Tennessee Valley Authority, Post Office Box 2000, Soddy Daisy, Tennessee 37384-2000

November 16, 2015

10 CFR 50.4

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

Sequoyah Nuclear Plant, Units 1 and 2
Renewed Facility Operating License Nos. DPR-77 and DPR-79
NRC Docket Nos. 50-327 and 50-328

Subject: **Sequoyah Unit 1 Cycle 21, and Unit 2 Cycle 20 Core Operating Limits Reports, Revision No. 1**

References: 1. Letter from NRC to TVA, "Sequoyah Nuclear Plant, Units 1 and 2 – Issuance of Amendments for the Conversion to the Improved Technical Specifications with Beyond Scope Issues (TAC Nos. MF3128 and MF3129)," dated September 30, 20015 (ML15238B460)

In accordance with Sequoyah Nuclear Plant (SQN) Units 1 and 2 Technical Specifications (TSs) 5.6.3.d, enclosed is the Unit 1 Cycle 21 Core Operating Limits Report (COLR), Revision 1, and Unit 2 Cycle 20 COLR, Revision 1. In accordance with TSs 5.6.3.d, the COLRs are required to be provided to the Nuclear Regulatory Commission (NRC) within 30 days of issuance for each reload cycle. Sequoyah Units 1 and 2 were issued license amendment Nos. 334 and 327, respectively for improved standard TSs (Reference 1). These license amendments resulted in the revisions to each of the COLRs as discussed in Enclosure 1. The revised COLRs became effective on October 21, 2016.

There are no new regulatory commitments in this letter. If you have any questions, please contact Jonathan Johnson, SQN Site Licensing Manager at (423) 843-8129.

D030
NRR

Respectfully,

John T. Carlin
Site Vice President
Sequoyah Nuclear Plant

Enclosures

1. Units 1 and 2 Core Operating Limits Report Changes
2. Sequoyah Unit 1 Cycle 21 Core Operating Limits Report, Revision 1
3. Sequoyah Unit 2 Cycle 20 Core Operating Limits Report, Revision 1

ZTK:DVG
Enclosures
cc (Enclosures):
NRC Regional Administrator – Region II
NRC Senior Resident Inspector – SQN

ENCLOSURE 1

SEQUOYAH UNITS 1 AND 2
CORE OPERATING LIMITS REPORT CHANGES

The following describes the changes made to each Units' Core Operating Limits Report (COLR), as result of the NRC review and approval of License Amendment Request for the conversion of the Sequoyah Technical Specification (TS) to Improved Standard Technical Specification, NUREG-1431, Revision 4.

1. Acronyms for All Rods Out (ARO) and Hot Zero THERMAL POWER (HZP) were removed from the COLRs.

2. In Section 1.0, a table was added to assist user of the COLRs.

3. Section 2.0 was updated to align the new TSs Reporting Requirements Section, 5.6.3, "Core Operating Limits Report".

4. In Section 2.1 the Cycle-Specific Parameter Limits were relocated from the TSs to the COLRs. These parameters involve the Shutdown Margin requirements with references to the associated Limiting Condition for Operation (LCO).

5. 60 ppm Moderator Temperature Coefficient limits were added in Section 2.2 consistent with the NOTE in TSs LCO 3.1.3, "Moderator Temperature Coefficient," Surveillance Requirement 3.1.3.2.

6. Control Bank Insertion Limits requirement were added in Section 2.4 as necessary for TSs LCO 3.1.6, "Control Bank Insertion Limits," Surveillance Requirements.

7. Section 2.5 was revised to add information relocated from previous TSs for consistency with approved TSs LCO 3.2.1, "Heat Flux Hot Channel Factor ($F_q(X, Y, Z)$)".

8. Section 2.6 was revised to add information relocated from previous TSs for consistency with approved TSs LCO 3.2.2, "Nuclear Enthalpy Rise Hot Channel Factor $F_{\Delta H}(X, Y)$".

9. Power Distribution Limits coefficient definitions, such as BQNOM and BHDES, were eliminated as these are defined in the TS Bases.

10. The boron concentration limit for TSs LCO 3.9.1, "Boron Concentration," were added to the COLRs consistent with the approved TVA License Amendment Request.

ENCLOSURE 2

SEQUOYAH UNIT 1 CYCLE 21
CORE OPERATING LIMITS REPORT REVISION 1

SEQUOYAH UNIT 1 CYCLE 21
CORE OPERATING LIMITS REPORT

REVISION 1

October 2015

Prepared by:

_______________ / 10/16/15
Christine A. Setter, PWR Fuel Engineering Date

Verified by:

_______________ / 10/16/15
John E. Strange, PWR Fuel Engineering Date

Reviewed by:

_______________ / 10-16-15
Kathleen A. Cunningham, PWR Fuel Engineering Manager Date

_______________ / 10/21/15
Brandon S. Catalanotto, Reactor Engineering Manager Date

Approved by:

_______________ / 10/21/15
PORC Chairman Date

_______________ / 10/21/2015
Plant Manager Date

Revision 1

Pages affected All

Reason for Revision: Update for Improved Technical Specifications (ITS) Implementation

1.0 CORE OPERATING LIMITS REPORT

This CORE OPERATING LIMITS REPORT (COLR) for Sequoyah Unit 1 Cycle 21 has been prepared in accordance with the requirements of Technical Specification (TS) 5.6.3.

The TSs affected by this Report are listed below:

TS Section	Technical Specification	COLR Parameter	COLR Section	COLR Page
3.1.1	SHUTDOWN MARGIN (SDM)	SDM	2.1	3
3.1.3	Moderator Temperature Coefficient (MTC)	BOL MTC Limit EOL MTC Limit 300 ppm Surveillance Limit 60 ppm Surveillance Limit	2.2.1 2.2.2 2.2.3 2.2.4	4 4 4 4
3.1.4	Rod Group Alignment Limits	SDM	2.1.3	3
3.1.5	Shutdown Bank Insertion Limits	Shutdown Bank Insertion Limits SDM	2.3 2.1.4	4 3
3.1.6	Control Bank Insertion Limits	Control Bank Insertion Limits SDM	2.4 2.1.5	5 3
3.1.8	PHYSICS TESTS Exceptions – MODE 2	SDM	2.1.6	3
3.2.1	Heat Flux Hot Channel Factor ($F_Q(X,Y,Z)$)	F_Q^{RTP} K(Z) $NSLOPE^{AFD}$ $PSLOPE^{AFD}$ $NSLOPE^{f2(\Delta I)}$ $PSLOPE^{f2(\Delta I)}$ $F_Q(X,Y,Z)$ Appropriate Factor ITS LCO 3.2.1 Required Action A.3	2.5.1 2.5.2 2.5.3 2.5.4 2.5.5 2.5.6 2.5.7 2.5.8	6 6 6 6 6 6 6 6
3.2.2	Nuclear Enthalpy Rise Hot Channel Factor ($F_{\Delta H}(X,Y)$)	MAP(X,Y,Z) RRH TRH $F_{\Delta H}(X,Y)$ Appropriate Factor ITS 3.2.2 Required Action A.4 ITS 3.2.2 Required Action B.1	2.6.1 2.6.2 2.6.3 2.6.4 2.6.5 2.6.6	6 6 6 7 7 7
3.2.3	AXIAL FLUX DIFFERENCE (AFD)	AFD Limits	2.7	7
3.3.1	Reactor Trip System (RTS) Instrumentation	QTNL, QTPL, QTNS, and QTPS QPNL, QPPL, QPNS, and QPPS	2.8.1 2.8.2	8 9
3.9.1	Boron Concentration	Refueling Boron Concentration	2.9	9
5.6.3	CORE OPERATING LIMITS REPORT (COLR)	Analytical Methods	2.0	3

2.0 OPERATING LIMITS

The cycle-specific parameter limits for the TS listed in section 1.0 are presented in the following subsections. These limits have been developed using the NRC approved methodologies specified in TS 5.6.3. The versions of the topical reports which describe the methodologies used for this cycle are listed in Table 1.

