



# Luminant

**Kenneth J. Peters**  
Senior Vice President  
& Chief Nuclear Officer  
Kenneth.Peters@Luminant.com

**Luminant Power**  
P O Box 1002  
6322 North FM 56  
Glen Rose, TX 76043

**T** 254 897 6565  
**C** 817 776 0037  
**F** 254 897 6652

CP-201600503  
TXX-16071

Ref. # 10CFR50.36(c)(5)

May 19, 2016

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

SUBJECT: COMANCHE PEAK NUCLEAR POWER PLANT (CPNPP)  
DOCKET NO. 50-445  
CORE OPERATING LIMITS REPORT

Dear Sir or Madam:

Enclosed is Revision 0 of the Core Operating Limits Report for Comanche Peak Nuclear Power Plant (CPNPP) Unit 1, Cycle 19. This report is prepared and submitted pursuant to Technical Specification 5.6.5.

This communication contains no new licensing basis commitments regarding CPNPP Unit 1.

Should you have any questions, please contact Mr. J. D. Seawright at (254) 897-0140.

Sincerely,

Luminant Generation Company LLC

Kenneth J. Peters

By:

Timothy A. Hope  
Manager, Regulatory Affairs

Enclosure

c - Marc L. Dapas, Region IV  
Margaret M. Watford, NRR  
Resident Inspectors, Comanche Peak

A001  
NRR

Enclosure to TXX-16071

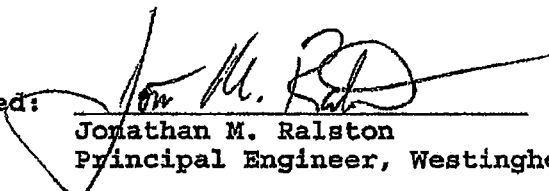
**Unit 1 Cycle 19**  
**Core Operating Limits Report**

CPNPP UNIT 1 CYCLE 19

CORE OPERATING LIMITS REPORT

April 2016

Prepared:

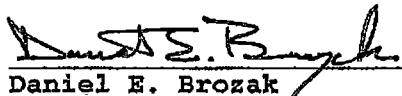
  
Jonathan M. Ralston

Principal Engineer, Westinghouse Electric Company, LLC

Date:

4-18-2016

Reviewed:


  
Daniel E. Brozak

Principal Engineer, Westinghouse Electric Company, LLC

Date:

4-18-2016

Reviewed:

  
Brian L. Guthrie

Principal Engineer, Westinghouse Electric Company, LLC

Date:

4-18-2016

Approved:

  
Kevin N. Roland, Manager

Westinghouse Integrated Site Engineering - TX/KS

Date:

4-18-2016

## DISCLAIMER

The information contained in this report was prepared for the specific requirement of Luminant Generation Company LLC and may not be appropriate for use in situations other than those for which it was specifically prepared. Luminant Generation Company LLC PROVIDES NO WARRANTY HEREUNDER, EXPRESS OR IMPLIED, OR STATUTORY, OF ANY KIND OR NATURE WHATSOEVER, REGARDING THIS REPORT OR ITS USE, INCLUDING BUT NOT LIMITED TO ANY WARRANTIES ON MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

By making this report available, Luminant Generation Company LLC does not authorize its use by others, and any such use is forbidden except with the prior written approval of Luminant Generation Company LLC. Any such written approval shall itself be deemed to incorporate the disclaimers of liability and disclaimers of warranties provided herein. In no event shall Luminant Generation Company LLC have any liability for any incidental or consequential damages of any type in connection with the use, authorized or unauthorized, of this report or of the information in it.

## TABLE OF CONTENTS

|                         |     |
|-------------------------|-----|
| DISCLAIMER .....        | ii  |
| TABLE OF CONTENTS ..... | iii |
| LIST OF TABLES .....    | iv  |
| LIST OF FIGURES .....   | v   |

| <u>SECTION</u>                                                                                 | <u>PAGE</u> |
|------------------------------------------------------------------------------------------------|-------------|
| 1.0 CORE OPERATING LIMITS REPORT .....                                                         | 1           |
| 2.0 OPERATING LIMITS .....                                                                     | 2           |
| 2.1 SAFETY LIMITS (SLs) .....                                                                  | 2           |
| 2.2 SHUTDOWN MARGIN (SDM) .....                                                                | 2           |
| 2.3 MODERATOR TEMPERATURE COEFFICIENT (MTC) .....                                              | 2           |
| 2.4 ROD GROUP ALIGNMENT LIMITS .....                                                           | 3           |
| 2.5 SHUTDOWN BANK INSERTION LIMITS .....                                                       | 3           |
| 2.6 CONTROL BANK INSERTION LIMITS .....                                                        | 4           |
| 2.7 PHYSICS TESTS EXCEPTIONS - MODE 2 .....                                                    | 4           |
| 2.8 HEAT FLUX HOT CHANNEL FACTOR ( $F_o(Z)$ ) .....                                            | 4           |
| 2.9 NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR ( $F_{\Delta H}^N$ ) .....                        | 6           |
| 2.10 AXIAL FLUX DIFFERENCE (AFD) .....                                                         | 6           |
| 2.11 REACTOR TRIP SYSTEM (RTS) INSTRUMENTATION .....                                           | 6           |
| 2.12 RCS PRESSURE, TEMPERATURE, AND FLOW DEPARTURE FROM<br>NUCLEATE BOILING (DNB) LIMITS ..... | 7           |
| 2.13 BORON CONCENTRATION .....                                                                 | 8           |
| 3.0 REFERENCES .....                                                                           | 8           |

COLR for CPNPP Unit 1 Cycle 19

LIST OF TABLES

| <u>TABLE</u>                                                  | <u>PAGE</u> |
|---------------------------------------------------------------|-------------|
| 1 $F_0(Z)$ MARGIN DECREASES IN EXCESS OF 2% PER 31 EFPD ..... | 9           |

## LIST OF FIGURES

| <u>FIGURE</u> |                                                                            | <u>PAGE</u> |
|---------------|----------------------------------------------------------------------------|-------------|
| 1             | REACTOR CORE SAFETY LIMITS .....                                           | 10          |
| 2             | ROD BANK INSERTION LIMITS VERSUS THERMAL POWER .....                       | 11          |
| 3             | K(Z) - NORMALIZED $F_0(Z)$ AS A FUNCTION OF<br>CORE HEIGHT .....           | 12          |
| 4             | W(Z) AS A FUNCTION OF CORE HEIGHT -<br>(150 MWD/MTU) .....                 | 13          |
| 5             | W(Z) AS A FUNCTION OF CORE HEIGHT -<br>(3,000 MWD/MTU) .....               | 14          |
| 6             | W(Z) AS A FUNCTION OF CORE HEIGHT -<br>(9,000 MWD/MTU) .....               | 15          |
| 7             | W(Z) AS A FUNCTION OF CORE HEIGHT -<br>(16,000 MWD/MTU) .....              | 16          |
| 8             | W(Z) AS A FUNCTION OF CORE HEIGHT -<br>(18,000 MWD/MTU) .....              | 17          |
| 9             | AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION<br>OF RATED THERMAL POWER ..... | 18          |

## COLR for CPNPP Unit 1 Cycle 19

### 1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for CPNPP UNIT 1 CYCLE 19 has been prepared in accordance with the requirements of Technical Specification 5.6.5.

