

CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO 2
PLANT OPERATING MANUALVOLUME 6
PART 5

FUEL MANAGEMENT PROCEDURE

FMP-001
CORE OPERATING LIMITS REPORT (COLR)

REVISION 7

EFFECTIVE DATE

Approval

Salman Ahmed for Paul Catavella

Superintendent - Mechanical Systems 1/8/97
Date

Concurrence

Dale E. Young

PNSC Chairman 1/8/97
Date

LIST OF EFFECTIVE PAGES

<u>Page(s)</u>	<u>Revision</u>
1	7
LEP	7
Table of Contents	7
4 through 15	7

NOTE: The body of this procedure has been revised in its entirety. Revision bars are not used to mark changes to either the body of the procedure or to the Attachments.

SUMMARY OF CHANGES

Description of Change	Reason/Justification
1. Reformatted procedure layout per AP-007.	Admin change
2. Deleted "Recommended By" line on cover page.	Admin change
3. Changed H.B. Robinson Unit 2 to HBRSEP Unit No. 2 throughout.	Admin change
4. Deleted old Reference 2.2 and added PLP-100, ESR 95-00860, and ESR 96-00767 as new references.	Admin change. Ref. 2.2 was not referenced in FMP-001. TRM added to support ITS implementation. ESRs added as rev. basis.
5. Added note after section 1.0 describing new format for CTS/ITS cross references. Added ITS references throughout.	Admin change to support ITS implementation
6. Changed Reactor Systems Engineering Subunit to RESS/Reactor Engineering in section 3.1 responsibilities. Added responsibilities for PNSC to section 3.0.	Admin change
7. Added ITS and TRM to abbreviations in section 4.2.	Admin change
8. Changed words in section 5.2 to reflect present tense.	Admin change
9. Deleted blank cover page for Att. 7.1	Admin change
10. Changed Fq from 2.40 to 2.49 in section 2.4.1 and Fdh from 1.73 to 1.80 in section 2.5.1. Deleted "for burnups < 87 EFPD."	ESR 96-00767

TABLE OF CONTENTS

SECTION	PAGE
1.0 PURPOSE	4
2.0 REFERENCES	4
3.0 RESPONSIBILITIES	4
4.0 DEFINITIONS/ABBREVIATIONS	5
5.0 GENERAL	5
5.1 BACKGROUND INFORMATION	5
5.2 REVISION OF THE COLR	6
5.3 CORE OPERATING LIMITS REPORT	6
6.0 INSTRUCTIONS	6
7.0 ATTACHMENTS	6
7.1 HBRSEP UNIT NO. 2, CYCLE 18 CORE OPERATING LIMITS REPORT, REVISION 2	7

1.0 PURPOSE

- 1.1 To present the cycle-specific Core Operating Limits Report (COLR) for HBRSEP Unit No. 2.
- 1.2 To provide a means of incorporating the COLR into the Plant Operating Manual (POM) so it that resides in a location that can be controlled and references to ensure that the requirements specified in NRC Generic Letter 88-16 and Technical Specification 6.9.3.3 (Improved Technical Specification 5.6) are met.

NOTE: This revision cross references Current Technical Specifications (CTS) with the Improved Technical Specifications (ITS). The new reference format will look like this: T.S. 3.1.1 (ITS 3.4.2).

2.0 REFERENCES

- 2.1 Technical Specifications 1.22, 3.1.3.1, 3.1.3.3, 3.10.1.2, 3.10.1.3, 3.10.1.4, 3.10.2.1, 3.10.2.2, 3.10.2.2.1, 3.10.2.2.2, 3.10.2.7, 3.10.2.9, 3.10.2.11, 6.5.1.6.6.j, and 6.9.3.3 (Improved Technical Specifications 1.1, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, and 5.6)
- 2.2 PLP-100, Technical Requirements Manual (TRM)
- 2.3 NRC Generic Letter 88-16, "Removal of Cycle-Specific Parameter Limits from Technical Specifications," October 4, 1988.
- 2.4 License Amendment No. 141 - Regarding Removal of Cycle-Specific Parameter Limits to Core Operating Limits Report
- 2.5 ESR 95-00860, Cycle 18 Core Reload
- 2.6 ESR 96-00767, Review Siemens Modified LBLOCA Documents

