11/2/95

# CORE OPERATING LIMITS REPORT

## PALO VERDE NUCLEAR GENERATING STATION (PVNGS)

## UNIT 3 CYCLE 6

**Revision 0**

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## INDEX

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## REVISION HISTORY

| Revision | Date | Pages |
|---|---|---|
| 0 | 11/02/95 | First issue U3C6<br>(24 Total Pages) |

# CORE OPERATING LIMITS REPORT

## PALO VERDE NUCLEAR GENERATING STATION (PVNGS)
## UNIT 3 CYCLE 6

This Core Operating Limits Report for PVNGS Unit 3 Cycle 6 has been prepared in accordance with the requirements of Technical Specification 6.9.1. The core operating limits have been developed using the NRC approved methodologies specified in References 1 through 12.

### AFFECTED PVNGS TECHNICAL SPECIFICATIONS

1) 3.1.1.2 Shutdown Margin $K_{N-1}$ - Any CEA Withdrawn
2) 3.1.1.3 Moderator Temperature Coefficient
3) 3.1.2.7 Boron Dilution Alarms
4) 3.1.3.1 Movable Control Assemblies - CEA Position
5) 3.1.3.6 Regulating CEA Insertion Limits
6) 3.1.3.7 Part Length CEA Insertion Limits
7) 3.2.1 Linear Heat Rate
8) 3.2.3 Azimuthal Power Tilt - $T_q$
9) 3.2.4 DNBR Margin
10) 3.2.7 Axial Shape Index

### CORE OPERATING LIMITS

The cycle-specific operating limits for the specifications listed are presented below.

#### 3.1.1.2 - Shutdown Margin $K_{N-1}$ - Any CEA Withdrawn

The Shutdown Margin shall be greater than or equal to that shown in Figure 1.

#### 3.1.1.3 - Moderator Temperature Coefficient

The moderator temperature coefficient (MTC) shall be within the area of Acceptable Operation shown in Figure 2.

CORE OPERATING LIMITS - CONTINUED

3.1.2.7 - Boron Dilution Alarms

With one or both start-up channel high neutron flux alarms inoperable, the RCS boron concentration shall be determined at the applicable monitoring frequency specified in Tables 1 through 5.

3.1.3.1 - Movable Control Assemblies - CEA Position

With one or more full-length or part-length CEAs misaligned from any other CEAs in its group by more than 6.6 inches, the minimum required MODES 1 and 2 core power reduction is specified in Figure 3.

3.1.3.6 - Regulating CEA Insertion Limits

One or more CEAC's OPERABLE: With COLSS IN SERVICE, regulation CEA groups shall be limited to the withdrawal sequence and to the insertion limits shown in Figure 4; with COLSS OUT OF SERVICE, regulation CEA groups shall be limited to the withdrawal sequence and to the insertion limits shown in Figure 5.

3.1.3.7 - Part Length CEA Insertion Limits

One or more CEAC's OPERABLE: The part length CEA groups shall be limited to the insertion limits shown in Figure 6.

3.2.1 - Linear Heat Rate

The linear heat rate limit of 13.5 kW/ft shall be maintained.

3.2.3 - Azimuthal Power Tilt - $T_q$

The AZIMUTHAL POWER TILT ($T_q$) shall be less than or equal to the limit in Figure 7 with COLSS IN SERVICE.

CORE OPERATING LIMITS - CONTINUED

3.2.4 - DNBR Margin

COLSS IN SERVICE and Both CEAC's INOPERABLE - Maintaining COLSS calculated core power less than or equal to COLSS calculated core power operation limit based on DNBR decreased by the allowance shown in Figure 8.

COLSS OUT OF SERVICE and Either One or Both CEAC's are OPERABLE - Operating within the region of acceptable operation of Figure 9 using any operable CPC channel.

COLSS OUT OF SERVICE and CEAC's INOPERABLE - Operating within the region of acceptable operation of Figure 10 using any operable CPC channel.

3.2.7 - Axial Shape Index

The core average AXIAL SHAPE INDEX (ASI) shall be maintained within the following limits:

COLSS OPERABLE
$-0.28 \leq ASI \leq 0.26$

COLSS OUT OF SERVICE (CPC)
$-0.20 \leq ASI \leq 0.20$

## REFERENCES

See Technical Specification Section 6.9.1.10 for References

LIST OF FIGURES

FIGURE 1

SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE

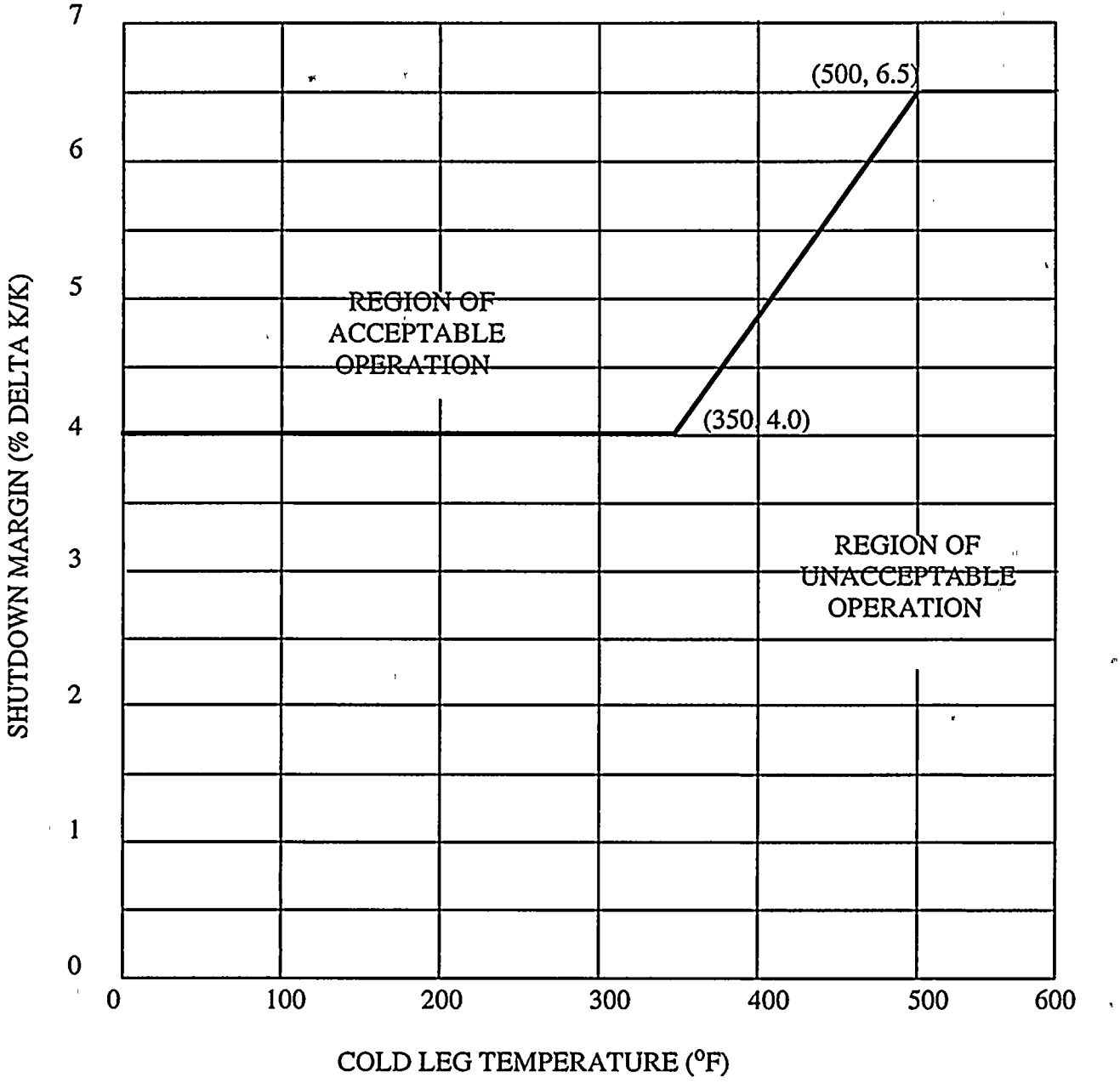


FIGURE 2 - MTC ACCEPTABLE OPERATION, MODES 1 AND 2