The following abbreviations are used in this section:

BOL stands for Beginning of Cycle Life
EOL stands for End of Cycle Life
RTP stands for RATED THERMAL POWER

2.1 SHUTDOWN MARGIN – SDM (TS 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.1.8)

2.1.1 For TS 3.1.1, SDM shall be ≥ 1.6 %Δk/k in MODE 2 with k_{eff} < 1.0, MODE 3 and MODE 4

2.1.2 For TS 3.1.1, SDM shall be ≥ 1.0 %Δk/k in MODE 5.

2.1.3 For TS 3.1.4, SDM shall be ≥ 1.6 %Δk/k in MODE 1 and MODE 2.

2.1.4 For TS 3.1.5, SDM shall be ≥ 1.6 %Δk/k in MODE 1 and MODE 2.

2.1.5 For TS 3.1.6, SDM shall be ≥ 1.6 %Δk/k in MODE 1 and MODE 2 with $k_{eff} \geq 1.0$.

2.1.6 For TS 3.1.8, SDM shall be ≥ 1.6 %Δk/k in MODE 2.

2.2 Moderator Temperature Coefficient – MTC (TS 3.1.3)

2.2.1 The BOL MTC limit is:
less positive than -0.05×10^{-5} Δk/k/°F .

2.2.2 The EOL MTC limit is:
less negative than or equal to -4.50×10^{-4} Δk/k/°F.

2.2.3 The 300 ppm Surveillance limit is:
less negative than or equal to -3.74×10^{-4} Δk/k/°F.

2.2.4 The 60 ppm Surveillance limit is:
less negative than or equal to -4.15×10^{-4} Δk/k/°F.

2.3 Shutdown Bank Insertion Limits (TS 3.1.5)

2.3.1 Each shutdown bank shall be withdrawn to a position as defined below:

Cycle Burnup (MWd/mtU)	Steps Withdrawn
≥ 0	≥ 225 to ≤ 231

2.4 Control Bank Insertion Limits (TS 3.1.6)

2.4.1 The control banks shall be limited in physical insertion as shown in Figure 1.

2.4.2 Each control bank shall be considered fully withdrawn from the core at ≥ 225 steps.

2.4.3 The control banks shall be operated in sequence by withdrawal of Bank A, Bank B, Bank C, and Bank D. The control banks shall be sequenced in reverse order upon insertion.

2.4.4 Each control bank not fully withdrawn from the core shall be operated with the following overlap as a function of full out position.

Full Out Position (steps)	Bank Overlap (steps)	Bank Difference (steps)
225	97	128
226	98	128
227	99	128
228	100	128
229	101	128
230	102	128
231	103	128

2.5 Heat Flux Hot Channel Factor – $F_Q(X,Y,Z)$ (TS 3.2.1)

2.5.1 F_Q^{RTP} = 2.62

2.5.2 K(Z) is provided in Figure 2

2.5.3 $NSLOPE^{AFD}$ = 1.21

2.5.4 $PSLOPE^{AFD}$ = 1.55

2.5.5 $NSLOPE^{f2(\Delta I)}$ = 1.48

2.5.6 $PSLOPE^{f2(\Delta I)}$ = 2.00

2.5.7 The appropriate factor for increase in $F_Q^M(X,Y,Z)$ for compliance with SR 3.2.1.2 and SR 3.2.1.3 is specified as follows:

For all cycle burnups, use 2.0%

2.5.8 ITS LCO 3.2.1 Required Action A.3 reduces the Overpower Delta T Trip setpoints (value of K_4) at least 1% (in ΔT span) for each 1% that $F_Q^C(X,Y,Z)$ exceeds its limit.

2.6 Nuclear Enthalpy Rise Hot Channel Factor - $F_{\Delta H}(X,Y)$ (TS 3.2.2)

2.6.1 MAP(X,Y,Z) is provided in Table 2.

2.6.2 RRH = 3.34 when $0.8 < P \leq 1.0$

RRH = 1.67 when $P \leq 0.8$

P = THERMAL POWER / RATED THERMAL POWER

RRH = Thermal power reduction required to compensate for each 1% that $F_{\Delta H}(X,Y)$ exceeds its limit.

2.6.3 TRH = 0.0334 when $0.8 < P < 1.0$

TRH = 0.0167 when $P < 0.8$

P = THERMAL POWER / RATED THERMAL POWER

TRH = Reduction in Overtemperature Delta T K_1 setpoint required to compensate for each 1% that $F_{\Delta H}(X,Y)$ exceeds its limit.

2.6.4 The appropriate factor for increase in $F_{\Delta H}{}^{M}$ (X,Y) for compliance with SR 3.2.2.1 and SR 3.2.2.2 is specified as follows:

For all cycle burnups, use 2.0%

2.6.5 ITS 3.2.2 Required Action A.4 reduces the Overtemperature Delta T setpoint (K_1 term in Table 3.3.1-1) by ≥ TRH multiplied by the $F_{\Delta H}$ min margin.

2.6.6 ITS 3.2.2 Required Action B.1 reduces the Overtemperature Delta T setpoint (K_1 term in Table 3.3.1-1) by ≥ TRH multiplied by the $f_1(\Delta I)$ min margin.

2.7 AXIAL FLUX DIFFERENCE – AFD (TS 3.2.3)

2.7.1 The AFD limits are specified in Figure 3

2.8 Reactor Trip System Instrumentation (TS 3.3.1)

2.8.1 Trip Reset Term [$f_1(\Delta I)$] for Overtemperature Delta-T Trip

The following parameters are required to specify the power level-dependent $f_1(\Delta I)$ trip reset term limits for Table 3.3.1-1 (function 6), Overtemperature Delta-T trip function:

2.8.1.1 QTNL = -20%

where QTNL = the maximum negative ΔI setpoint at RATED THERMAL POWER at which the trip setpoint is not reduced by the axial power distribution.

2.8.1.2 QTPL = +5%

where QTPL = the maximum positive ΔI setpoint at RATED THERMAL POWER at which the trip setpoint is not reduced by the axial power distribution.

2.8.1.3 QTNS = 2.50%

where QTNS = the percent reduction in Overtemperature Delta-T trip setpoint for each percent that the magnitude of ΔI exceeds its negative limit at RATED THERMAL POWER (QTNL).

2.8.1.4 QTPS = 1.40%

where QTPS = the percent reduction in Overtemperature Delta-T trip setpoint for each percent that the magnitude of ΔI exceeds its positive limit at RATED THERMAL POWER (QTPL).

2.8.2 Trip Reset Term [$f_2(\Delta I)$] for Overpower Delta-T Trip

The following parameters are required to specify the power level-dependent $f_2(\Delta I)$ trip reset term limits for Table 3.3.1-1 (function 7), Overpower Delta-T trip function:

2.8.2.1 QPNL = -25%

where QPNL = the maximum negative ΔI setpoint at RATED THERMAL POWER at which the trip setpoint is not reduced by the axial power distribution.

2.8.2.2 QPPL = +25%

where QPPL = the maximum positive ΔI setpoint at RATED THERMAL POWER at which the trip setpoint is not reduced by the axial power distribution.

2.8.2.3 QPNS = 1.70%

where QPNS = the percent reduction in Overpower Delta-T trip setpoint for each percent that the magnitude of ΔI exceeds its negative limit at RATED THERMAL POWER (QPNL).

2.8.2.4 QPPS = 1.70%

where QPPS = the percent reduction in Overpower Delta-T trip setpoint for each percent that the magnitude of ΔI exceeds its positive limit at RATED THERMAL POWER (QPPL).