3.0 RESPONSIBILITIES

- 3.1 RESS Reactor Systems and/or the Nuclear Fuels Management and Safety Analysis Section (NFM&SA) is responsible for revising this procedure as changes to the COLR are required. At a minimum, revisions are required once per cycle, at Beginning Of Cycle, to make the COLR cycle-specific.
- 3.2 The Plant Nuclear Safety Committee (PNSC) is responsible for reviewing revisions to the COLR in accordance with Technical Specification 6.5.1.6.6.j (TRM) and providing concurrence prior to implementation of COLR revisions.
- 3.3 RESS Reactor Systems and Operations are responsible for monitoring plant conditions to ensure the Core Operating Limits specified in this procedure are met.

4.0 DEFINITIONS/ABBREVIATIONS

4.1 Definitions

- 4.1.1 $F_Q(Z)$ - the Heat Flux Hot Channel Factor is the maximum local heat flux on the surface of a fuel rod divided by the average fuel rod heat flux.
- 4.1.2 F_Q^{RTP} - the cycle-specific F_Q limit at Rated Thermal Power (RTP).
- 4.1.3 $K(Z)$ - the normalized axial dependence factor for F_Q versus core elevation.
- 4.1.4 $F_{\Delta H}$ - the Nuclear Enthalpy Rise Hot Channel Factor is the integral of linear power along the rod with the highest integrated power divided by the average rod power.
- 4.1.5 $F_{\Delta H}^{RTP}$ - the cycle-specific $F_{\Delta H}$ limit at Rated Thermal Power (RTP).
- 4.1.6 $PF_{\Delta H}$ - the Power Factor Multiplier for $F_{\Delta H}^{RTP}$.
- 4.1.7 AFD - the Axial Flux Difference is the difference in signals between the top and bottom halves of a two-section excore detector which is proportional to the difference in power between the top and bottom halves of the core.
- 4.1.8 $V(Z)$ - the ratio of the maximum $F_Q^T(Z)$ produced during and following transient maneuvers to the equilibrium $F_Q^T(Z)$ value at target axial offset conditions.
- 4.1.9 P - the fraction of rated power (2300 Mwt) at which the core is operating
- 4.1.10 RTP - Rated Thermal Power, 2300 Mwt

4.2 Abbreviations

- 4.2.1 POM - Plant Operating Manual
- 4.2.2 PNSC - Plant Nuclear Safety Committee
- 4.2.3 COLR - Core Operating Limits Report
- 4.2.4 MTC - Moderator Temperature Coefficient.
- 4.2.5 ITS - Improved Technical Specifications
- 4.2.6 TRM - Technical Requirements Manual

5.0 GENERAL

5.1 Background Information

HBRSEP Unit No. 2, like all other commercial nuclear power plants, is required to operate within specific core operating limits and restrictions as specified in the Technical Specifications. Examples of these limits/restrictions include power dependent rod insertion limits, and limits on $F_Q(Z)$ and $F_{\Delta H}$, among others. Technical Specification changes and NRC approval were required as specific numerical values for these limits/restrictions were revised. If these changes were frequent, e.g. on a cycle-specific basis, or if they were needed on accelerated schedules, considerable administrative burdens were placed on both the NRC and on utility personnel.

To reduce this burden, the CORE OPERATING LIMITS REPORT (COLR) concept was developed in which specific numerical values for certain core operating limits and/or restrictions would be removed from the Technical Specifications and relocated to a COLR document. Using NRC approved methodologies, numerical values for these operating limits and/or restrictions

ATTACHMENT 7.1
Page 1 of 9
HBRSEP Unit No. 2, Cycle 18
CORE OPERATING LIMITS REPORT
Revision 2

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for HBRSEP Unit No. 2, Cycle 18 has been prepared per ESR 95-00860 and ESR 96-00767 in accordance with the requirements of T.S. 6.9.3.3 (ITS 5.6).