The Technical Specifications affected by this report are listed below:

|           |                                                                                     |
|-----------|-------------------------------------------------------------------------------------|
| SLs 2.1   | SAFETY LIMITS (SLs)                                                                 |
| LCO 3.1.1 | SHUTDOWN MARGIN (SDM)                                                               |
| LCO 3.1.3 | MODERATOR TEMPERATURE COEFFICIENT (MTC)                                             |
| LCO 3.1.4 | ROD GROUP ALIGNMENT LIMITS                                                          |
| LCO 3.1.5 | SHUTDOWN BANK INSERTION LIMITS                                                      |
| LCO 3.1.6 | CONTROL BANK INSERTION LIMITS                                                       |
| LCO 3.1.8 | PHYSICS TESTS EXCEPTIONS - MODE 2                                                   |
| LCO 3.2.1 | HEAT FLUX HOT CHANNEL FACTOR ( $F_q(Z)$ )                                           |
| LCO 3.2.2 | NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR ( $F_{\Delta H}^N$ )                       |
| LCO 3.2.3 | AXIAL FLUX DIFFERENCE (AFD)                                                         |
| LCO 3.3.1 | REACTOR TRIP SYSTEM (RTS) INSTRUMENTATION                                           |
| LCO 3.4.1 | RCS PRESSURE, TEMPERATURE, AND FLOW DEPARTURE FROM<br>NUCLEATE BOILING (DNB) LIMITS |
| LCO 3.9.1 | BORON CONCENTRATION                                                                 |



## 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 Technical Specification 5.6.5b, Items 1 through 4 and 7 through 15. These limits have been determined such that all applicable limits of the safety analysis are met.

### 2.1 SAFETY LIMITS (SLs) (SLs 2.1)

2.1.1 In MODES 1 and 2, the combination of thermal power, reactor coolant system highest loop average temperature, and pressurizer pressure shall not exceed the safety limits specified in Figure 1.

### 2.2 SHUTDOWN MARGIN (SDM) (LCO 3.1.1)

2.2.1 The SDM shall be greater than or equal to 1.3%  $\Delta k/k$  in MODE 2 with  $K_{eff} < 1.0$ , and in MODES 3, 4, and 5.

### 2.3 MODERATOR TEMPERATURE COEFFICIENT (MTC) (LCO 3.1.3)

2.3.1 The MTC upper and lower limits, respectively, are:

The BOL/ARO/HZP-MTC shall be less positive than +5 pcm/°F.

The EOL/ARO/RTP-MTC shall be less negative than -40 pcm/°F.

2.3.2 SR 3.1.3.2

The MTC surveillance limit is:

The 300 ppm/ARO/RTP-MTC shall be less negative than or equal to -31 pcm/°F.

The 60 ppm/ARO/RTP-MTC shall be less negative than or equal to -38 pcm/°F.

where: BOL stands for Beginning of Cycle Life

ARO stands for All Rods Out

HZP stands for Hot Zero THERMAL POWER

EOL stands for End of Cycle Life

RTP stands for RATED THERMAL POWER

2.4 ROD GROUP ALIGNMENT LIMITS (LCO 3.1.4)

2.4.1 The SDM shall be greater than or equal to 1.3%  $\Delta k/k$  in MODES 1 and 2.

2.5 SHUTDOWN BANK INSERTION LIMITS (LCO 3.1.5)

2.5.1 The shutdown rods shall be fully withdrawn. Fully withdrawn shall be the condition where shutdown rods are at a position within the interval of 218 and 231 steps withdrawn, inclusive.

2.6 CONTROL BANK INSERTION LIMITS (LCO 3.1.6)

2.6.1 The control banks shall be limited in physical insertion as shown in Figure 2.

2.6.2 The control banks shall always be withdrawn and inserted in the prescribed sequence. For withdrawal, the sequence is control bank A, control bank B, control bank C, and control bank D. The insertion sequence is the reverse of the withdrawal sequence.

2.6.3 A 115 step Tip-to-Tip relationship between each sequential control bank shall be maintained.

2.7 PHYSICS TESTS EXCEPTIONS - MODE 2 (LCO 3.1.8)

2.7.1 The SDM shall be greater than or equal to 1.3%  $\Delta k/k$  in MODE 2 during PHYSICS TESTS.

2.8 HEAT FLUX HOT CHANNEL FACTOR ( $F_Q(Z)$ ) (LCO 3.2.1)

$$2.8.1 \quad F_Q(Z) \leq \frac{F_Q^{RTP}}{P} [K(Z)] \text{ for } P > 0.5$$

$$F_Q(Z) \leq \frac{F_Q^{RTP}}{0.5} [K(Z)] \text{ for } P \leq 0.5$$

$$\text{where: } P = \frac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$$

2.8.2  $F_0^{RTP} = 2.50$

2.8.3  $K(Z)$  is provided in Figure 3.

2.8.4 Elevation and burnup dependent  $W(Z)$  values are provided in Figures 4, 5, 6, 7 and 8. For  $W(Z)$  data at a desired burnup not listed in the figures, but less than the maximum listed burnup, values at 3 or more burnup steps should be used to interpolate the  $W(Z)$  data to the desired burnup with a polynomial type fit that uses the nearest three burnup steps. For  $W(Z)$  data at a desired burnup outside of the listed burnup steps, a linear extrapolation of the  $W(Z)$  data for the nearest two burnup steps can be used.

2.8.5 SR 3.2.1.2

If the two most recent  $F_0(Z)$  evaluations show an increase in the expression

$$\text{maximum over } Z \quad [ F_0^c(Z) / K(Z) ],$$

the burnup dependent values in Table 1 shall be used instead of a constant 2% to increase  $F_0^w(Z)$  per Surveillance Requirement 3.2.1.2, Note a. A constant factor of 2% shall be used for all cycle burnups that are outside the range of Table 1.

