Consumers Power Company

REGULATORY DOCKET FILE COPY

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September 26, 1977

Director of Nuclear Reactor Regulation
Att: Mr Albert Schwencer, Chief
Operating Reactors Branch No 1
US Nuclear Regulatory Commission
Washington, DC 20555

DOCKET 50-255, LICENSE DPR-20 -
PALISADES PLANT - ADDITIONAL INFORMATION
RELATING TO POWER INCREASE REQUEST

As requested by your staff in the review of our power increase request, the following is forwarded for review.

Attachment 1 - Corrections to Proposed Technical Specifications Changes.

Attachment 2 - Comments on Change to Tech Spec Figure 3-9.

Attachment 3 - Acceptance Criteria for Testing To Be Performed during power escalation.

Attachment 4 - Comparison of Consumers PDQ Calculations Vs Measurements.

These attachments should provide the information to answer all outstanding requests and allow for a timely resolution of our requested power increase.

David P. Hoffman

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Assistant Nuclear Licensing Administrator

CC: JGKeppler, USNRC

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ATTACHMENT 1

Corrections to Proposed Technical Specification Changes

2.1 SAFETY LIMITS - REACTOR CORE (Contd)

probability at a 95% confidence level that DNB will not occur which is considered an appropriate margin to DNB for all operating conditions.[1] The curves of Figures 2-1, 2-2, and 2-3 represent the loci of points of thermal power, primary coolant system pressure and average temperature of various pump combinations for which the DNBR is 1.3. The area of safe operation is below these lines. For 3- and 2-pump operation, the limiting condition is void fraction rather than DNBR. The void fraction limits assure stable flow and maintenance of DNBR greater than 1.3.

The curves are based on the following nuclear hot channel factors:

3- and 2-Pump Operation: $F_q^N = 3.62$ and $F_{\Delta H}^N = 1.94$

4-Pump Operation: $F_q^N = 2.48$ and $F_{ROD}^N = 1.77$*

These limiting hot channel factors are higher than those calculated at rated power for the range from all control rods fully withdrawn to maximum allowable control rod insertion. (Control rod insertion limits are covered in Specification 3.10.) Somewhat worse hot channel factors could occur at lower power levels because additional control rods may be in the core; however, the control rod insertion limits dictated by Figure 3-6 insure that the minimum DNBR is always greater at part-power than at rated power.

Flow maldistribution effects of operation under less than full primary coolant flow have been evaluated via model tests.[2] The flow model data established the maldistribution factors and hot channel inlet temperatures for the thermal analyses that were used to establish the safe operating envelopes presented in Figures 2-1 and 2-2. These figures were established on the basis that the thermal margin for part-loop operation should be equal to or greater than the thermal margin for normal operation.

The reactor protective system is designed to prevent any anticipated combination of transient conditions for primary coolant system temperature, pressure and thermal power level that would result in a DNBR of less than 1.3.[3]

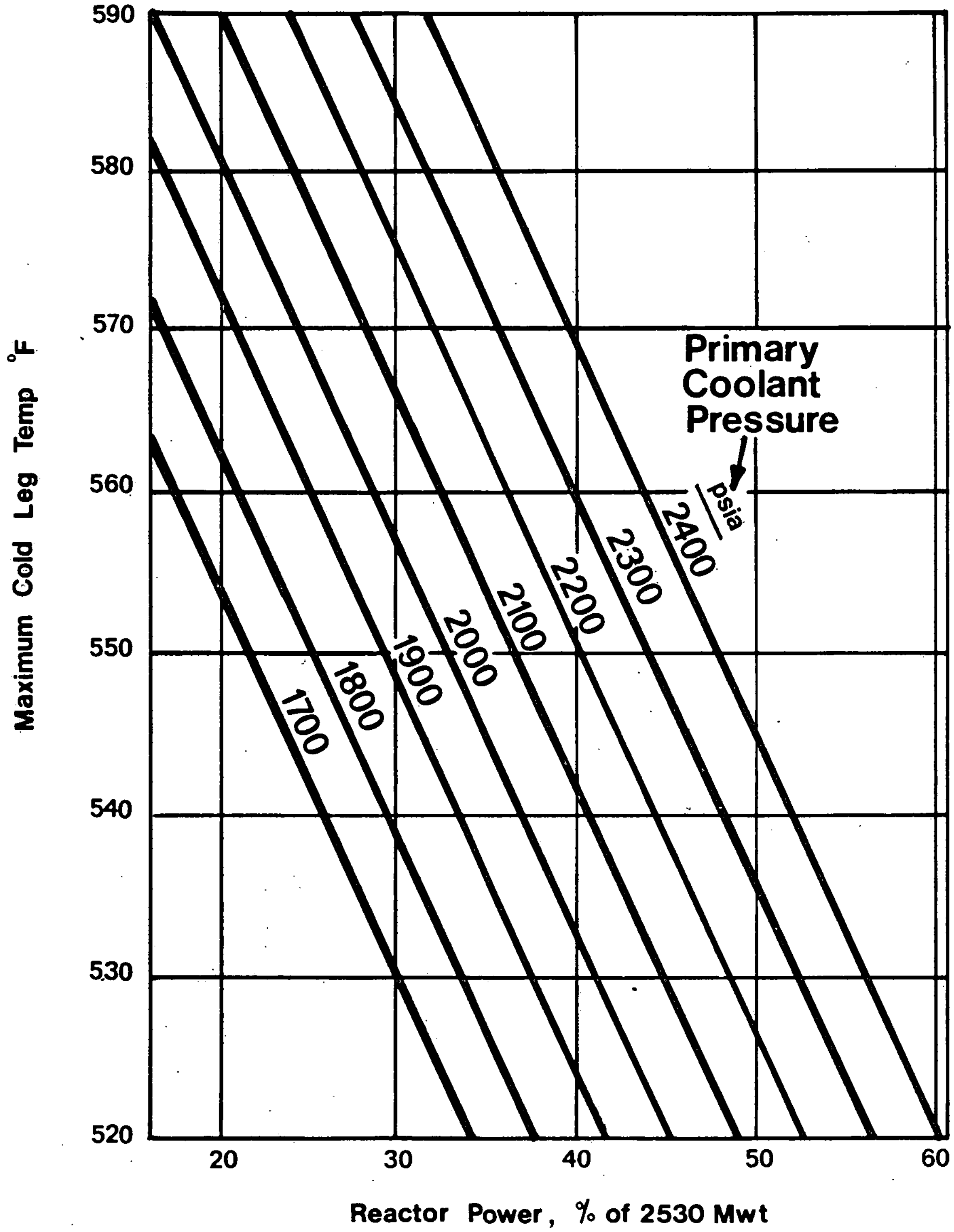
*F_{ROD}^N = Peak Rod Power/Average Rod Power