The Technical Specifications (Improved Technical Specifications) affected by this report are listed below:

T.S. 3.1.3.1 (ITS 3.1.3) T.S. 3.1.3.3 (ITS 3.1.3)	Moderator Temperature Coefficient
T.S. 3.10.1.2 (ITS 3.1.5)	Shutdown Rod Insertion Limits
T.S. 3.10.1.3 (ITS 3.1.6) T.S. 3.10.1.4 (TRM)	Control Rod Insertion Limits
T.S. 3.10.2.1 (ITS 3.2.1, 3.2.3) T.S. 3.10.2.2 (TRM) T.S. 3.10.2.2.1 (ITS 3.2.1) T.S. 3.10.2.2.2 (ITS 3.2.3)	Heat Flux Hot Channel Factor
T.S. 3.10.2.1 (ITS 3.2.2, 3.2.3)	Nuclear Enthalpy Rise Hot Channel Factor
T.S. 3.10.2.2 (TRM) T.S. 3.10.2.2.1 (ITS 3.2.1) T.S. 3.10.2.2.2 (ITS 3.2.3) T.S. 3.10.2.7 (ITS 3.2.3) T.S. 3.10.2.9 (ITS 3.2.3) T.S. 3.10.2.11 (ITS 3.2.3)	Axial Flux Difference
T.S. 6.9.3.3 (ITS 5.6) T.S. 6.9.3.3.b (ITS 5.6)	Core Operating Limits Reports

ATTACHMENT 7.1
Page 2 of 9
HBRSEP Unit No. 2, Cycle 18
CORE OPERATING LIMITS REPORT
Revision 2

2.0 OPERATING LIMITS

The cycle-specific parameter limits for the specifications listed in Section 1.0 are presented in the following subsections. These limits have been developed using the NRC-approved methodologies specified in T.S. 6.9.3.3 (ITS 5.6) and the COLR Section 3.0.

2.1 Moderator Temperature Coefficient (T.S. 3.1.3.1, 3.1.3.3) (ITS 3.1.3)

2.1.1 The Moderator Temperature Coefficient (MTC) limits are:

- a) The MTC shall be less than or equal to +5.0 pcm/°F at less than 50% of rated power, or
- b) The MTC shall be less than or equal to 0.0 pcm/°F at 50% of rated power and above.

2.2 Shutdown Rod Insertion Limits (T.S. 3.10.1.2) (ITS 3.1.5)

2.2.1 The shutdown rods shall be withdrawn to at least 225 steps.

2.3 Control Rod Insertion Limits (T.S. 3.10.1.3, 3.10.1.4) (ITS 3.1.6, TRM)

2.3.1 The control rods shall be limited in physical insertion as shown in Figure 1.0.

2.4 Heat Flux Hot Channel Factor - $F_Q(Z)$ (T.S. 3.10.2.1, 3.10.2.2, 3.10.2.2.1, 3.10.2.2.2) (ITS 3.2.1, 3.2.3, TRM)

$$F_Q(Z) \leq (F_Q^{RTP} / P) \times K(Z) \text{ for } P > 0.5$$

$$F_Q(Z) < (F_Q^{RTP} / 0.5) \times K(Z) \text{ for } P \leq 0.5$$

Where: P = (Thermal Power / Rated Thermal Power)

2.4.1 $F_Q^{RTP} = 2.49$ for ANF-12, ROB-13, ROB-14, and ROB-15 reload batches

$F_Q^{RTP} = 2.32$ for XN-6 reload batch

2.4.2 $K(Z)$ is specified in Figure 2.0

ATTACHMENT 7.1
Page 3 of 9
HBRSEP Unit No. 2, Cycle 18
CORE OPERATING LIMITS REPORT
Revision 2

2.5 Nuclear Enthalpy Rise Hot Channel Factor - $F_{\Delta H}$ (T.S. 3.10.2.1) (ITS 3.2.2, 3.2.3)

$$F_{\Delta H} < F_{\Delta H}^{RTP} (1 + PF_{\Delta H}(1-P))$$

Where: $P = (\text{Thermal Power} / \text{Rated Thermal Power})$

2.5.1 $F_{\Delta H}^{RTP} = 1.80$ for ANF-12, ROB-13, ROB-14, and ROB-15 reload batches

$F_{\Delta H}^{RTP} = 1.65$ for XN-6 reload batch

2.5.2 $PF_{\Delta H} = 0.2$

2.6 Axial Flux Difference (T.S. 3.10.2.2, 3.10.2.2.1, 3.10.2.2.2, 3.10.2.7, 3.10.2.9, 3.10.2.11) (ITS 3.2.1, 3.2.3, TRM)

2.6.1 The axial flux difference target bands are $\pm 3\%$ and $\pm 5\%$ about the target AFD.

2.6.2 $V(Z)$ values for the $\pm 3\%$ and $\pm 5\%$ target bands are specified in Figure 3.0.

