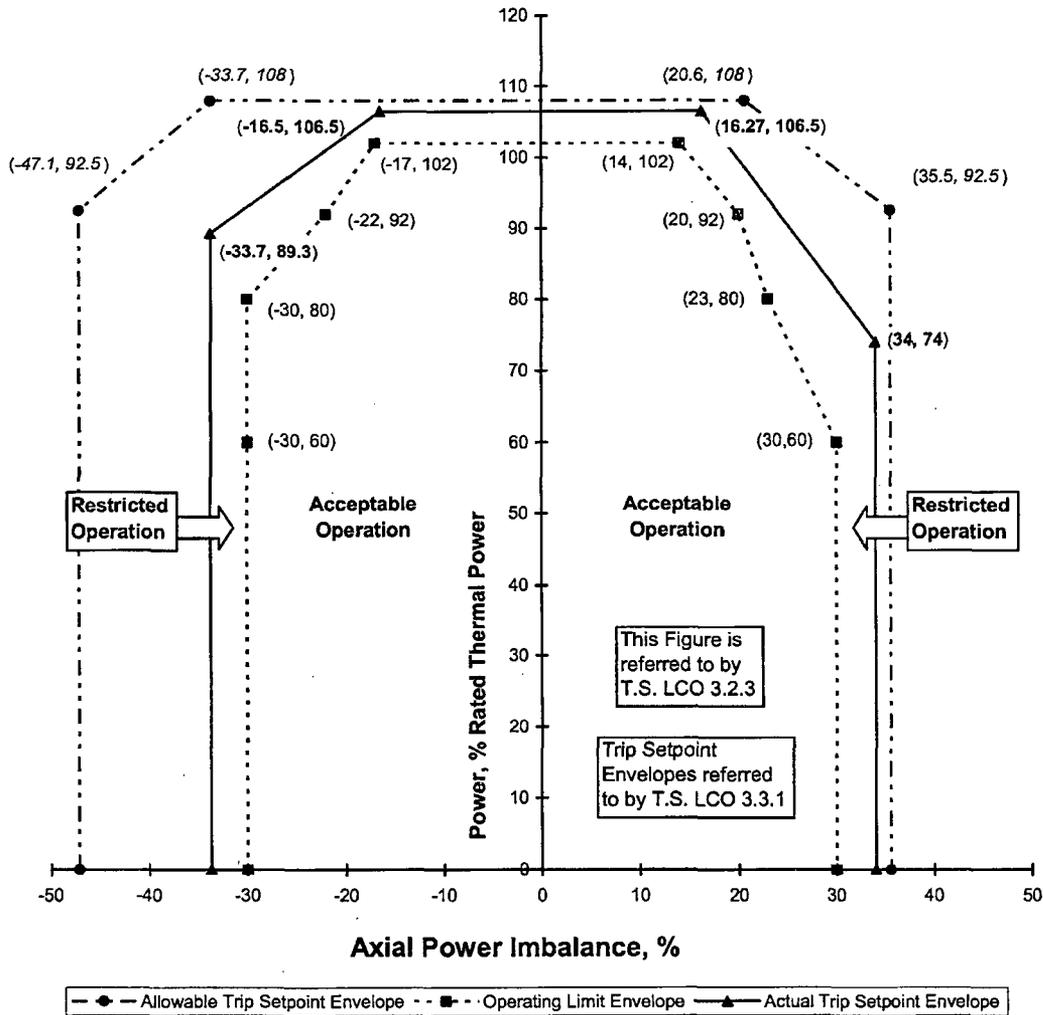
AXIAL POWER SHAPING ROD (APSR) Insertion Limits

The Axial Power Shaping Rods (APSRs) shall be inserted at the initial startup following fuel reload and may be positioned as necessary during the Power Imbalance Detector Correlation (PIDC) test. The APSRs shall be fully withdrawn from the core before exceeding 4 EFPD and prior to thermal power escalation above 80% RTP. Once the APSR pull maneuver has been completed, the APSRs shall not be inserted for the remainder of the fuel cycle during normal operation.