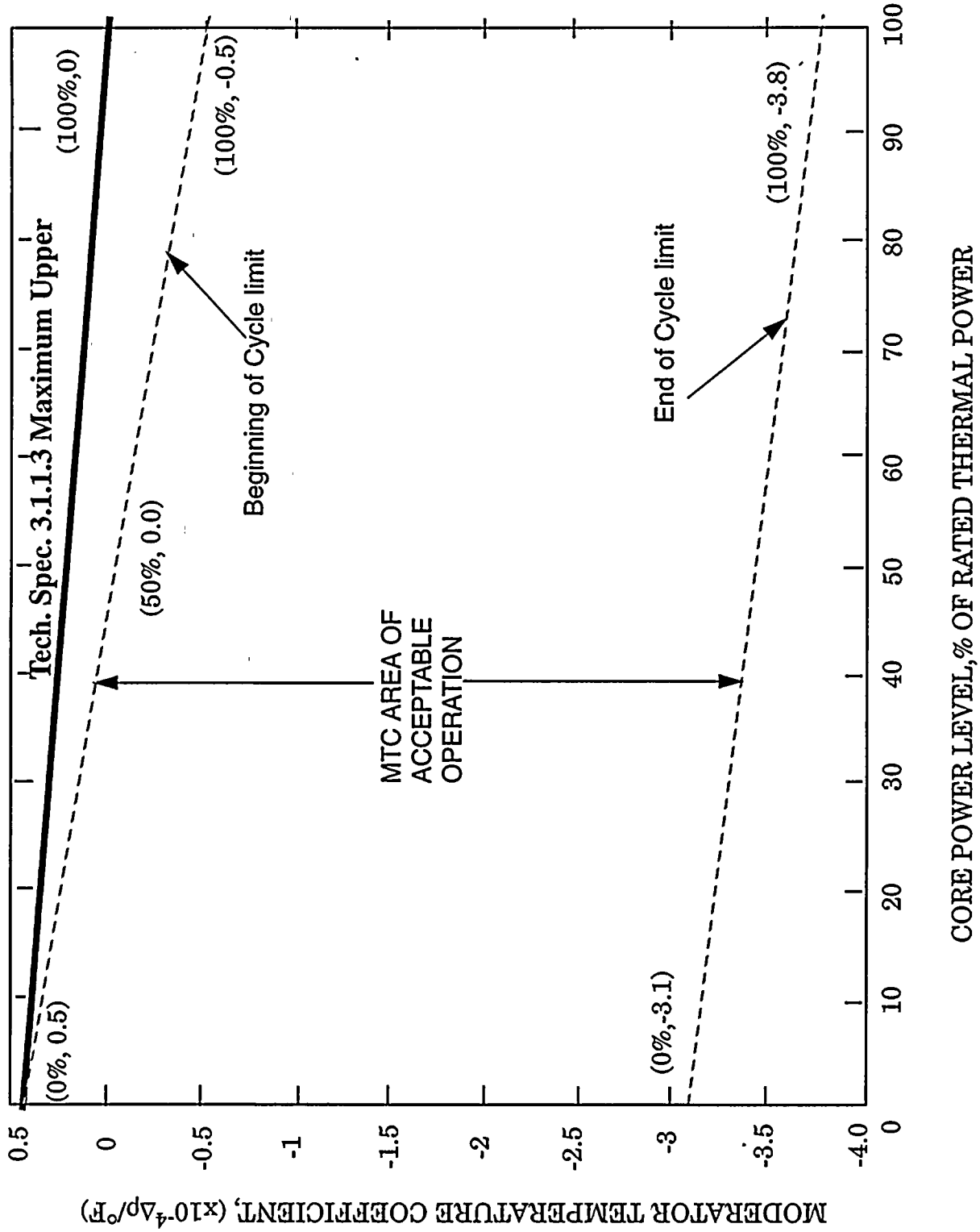
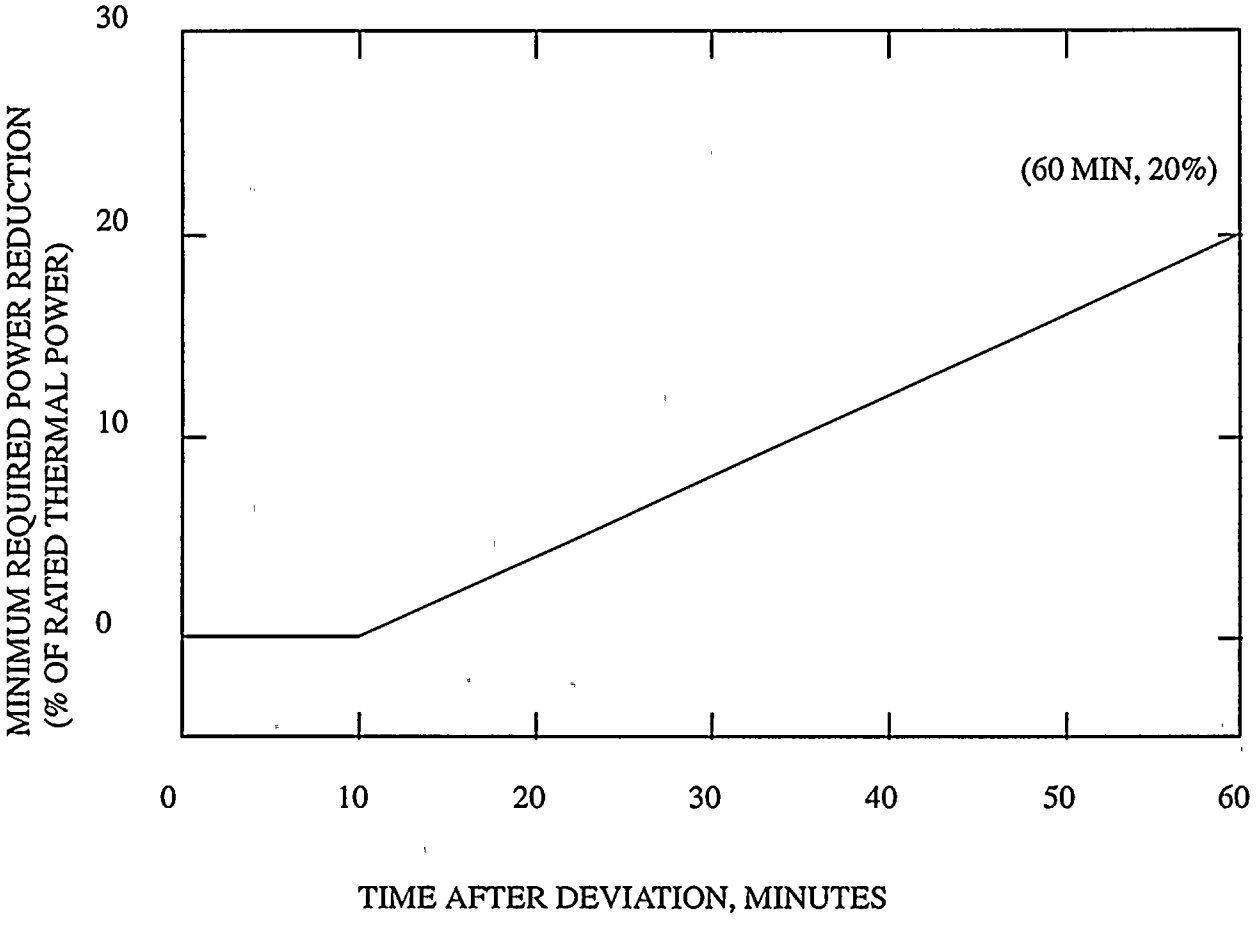


FIGURE 3

CORE POWER LIMIT AFTER CEA DEVIATION*




* WHEN CORE POWER IS REDUCED TO 55% OF RATED THERMAL POWER PER THIS LIMIT CURVE, FURTHER REDUCTION IS NOT REQUIRED

PVNGS UNIT 3 CYCLE 6 CORE OPERATING LIMITS REPORT

FIGURE 4

CEA INSERTION LIMITS VERSUS THERMAL POWER

(COLSS IN SERVICE)