2.6.3 The AFD Acceptable Operation Limits are specified in Figure 4.0.

ATTACHMENT 7.1
Page 4 of 9
HBRSEP Unit No. 2, Cycle 18
CORE OPERATING LIMITS REPORT
Revision 2

3.0 METHODOLOGY REFERENCES

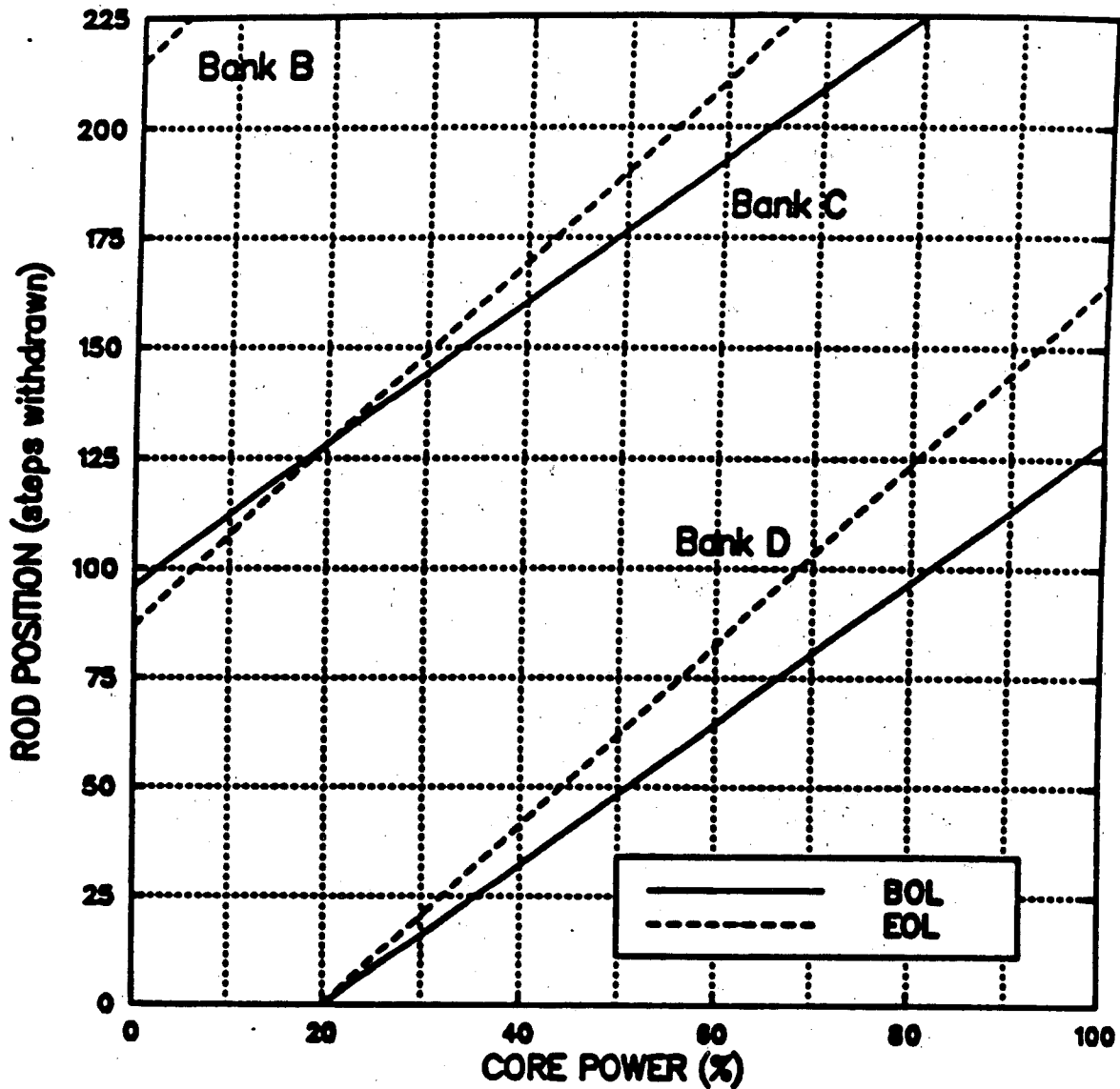
- a) XN-75-27(A), and Supplements 1, 2, 3, and 4 "Exxon Nuclear Neutronics Design Methods for Pressurized Water Reactors," Exxon Nuclear Company.
 - b) XN-NF-84-73(P), Revision 5, "Advanced Nuclear Fuels Methodology for Pressurized Water Reactors: Analysis of Chapter 15 Events," Advanced Nuclear Fuels Corporation.
 - c) XN-NF-82-21(A), Revision 1, "Application of Exxon Nuclear Company PWR Thermal Margin Methodology to Mixed Core Configurations," Exxon Nuclear Company.
 - d) XN-NF-84-093(A), and Supplement 1, "Steamline Break Methodology for PWRs," Advanced Nuclear Fuels Corporation.
 - e) XN-75-32(A) Supplements 1, 2, 3, and 4, "Computational Procedure for Evaluating Fuel Rod Bow," Exxon Nuclear Company.
 - f) XN-NF-82-49(A), Revision 1 Supplement 1, "Exxon Nuclear Company Evaluation Model Revised EXEM PWR Small Break Model," Siemens Power Corporation.
 - g) XN-NF-82-20(A), Revision 1 and Supplements 1, 2, 3, and 4, "Exxon Nuclear Company Evaluation Model EXEM/PWR ECCS Model Updates," Exxon Nuclear Company.
- XN-NF-82-07(A), Revision 1, Exxon Nuclear Company ECCS Cladding Swelling and Rupture Model," Exxon Nuclear Company.
- XN-NF-81-58(A), Revision 2 and Supplements 1, 2, 3, and 4, "RODEX2 Fuel Rod Thermal Response Evaluation Model," Exxon Nuclear Company.
- XN-NF-85-16(A), Volume 1 and Supplements 1, 2, and 3, Volume 2, Revision 1, and Supplement 1, "PWR 17x17 Fuel Cooling Test Program," Exxon Nuclear Company.
- XN-NF-85-105(A), and Supplement 1, "Scaling of FCTF Based Reflood Heat Transfer Correlation for Other Bundle Designs," Exxon Nuclear Company.
- h) XN-NF-78-44(A), "A Generic Analysis of the Control Rod Ejection Transient for Pressurized Water Reactors," Exxon Nuclear Company.