References

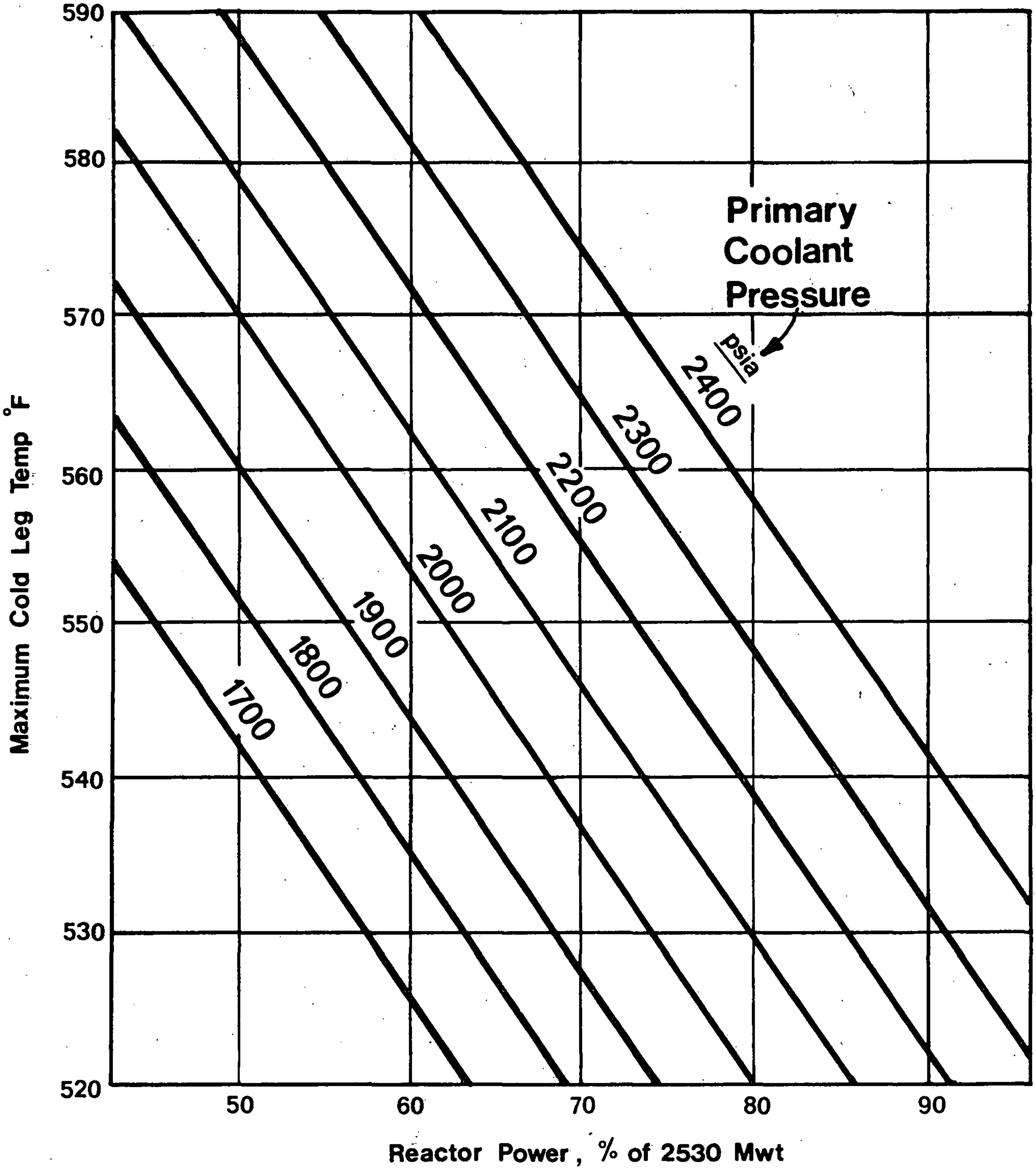
(1) FSAR, Section 3.3.3.5.