These limits are
referred to by
Technical
Specification
LCO 3.2.2

AXIAL POWER IMBALANCE Operating Limits

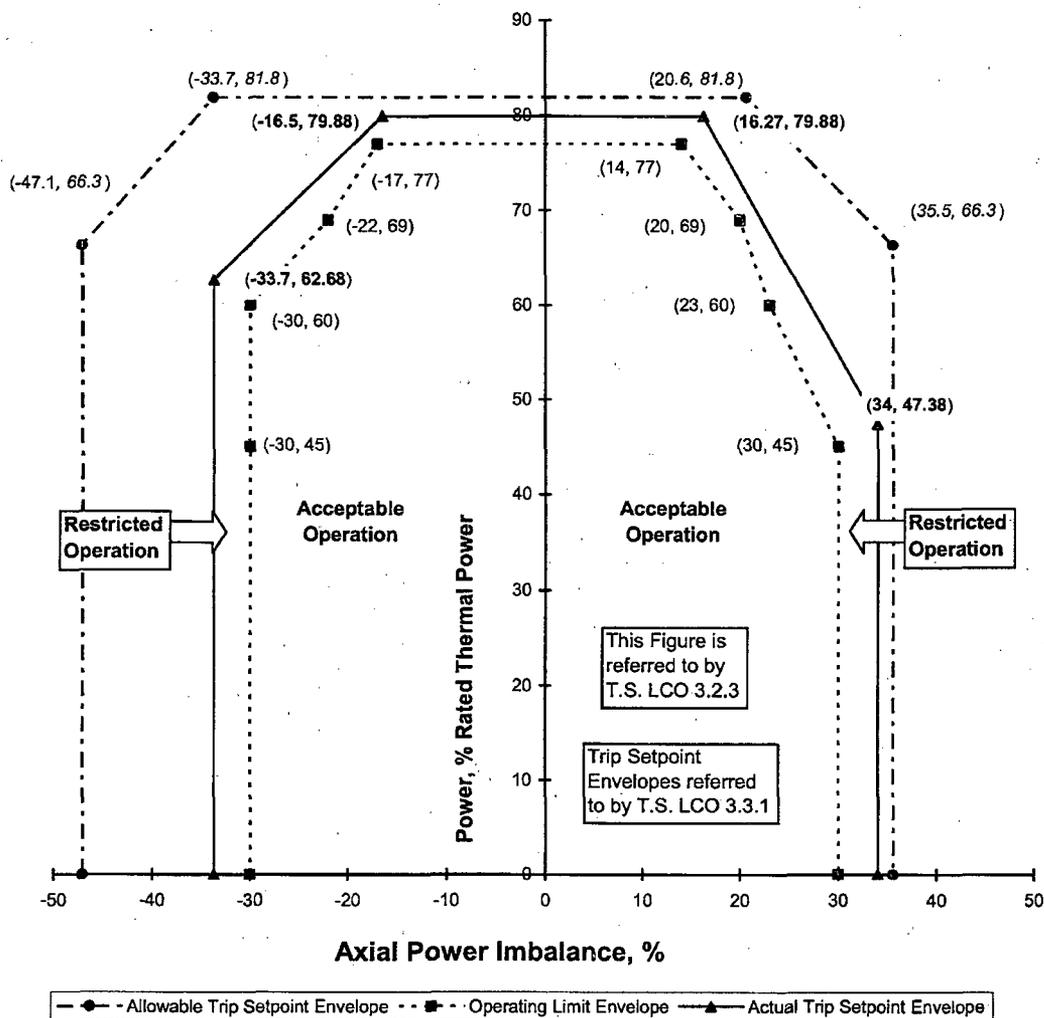
**Axial Power Imbalance Error Adjusted
 Operating Limit and Trip Setpoint Envelopes**
 Four Pump Operation
 0 EFPD to EOC
 100% RTP = 2568 MWt



AXIAL POWER IMBALANCE Operating Limits (Continued)

**Axial Power Imbalance Error Adjusted
 Operating Limit and Trip Setpoint Envelopes**

Three Pump Operation
 0 EFPD to EOC
 100% RTP = 2568 MWt



QUADRANT POWER TILT

QUADRANT POWER TILT Limits For Thermal Power \leq 60%

For Operation from 0 EFPD to EOC
 100%RTP = 2568 MWt

QUADRANT POWER TILT As Measured By:	STEADY-STATE <u>LIMIT(%)</u>	TRANSIENT <u>LIMIT(%)</u>	MAXIMUM <u>LIMIT(%)</u>
Symmetrical Incore Detector System	7.50	10.03	20.0
Power Range Channels	4.94	6.96	20.0
Minimum Incore Detector System	3.07	4.40	20.0
Measurement System Independent	8.58	11.07	20.0