ATTACHMENT 7.1
Page 5 of 9
HBRSEP Unit No. 2, Cycle 18
CORE OPERATING LIMITS REPORT
Revision 2

- i) XN-NF-621(A) Revision 1, "Exxon Nuclear DNB Correlation for PWR Fuel Designs," Exxon Nuclear Company.
- j) ANF-1224(A) and Supplement 1, "Departure from Nucleate Boiling Correlation for High Thermal Performance Fuel," Advanced Nuclear Fuels Corporation.
- k) XN-NF-82-06(A), Revision 1 and Supplements 2, 4, and 5, "Qualification of Exxon Nuclear Fuel for Extended Burnup (PWR)," Exxon Nuclear Company.
- l) Not Used
- m) Not Used
- n) Not Used
- o) Not Used
- p) ANF-88-054(A), "PDC-3: Advanced Nuclear Fuels Corporation Power Distribution Control for Pressurized Water Reactors and Application of PDC-3 to H. B. Robinson Unit 2," Advanced Nuclear Fuels Corporation.
- q) ANF-88-133(A), and Supplement 1, "Qualification of Advanced Nuclear Fuels PWR Design Methodology for Rod Burnups of 62 GWd/MTU," Advanced Nuclear Fuels Corporation.
- r) ANF-89-151 (P) (A), and correspondence "ANF-RELAP Methodology for Pressurized Water Reactors: Analysis of Non-LOCA Chapter 15 Events," Advanced Nuclear Fuels Corporation.
- s) EMF-92-081 (P) (A), and Supplement 1, "Statistical Setpoint/Transient Methodology for Westinghouse Type Reactors," Siemens Power Corporation.