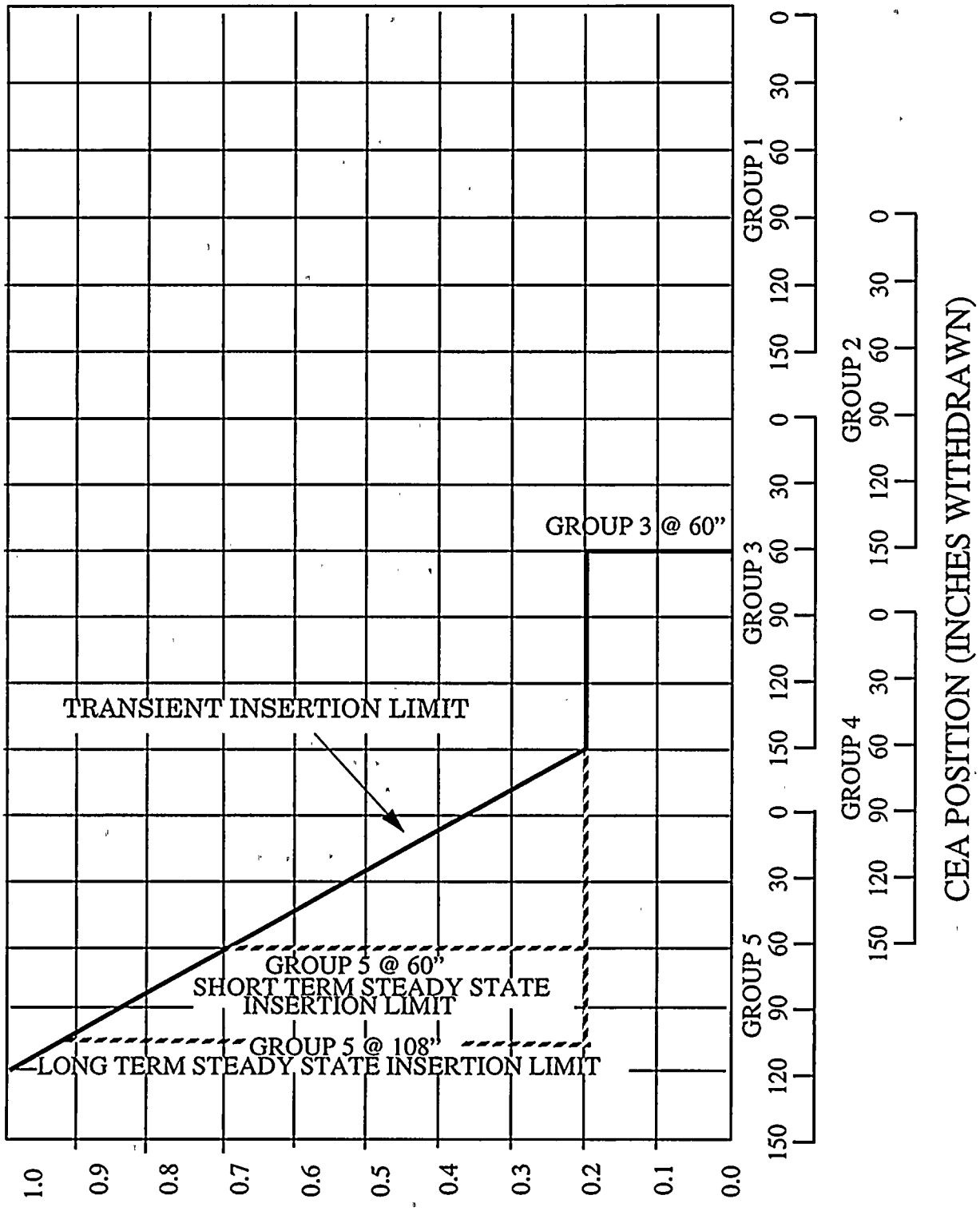


FIGURE 5

CEA INSERTION LIMITS VERSUS THERMAL POWER
(COLSS OUT OF SERVICE)