2.9 Boron Concentration (TS 3.9.1)

2.9.1 The refueling boron concentration shall be ≥ 2080 ppm.

Table 1

COLR Methodology Topical Reports

1. BAW-10180-A, Revision 1, "NEMO-Nodal Expansion Method Optimized," March 1993.
   (Methodology for TS 3.1.1-SHUTDOWN MARGIN, 3.1.3-Moderator Temperature Coefficient, 3.9.1-Boron Concentration)
2. BAW-10169P-A, Revision 0, "RSG Plant Safety Analysis-B&W Safety Analysis Methodology for Recirculating Steam Generator Plants," October 1989.
   (Methodology for TS 3.1.3-Moderator Temperature Coefficient)
3. BAW-10163P-A, Revision 0, "Core Operating Limit Methodology for Westinghouse-Designed PWRs," June 1989.
   (Methodology for TS 3.3.1-Reactor Trip System Instrumentation [$f_1(\Delta I)$, $f_2(\Delta I)$ limits], 3.1.5-Shutdown Bank Insertion Limits, 3.1.6-Control Bank Insertion Limits, 3.2.1-Heat Flux Hot Channel Factor, 3.2.2-Nuclear Enthalpy Rise Hot Channel Factor, 3.2.3-AXIAL FLUX DIFFERENCE)
4. EMF-2328(P)(A), "PWR Small Break LOCA Evaluation Model," March 2001.
   (Methodology for TS 3.2.1-Heat Flux Hot Channel Factor)
5. BAW-10227P-A, Revision 1, "Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel," June 2003.
   (Methodology for TS 3.2.1-Heat Flux Hot Channel Factor)
6. BAW-10186P-A, Revision 2, "Extended Burnup Evaluation," June 2003.
   (Methodology for TS 3.2.1-Heat Flux Hot Channel Factor)
7. EMF-2103P-A, Revision 0, "Realistic Large Break LOCA Methodology for Pressurized Water Reactors," April 2003.
   (Methodology for TS 3.2.1-Heat Flux Hot Channel Factor)
8. BAW-10241P-A, Revision 1, "BHTP DNB Correlation Applied with LYNXT," July 2005.
   (Methodology for TS 3.2.2-Nuclear Enthalpy Rise Hot Channel Factor, 3.3.1-Reactor Trip System Instrumentation [$f_1(\Delta I)$ limits])
9. BAW-10199P-A, Revision 0, "The BWU Critical Heat Flux Correlations," August 1996.
   (Methodology for TS 3.2.2-Nuclear Enthalpy Rise Hot Channel Factor, 3.3.1-Reactor Trip System Instrumentation [$f_1(\Delta I)$ limits])
10. BAW-10189P-A, "CHF Testing and Analysis of the Mark-BW Fuel Assembly Design," January 1996.
    (Methodology for TS 3.2.2-Nuclear Enthalpy Rise Hot Channel Factor, 3.3.1-Reactor Trip System Instrumentation [$f_1(\Delta I)$ limits])
11. BAW-10159P-A, "BWCMV Correlation of Critical Heat Flux in Mixing Vane Grid Fuel Assemblies," August 1990.
    (Methodology for TS 3.2.2-Nuclear Enthalpy Rise Hot Channel Factor, 3.3.1-Reactor Trip System Instrumentation [$f_1(\Delta I)$ limits])
12. BAW-10231P-A, Revision 1, "COPERNIC Fuel Rod Design Computer Code," January 2004.
    (Methodology for TS 3.3.1-Reactor Trip System Instrumentation [$f_2(\Delta I)$ limits])

Table 2
Maximum Allowable Peaking Limits MAP(X,Y,Z) for Operation
(TS 3.2.2)

AXIAL(X,Y)	ELEVATION (ft)	MAP(X,Y,Z)	AXIAL(X,Y)	ELEVATION (ft)	MAP(X,Y,Z)
1.1	1	1.8128	1.4	1	2.5969
	2	1.8125		2	2.5380
	3	1.8122		3	2.4827
	4	1.8119		4	2.4411
	5	1.8115		5	2.4315
	6	1.8109		6	2.4800
	7	1.8106		7	2.5356
	8	1.8104		8	2.4447
	9	1.8098		9	2.3555
	10	1.8092		10	2.1738
	11	1.7599		11	2.0238
1.2	1	2.0671	1.5	1	2.6723
	2	2.0664		2	2.6061
	3	2.0656		3	2.5417
	4	2.0649		4	2.4913
	5	2.0642		5	2.4801
	6	2.0636		6	2.5380
	7	2.0624		7	2.6273
	8	2.0615		8	2.5311
	9	2.0457		9	2.4447
	10	1.9492		10	2.2772
	11	1.8589		11	2.0975
1.3	1	2.3433	1.6	1	2.7308
	2	2.3419		2	2.6605
	3	2.3412		3	2.5947
	4	2.3397		4	2.5371
	5	2.3389		5	2.5234
	6	2.3381		6	2.5906
	7	2.3357		7	2.7077
	8	2.3130		8	2.6117
	9	2.1886		9	2.5240
	10	2.0643		10	2.3758
	11	1.9439		11	2.1662

Table 2 (continued)

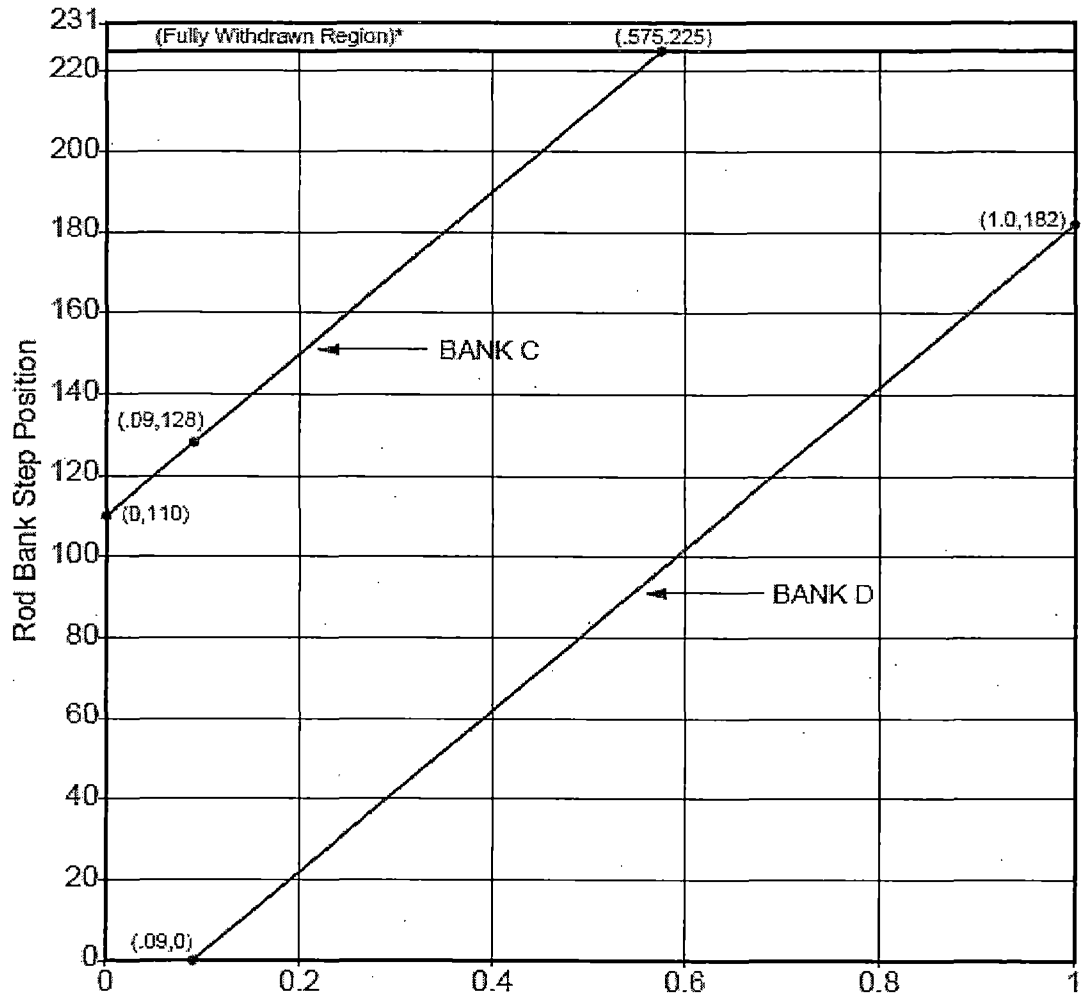
AXIAL(X,Y)	ELEVATION (ft)	MAP(X,Y,Z)
	1	2.7664
	2	2.7083
	3	2.6380
	4	2.5791
	5	2.5639
1.7	6	2.6359
	7	2.7795
	8	2.6870
	9	2.5798
	10	2.4726
	11	2.2304
	1	2.7963
	2	2.7466
	3	2.6775
	4	2.6172
	5	2.6010
1.8	6	2.6802
	7	2.8456
	8	2.7552
	9	2.6648
	10	2.5655
	11	2.2931
	1	2.8235
	2	2.7739
	3	2.7125
	4	2.6523
	5	2.6328
1.9	6	2.7200
	7	2.9065
	8	2.8193
	9	2.7288
	10	2.6384
	11	2.3482