ATTACHMENT 7.1
Page 6 of 11
HBRSEP Unit No. 2, Cycle 18
CORE OPERATING LIMITS REPORT
Revision 2

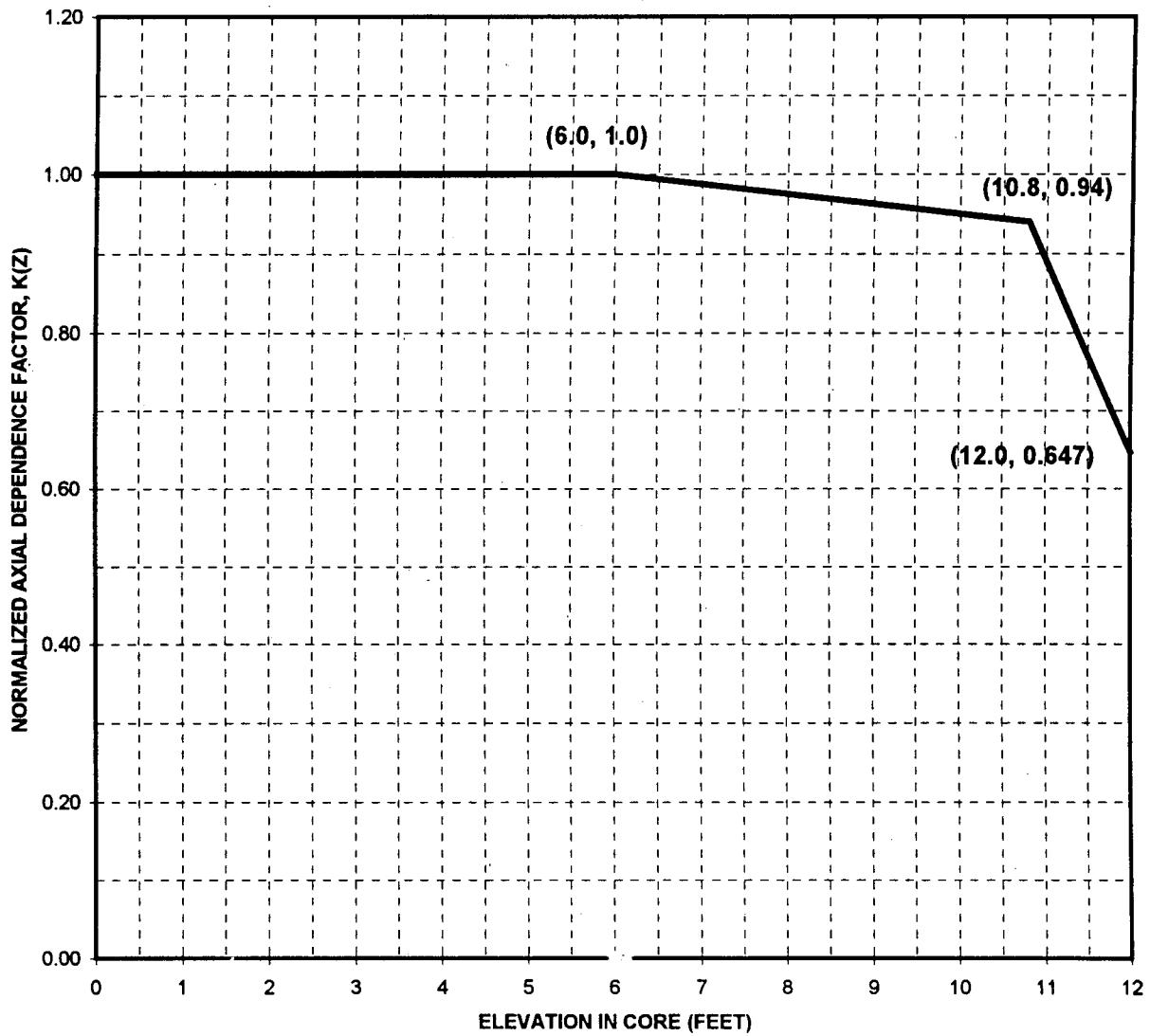
Figure 1.0, Control Group Insertion Limits for Three Loop Operation