QUADRANT POWER TILT Limits For Thermal Power $>$ 60%

For Operation from 0 EFPD to EOC
 100%RTP = 2568 MWt

QUADRANT POWER TILT As Measured By:	STEADY-STATE <u>LIMIT(%)</u>	TRANSIENT <u>LIMIT(%)</u>	MAXIMUM <u>LIMIT(%)</u>
Symmetrical Incore Detector System	4.29	10.03	20.0
Power Range Channels	1.96	6.96	20.0
Minimum Incore Detector System	1.90	4.40	20.0
Measurement System Independent	4.92	11.07	20.0

These limits are referred to by Technical Specification LCO 3.2.4
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Power Peaking Factors for FIDMS

These Limits are referred to by Technical Specification LCO 3.2.5

Heat Flux Hot Channel Factor F_Q

100% RTP = 2568 MWt

F_Q shall be limited by the following relationships:

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

LHR^{allow} (Bu) = See the following table

LHR^{avg} = 5.8533 kW/ft for Batch 16 E2,F2 Mark-B-HTP fuel

LHR^{avg} = 5.8636 kW/ft for Batch 17 Mark-B-HTP fuel

LHR^{avg} = 5.8533 kW/ft for Batch 18 Mark-B-HTP fuel

P = ratio of THERMAL POWER / RATED THERMAL POWER

Bu = fuel burnup (MWd/mtU)

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 16E2,F2 (Mark-B-HTP) UO₂ Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	16.0	16.0	14.3
2.506	16.9	16.9	14.3
4.264	17.0	16.5	14.3
6.021	17.3	17.3	14.3
7.779	17.3	17.3	14.3
9.536	17.0	17.0	14.3
12.000	16.1	16.1	14.3

This table is referred to
 by Technical Specification
 LCO 3.2.5

Power Peaking Factors (Continued)

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 17A,B,C,D,E (Mark-B-HTP) UO₂ Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	16.0	16.0	14.3
2.506	16.9	16.9	14.3
4.264	17.0	16.5	14.3
6.021	17.3	17.3	14.3
7.779	17.3	17.3	14.3
9.536	17.0	17.0	14.3
12.000	16.1	16.1	14.3

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 17F (Mark-B-HTP) UO₂ Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup Range, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	15.7	15.7	13.9
2.506	16.6	16.6	13.9
4.264	16.7	16.2	13.9
6.021	17.0	17.0	13.9
7.779	17.0	17.0	13.9
9.536	16.7	16.7	13.9
12.000	15.8	15.8	13.9

These tables are referred to
 by Technical Specification.
 LCO 3.2.5

Power Peaking Factors (Continued)

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 18 (Mark-B-HTP) UO₂ Fuel LHR^{allow}**
 Allowable Peak LHR for Specified Burnup, kW/ft

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	15.9	15.9	14.3
2.506	16.8	16.8	14.3
4.264	16.9	16.4	14.3
6.021	17.3	17.3	14.3
7.779	17.3	17.3	14.3
9.536	17.0	17.0	14.3
12.000	16.1	16.1	14.3

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 16E2,F2 (Mark-B-HTP) 3 wt% Gadolinia Fuel LHR^{allow}**
 Allowable Peak LHR for Specified Burnup Range, kW/ft

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	14.9	14.9	12.2
2.506	15.7	15.7	12.2
4.264	15.8	15.4	12.2
6.021	16.0	16.0	12.2
7.779	16.0	16.0	12.2
9.536	15.8	15.8	12.2
12.000	15.0	15.0	12.2

These tables are referred to
 by Technical Specification.
 LCO 3.2.5

Power Peaking Factors (Continued)

CR-3 Cycle 16 Reload Allowable LHR Limits
Batch 16F2 (Mark-B-HTP) 8 wt% Gadolinia Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup, kW/ft

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	13.5	13.5	11.1
2.506	14.3	14.3	11.1
4.264	14.4	14.0	11.1
6.021	14.7	14.7	11.1
7.779	14.7	14.7	11.1
9.536	14.4	14.4	11.1
12.000	13.6	13.6	11.1

CR-3 Cycle 16 Reload Allowable LHR Limits
Batch 17 (Mark-B-HTP) 2 and 3 wt% Gadolinia Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup Range, kW/ft

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	14.9	14.9	12.2
2.506	15.7	15.7	12.2
4.264	15.8	15.4	12.2
6.021	16.0	16.0	12.2
7.779	16.0	16.0	12.2
9.536	15.8	15.8	12.2
12.000	15.0	15.0	12.2