2.9 NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR ( $F_{\Delta H}^N$ ) (LCO 3.2.2)

$$2.9.1 \quad F_{\Delta H}^N \leq F_{\Delta H}^{RTP} [1 + PF_{\Delta H} (1-P)]$$

$$\text{where: } P = \frac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$$

$$2.9.2 \quad F_{\Delta H}^{RTP} = 1.60 \text{ for all Fuel Assembly Regions}$$

$$2.9.3 \quad PF_{\Delta H} = 0.3$$

2.10 AXIAL FLUX DIFFERENCE (AFD) (LCO 3.2.3)

2.10.1 The AFD Acceptable Operation Limits are provided in Figure 9.

2.11 REACTOR TRIP SYSTEM (RTS) INSTRUMENTATION (LCO 3.3.1)

2.11.1 The numerical values pertaining to the Overtemperature N-16 reactor trip setpoint are listed below;

$$K_1 = 1.15$$

$$K_2 = 0.0139 / ^\circ\text{F}$$

$$K_3 = 0.00071 / \text{psig}$$

$$T_c^\circ = \text{indicated loop specific } T_c \text{ at Rated Thermal Power, } ^\circ\text{F}$$

$$P^i \geq 2235 \text{ psig}$$

$$\tau_1 \geq 10 \text{ sec}$$

$$\tau_2 \leq 3 \text{ sec}$$

$$f_1(\Delta q) = -2.78 \cdot \{(q_t - q_b) + 18\% \} \text{ when } (q_t - q_b) \leq -18\% \text{ RTP}$$

$$= 0\% \text{ when } -18\% \text{ RTP} < (q_t - q_b) < +10.0\% \text{ RTP}$$

$$= 2.34 \cdot \{(q_t - q_b) - 10.0\% \} \text{ when } (q_t - q_b) \geq +10.0\% \text{ RTP}$$

2.12 RCS PRESSURE, TEMPERATURE, AND FLOW DEPARTURE FROM  
NUCLEATE BOILING (DNB) LIMITS (LCO 3.4.1)

2.12.1 RCS DNB parameters for pressurizer pressure, RCS average temperature, and RCS total flow rate shall be within the surveillance limits specified below:

2.12.2 SR 3.4.1.1

Pressurizer pressure  $\geq$  2220 psig (4 channels)  
 $\geq$  2222 psig (3 channels)

The pressurizer pressure limits correspond to the analytical limit of 2205 psig used in the safety analysis with allowance for measurement uncertainty. These uncertainties are based on the use of control board indications and the number of available channels.

2.12.3 SR 3.4.1.2

RCS average temperature  $\leq$  588 °F (4 channels)  
 $\leq$  588 °F (3 channels)

The RCS average temperature limits correspond to the analytical limit of 591.9 °F which is bounded by that used in the safety analysis with allowance for measurement uncertainty. These uncertainties are based on the use of control board indications and the number of available channels.

2.12.4 SR 3.4.1.3

The RCS total flow rate shall be  $\geq 403,700$  gpm.

2.12.5 SR 3.4.1.4

The RCS total flow rate based on precision heat balance shall be  $\geq 403,700$  gpm.

The required RCS flow, based on an elbow tap differential pressure instrument measurement prior to MODE 1 after the refueling outage, shall be greater than 327,000 gpm.

2.13 BORON CONCENTRATION (LCO 3.9.1)

2.13.1 The required refueling boron concentration is  $\geq 1779$  ppm.

3.0 REFERENCES

Technical Specification 5.6.5.

COLR for CPNPP Unit 1 Cycle 19

Table 1  
 $F_0(Z)$  MARGIN DECREASES IN EXCESS OF 2% PER 31 EFPD

| Cycle<br>Burnup<br>(MWD/MTU) | Maximum Decrease<br>In $F_0(Z)$ MARGIN<br>(Percent) |
|------------------------------|-----------------------------------------------------|
| 795                          | 2.00                                                |
| 1010                         | 2.15                                                |
| 1225                         | 2.18                                                |
| 1440                         | 2.02                                                |
| 1655                         | 2.00                                                |
| 3160                         | 2.00                                                |
| 3375                         | 2.01                                                |
| 3589                         | 2.27                                                |
| 3804                         | 2.18                                                |
| 4019                         | 2.06                                                |
| 4234                         | 2.00                                                |

Note: All cycle burnups outside the range of the table shall use a constant 2% decrease in  $F_0(Z)$  margin for compliance with Surveillance Requirement 3.2.1.2, Note a. Linear interpolation is acceptable to determine the  $F_0(Z)$  margin decrease for cycle burnups which fall between the specified burnups.