- NOTE**
- The breakpoint between BOL and EOL RIL occurs at 50% of the cycle as defined by burnup
 - Control Bank A must be withdrawn from the core prior to power operation

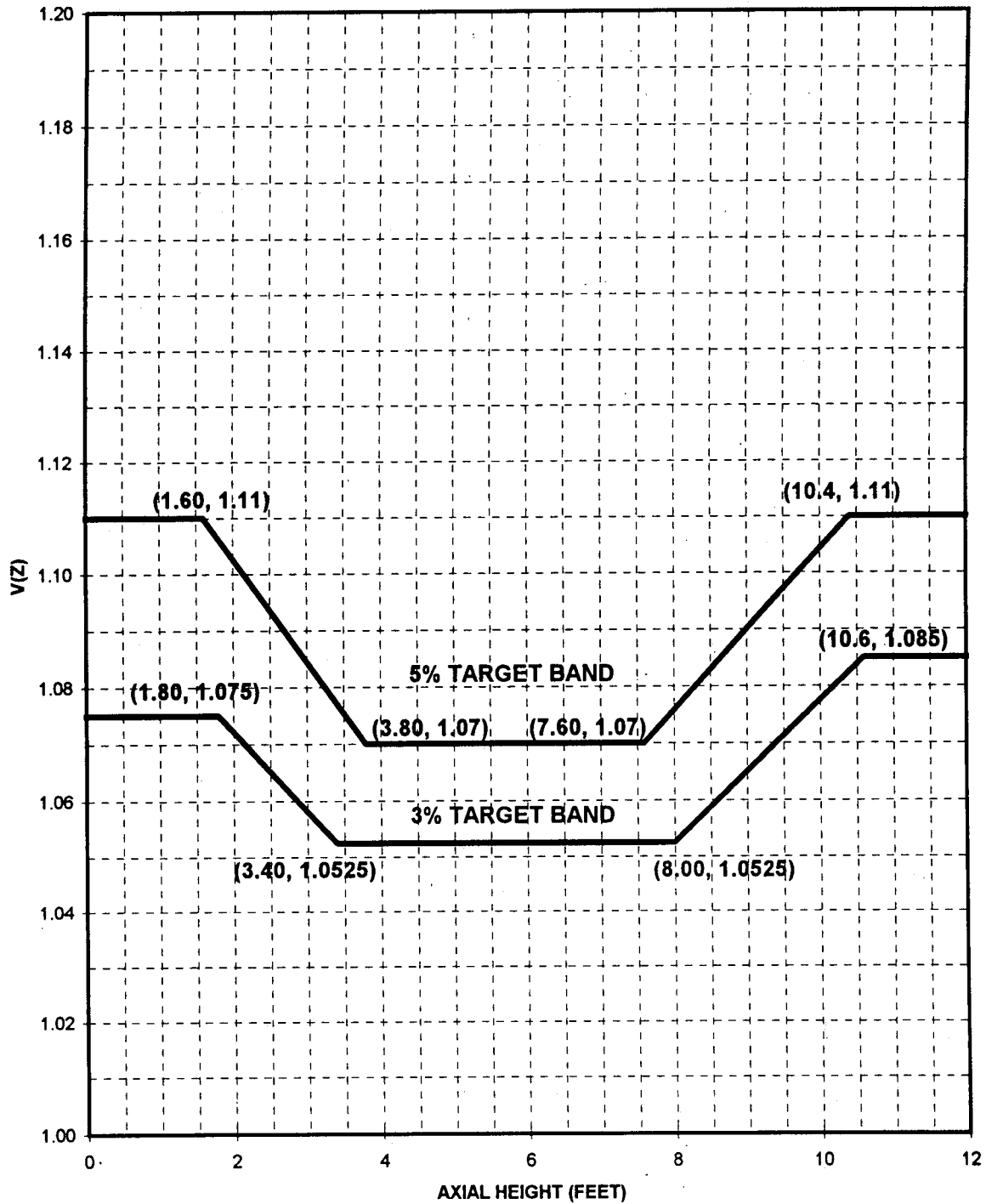
ATTACHMENT 7.1
Page 7 of 9
HBRSEP Unit No. 2, Cycle 18
CORE OPERATING LIMITS REPORT
Revision 2