These tables are referred to
 by Technical Specification.
 LCO 3.2.5

Power Peaking Factors (Continued)

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 17 (Mark-B-HTP) 6 wt% Gadolinia Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	14.0	14.0	11.8
2.506	14.8	14.8	11.8
4.264	14.9	14.5	11.8
6.021	15.2	15.2	11.8
7.779	15.2	15.2	11.8
9.536	14.9	14.9	11.8
12.000	14.1	14.1	11.8

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 17 (Mark-B-HTP) 8 wt% Gadolinia Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup Range, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	13.5	13.5	11.1
2.506	14.3	14.3	11.1
4.264	14.4	14.0	11.1
6.021	14.7	14.7	11.1
7.779	14.7	14.7	11.1
9.536	14.4	14.4	11.1
12.000	13.6	13.6	11.1

These tables are referred to
 by Technical Specification.
 LCO 3.2.5

Power Peaking Factors (Continued)

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 18 (Mark-B-HTP) 3 wt% Gadolinia Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	14.8	14.8	12.2
2.506	15.6	15.6	12.2
4.264	15.7	15.3	12.2
6.021	16.0	16.0	12.2
7.779	16.0	16.0	12.2
9.536	15.8	15.8	12.2
12.000	15.0	15.0	12.2

**CR-3 Cycle 16 Reload Allowable LHR Limits
 Batch 18 (Mark-B-HTP) 6 wt% Gadolinia Fuel LHR^{allow}
 Allowable Peak LHR for Specified Burnup Range, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	13.9	13.9	11.8
2.506	14.7	14.7	11.8
4.264	14.8	14.4	11.8
6.021	15.2	15.2	11.8
7.779	15.2	15.2	11.8
9.536	14.9	14.9	11.8
12.000	14.1	14.1	11.8

These tables are referred to
 by Technical Specification.
 LCO 3.2.5

Power Peaking Factors (Continued)

**CR-3 Cycle 16 Reload Allowable LHR Limits
Batch 18 (Mark-B-HTP) 8 wt% Gadolinia Fuel LHR^{allow}
Allowable Peak LHR for Specified Burnup, kW/ft**

CORE ELEVATION (FT)	0 MWD/MTU	45,000 MWD/MTU	62,000 MWD/MTU
0.000	13.4	13.4	11.1
2.506	14.2	14.2	11.1
4.264	14.3	13.9	11.1
6.021	14.7	14.7	11.1
7.779	14.7	14.7	11.1
9.536	14.4	14.4	11.1
12.000	13.6	13.6	11.1

These tables are referred to
by Technical Specification.
LCO 3.2.5

Power Peaking Factors (Continued)

This Limit is referred to by Technical Specification LCO 3.2.5

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

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

ARP = Allowable Radial Peak, See the following table

P = ratio of 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

$1/\text{RH} = 0.3$

Cycle 16 Allowable Radial Peaks (ARP)