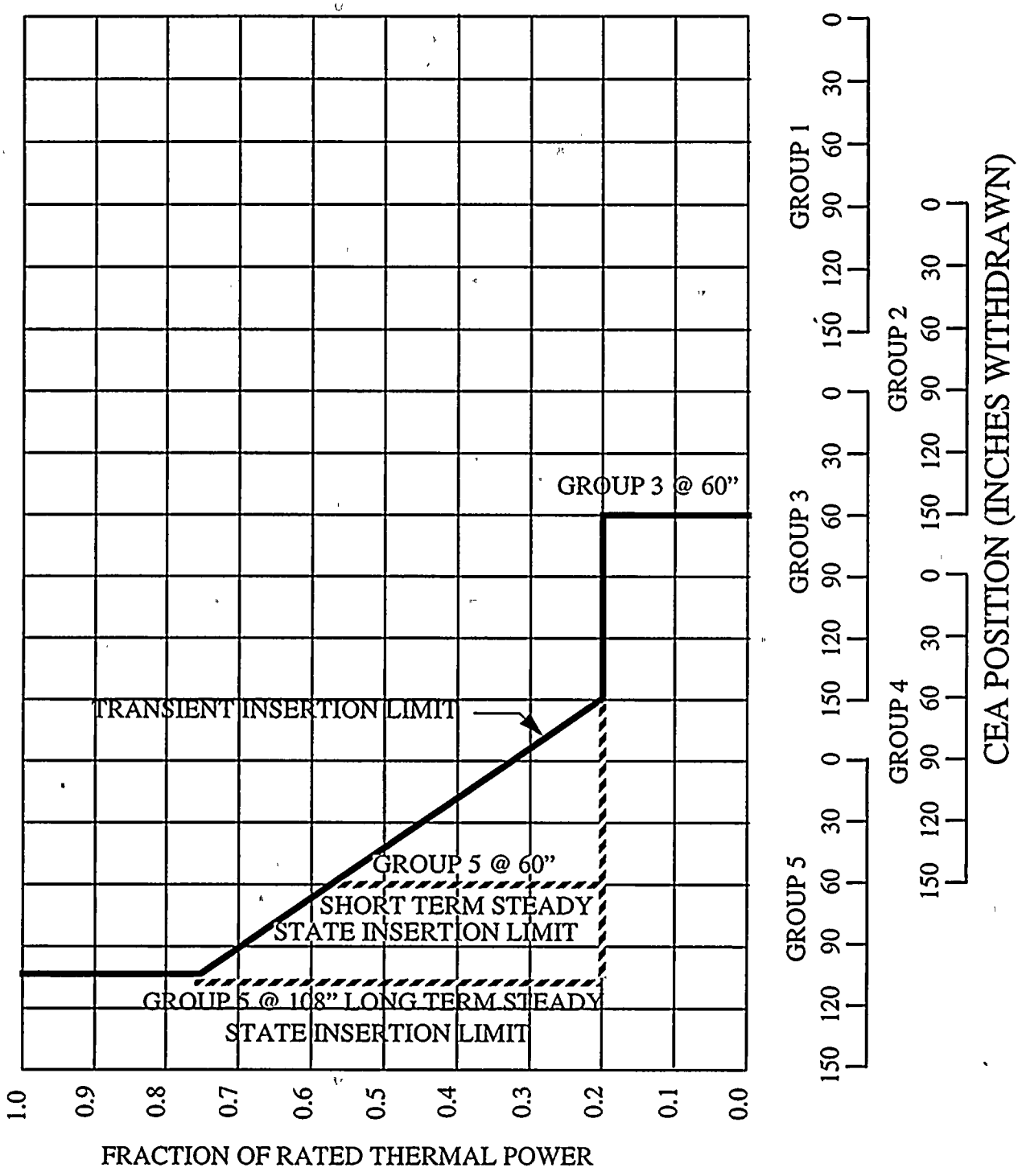


FIGURE 6

PART LENGTH CEA INSERTION LIMIT VERSUS THERMAL POWER

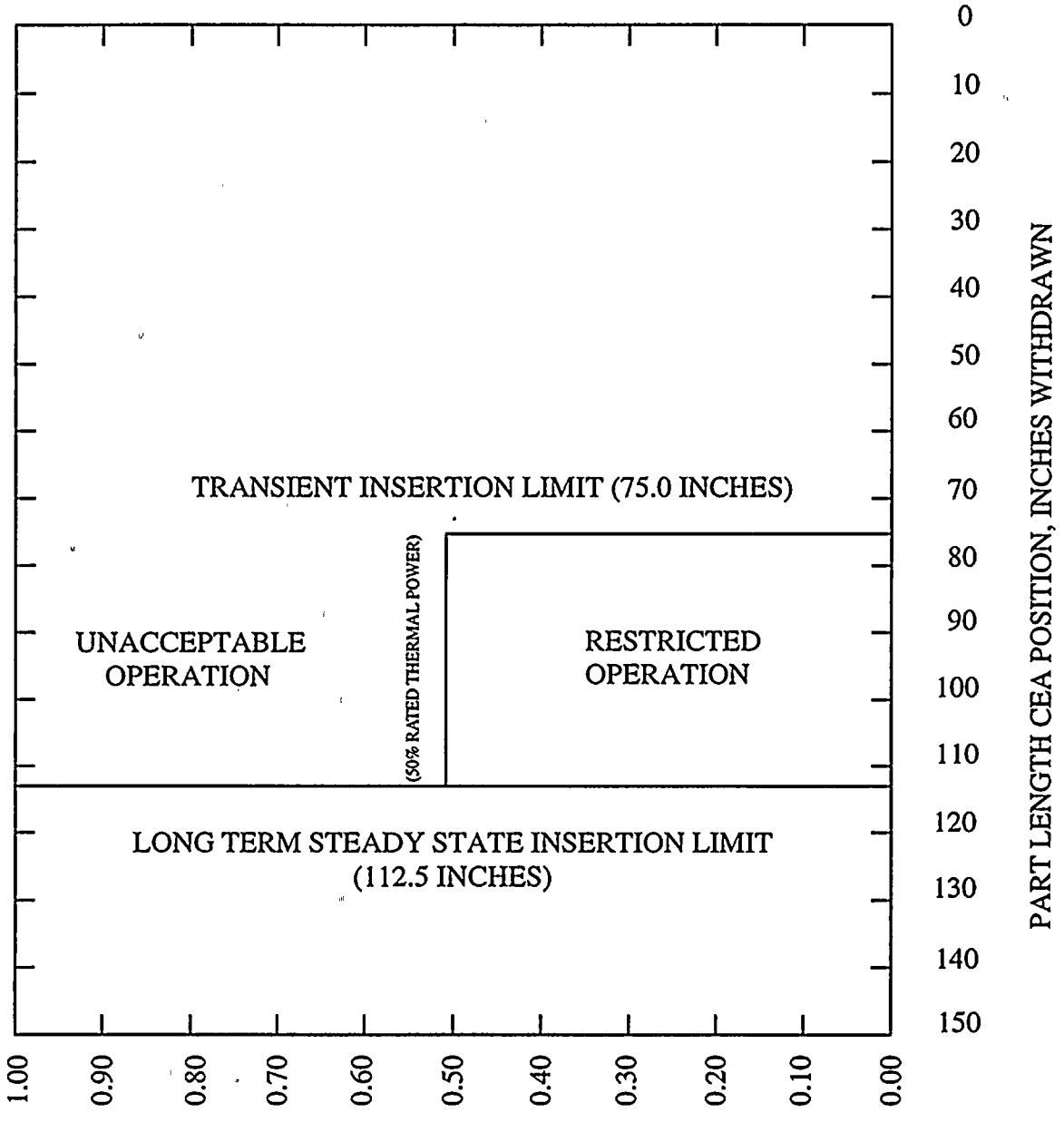


FIGURE 7

AZIMUTHAL POWER TILT LIMIT VERSUS THERMAL POWER

(COLSS IN SERVICE)