AXIAL(X,Y)	ELEVATION (ft)	MAP(X,Y,Z)
	1	2.4339
	2	2.4060
	3	2.3856
	4	2.3423
	5	2.3114
>1.9	6	2.6006
	7	2.5003
	8	2.4004
	9	2.2989
	10	2.1483
	11	1.9630
	1	2.5057
	2	2.4754
	3	2.4449
	4	2.3591
	5	2.4205
2.1	6	2.7643
	7	2.6474
	8	2.5360
	9	2.4400
	10	2.3277
	11	2.0549
	1	2.5380
	2	2.5216
	3	2.4619
	4	2.4294
	5	2.4290
2.3	6	2.8222
	7	2.7334
	8	2.6234
	9	2.5186
	10	2.4215
	11	2.1250

Table 2 (continued)

AXIAL(X,Y)	ELEVATION (ft)	MAP(X,Y,Z)
2.5	1	2.6440
	2	2.5160
	3	2.5045
	4	2.4488
	5	2.5803
	6	2.9481
	7	2.8544
	8	2.7286
	9	2.6450
	10	2.5527
	11	2.1731
2.7	1	2.5554
	2	2.5529
	3	2.5197
	4	2.4375
	5	2.5643
	6	2.9839
	7	2.8837
	8	2.7939
	9	2.7040
	10	2.5997
	11	2.1995
2.9	1	2.4223
	2	2.5653
	3	2.5075
	4	2.3955
	5	2.7295
	6	3.0921
	7	3.0070
	8	2.8896
	9	2.8058
	10	2.6974
	11	2.2039

AXIAL(X,Y)	ELEVATION (ft)	MAP(X,Y,Z)
3.1	1	2.2448
	2	2.5535
	3	2.4678
	4	2.3229
	5	2.8913
	6	3.1515
	7	3.0181
	8	2.9699
	9	2.8941
	10	2.7819
	11	2.1866
3.3	1	2.0228
	2	2.5172
	3	2.4007
	4	2.2195
	5	3.0496
	6	3.2226
	7	3.1446
	8	3.0350
	9	2.9688
	10	2.8533
	11	2.1473
3.5	1	1.7563
	2	2.4566
	3	2.3062
	4	2.0854
	5	3.2045
	6	3.2929
	7	3.2627
	8	3.0846
	9	3.0299
	10	2.9117
	11	2.0862



(Fully Inserted)

Fraction of RATED THERMAL POWER

FIGURE 1
Rod Bank Insertion Limits Versus THERMAL POWER, Four Loop Operation (TS 3.1.6)

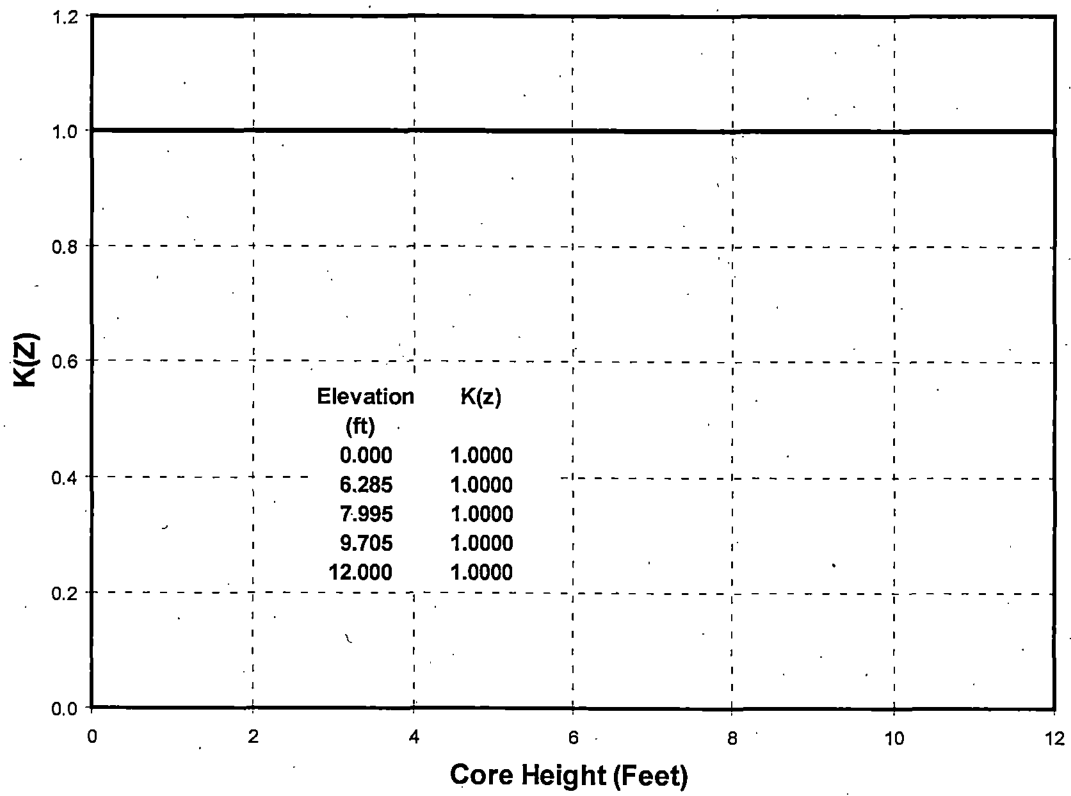
* Fully withdrawn region shall be the condition where shutdown and control banks are at a position within the interval of ≥225 and ≤231steps withdrawn, inclusive.

Fully withdrawn shall be the position as defined below

Cycle Burnup (MWd/mtU)	Steps Withdrawn
≥ 0	≥ 225 to ≤ 231

This figure is valid for operation at a RATED THERMAL POWER of 3455 MWth when the LEFM is in operation.

If the LEFM becomes inoperable, then prior to the next NIS calibration, the maximum allowable power level must be reduced by 1.3% in power, and the rod insertion limit lines must be increased by 3 steps withdrawn until the LEFM is returned to operation.



Elevation (ft)	K(z)
0.000	1.0000
6.285	1.0000
7.995	1.0000
9.705	1.0000
12.000	1.0000

FIGURE 2

K(Z) - Normalized $F_Q(X,Y,Z)$ as a Function of Core Height

(TS 3.2.1)

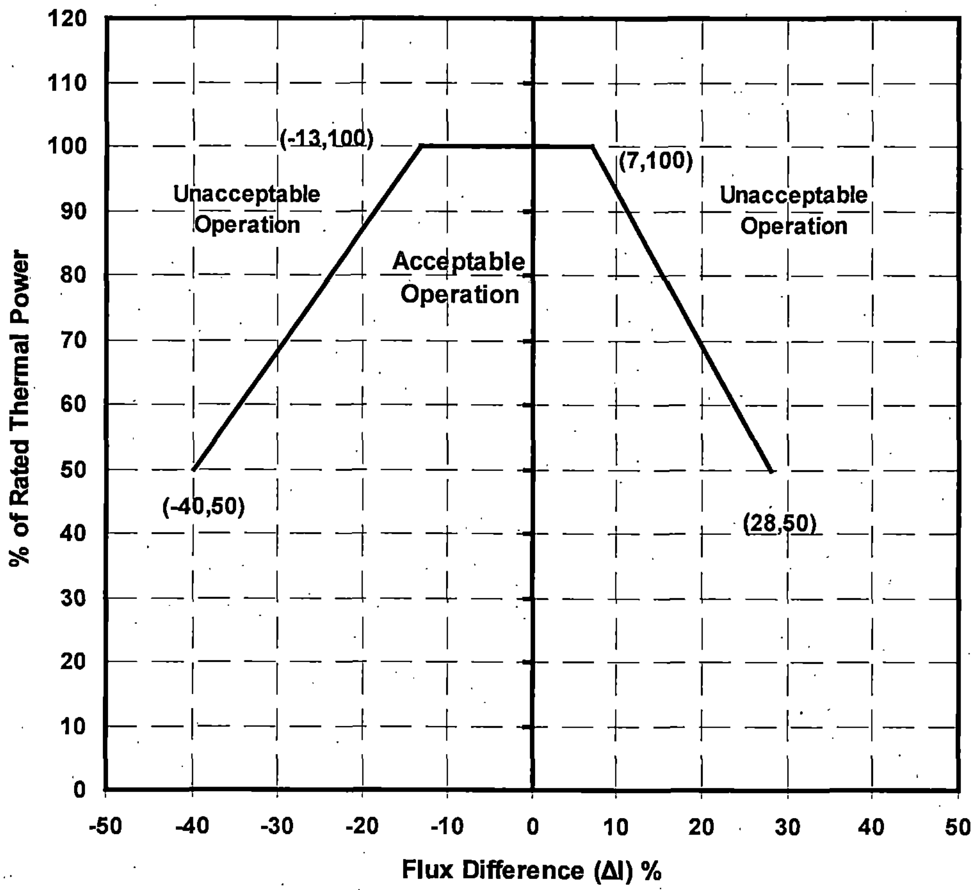


FIGURE 3

AXIAL FLUX DIFFERENCE Limits As A Function of RATED THERMAL POWER For Burnup Range 0 EFPD to EOL

(TS 3.2.3)

This figure is valid for operation at a RATED THERMAL POWER of 3455 MWth when the LEFM is in operation.