Figure 1  
Reactor Core Safety Limits

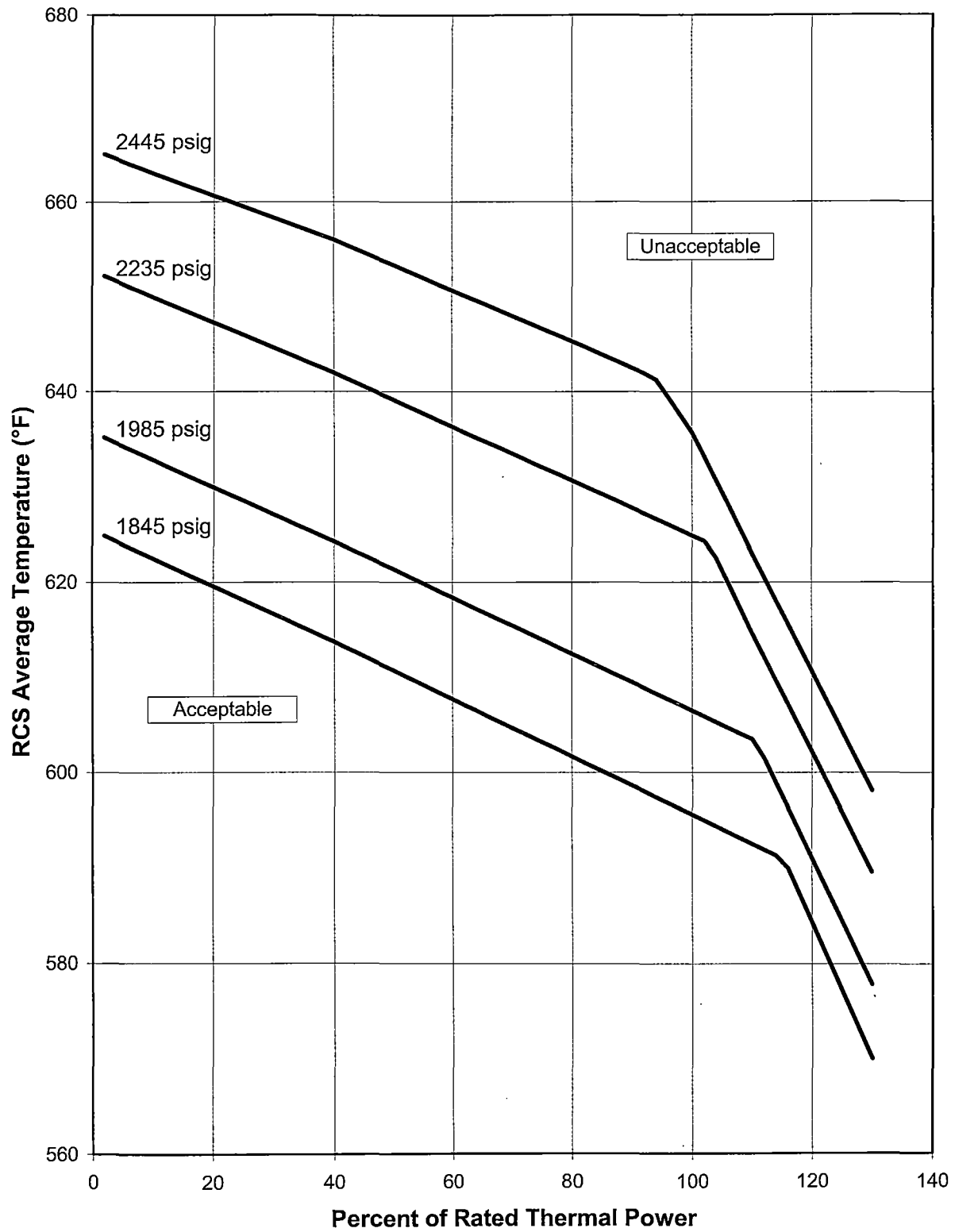
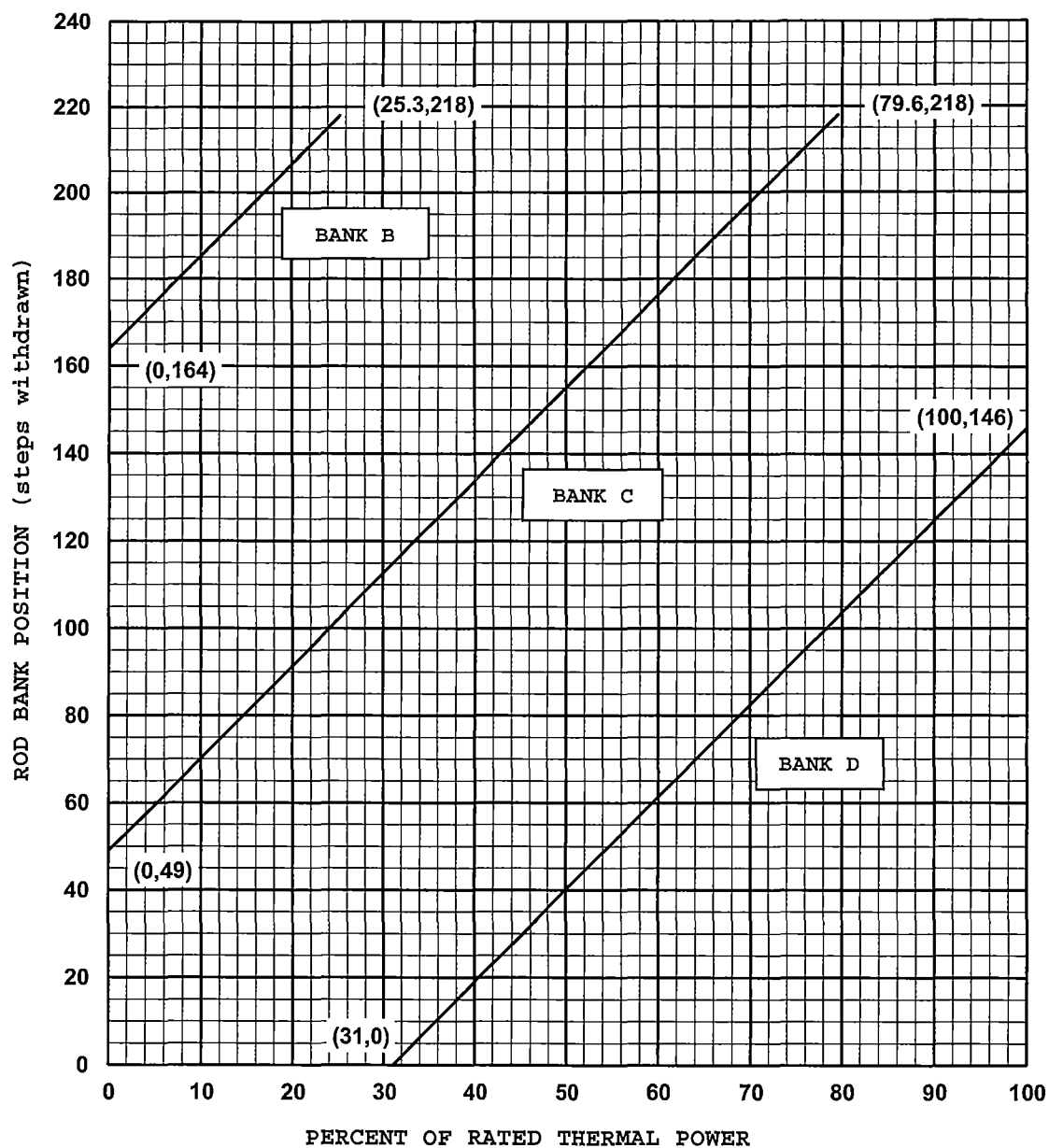