(2) FSAR, Section 3.3.3.3, Appendix C.

(3) FSAR, Section 14.1.



Reactor Core Safety Limits 2 Pump Operation	Palisades Technical Specifications	Figure 2-1



Reactor Core Safety Limits 3 Pump Operation	Palisades Technical Specifications	Figure 2-2

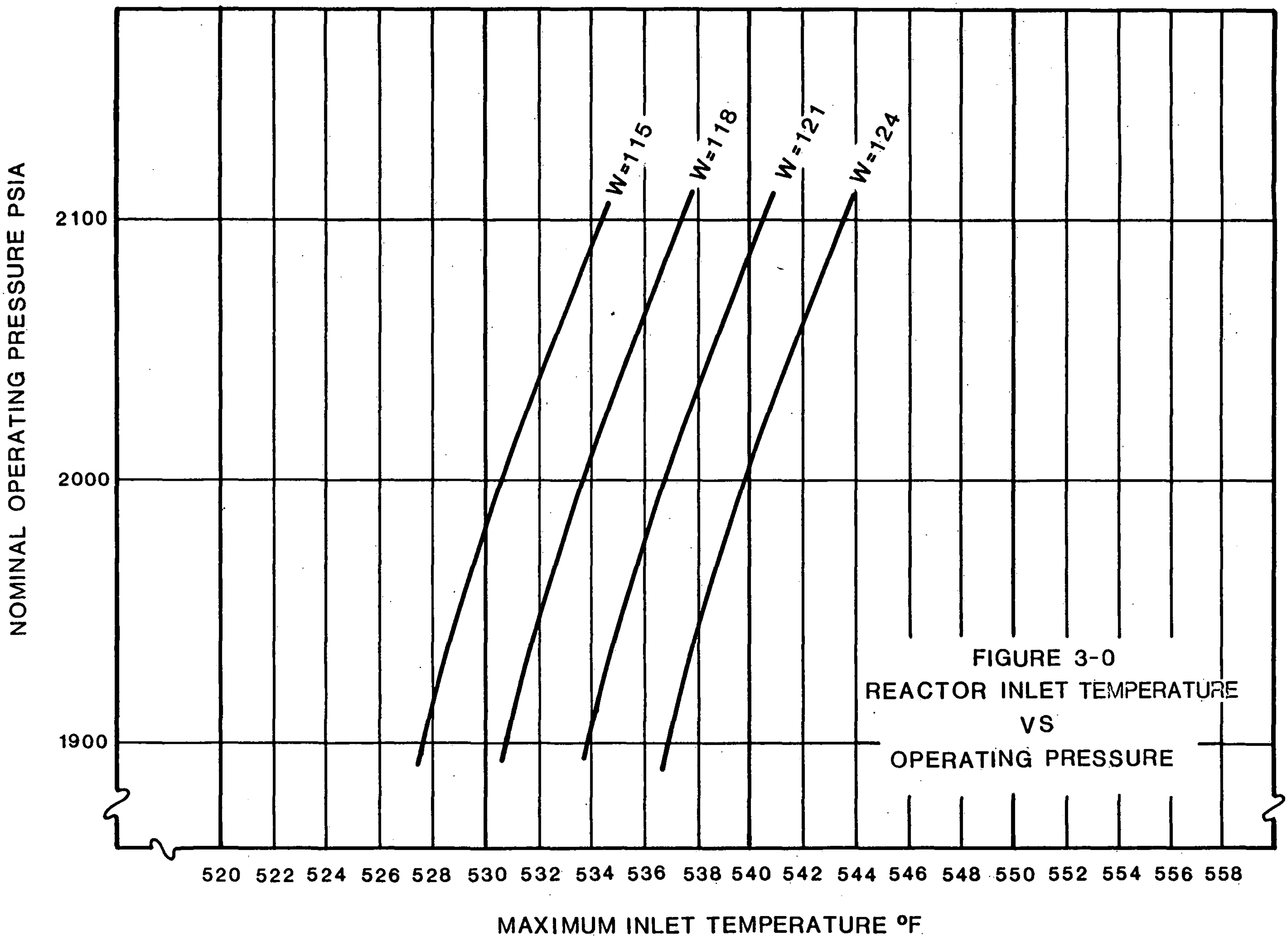


FIGURE 3-0
REACTOR INLET TEMPERATURE
VS
OPERATING PRESSURE

3.10 CONTROL ROD AND POWER DISTRIBUTION LIMITS (Contd)

3.10.4 Misaligned or Inoperable Control Rod or Part-Length Rod

a. A control rod or a part-length rod is considered misaligned if it is out of position from the remainder of the bank by more than 8 inches.

b. A control rod is considered inoperable if it cannot be moved by its operator or if it cannot be tripped. A part-length rod is considered inoperable if it is not fully withdrawn from the core and cannot be moved by its operator. If more than one control rod or part-length rod becomes misaligned or inoperable, the reactor shall be placed in the hot shutdown condition within 12 hours.

c. If a control rod or a part-length rod is misaligned, hot channel factors must promptly be shown to be within design limits or reactor power shall be reduced to 75% or less of rated power within two hours. In addition, shutdown margin and individual rod worth limits must be met. Individual rod worth calculations will consider the effects of xenon redistribution and reduced fuel burnup in the region of the misaligned control rod or part-length rod.