If the LEFM becomes inoperable, then prior to the next NIS calibration, the maximum allowable power level must be reduced by 1.3% in power, and the AFD limit lines must be made more restrictive by 1% in AFD until the LEFM is returned to operation.

ENCLOSURE 3

SEQUOYAH UNIT 2 CYCLE 20
CORE OPERATING LIMITS REPORT REVISION 1

SEQUOYAH UNIT 2 CYCLE 20
CORE OPERATING LIMITS REPORT

REVISION 1

October 2015

Prepared by:

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Brandon S. Catalanotto, Reactor Engineering Manager — Date

Approved by:

[signature] / 10/21/15
PORC Chairman — Date

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Revision 1

Pages affected All

Reason for Revision: Update for Improved Technical Specifications (ITS) Implementation

1.0 CORE OPERATING LIMITS REPORT

This CORE OPERATING LIMITS REPORT (COLR) for Sequoyah Unit 2 Cycle 20 has been prepared in accordance with the requirements of Technical Specification (TS) 5.6.3.

The TSs affected by this Report are listed below:

TS Section	Technical Specification	COLR Parameter	COLR Section	COLR Page
3.1.1	SHUTDOWN MARGIN (SDM)	SDM	2.1	3
3.1.3	Moderator Temperature Coefficient (MTC)	BOL MTC Limit EOL MTC Limit 300 ppm Surveillance Limit 60 ppm Surveillance Limit	2.2.1 2.2.2 2.2.3 2.2.4	4 4 4 4
3.1.4	Rod Group Alignment Limits	SDM	2.1.3	3
3.1.5	Shutdown Bank Insertion Limits	Shutdown Bank Insertion Limits SDM	2.3 2.1.4	4 3
3.1.6	Control Bank Insertion Limits	Control Bank Insertion Limits SDM	2.4 2.1.5	5 3
3.1.8	PHYSICS TESTS Exceptions – MODE 2	SDM	2.1.6	3
3.2.1	Heat Flux Hot Channel Factor ($F_Q(X,Y,Z)$)	F_Q^{RTP} K(Z) $NSLOPE^{AFD}$ $PSLOPE^{AFD}$ $NSLOPE^{f2(\Delta I)}$ $PSLOPE^{f2(\Delta I)}$ $F_Q(X,Y,Z)$ Appropriate Factor ITS LCO 3.2.1 Required Action A.3	2.5.1 2.5.2 2.5.3 2.5.4 2.5.5 2.5.6 2.5.7 2.5.8	6 6 6 6 6 6 6 6
3.2.2	Nuclear Enthalpy Rise Hot Channel Factor ($F_{\Delta H}(X,Y)$)	MAP(X,Y,Z) RRH TRH $F_{\Delta H}(X,Y)$ Appropriate Factor ITS 3.2.2 Required Action A.4 ITS 3.2.2 Required Action B.1	2.6.1 2.6.2 2.6.3 2.6.4 2.6.5 2.6.6	6 6 6 7 7 7
3.2.3	AXIAL FLUX DIFFERENCE (AFD)	AFD Limits	2.7	7
3.3.1	Reactor Trip System (RTS) Instrumentation	QTNL, QTPL, QTNS, and QTPS QPNL, QPPL, QPNS, and QPPS	2.8.1 2.8.2	8 9
3.9.1	Boron Concentration	Refueling Boron Concentration	2.9	9
5.6.3	CORE OPERATING LIMITS REPORT (COLR)	Analytical Methods	2.0	3

2.0 OPERATING LIMITS

The cycle-specific parameter limits for the TS listed in section 1.0 are presented in the following subsections. These limits have been developed using the NRC approved methodologies specified in TS 5.6.3. The versions of the topical reports which describe the methodologies used for this cycle are listed in Table 1.

The following abbreviations are used in this section:

BOL stands for Beginning of Cycle Life
EOL stands for End of Cycle Life
RTP stands for RATED THERMAL POWER

2.1 SHUTDOWN MARGIN – SDM (TS 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.1.8)

2.1.1 For TS 3.1.1, SDM shall be $\geq$ 1.6 %Δk/k in MODE 2 with k_{eff} < 1.0, MODE 3 and MODE 4

2.1.2 For TS 3.1.1, SDM shall be $\geq$ 1.0 %Δk/k in MODE 5.

2.1.3 For TS 3.1.4, SDM shall be $\geq$ 1.6 %Δk/k in MODE 1 and MODE 2.

2.1.4 For TS 3.1.5, SDM shall be $\geq$ 1.6 %Δk/k in MODE 1 and MODE 2.

2.1.5 For TS 3.1.6, SDM shall be $\geq$ 1.6 %Δk/k in MODE 1 and MODE 2 with $k_{eff} \geq$ 1.0.

2.1.6 For TS 3.1.8, SDM shall be $\geq$ 1.6 %Δk/k in MODE 2.

2.2 Moderator Temperature Coefficient – MTC (TS 3.1.3)

2.2.1 The BOL MTC limit is:
less positive than -0.16×10^{-5} Δk/k/°F .

2.2.2 The EOL MTC limit is:
less negative than or equal to -4.50×10^{-4} Δk/k/°F.

2.2.3 The 300 ppm Surveillance limit is:
less negative than or equal to -3.75×10^{-4} Δk/k/°F.

2.2.4 The 60 ppm Surveillance limit is:
less negative than or equal to -4.20×10^{-4} Δk/k/°F.

2.3 Shutdown Bank Insertion Limits (TS 3.1.5)

2.3.1 Each shutdown bank shall be withdrawn to a position as defined below:

Cycle Burnup (MWd/mtU)	Steps Withdrawn
≥ 0	≥ 225 to ≤ 231

2.4 Control Bank Insertion Limits (TS 3.1.6)

2.4.1 The control banks shall be limited in physical insertion as shown in Figure 1.

2.4.2 Each control bank shall be considered fully withdrawn from the core at ≥ 225 steps.

2.4.3 The control banks shall be operated in sequence by withdrawal of Bank A, Bank B, Bank C, and Bank D. The control banks shall be sequenced in reverse order upon insertion.

2.4.4 Each control bank not fully withdrawn from the core shall be operated with the following overlap as a function of full out position.

Full Out Position (steps)	Bank Overlap (steps)	Bank Difference (steps)
225	97	128
226	98	128
227	99	128
228	100	128
229	101	128
230	102	128
231	103	128

2.5 Heat Flux Hot Channel Factor – $F_Q(X,Y,Z)$ (TS 3.2.1)

2.5.1 F_Q^{RTP} = 2.62

2.5.2 K(Z) is provided in Figure 2

2.5.3 $NSLOPE^{AFD}$ = 1.44

2.5.4 $PSLOPE^{AFD}$ = 1.76

2.5.5 $NSLOPE^{f2(\Delta I)}$ = 1.48

2.5.6 $PSLOPE^{f2(\Delta I)}$ = 2.98

2.5.7 The appropriate factor for increase in $F_Q^M(X,Y,Z)$ for compliance with SR 3.2.1.2 and SR 3.2.1.3 is specified as follows:

For cycle burnups:	0 to 3312 MWd/mtU,	use 2.0%
For cycle burnups:	> 3312 to 3864 MWd/mtU,	use 2.12%
For cycle burnups:	> 3864 MWd/mtU,	use 2.0%

2.5.8 ITS LCO 3.2.1 Required Action A.3 reduces the Overpower Delta T Trip setpoints (value of K_4) at least 1% (in ΔT span) for each 1% that $F_Q^C(X,Y,Z)$ exceeds its limit.