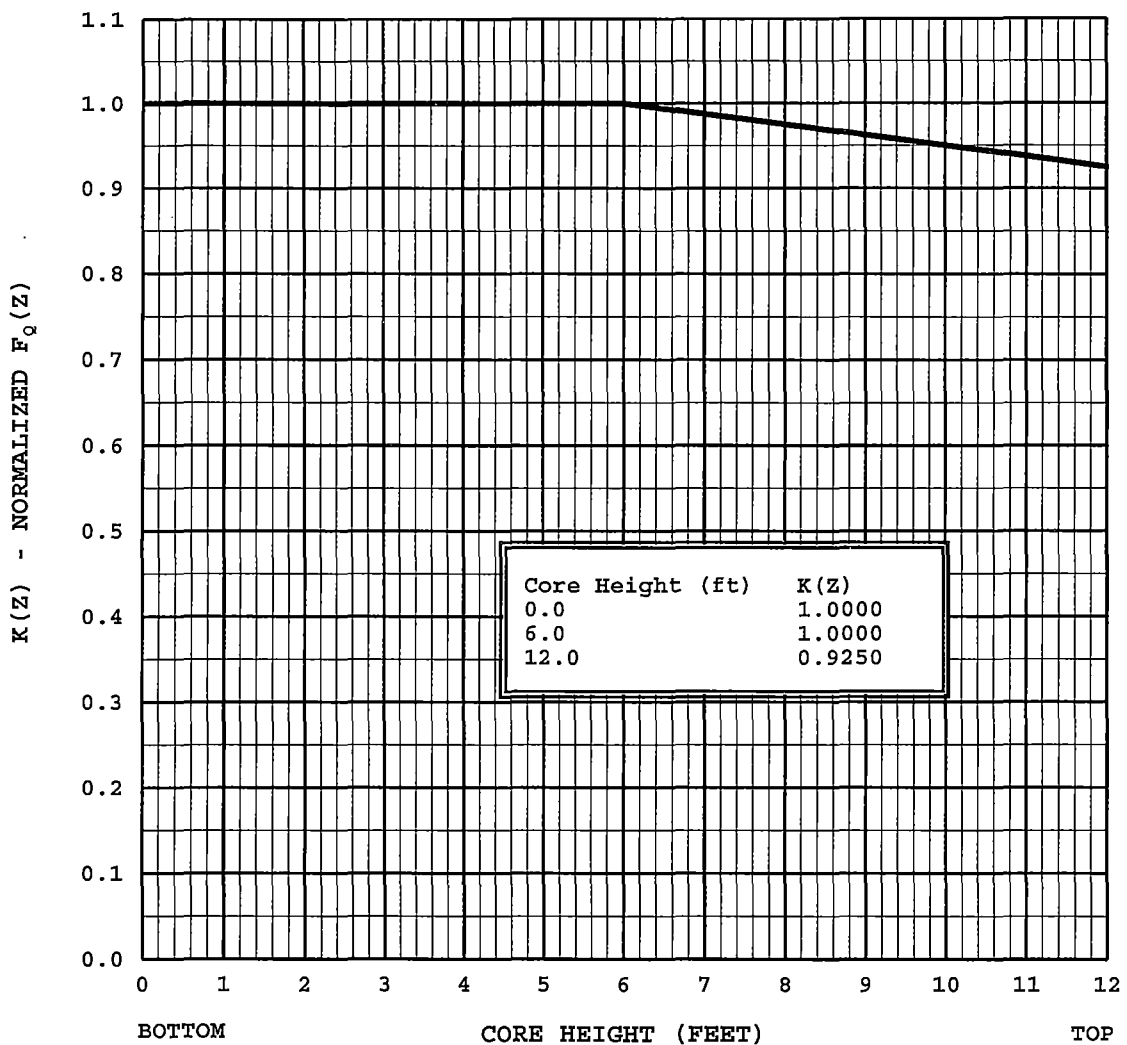
FIGURE 2

## ROD BANK INSERTION LIMITS VERSUS THERMAL POWER



- NOTES:
1. Fully withdrawn shall be the condition where control rods are at a position within the interval of 218 and 231 steps withdrawn, inclusive.
  2. Control Bank A shall be fully withdrawn.

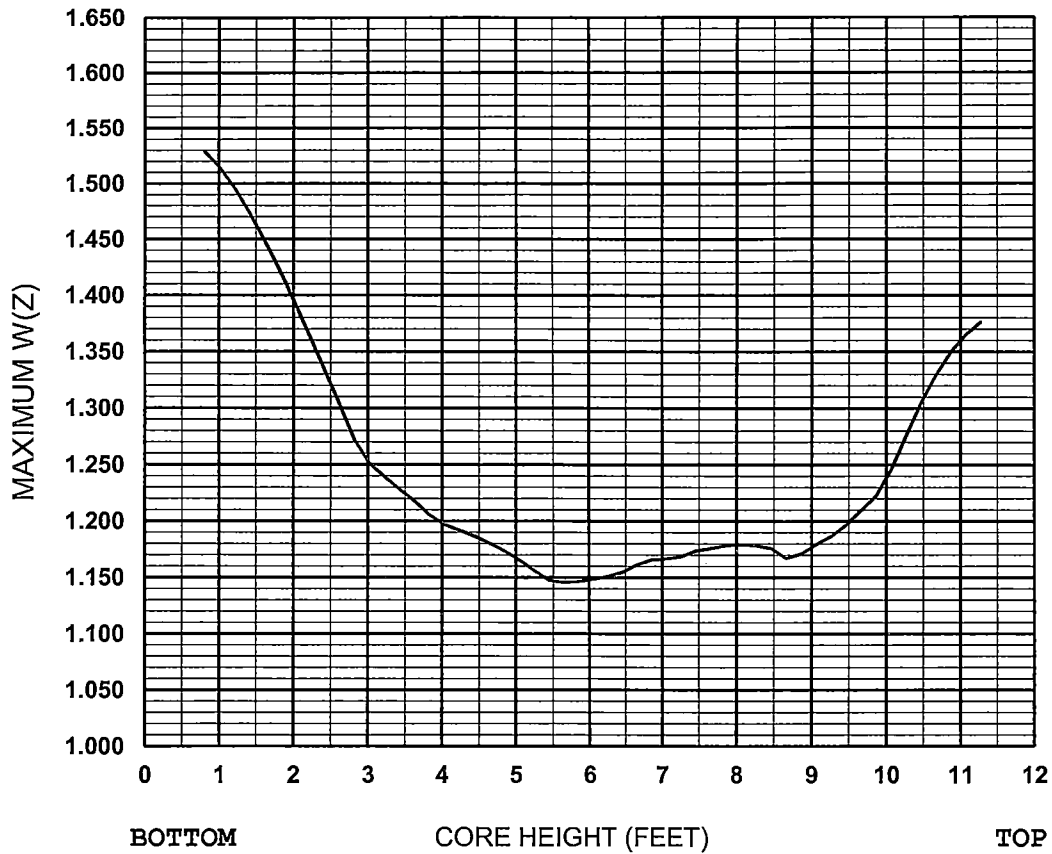
FIGURE 3

 $K(Z)$  - NORMALIZED  $F_Q(Z)$  AS A FUNCTION OF CORE HEIGHT

COLR for CPNPP Unit 1 Cycle 19

FIGURE 4

W(Z) AS A FUNCTION OF CORE HEIGHT  
(150 MWD/MTU)