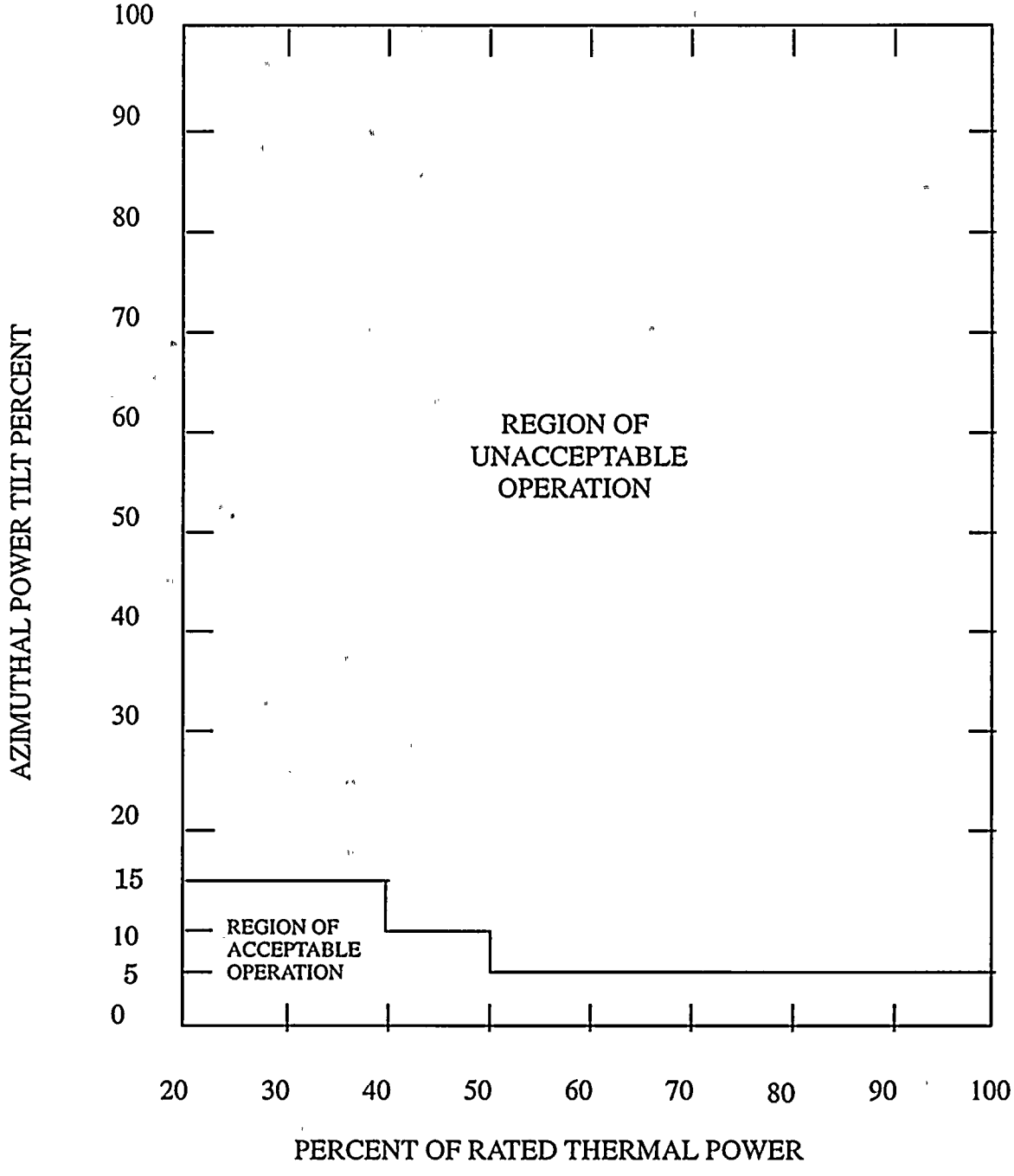
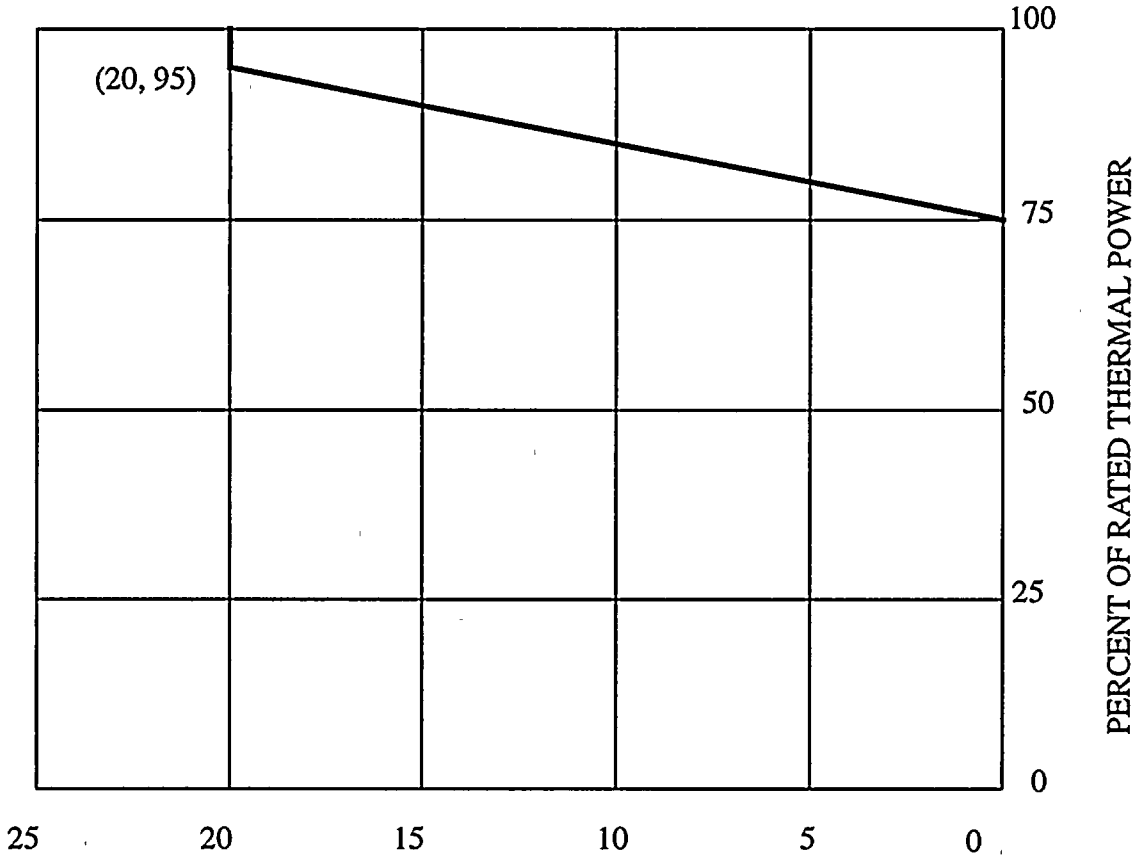