2.6 Nuclear Enthalpy Rise Hot Channel Factor - $F_{\Delta H}(X,Y)$ (TS 3.2.2)

2.6.1 MAP(X,Y,Z) is provided in Tables 2a and 2b.

2.6.2 RRH = 3.34 when $0.8 < P \leq 1.0$

RRH = 1.67 when $P \leq 0.8$

P = THERMAL POWER / RATED THERMAL POWER

RRH = Thermal power reduction required to compensate for each 1% that $F_{\Delta H}(X,Y)$ exceeds its limit.

2.6.3 TRH = 0.0334 when $0.8 < P < 1.0$

TRH = 0.0167 when $P < 0.8$

P = THERMAL POWER / RATED THERMAL POWER

TRH = Reduction in Overtemperature Delta T K_1 setpoint required to compensate for each 1% that $F_{\Delta H}(X,Y)$ exceeds its limit.

2.6.4 The appropriate factor for increase in $F_{\Delta H}^{M}$ (X,Y) for compliance with SR 3.2.2.1 and SR 3.2.2.2 is specified as follows:

For all cycle burnups, use 2.0%

2.6.5 ITS 3.2.2 Required Action A.4 reduces the Overtemperature Delta T setpoint (K_1 term in Table 3.3.1-1) by ≥ TRH multiplied by the $F_{\Delta H}$ min margin.

2.6.6 ITS 3.2.2 Required Action B.1 reduces the Overtemperature Delta T setpoint (K_1 term in Table 3.3.1-1) by ≥ TRH multiplied by the $f_1(\Delta I)$ min margin.

2.7 AXIAL FLUX DIFFERENCE – AFD (TS 3.2.3)

2.7.1 The AFD limits are specified in Figure 3

2.8 Reactor Trip System Instrumentation (TS 3.3.1)

2.8.1 Trip Reset Term [$f_1(\Delta I)$] for Overtemperature Delta-T Trip

The following parameters are required to specify the power level-dependent $f_1(\Delta I)$ trip reset term limits for Table 3.3.1-1 (function 6), Overtemperature Delta-T trip function:

2.8.1.1 QTNL = -20%

where QTNL = the maximum negative ΔI setpoint at RATED THERMAL POWER at which the trip setpoint is not reduced by the axial power distribution.

2.8.1.2 QTPL = +5%

where QTPL = the maximum positive ΔI setpoint at RATED THERMAL POWER at which the trip setpoint is not reduced by the axial power distribution.

2.8.1.3 QTNS = 2.50%

where QTNS = the percent reduction in Overtemperature Delta-T trip setpoint for each percent that the magnitude of ΔI exceeds its negative limit at RATED THERMAL POWER (QTNL).

2.8.1.4 QTPS = 1.40%

where QTPS = the percent reduction in Overtemperature Delta-T trip setpoint for each percent that the magnitude of ΔI exceeds its positive limit at RATED THERMAL POWER (QTPL).

2.8.2 Trip Reset Term [$f_2(\Delta I)$] for Overpower Delta-T Trip

The following parameters are required to specify the power level-dependent $f_2(\Delta I)$ trip reset term limits for Table 3.3.1-1 (function 7), Overpower Delta-T trip function:

2.8.2.1 QPNL = -25%

where QPNL = the maximum negative ΔI setpoint at RATED THERMAL POWER at which the trip setpoint is not reduced by the axial power distribution.

2.8.2.2 QPPL = +25%

where QPPL = the maximum positive ΔI setpoint at RATED THERMAL POWER at which the trip setpoint is not reduced by the axial power distribution.

2.8.2.3 QPNS = 1.70%

where QPNS = the percent reduction in Overpower Delta-T trip setpoint for each percent that the magnitude of ΔI exceeds its negative limit at RATED THERMAL POWER (QPNL).

2.8.2.4 QPPS = 1.70%

where QPPS = the percent reduction in Overpower Delta-T trip setpoint for each percent that the magnitude of ΔI exceeds its positive limit at RATED THERMAL POWER (QPPL).

2.9 Boron Concentration (TS 3.9.1)

2.9.1 The refueling boron concentration shall be ≥ 2000 ppm.

Table 1

COLR Methodology Topical Reports

1. BAW-10180-A, Revision 1, "NEMO-Nodal Expansion Method Optimized," March 1993.
   (Methodology for TS 3.1.1-SHUTDOWN MARGIN, 3.1.3-Moderator Temperature Coefficient, 3.9.1-Boron Concentration)
2. BAW-10169P-A, Revision 0, "RSG Plant Safety Analysis-B&W Safety Analysis Methodology for Recirculating Steam Generator Plants," October 1989.
   (Methodology for TS 3.1.3-Moderator Temperature Coefficient)
3. BAW-10163P-A, Revision 0, "Core Operating Limit Methodology for Westinghouse-Designed PWRs," June 1989.
   (Methodology for TS 3.3.1-Reactor Trip System Instrumentation [$f_1(\Delta I)$, $f_2(\Delta I)$ limits], 3.1.5-Shutdown Bank Insertion Limits, 3.1.6-Control Bank Insertion Limits, 3.2.1-Heat Flux Hot Channel Factor, 3.2.2-Nuclear Enthalpy Rise Hot Channel Factor, 3.2.3-AXIAL FLUX DIFFERENCE)
4. EMF-2328(P)(A), "PWR Small Break LOCA Evaluation Model," March 2001.
   (Methodology for TS 3.2.1-Heat Flux Hot Channel Factor)
5. BAW-10227P-A, Revision 1, "Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel," June 2003.
   (Methodology for TS 3.2.1-Heat Flux Hot Channel Factor)
6. BAW-10186P-A, Revision 2, "Extended Burnup Evaluation," June 2003.
   (Methodology for TS 3.2.1-Heat Flux Hot Channel Factor)
7. EMF-2103P-A, Revision 0, "Realistic Large Break LOCA Methodology for Pressurized Water Reactors," April 2003.
   (Methodology for TS 3.2.1-Heat Flux Hot Channel Factor)
8. BAW-10241P-A, Revision 1, "BHTP DNB Correlation Applied with LYNXT," July 2005.
   (Methodology for TS 3.2.2-Nuclear Enthalpy Rise Hot Channel Factor, 3.3.1-Reactor Trip System Instrumentation [$f_1(\Delta I)$ limits])
9. BAW-10199P-A, Revision 0, "The BWU Critical Heat Flux Correlations," August 1996.
   (Methodology for TS 3.2.2-Nuclear Enthalpy Rise Hot Channel Factor, 3.3.1-Reactor Trip System Instrumentation [$f_1(\Delta I)$ limits])
10. BAW-10189P-A, "CHF Testing and Analysis of the Mark-BW Fuel Assembly Design," January 1996.
    (Methodology for TS 3.2.2-Nuclear Enthalpy Rise Hot Channel Factor, 3.3.1-Reactor Trip System Instrumentation [$f_1(\Delta I)$ limits])
11. BAW-10159P-A, "BWCMV Correlation of Critical Heat Flux in Mixing Vane Grid Fuel Assemblies," August 1990.
    (Methodology for TS 3.2.2-Nuclear Enthalpy Rise Hot Channel Factor, 3.3.1-Reactor Trip System Instrumentation [$f_1(\Delta I)$ limits])
12. BAW-10231P-A, Revision 1, "COPERNIC Fuel Rod Design Computer Code," January 2004.
    (Methodology for TS 3.3.1-Reactor Trip System Instrumentation [$f_2(\Delta I)$ limits])

Table 2a
Maximum Allowable Peaking Limits MAP(X,Y,Z) for Operation
Advanced W17 HTP™ Fuel (TS 3.2.2)

AXIAL(X,Y)	ELEVATION (ft)	MAP(X,Y,Z)
1.1	1	1.8128
	2	1.8125
	3	1.8122
	4	1.8119
	5	1.8115
	6	1.8109
	7	1.8106
	8	1.8104
	9	1.8098
	10	1.8092
	11	1.7599
1.2	1	2.0671
	2	2.0664
	3	2.0656
	4	2.0649
	5	2.0642
	6	2.0636
	7	2.0624
	8	2.0615
	9	2.0457
	10	1.9492
	11	1.8589
1.3	1	2.3433
	2	2.3419
	3	2.3412
	4	2.3397
	5	2.3389
	6	2.3381
	7	2.3357
	8	2.3130
	9	2.1886
	10	2.0643
	11	1.9439