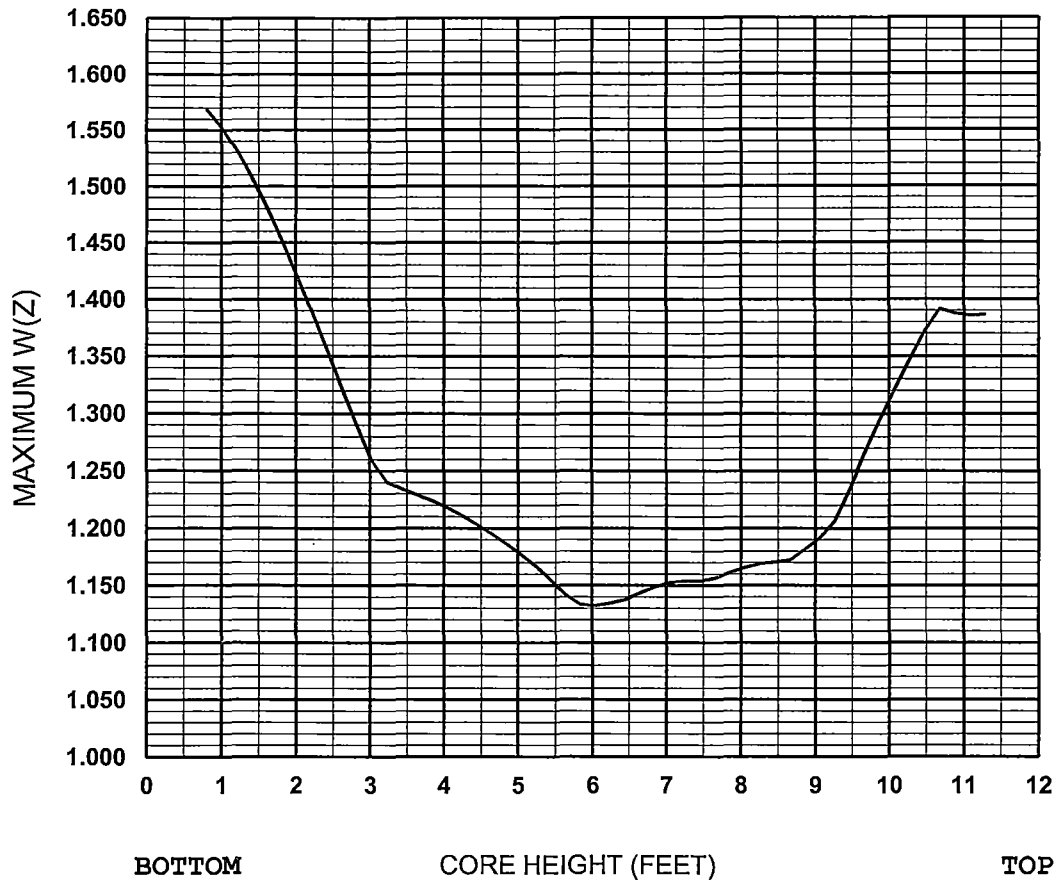
| Axial Node | W(Z)   | Axial Node | W(Z)   | Axial Node | W(Z)   | Axial Node | W(Z)   |
|------------|--------|------------|--------|------------|--------|------------|--------|
| 58 - 61    | ---    | 44         | 1.1674 | 30         | 1.1467 | 16         | 1.2512 |
| 57         | 1.3763 | 43         | 1.1760 | 29         | 1.1459 | 15         | 1.2720 |
| 56         | 1.3656 | 42         | 1.1786 | 28         | 1.1478 | 14         | 1.3039 |
| 55         | 1.3503 | 41         | 1.1795 | 27         | 1.1566 | 13         | 1.3342 |
| 54         | 1.3302 | 40         | 1.1787 | 26         | 1.1660 | 12         | 1.3644 |
| 53         | 1.3055 | 39         | 1.1761 | 25         | 1.1737 | 11         | 1.3941 |
| 52         | 1.2767 | 38         | 1.1737 | 24         | 1.1808 | 10         | 1.4225 |
| 51         | 1.2464 | 37         | 1.1687 | 23         | 1.1869 | 9          | 1.4494 |
| 50         | 1.2229 | 36         | 1.1669 | 22         | 1.1921 | 8          | 1.4741 |
| 49         | 1.2101 | 35         | 1.1658 | 21         | 1.1973 | 7          | 1.4963 |
| 48         | 1.1969 | 34         | 1.1612 | 20         | 1.2059 | 6          | 1.5151 |
| 47         | 1.1869 | 33         | 1.1547 | 19         | 1.2180 | 5          | 1.5291 |
| 46         | 1.1795 | 32         | 1.1508 | 18         | 1.2285 | 1 - 4      | ---    |
| 45         | 1.1712 | 31         | 1.1486 | 17         | 1.2395 |            |        |

$$\text{Core Height (ft)} = (\text{Node} - 1) * 0.2013217$$

COLR for CPNPP Unit 1 Cycle 19

FIGURE 5

W(Z) AS A FUNCTION OF CORE HEIGHT  
(3,000 MWD/MTU)



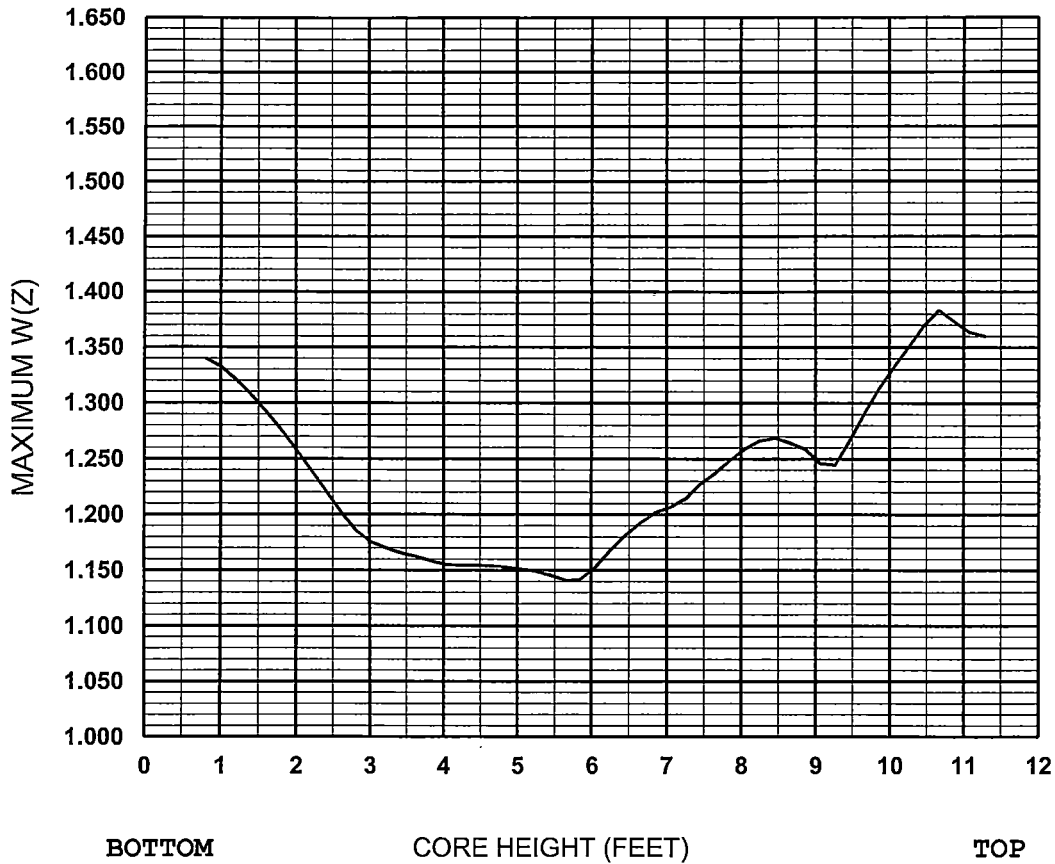
| Axial Node | W(Z)   | Axial Node | W(Z)   | Axial Node | W(Z)   | Axial Node | W(Z)   |
|------------|--------|------------|--------|------------|--------|------------|--------|
| 58 - 61    | ---    | 44         | 1.1723 | 30         | 1.1334 | 16         | 1.2598 |
| 57         | 1.3868 | 43         | 1.1706 | 29         | 1.1416 | 15         | 1.2906 |
| 56         | 1.3858 | 42         | 1.1692 | 28         | 1.1548 | 14         | 1.3234 |
| 55         | 1.3878 | 41         | 1.1659 | 27         | 1.1669 | 13         | 1.3563 |
| 54         | 1.3914 | 40         | 1.1613 | 26         | 1.1776 | 12         | 1.3890 |
| 53         | 1.3718 | 39         | 1.1567 | 25         | 1.1874 | 11         | 1.4212 |
| 52         | 1.3465 | 38         | 1.1541 | 24         | 1.1961 | 10         | 1.4521 |
| 51         | 1.3203 | 37         | 1.1540 | 23         | 1.2039 | 9          | 1.4812 |
| 50         | 1.2934 | 36         | 1.1527 | 22         | 1.2116 | 8          | 1.5080 |
| 49         | 1.2648 | 35         | 1.1490 | 21         | 1.2186 | 7          | 1.5320 |
| 48         | 1.2336 | 34         | 1.1436 | 20         | 1.2244 | 6          | 1.5527 |
| 47         | 1.2066 | 33         | 1.1376 | 19         | 1.2295 | 5          | 1.5686 |
| 46         | 1.1917 | 32         | 1.1347 | 18         | 1.2345 | 1 - 4      | ---    |
| 45         | 1.1819 | 31         | 1.1324 | 17         | 1.2404 |            |        |