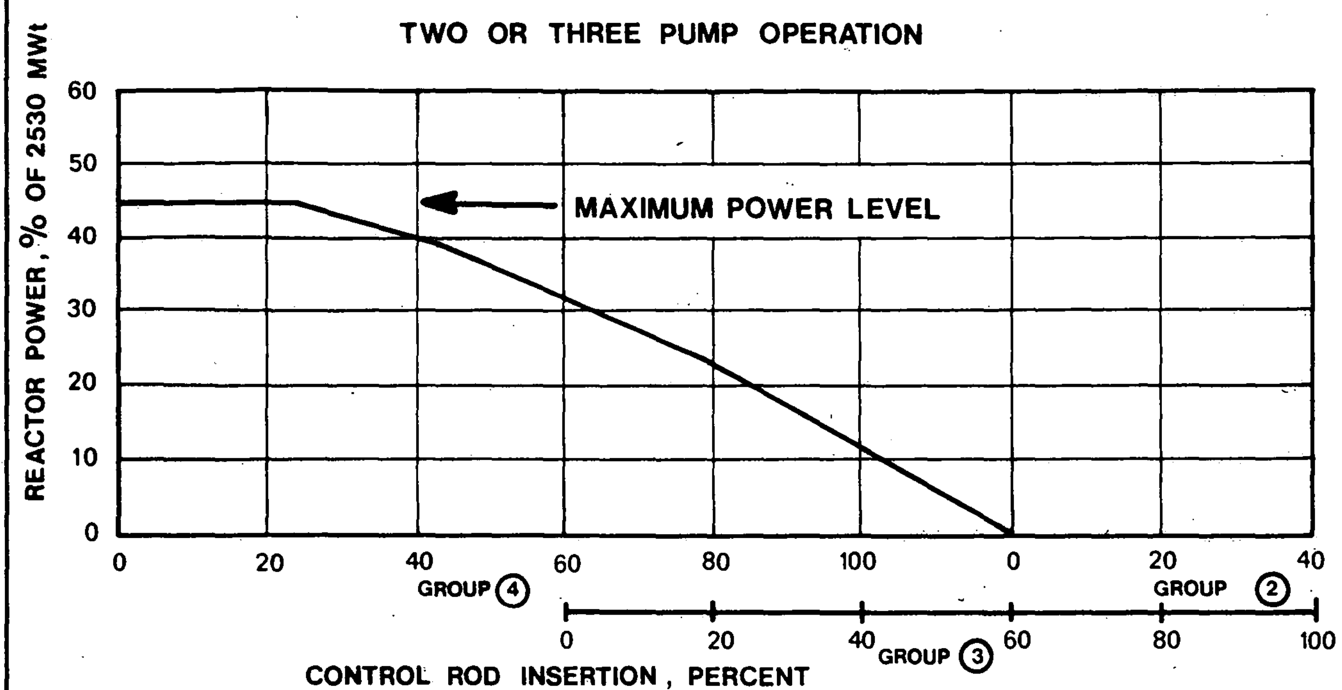
3.10.5 Regulating Group Insertion Limits