AXIAL(X,Y)	ELEVATION (ft)	MAP(X,Y,Z)
1.4	1	2.5969
	2	2.5380
	3	2.4827
	4	2.4411
	5	2.4315
	6	2.4800
	7	2.5356
	8	2.4447
	9	2.3555
	10	2.1738
	11	2.0238
1.5	1	2.6723
	2	2.6061
	3	2.5417
	4	2.4913
	5	2.4801
	6	2.5380
	7	2.6273
	8	2.5311
	9	2.4447
	10	2.2772
	11	2.0975
1.6	1	2.7308
	2	2.6605
	3	2.5947
	4	2.5371
	5	2.5234
	6	2.5906
	7	2.7077
	8	2.6117
	9	2.5240
	10	2.3758
	11	2.1662

Table 2a (continued)

AXIAL(X,Y)	ELEVATION (ft)	MAP(X,Y,Z)
1.7	1	2.7664
	2	2.7083
	3	2.6380
	4	2.5791
	5	2.5639
	6	2.6359
	7	2.7795
	8	2.6870
	9	2.5798
	10	2.4726
	11	2.2304
1.8	1	2.7963
	2	2.7466
	3	2.6775
	4	2.6172
	5	2.6010
	6	2.6802
	7	2.8456
	8	2.7552
	9	2.6648
	10	2.5655
	11	2.2931
1.9	1	2.8235
	2	2.7739
	3	2.7125
	4	2.6523
	5	2.6328
	6	2.7200
	7	2.9065
	8	2.8193
	9	2.7288
	10	2.6384
	11	2.3482

AXIAL(X,Y)	ELEVATION (ft)	MAP(X,Y,Z)
>1.9	1	2.4339
	2	2.4060
	3	2.3856
	4	2.3423
	5	2.3114
	6	2.6006
	7	2.5003
	8	2.4004
	9	2.2989
	10	2.1483
	11	1.9630
2.1	1	2.5057
	2	2.4754
	3	2.4449
	4	2.3591
	5	2.4205
	6	2.7643
	7	2.6474
	8	2.5360
	9	2.4400
	10	2.3277
	11	2.0549
2.3	1	2.5380
	2	2.5216
	3	2.4619
	4	2.4294
	5	2.4290
	6	2.8222
	7	2.7334
	8	2.6234
	9	2.5186
	10	2.4215
	11	2.1250

Table 2a (continued)

AXIAL(X,Y)	ELEVATION (ft)	MAP(X,Y,Z)	AXIAL(X,Y)	ELEVATION (ft)	MAP(X,Y,Z)
2.5	1	2.6440	3.1	1	2.2448
	2	2.5160		2	2.5535
	3	2.5045		3	2.4678
	4	2.4488		4	2.3229
	5	2.5803		5	2.8913
	6	2.9481		6	3.1515
	7	2.8544		7	3.0181
	8	2.7286		8	2.9699
	9	2.6450		9	2.8941
	10	2.5527		10	2.7819
	11	2.1731		11	2.1866
2.7	1	2.5554	3.3	1	2.0228
	2	2.5529		2	2.5172
	3	2.5197		3	2.4007
	4	2.4375		4	2.2195
	5	2.5643		5	3.0496
	6	2.9839		6	3.2226
	7	2.8837		7	3.1446
	8	2.7939		8	3.0350
	9	2.7040		9	2.9688
	10	2.5997		10	2.8533
	11	2.1995		11	2.1473
2.9	1	2.4223	3.5	1	1.7563
	2	2.5653		2	2.4566
	3	2.5075		3	2.3062
	4	2.3955		4	2.0854
	5	2.7295		5	3.2045
	6	3.0921		6	3.2929
	7	3.0070		7	3.2627
	8	2.8896		8	3.0846
	9	2.8058		9	3.0299
	10	2.6974		10	2.9117
	11	2.2039		11	2.0862

Table 2b
Maximum Allowable Peaking Limits MAP(X,Y,Z) for Operation
Mark-BW Fuel (TS 3.2.2)

AXIAL(X,Y)	ELEVATION (ft)	MAP(X,Y,Z)
1.1	2	1.9343
	4	1.9300
	6	1.9234
	8	1.9115
	10	1.8894
1.2	2	2.1663
	4	2.1558
	6	2.1410
	8	2.1153
	10	2.0582
1.3	2	2.4023
	4	2.3825
	6	2.3599
	8	2.3100
	10	2.1760
1.4	2	2.6453
	4	2.6136
	6	2.5610
	8	2.4199
	10	2.2787
1.5	2	2.7189
	4	2.8181
	6	2.6735
	8	2.5280
	10	2.3749
1.7	2	2.7720
	4	2.9219
	6	2.8641
	8	2.7064
	10	2.5539

AXIAL(X,Y)	ELEVATION (ft)	MAP(X,Y,Z)
1.9	2	2.8143
	4	2.9856
	6	3.0073
	8	2.8509
	10	2.7048
>1.9	2	2.4405
	4	2.4405
	6	2.7376
	8	2.5906
	10	2.3456
2.2	2	2.5881
	4	2.5881
	6	2.9899
	8	2.7800
	10	2.5367
2.6	2	2.6111
	4	2.6111
	6	3.2947
	8	3.2055
	10	2.8049
3	2	2.9142
	4	2.9142
	6	4.0216
	8	3.6527
	10	3.1711
3.5	2	2.9618
	4	2.9618
	6	4.2351
	8	3.7452
	10	3.3214