$$\text{Core Height (ft)} = (\text{Node} - 1) * 0.2013217$$

COLR for CPNPP Unit 1 Cycle 19

FIGURE 6

W(Z) AS A FUNCTION OF CORE HEIGHT  
(9,000 MWD/MTU)



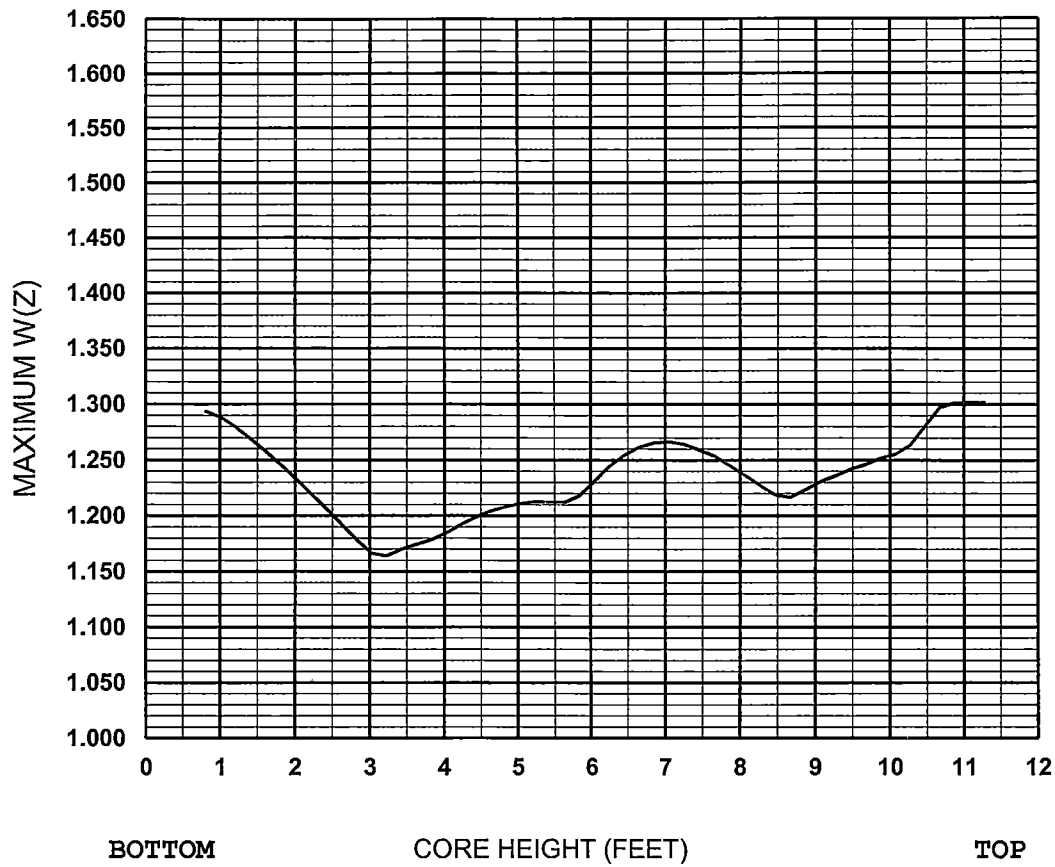
| Axial Node | W(Z)   | Axial Node | W(Z)   | Axial Node | W(Z)   | Axial Node | W(Z)   |
|------------|--------|------------|--------|------------|--------|------------|--------|
| 58 - 61    | ---    | 44         | 1.2645 | 30         | 1.1417 | 16         | 1.1755 |
| 57         | 1.3601 | 43         | 1.2689 | 29         | 1.1410 | 15         | 1.1854 |
| 56         | 1.3638 | 42         | 1.2663 | 28         | 1.1458 | 14         | 1.2012 |
| 55         | 1.3731 | 41         | 1.2592 | 27         | 1.1494 | 13         | 1.2200 |
| 54         | 1.3835 | 40         | 1.2490 | 26         | 1.1513 | 12         | 1.2388 |
| 53         | 1.3701 | 39         | 1.2375 | 25         | 1.1528 | 11         | 1.2570 |
| 52         | 1.3513 | 38         | 1.2275 | 24         | 1.1541 | 10         | 1.2747 |
| 51         | 1.3334 | 37         | 1.2144 | 23         | 1.1547 | 9          | 1.2914 |
| 50         | 1.3142 | 36         | 1.2069 | 22         | 1.1543 | 8          | 1.3067 |
| 49         | 1.2918 | 35         | 1.2019 | 21         | 1.1553 | 7          | 1.3205 |
| 48         | 1.2668 | 34         | 1.1926 | 20         | 1.1588 | 6          | 1.3321 |
| 47         | 1.2448 | 33         | 1.1812 | 19         | 1.1626 | 5          | 1.3398 |
| 46         | 1.2462 | 32         | 1.1676 | 18         | 1.1656 | 1 - 4      | ---    |
| 45         | 1.2588 | 31         | 1.1522 | 17         | 1.1699 |            |        |

$$\text{Core Height (ft)} = (\text{Node} - 1) * 0.2013217$$

COLR for CPNPP Unit 1 Cycle 19

FIGURE 7

W(Z) AS A FUNCTION OF CORE HEIGHT  
(16,000 MWD/MTU)