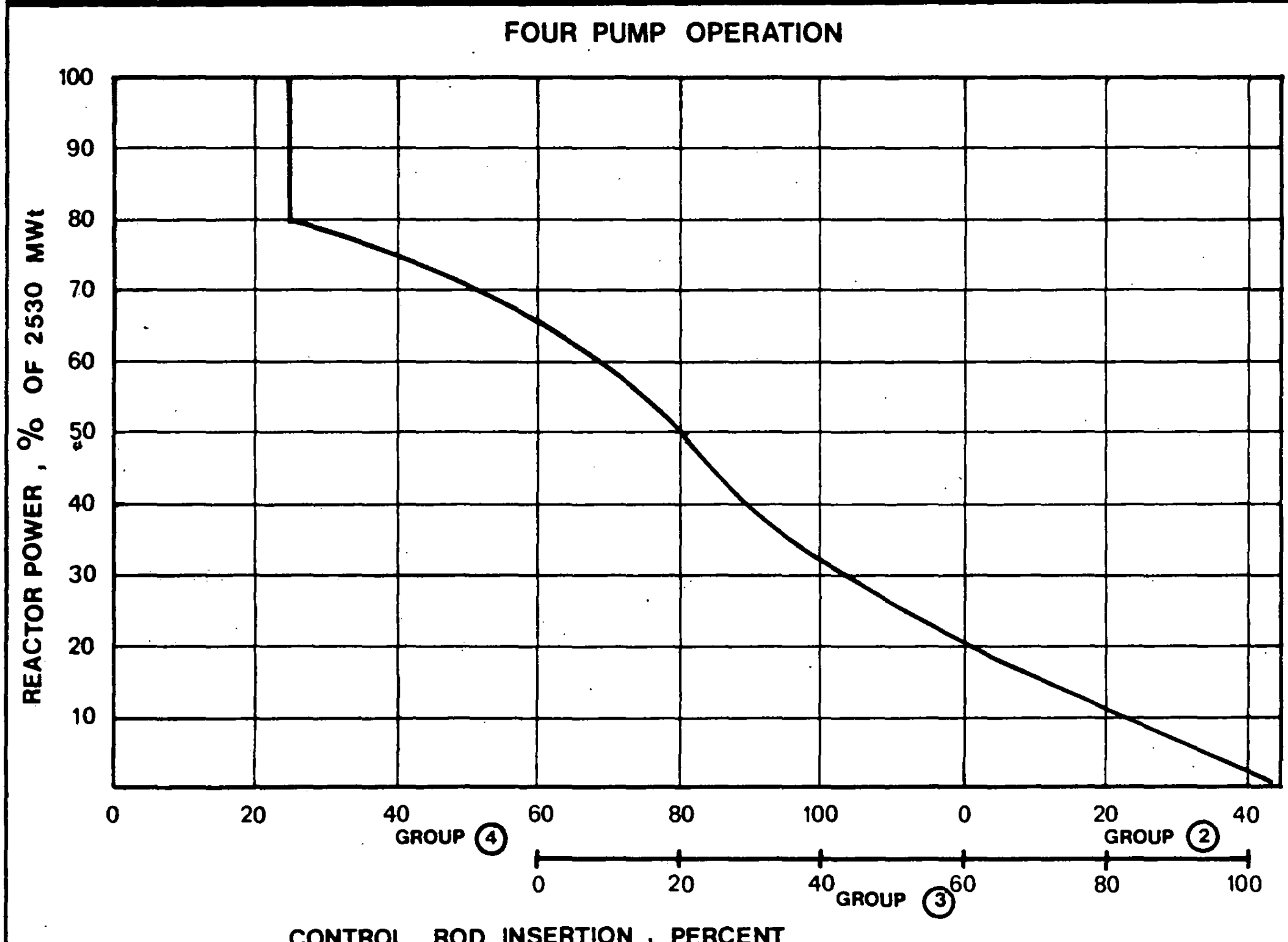
a. To implement the limits on shutdown margin, individual rod worth and hot channel factors, the limits on control rod regulating group insertion shall be established as shown on Figure 3-6. The 4-pump operation limits of Figure 3-6 do not apply for decreasing power level rapidly when such a decrease is needed to avoid or minimize a situation harmful to the plant personnel or equipment. Once such a power decrease is achieved, the limits of Figure 3-6 will be returned to by borating the control rods above the insertion limit within two hours. Limits more restrictive than Figure 3-6 may be implemented during fuel cycle life based on physics calculations and physics data obtained during plant start-up and subsequent operation. New limits shall be submitted to the NRC within 45 days.

b. The sequence of withdrawal of the regulating groups shall be 1, 2, 3, 4.

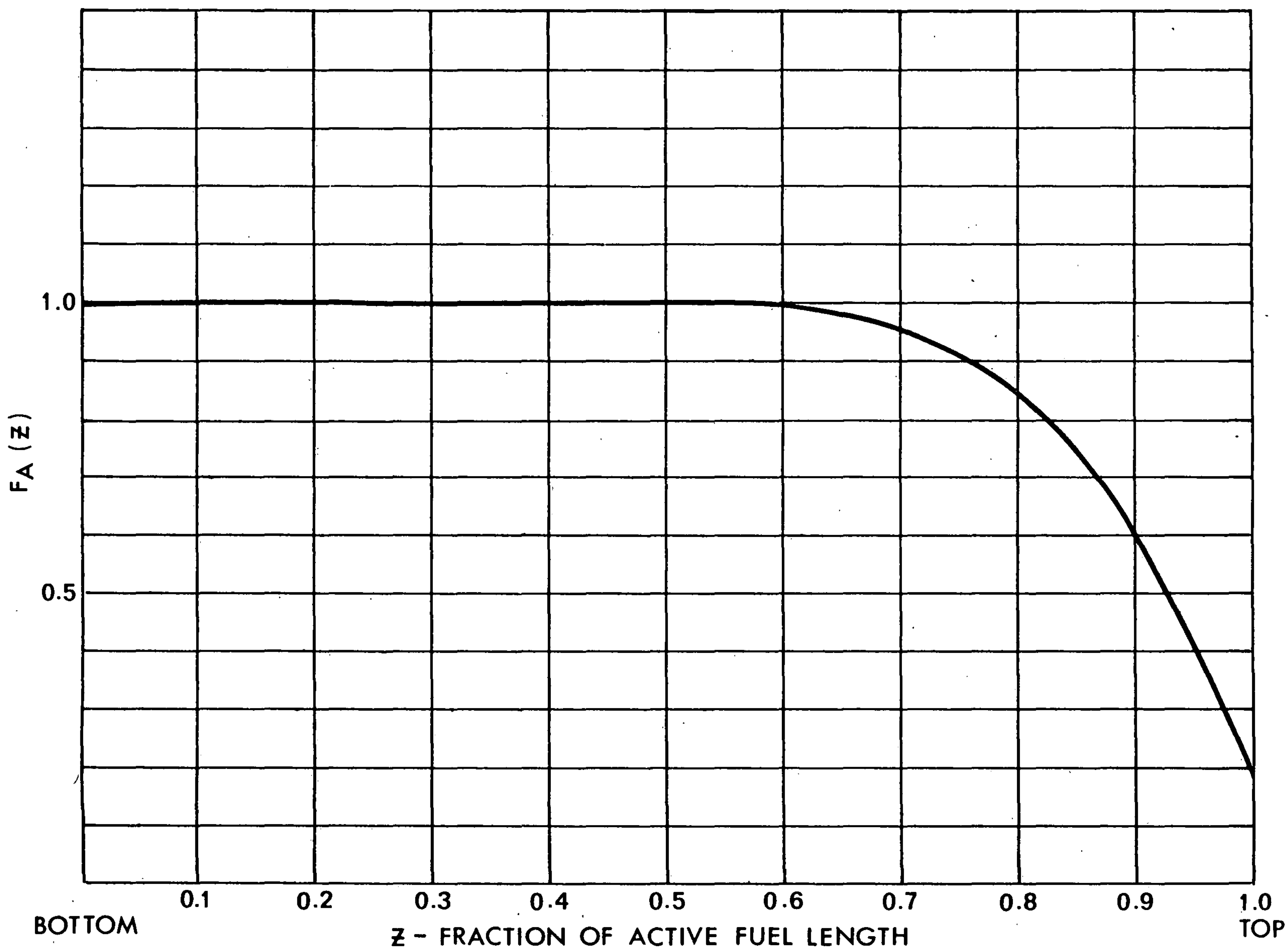
c. An overlap of control banks in excess of 40% shall not be permitted.