Axial Peak	Axial Location (X/L)	ARP ⁽¹⁾	Axial Peak	Axial Location (X/L)	ARP ⁽¹⁾	Axial Peak	Axial Location (X/L)	ARP ⁽¹⁾
1.1	0.01	1.9292	1.4	0.01	2.1798	1.7	0.01	2.1194
1.1	0.14	1.9287	1.4	0.14	2.1798	1.7	0.14	1.9723
1.1	0.2	1.9284	1.4	0.2	2.1798	1.7	0.2	1.9392
1.1	0.3	1.9278	1.4	0.3	2.1162	1.7	0.3	1.8853
1.1	0.4	1.9271	1.4	0.4	2.0509	1.7	0.4	1.8194
1.1	0.5	1.9266	1.4	0.5	1.9779	1.7	0.5	1.7658
1.1	0.6	1.9258	1.4	0.6	1.8969	1.7	0.6	1.6942
1.1	0.7	1.9254	1.4	0.7	1.8263	1.7	0.7	1.6361
1.1	0.8	1.9248	1.4	0.8	1.7407	1.7	0.8	1.5606
1.1	0.89	1.8866	1.4	0.89	1.6847	1.7	0.89	1.5170
1.1	0.99	1.7941	1.4	0.99	1.6141	1.7	0.99	1.4608
1.2	0.01	2.0160	1.5	0.01	2.1798	1.8	0.01	2.1130
1.2	0.14	2.0148	1.5	0.14	2.1467	1.8	0.14	1.8927
1.2	0.2	2.0141	1.5	0.2	2.1100	1.8	0.2	1.8598
1.2	0.3	2.0128	1.5	0.3	2.0385	1.8	0.3	1.8142
1.2	0.4	2.0109	1.5	0.4	1.9680	1.8	0.4	1.7524
1.2	0.5	2.0103	1.5	0.5	1.9053	1.8	0.5	1.7012
1.2	0.6	2.0092	1.5	0.6	1.8262	1.8	0.6	1.6346
1.2	0.7	1.9600	1.5	0.7	1.7594	1.8	0.7	1.5792
1.2	0.8	1.8745	1.5	0.8	1.6766	1.8	0.8	1.5092
1.2	0.89	1.8191	1.5	0.89	1.6259	1.8	0.89	1.4683
1.2	0.99	1.7304	1.5	0.99	1.5625	1.8	0.99	1.4148
1.3	0.01	2.1110	1.6	0.01	2.1352	1.9	0.01	2.0497
1.3	0.14	2.1091	1.6	0.14	2.0562	1.9	0.14	1.8163
1.3	0.2	2.1082	1.6	0.2	2.0239	1.9	0.2	1.7858
1.3	0.3	2.1062	1.6	0.3	1.9604	1.9	0.3	1.7424
1.3	0.4	2.1045	1.6	0.4	1.8919	1.9	0.4	1.6880
1.3	0.5	2.0476	1.6	0.5	1.8341	1.9	0.5	1.6395
1.3	0.6	1.9701	1.6	0.6	1.7578	1.9	0.6	1.5789
1.3	0.7	1.8954	1.6	0.7	1.6952	1.9	0.7	1.5276
1.3	0.8	1.8068	1.6	0.8	1.6166	1.9	0.8	1.4620
1.3	0.89	1.7499	1.6	0.89	1.5695	1.9	0.89	1.4230
1.3	0.99	1.6713	1.6	0.99	1.5100	1.9	0.99	1.3725

⁽¹⁾These limits have been increased to reflect the 3.8% peaking uncertainty treated by SCD.

Reactor Protection System (RPS) Instrumentation

RCS Variable Low Pressure Setpoint Equation

$$P_{\text{Trip}} \geq (11.59 * T_{\text{HOT}} - 5037.8) \text{ psig}$$

This limit is referred to by ITS
Table 3.3.1-1, Item 5

Reactor Coolant System DNB Pressure Limits

RCS loop pressure \geq 2064 psig

(Assumes 20% tube plugging and bounds either four or three RCPs operating).

These limits are
referred to by
SR 3.4.1.1

Reactor Coolant System DNB Temperature Limit

RCS Hot Leg Temperature $\leq 605.8^{\circ}\text{F}$

(Assumes 20% OTSG tube plugging).

These limits are
referred to by
SR 3.4.1.2

Reactor Coolant System DNB Flow Rate Limits

RCS total flow rate ≥ 133.5 E6 lb/hr with four RCPs operating, or ≥ 99.7 E6 lb/hr with three RCPs operating.

(Assumes 20% OTSG tube plugging).

These limits are
referred to by
SR 3.4.1.3

Refueling Boron Concentration

The Mode 6 refueling boron concentration must be greater than **2714 ppmB** prior to core alterations that include the introduction of any fuel assemblies not present in the cycle 15 core, subject to the following:

- 1) 2 ppm/EFPD shall be added for each EFPD that the cycle 15 length is less than 653 EFPD (based on 2568 MWt), while 1.0 ppm/EFPD may be deducted for each EFPD that the cycle 15 length is more than 653 EFPD (based on 2568 MWt);
- 2) must be corrected for the actual expected ^{10}B isotopic atom percent if less than the basis of 19.8 ^{10}B isotopic atom percent;
- 3) no allowance is included for intermediate core locations;
- 4) control rod assemblies and APSRs do not affect the required refueling boron concentration.

This limit is referred to by
Technical Specification
LCO 3.9.1

Revision History

Revision 0 – November 2007; Original Cycle 16 COLR.

Revision 1 – November 2007; Changed the title of one table of Allowable LHR Limits within the “Heat Flux Hot Channel Factor F_Q” section to specify Batch 17 (Mark-B-HTP) 2 and 3 wt%. Additionally, corrected four Allowable Radial Peak values within the “Enthalpy Rise Hot Channel Factor F^N_{ΔH}” section to reflect maximum allowable value of 2.1798.