Figure 2.0, Normalized Axial Dependence Factor $K(Z)$ for F_0 Versus Elevation



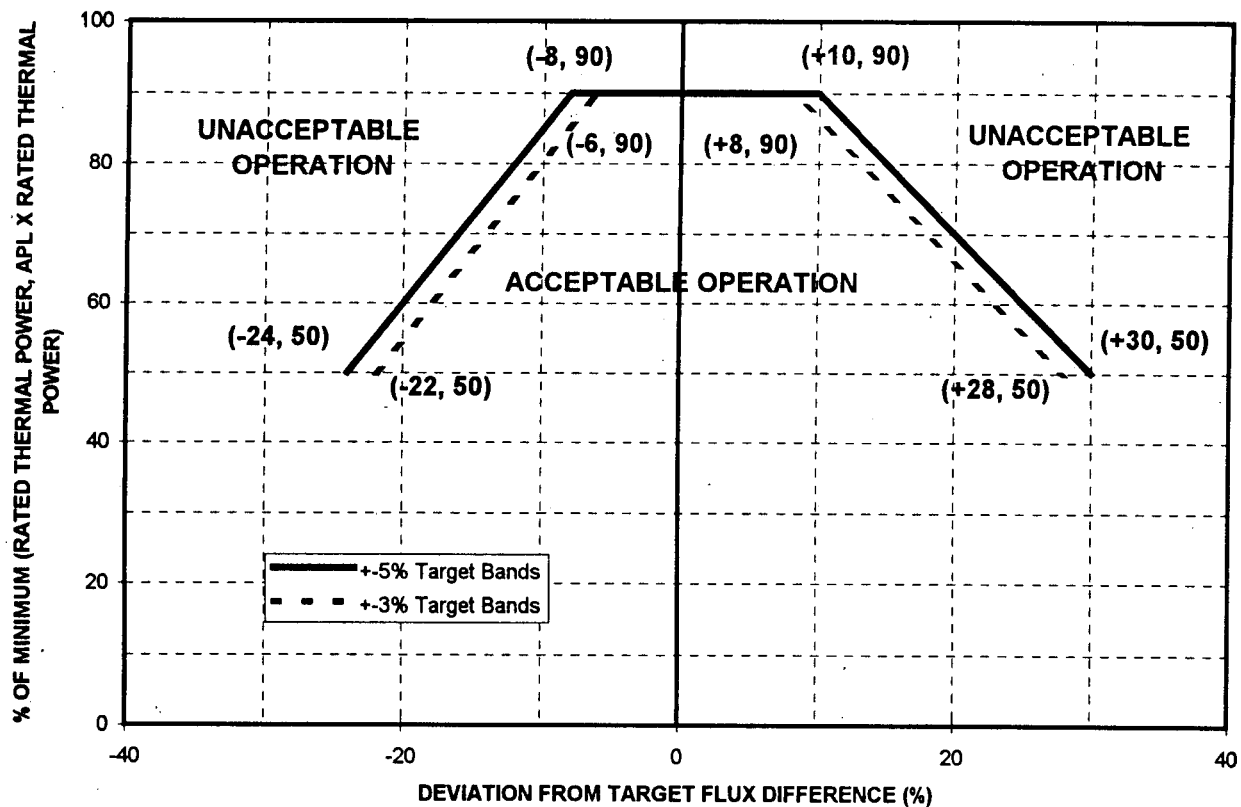
ATTACHMENT 7.1
Page 8 of 9
HBRSEP Unit No. 2, Cycle 18
CORE OPERATING LIMITS REPORT
Revision 2

Figure 3.0, $V(Z)$ as a Function of Core Height



ATTACHMENT 7.1
Page 9 of 9
HBRSEP Unit No. 2, Cycle 18
CORE OPERATING LIMITS REPORT
Revision 2

Figure 4.0, Allowable Deviation from Target Flux Difference



NOTE: For power levels above 90%, power operation is allowed within two target bands ($\pm 3\%$ and $\pm 5\%$).