d. If the reactor is subcritical, the rod position at which criticality could be achieved if the control rods were withdrawn in normal sequence shall not be lower than the insertion limit for zero power shown on Figure 3-6.





CONTROL ROD INSERTION LIMITS	PALISADES TECHNICAL SPECIFICATION	FIGURE 3-6



Axial Correction Factor For Peak Linear Heat Generation Rate	Palisades Technical Specifications	Figure 3-9

ATTACHMENT 2

Comments on Revised T.S. Figure 3-9

Co[...]nts on Revised Figure 3-9

Palisades Plant

Technical Specification

A review of Figure 3-9 has indicated that the axial correction factor proposed may be overly conservative and hence limit plant operations unnecessarily. This may be particularly true at end-of-cycle when neutron flux levels in the top 20% of the core are highest due to the "double-humped" power profile which is characteristic of EOC. Therefore, Figure 3-9 has been revised. The revised axial correction factor allows for slightly more flexibility in operating the reactor with top-peaked axial power profiles. The axial correction factor shown on Figure 3-9 was derived based on a revised axial power profile. For this revised power profile, power production in the top of the core was somewhat greater than that for the reference power profile that was used in evaluating the plant transients and LOCA for 2530 Mwt operation.[1,2] Refer to Figure 1 for a graphical comparison of the two power profiles. An evaluation of the limiting LOCA (i.e. the 0.6 DEG for D-fuel) and of DNB thermal margins using the revised axial power profile has shown that the revised profile results is a slight improvement in LOCA and DNB margins.[3,4] Therefore, the revised axial correction factor is conservative with respect to that previously proposed.

[1] XN-NF-77-18, "Plant Transient Analysis of the Palisades Reactor for Operation at 2530 Mwt".

[2] XN-NF-77-24, "LOCA Analysis for Palisades at 2530 Mwt Using the ENC WREM-II PWR ECCS Evaluation Model".

[3] Letter from ENC to CPCo on effect of revised axial power profile on LOCA (to be supplied).

[4] Letter from ENC to CPCo on effect of revised axial power profile on DNB thermal margins (to be supplied).