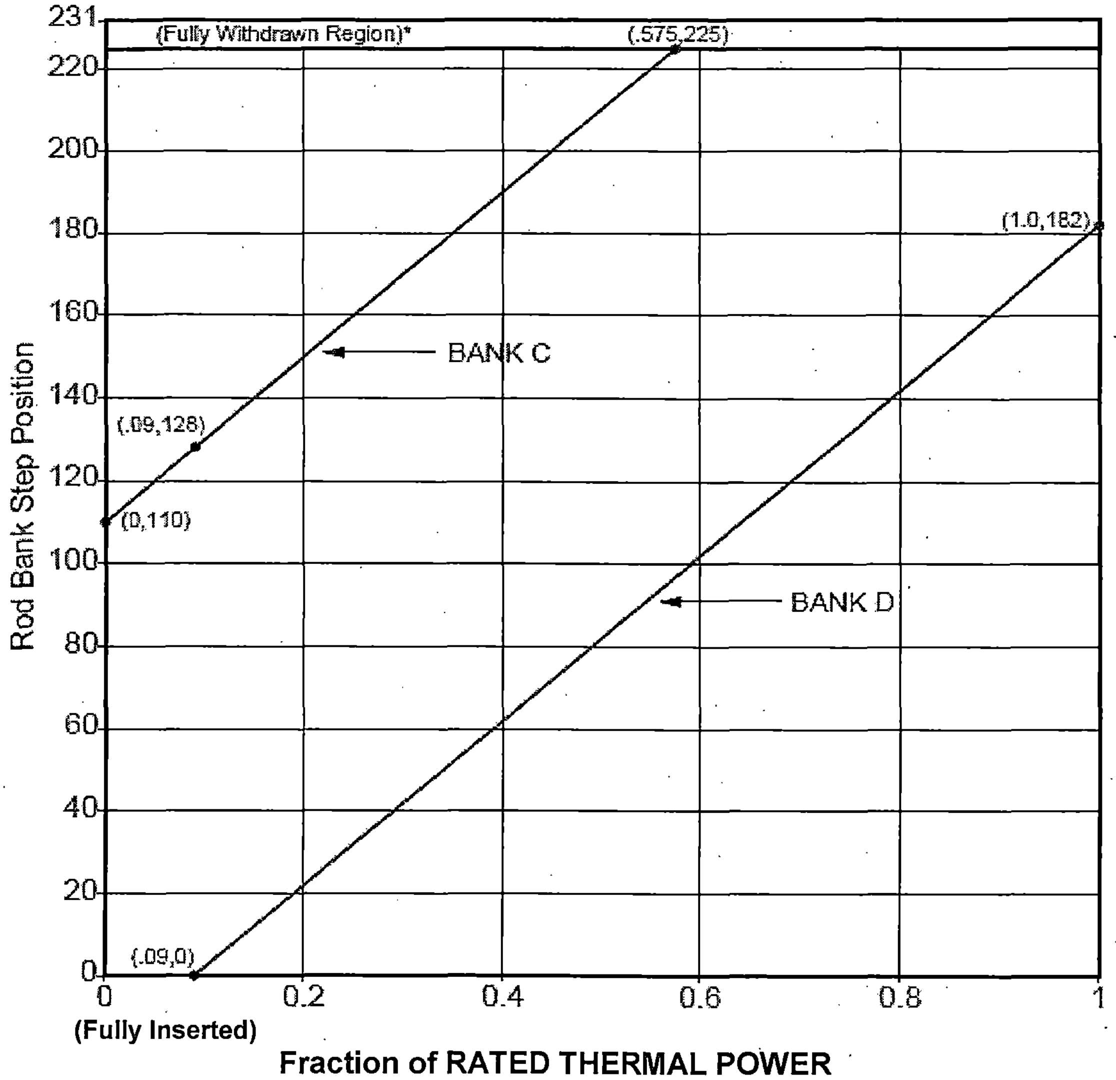


FIGURE 1
Rod Bank Insertion Limits Versus THERMAL POWER, Four Loop Operation
(TS 3.1.6)

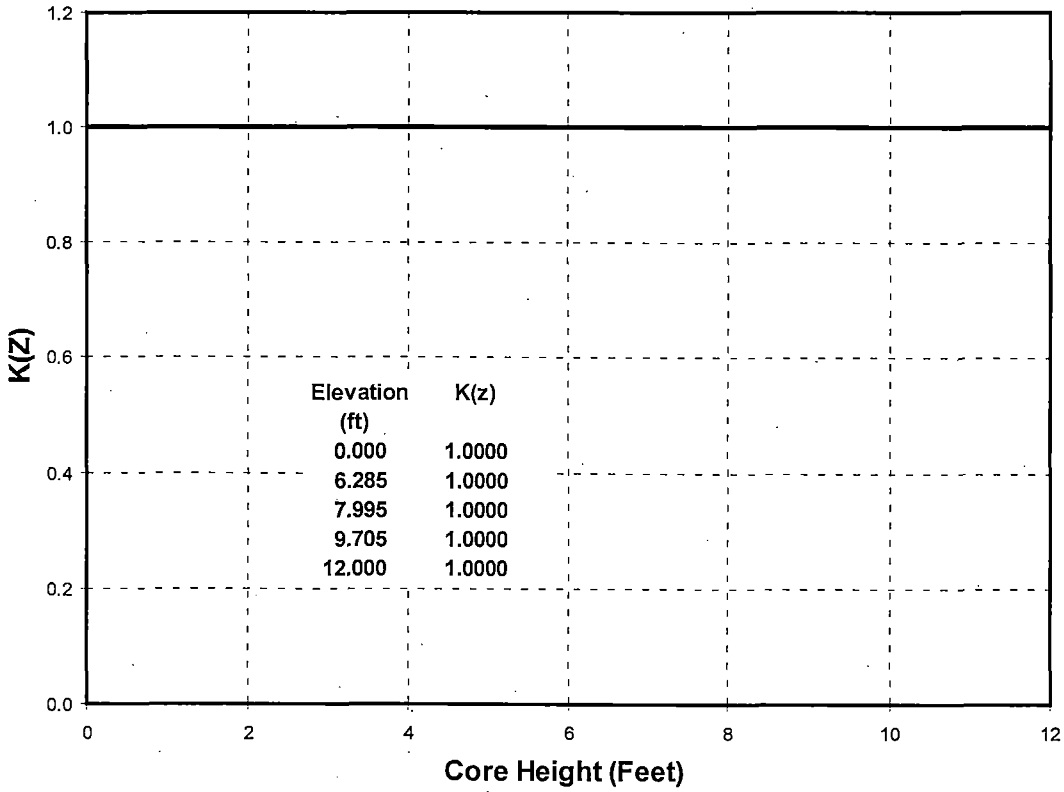
* Fully withdrawn region shall be the condition where shutdown and control banks are at a position within the interval of ≥225 and ≤231steps withdrawn, inclusive.

Fully withdrawn shall be the position as defined below,

Cycle Burnup (MWd/mtU)	Steps Withdrawn
≥ 0	≥ 225 to ≤ 231

This figure is valid for operation at a RATED THERMAL POWER of 3455 MWth when the LEFM is in operation.

If the LEFM becomes inoperable, then prior to the next NIS calibration, the maximum allowable power level must be reduced by 1.3% in power, and the rod insertion limit lines must be increased by 3 steps withdrawn until the LEFM is returned to operation.



Elevation (ft)	K(z)
0.000	1.0000
6.285	1.0000
7.995	1.0000
9.705	1.0000
12.000	1.0000

FIGURE 2

K(Z) - Normalized $F_Q(X,Y,Z)$ as a Function of Core Height

(TS 3.2.1)

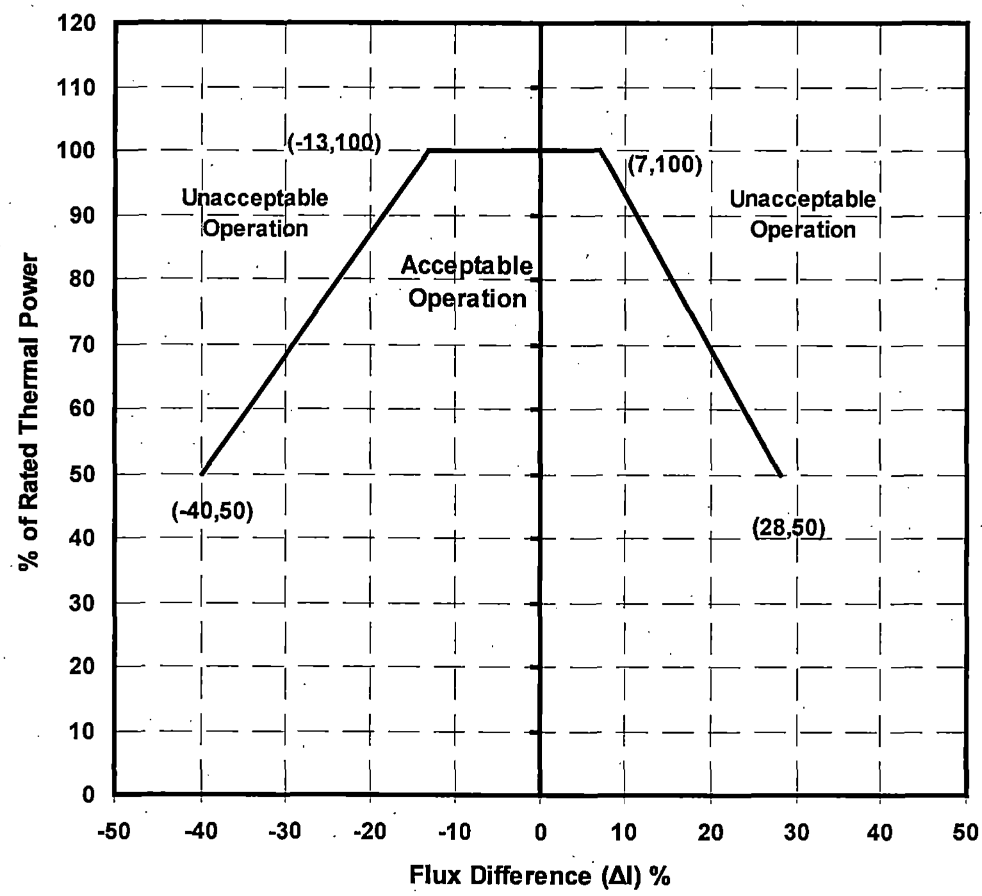


FIGURE 3

AXIAL FLUX DIFFERENCE Limits As A Function of RATED THERMAL POWER For Burnup Range 0 EFPD to EOL

(TS 3.2.3)

This figure is valid for operation at a RATED THERMAL POWER of 3455 MWth when the LEFM is in operation. If the LEFM becomes inoperable, then prior to the next NIS calibration, the maximum allowable power level must be reduced by 1.3% in power, and the AFD limit lines must be made more restrictive by 1% in AFD until the LEFM is returned to operation.