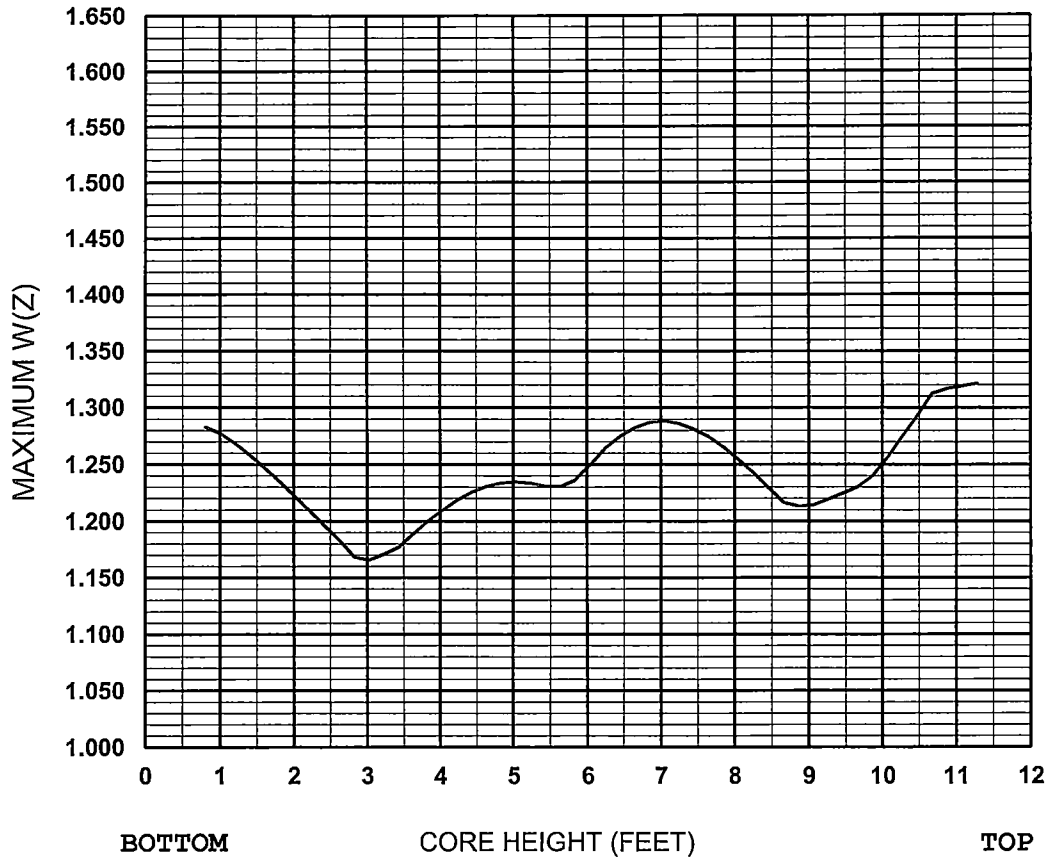


| Axial Node | W(Z)   | Axial Node | W(Z)   | Axial Node | W(Z)   | Axial Node | W(Z)   |
|------------|--------|------------|--------|------------|--------|------------|--------|
| 58 - 61    | ---    | 44         | 1.2166 | 30         | 1.2181 | 16         | 1.1666 |
| 57         | 1.3016 | 43         | 1.2191 | 29         | 1.2123 | 15         | 1.1787 |
| 56         | 1.3021 | 42         | 1.2280 | 28         | 1.2123 | 14         | 1.1928 |
| 55         | 1.3014 | 41         | 1.2370 | 27         | 1.2129 | 13         | 1.2064 |
| 54         | 1.2975 | 40         | 1.2457 | 26         | 1.2112 | 12         | 1.2198 |
| 53         | 1.2804 | 39         | 1.2540 | 25         | 1.2082 | 11         | 1.2329 |
| 52         | 1.2635 | 38         | 1.2594 | 24         | 1.2045 | 10         | 1.2457 |
| 51         | 1.2555 | 37         | 1.2644 | 23         | 1.1993 | 9          | 1.2578 |
| 50         | 1.2516 | 36         | 1.2668 | 22         | 1.1924 | 8          | 1.2691 |
| 49         | 1.2463 | 35         | 1.2656 | 21         | 1.1849 | 7          | 1.2796 |
| 48         | 1.2419 | 34         | 1.2614 | 20         | 1.1787 | 6          | 1.2883 |
| 47         | 1.2359 | 33         | 1.2542 | 19         | 1.1744 | 5          | 1.2936 |
| 46         | 1.2307 | 32         | 1.2444 | 18         | 1.1701 | 1 - 4      | ---    |
| 45         | 1.2234 | 31         | 1.2309 | 17         | 1.1639 |            |        |

$$\text{Core Height (ft)} = (\text{Node} - 1) * 0.2013217$$

FIGURE 8

W(Z) AS A FUNCTION OF CORE HEIGHT  
(18,000 MWD/MTU)



| Axial Node | W(Z)   | Axial Node | W(Z)   | Axial Node | W(Z)   | Axial Node | W(Z)   |
|------------|--------|------------|--------|------------|--------|------------|--------|
| 58 - 61    | ---    | 44         | 1.2165 | 30         | 1.2363 | 16         | 1.1656 |
| 57         | 1.3214 | 43         | 1.2292 | 29         | 1.2306 | 15         | 1.1686 |
| 56         | 1.3191 | 42         | 1.2426 | 28         | 1.2307 | 14         | 1.1837 |
| 55         | 1.3168 | 41         | 1.2542 | 27         | 1.2335 | 13         | 1.1966 |
| 54         | 1.3126 | 40         | 1.2650 | 26         | 1.2350 | 12         | 1.2094 |
| 53         | 1.2928 | 39         | 1.2746 | 25         | 1.2339 | 11         | 1.2222 |
| 52         | 1.2745 | 38         | 1.2810 | 24         | 1.2307 | 10         | 1.2346 |
| 51         | 1.2560 | 37         | 1.2862 | 23         | 1.2255 | 9          | 1.2465 |
| 50         | 1.2399 | 36         | 1.2886 | 22         | 1.2184 | 8          | 1.2579 |
| 49         | 1.2304 | 35         | 1.2872 | 21         | 1.2097 | 7          | 1.2684 |
| 48         | 1.2246 | 34         | 1.2826 | 20         | 1.1999 | 6          | 1.2774 |
| 47         | 1.2196 | 33         | 1.2748 | 19         | 1.1886 | 5          | 1.2829 |
| 46         | 1.2145 | 32         | 1.2642 | 18         | 1.1767 | 1 - 4      | ---    |
| 45         | 1.2132 | 31         | 1.2496 | 17         | 1.1709 |            |        |

$$\text{Core Height (ft)} = (\text{Node} - 1) * 0.2013217$$



FIGURE 9

AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF  
RATED THERMAL POWER