FIGURE 8

COLSS DNBR POWER OPERATING LIMIT
ALLOWANCE FOR BOTH CEACs INOPERABLE

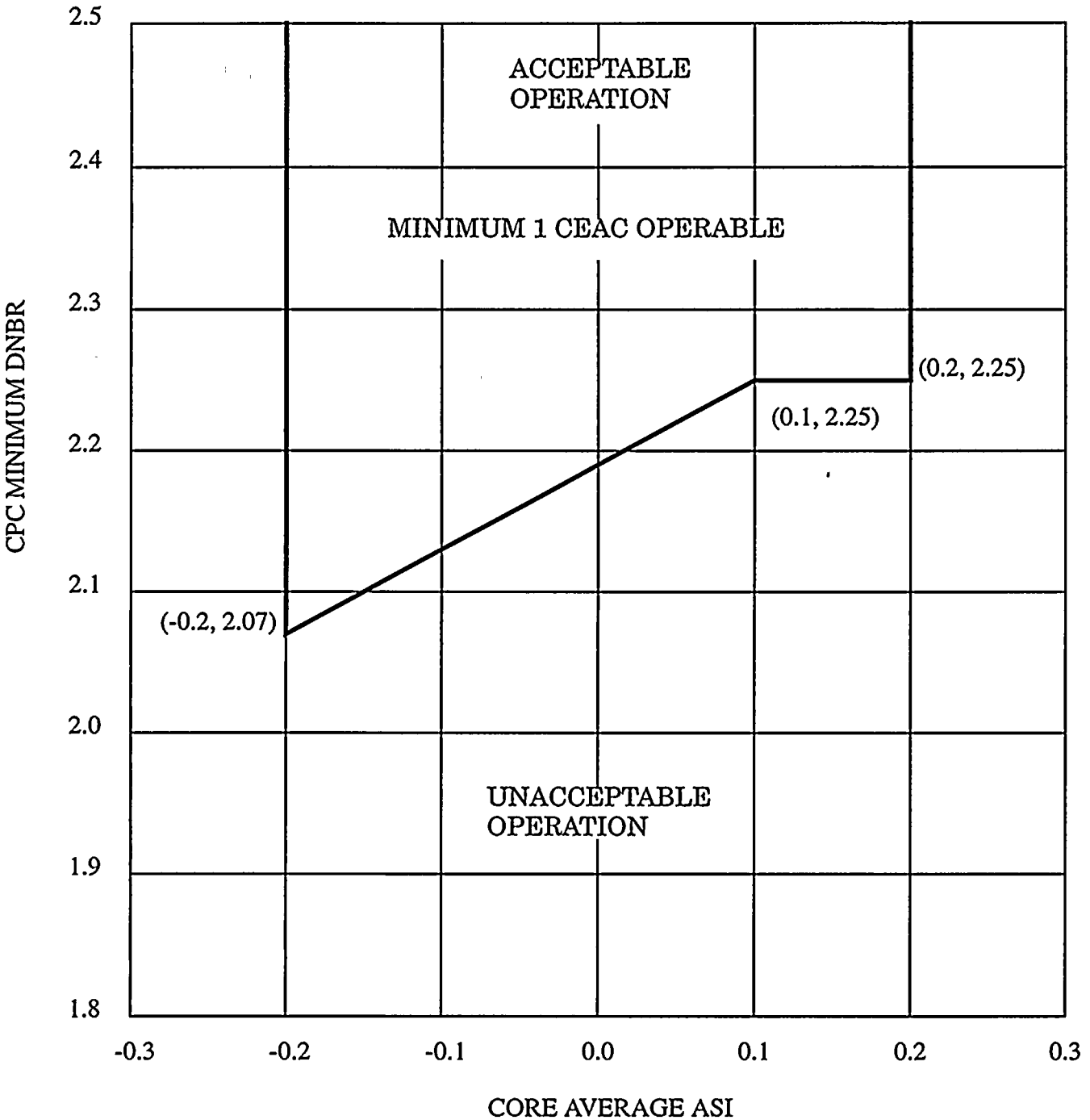


PVNGS UNIT 3 CYCLE 6 CORE OPERATING LIMITS REPORT

FIGURE 9

DNBR MARGIN OPERATING LIMIT BASED ON CORE PROTECTION CALCULATORS

(COLSS OUT OF SERVICE, CEACs OPERABLE)