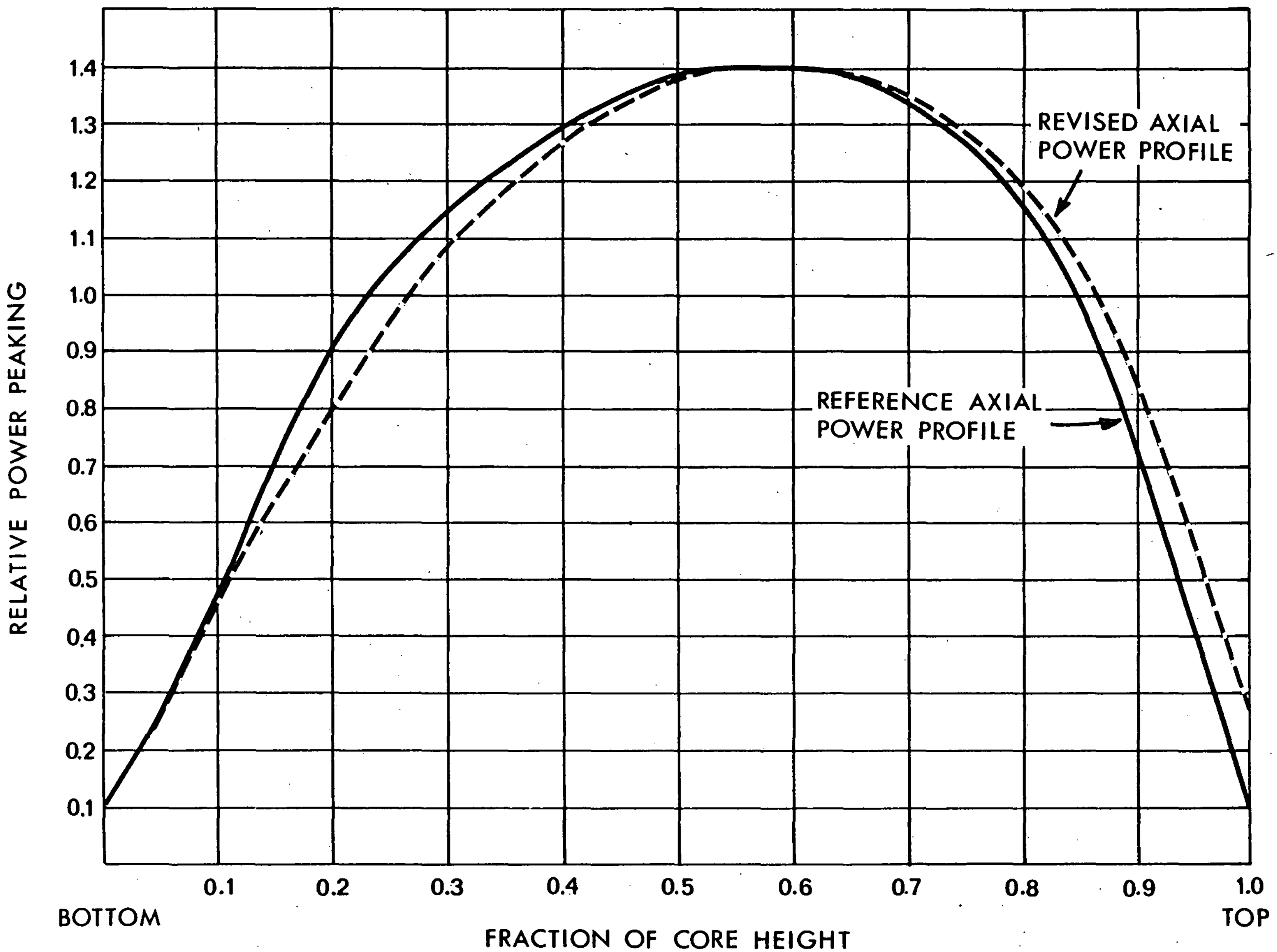

REVISED AXIAL POWER PROFILE
REFERENCE AXIAL POWER PROFILE
RELATIVE POWER PEAKING
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
BOTTOM
TOP
FRACTION OF CORE HEIGHT

FIGURE 1

ATTACHMENT 3

Acceptance Criteria for Power Increase Testing

Palisades Plant

By letter dated September 12, 1977 we identified the proposed steps for accomplishing the planned power increase from 2200 MW_t to 2530 MW_t. Some changes have been made to those proposed steps.

Step 4 - Moderate Temperature Coefficient test will take place prior to step 8.

Step 6 - There will be a hold after step 6 to allow the reactor to reach xenon equilibrium.

The following acceptance criteria will be used:

Power Coefficient: $-1.0 \times 10^{-4} \Delta\rho/\% \pm 30\%$

Moderator Temperature Coefficient: -3.5×10^{-4} to $+0.5 \times 10^{-4} \Delta\rho/°F$

Power Distribution:

(A) Power peaking factor in any bundle shall not increase by greater than 10% from 2200 MW_t conditions.

(B) Tech Spec LHGR limits shall not be exceeded.

(C) Bundle power and Peak rod power values assumed in EXXON reports XN-NF-77-18, XN-NF-77-22 and XN-NF-77-24 shall not be exceeded.

ATTACHMENT 4

Comparison of Consumers Power PDQ Calculations vs Measurements.

Attached are comparisons of our PDQ calculations with reactor measurements. The first two figures are comparisons made with Cycle 1 data, while the next four apply to Cycle 2. Figures 1-5 are rods-out equilibrium xenon cases at or near the maximum allowed power level. The agreement between the calculations and measurements are fairly good, the largest error being in the low power assemblies along the core periphery. The highest assembly power is predicted within 4% of the INCA value in the worst case. Figure 6 is a comparison of a rodded PDQ7 with a measurement of the power distribution in the top of the core when the Group 4 rods were about halfway inserted. The agreement again is rather good, especially in the limiting assemblies.

Table 1 shows a comparison between calculated and measured control rod bank worths from the beginning of cycle zero power tests. The calculated values are very similar to those computed by the vendor which were presented in the start-up test report.

CYCLE 1 - 400 MWd/MT, 60% POWER

.82	1.09	.90	1.17	.93	1.10	.84	.88
.85	1.11	.95	1.16	.93	1.10	.84	.79
+4	+2	+6	-1	0	0	0	-10
	.94	1.22	.97	1.18	.89	1.15	.87
	.97	1.25	1.02	1.18	.92	1.14	.80
	+3	+2	+5	0	+3	-1	-8
		1.33(2)	1.27	1.22	.90	1.08	.66
		1.34	1.29	1.21	.94	1.07	.60
		+1	+2	-1	+4	-1	-9
			.94	.95	1.10	.95	
			1.00	.95	1.13	.93	
			+6	0	+3	-2	
				1.15	.98	.60	
				1.15	.97	.57	
				0	-1	-5	

X.XX INCA
Y.YY CP Co PDQ
±Z (PDQ-INCA)/INCA %

Numbers in parentheses indicate the number of levels not instrumented.