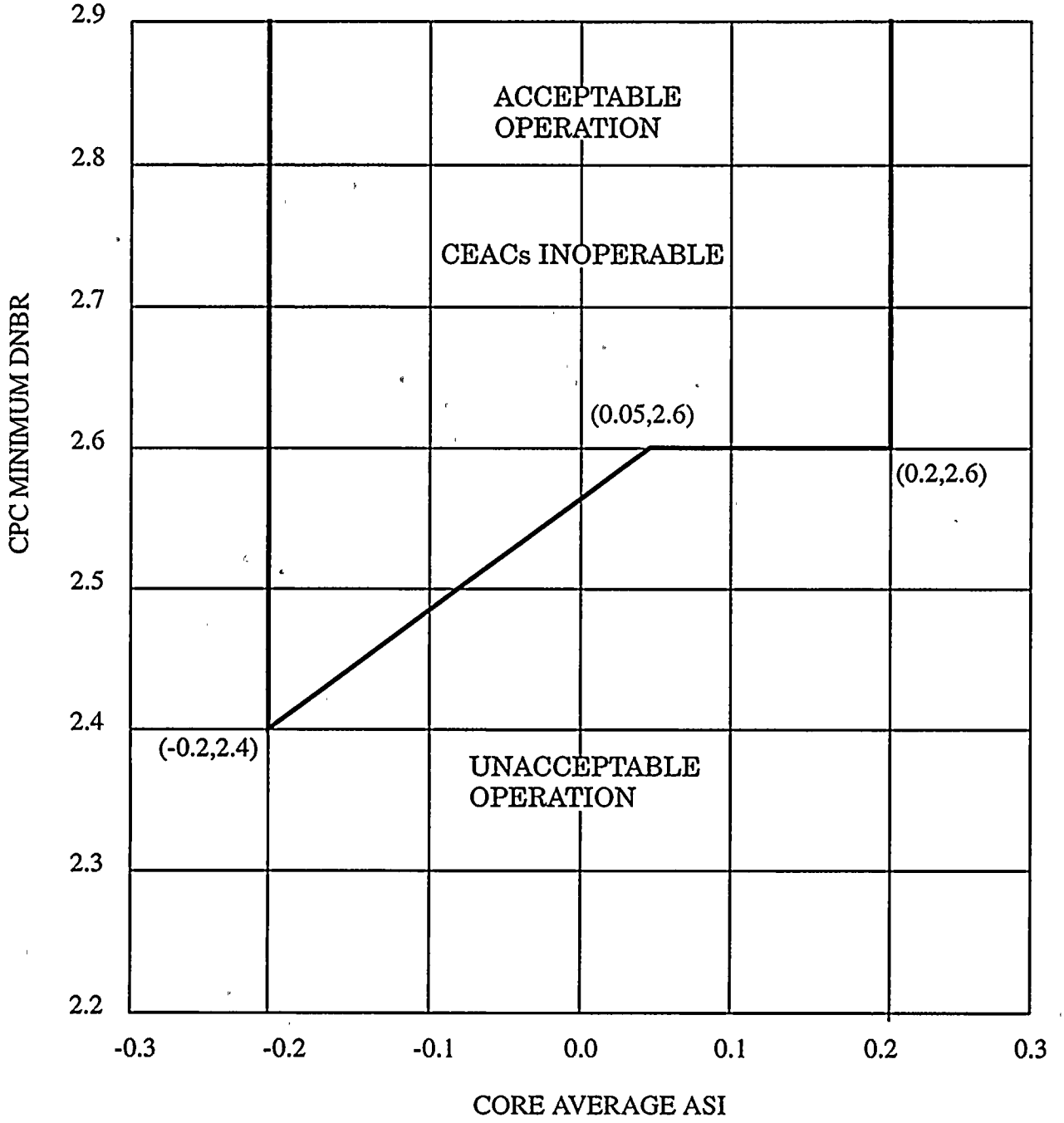


PVNGS UNIT 3 CYCLE 6 CORE OPERATING LIMITS REPORT

FIGURE 10

DNBR MARGIN OPERATING LIMIT BASED ON CORE PROTECTION CALCULATORS

(COLSS OUT OF SERVICE, CEACs INOPERABLE)



LIST OF TABLES

TABLE 1

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON DILUTION DETECTION AS A FUNCTION OF OPERATING CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $K_{eff} > 0.98$

| OPERATIONAL MODE | Number of Operating Charging Pumps | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 3 |
| 3 | 12 hours | 0.5 hour | ONA | ONA |
| 4 not on SCS | 12 hours | 1 hour | ONA | ONA |
| 5 not on SCS | 8 hours | 1 hour | ONA | ONA |
| 4 & 5 on SCS | ONA | ONA | ONA | ONA |

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed

TABLE 2

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON DILUTION DETECTION AS A FUNCTION OF OPERATING CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $0.98 \geq K_{eff} > 0.97$

| OPERATIONAL MODE | Number of Operating Charging Pumps | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 3 |
| 3 | 12 hours | 2 hours | 0.5 hours | ONA |
| 4 not on SCS | 12 hours | 2.5 hours | 1 hour | 0.5 hours |
| 5 not on SCS | 8 hours | 2.5 hours | 1 hour | 0.5 hours |
| 4 & 5 on SCS | 8 hours | 0.5 hours | ONA | ONA |

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed

TABLE 3

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON DILUTION DETECTION AS A FUNCTION OF OPERATING CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $0.97 \geq K_{eff} > 0.96$

| OPERATIONAL MODE | Number of Operating Charging Pumps | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 3 |
| 3 | 12 hours | 3.5 hours | 1.5 hours | 0.5 hours |
| 4 not on SCS | 12 hours | 3.5 hours | 1.5 hours | 1 hour |
| 5 not on SCS | 8 hours | 3.5 hours | 1.5 hours | 1 hour |
| 4 & 5 on SCS | 8 hours | 1 hour | 0.5 hours | ONA |

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed

TABLE 4

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON DILUTION DETECTION AS A FUNCTION OF OPERATING CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $0.96 \geq K_{eff} > 0.95$

| OPERATIONAL MODE | Number of Operating Charging Pumps | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 3 |
| 3 | 12 hours | 4.5 hours | 2 hours | 1 hour |
| 4 not on SCS | 12 hours | 5 hours | 2 hours | 1 hour |
| 5 not on SCS | 8 hours | 5 hours | 2 hours | 1 hour |
| 4 & 5 on SCS | 8 hours | 2 hours | 0.5 hours | ONA |

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed

TABLE 5

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON DILUTION DETECTION AS A FUNCTION OF OPERATING CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $K_{eff} \leq 0.95$

| OPERATIONAL MODE | Number of Operating Charging Pumps | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 3 |
| 3 | 12 hours | 6 hours | 2.5 hours | 1.5 hours |
| 4 not on SCS | 12 hours | 6 hours | 3 hours | 1.5 hours |
| 5 not on SCS | 8 hours | 6 hours | 3 hours | 1.5 hours |
| 4 & 5 on SCS | 8 hours | 2 hours | 1 hour | 0.5 hours |
| 6 ($\geq$ 4000 ppm) | 24 hours | 8 hours | 3.5 hours | 2 hours |
| 6 (< 4000 ppm) | 24 hours | 2 hours | 0.5 hours | ONA |

Notes: SCS = Shutdown Cooling System
ONA = Operation not allowed