FIGURE 1
Palisades Plant
Radial Power Distribution

CYCLE 1 - 10,800 MWd/MT, 80% POWER

.97	1.17	.97	1.18	1.05(4)	1.15(4)	.94	.84
1.00	1.16	1.03	1.17	1.03	1.15	.94	.77
+3	-1	+6	-1	-2	0	0	-8
	1.04	1.20	1.03	1.17(1)	1.02	1.10	.82
	1.04	1.19	1.05	1.18	1.02	1.16	.76
	0	-1	+2	+1	0	+5	-7
		1.24(1)	1.19(4)	1.15(4)	.94	.99	.66
		1.21	1.19	1.16	.99	1.05	.59
		-2	0	+1	+5	+6	-11
			1.00	1.00	1.02	.80(2)	
			1.02	.99	1.04	.83	
			+2	-1	+2	+4	
				1.11	.87	.56	
				1.08	.85	.51	
				-3	-2	-9	

X.XX INCA
Y.YY CP Co PDQ
±Z (PDQ-INCA)/INCA %

Numbers in parentheses indicate the number of levels not instrumented.

FIGURE 2
Palisades Plant
Radial Power Distribution

CYCLE 2 - 200 MWd/MT, 95% POWER

.83 .82 -1	1.16$^{(4)}$ 1.13 -3	1.19 1.13 -5	.85 .85 0	1.20 1.13 -6	.87 .93 +7	1.13 1.10 -3	.82 .77 -6
	.89 .88 -1	1.22 1.12 -8	.90$^{(4)}$ .87 -3	.90 .93 +3	1.40 1.41 +1	.83 .90 +8	.75 .75 0
		.89 .89 0	1.19$^{(3)}$ 1.19 0	1.23 1.23 0	.93 .99 +6	1.16 1.20 +3	.62 .60 -3
			1.28 1.25 -2	.92 1.00 +9	1.20 1.20 0	.92$^{(1)}$ .94 +2	
				1.32 1.34 +2	.97$^{(2)}$ .99 +2	.55 .56 +2	

X.XX INCA
Y.YY CP Co PDQ
±Z (PDQ-INCA)/INCA %

Numbers in parentheses indicate the number of levels not instrumented.

FIGURE 3
Palisades Plant
Radial Power Distribution

CYCLE 2 - 4,000 MWd/MT, 100% POWER

.95	1.23 (4)	1.26	.95	1.24	.90	1.11	.78
.98	1.23	1.22	.98	1.18	.98	1.06	.73
+3	0	-3	+3	-5	+9	-5	-6
	.99	1.29	.99 (4)	.94	1.31	.83	.71
	1.01	1.21	.98	1.00	1.33	.90	.71
	+2	-6	-1	+6	+2	+8	0
		.97	1.24	1.22	.91	1.05	.59
		1.00	1.20	1.20	.98	1.08	.55
		+3	-3	-2	+8	+3	-7
			1.28	.93	1.11	.85 (1)	
			1.21	.98	1.09	.84	
			-5	+5	-2	-1	
				1.19	.88 (2)	.51	
				1.18	.87	.50	
				-1	-1	-2	

X.XX INCA
Y.YY CP Co PDQ
±Z (PDQ-INCA)/INCA %

Numbers in parentheses indicate the number of levels not instrumented.

FIGURE 4
Palisades Plant
Radial Power Distribution

CYCLE 2 - 11,000 MWd/MT, 100% POWER

1.03 1.11 +8	1.32(4) 1.37 +4	1.33 1.35 +2	1.00 1.05 +5	1.22 1.19 -2	.91 .96 +5	1.10 1.02 -7	.74 .71 -4
	1.08 1.13 +5	1.34 1.32 -1	1.03(4) 1.04 +1	.96 1.00 +4	1.17(2) 1.19 +2	.82 .84 +2	.68 .67 -1
		1.04 1.08 +4	1.27 1.26 -1	1.24 1.20 -3	.90 .93 +3	.97 .97 0	.57(1) .53 -7
			1.26 1.24 -2	.95 .97 +2	1.08 1.03 -5	.82(1) .78 -5	
				1.09 1.07 -2	.84(2) .82 -2	.51 .50 -2	

X.XX INCA
Y.YY PDQ
±Z (PDQ-INCA)/INCA

Numbers in parentheses indicate the number of levels not instrumented.

FIGURE 5
Palisades Plant
Radial Power Distribution

CYCLE 2 - 10,000 MWd/MT, 50% POWER

Group 4 55% Inserted, Radial Power Distribution at 78% of Core Height

1.26	1.59 (4)	1.57	1.14	1.40	1.00	1.28	.87
1.31	1.62	1.55	1.17	1.33	1.07	1.18	.81
+4	+2	-1	+3	-5	+7	-8	-7
	1.26	1.53	1.11 (4)	1.00	1.22 (2)	.89	.73
	1.30	1.45	1.09	1.04	1.28	.94	.77
	+3	-5	-2	+4	+5	+6	+5
		1.07	1.16	1.14	.84	1.01	.60 (1)
		1.09	1.14	1.05	.89	1.00	.58
		+2	-2	-8	+6	-1	-3
			.77	.54	.88	.75 (1)	
			.74	.53	.83	.72	
			-4	-2	-6	-4	
				.54	.61 (2)	.42	
				.50	.57	.41	
				-7	-7	-2	

X.XX INCA
Y.YY PDQ
±Z (PDQ-INCA)/INCA

Numbers in parentheses indicate the number of levels not instrumented.

FIGURE 6
Palisades Plant

TABLE 1

Rod Bank Worths at BOC 2

Control Rod Group	Measured % Δρ	Calculated by CP Co % Δρ	$\frac{\text{Calculated-Measured}}{\text{Measured}}$ %
4	.66	.70	+6
3	.91	.93	+2
2	.84	.73	-13
1	1.92	2.13	+11
B	1.54	1.62	+5