BAW-1774

February 1983

OCONEE UNIT 1, CYCLE 8

— Reload Report —

Babcock & Wilcox
a McDermott company

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1. INTRODUCTION AND SUMMARY

This report justifies the operation of the eighth cycle of Oconee Nuclear Station, Unit 1, at the rated core power of 2568 MWt. Included are the required analyses as outlined in the USNRC document "Guidance for Proposed License Amendments Relating to Refueling," June 1975.

To support cycle 8 operation of Oconee 1, this report employs analytical techniques and design bases established in reports that have been submitted to and accepted by the USNRC and its predecessor (see references).

A brief summary of cycle 7 and 8 reactor parameters related to power capability is included in section 5 of this report. All of the accidents analyzed in the FSAR[1] have been reviewed for cycle 8 operation. In those cases where cycle 8 characteristics were conservative compared to those analyzed for previous cycles, no new accident analyses were performed.

Five of the fresh batch 10 assemblies are gadolinia lead test assemblies (LTA). These assemblies are part of a joint Duke Power/Babcock & Wilcox (B&W)/Department of Energy program to develop and demonstrate an advanced fuel assembly design incorporating UO_2-Gd_2O_3 for extended burnup in PWRs. Reference 2 describes the LTAs. Four Mark BZ demonstration fuel assemblies containing Zircaloy-4 intermediate spacer grids will be reinserted for a second cycle of irradiation. The Mark BZ assemblies are described in reference 3. The gadolinia LTAs and the Mark BZ assemblies will not adversely affect cycle 8 operation.

The Technical Specifications have been reviewed, and the modifications required for cycle 8 operation are justified in this report.

Based on the analyses performed, which account for the postulated effects of fuel densification and the final acceptance criteria for emergency core cooling systems, it has been concluded that Oconee Unit 1 can be operated safely for cycle 8 at the rated power level of 2568 MWt.

2. OPERATING HISTORY

The reference fuel cycle for the nuclear and thermal-hydraulic analyses of Oconee 1, cycle 8 is the currently operating cycle 7. The cycle 8 design length of 410 EFPD is based on a planned cycle 7 length of 420 EFPD. No operating anomalies have occurred during previous cycle operations that would adversely affect fuel performance in cycle 8.

3. GENERAL DESCRIPTION

The Oconee Unit 1 reactor core and fuel design basis are described in detail in section 3 of the Final Safety Analysis Report for Oconee Nuclear Station, Unit 1.[1] The cycle 8 core contains 177-fuel assemblies, each of which is a 15-by-15 array of 208 fuel rods, 16 control rod guide tubes, and one incore instrument guide tube. The fuel consists of dished-end, cylindrical pellets of uranium dioxide clad in cold-worked Zircaloy-4. The stand[illegible] Mark B fuel assemblies in all batches have an average fuel loading of 463.[illegible]g of uranium. The undensified active fuel lengths, theoretical densities, fuel and fuel rod dimensions, and other related fuel parameters are given in Tables 4-1 and 4-2.

Figure 3-1 is the core loading diagram for Oconee 1, cycle 8. The twenty batch 8A and four of the batch 8B assemblies will be discharged at the end of cycle 7, along with forty batch 7B and one batch 4E assembly. The remaining 44 batch 8 assemblies (designated 8C) and the fresh batch 10C — with initial enrichments of 3.07 and 3.41 wt % ^{235}U respectively — will be loaded into the central portion of the core. There are also five fresh batch 10 gadolinia LTAs[2] in the core interior. The center assembly, batch 10A, has an initial enrichment of 2.46 wt % ^{235}U; the four batch 10B LTAs, with an initial enrichment of 4.00 wt % ^{235}U are in locations symmetrical to H13. The batch 9 fuel, with an initial enrichment of 3.28 wt % ^{235}U, will mainly occupy the core periphery. Figure 3-2 is an eighth-core map showing the assembly burnup and enrichment distribution at the beginning of cycle 8.

Reactivity is controlled by 61 full-length Ag-In-Cd control rods, 60 burnable poison rod assemblies (BPRAs), and soluble boron shim. In addition to the full-length control rods, eight axial power shaping rods (APSRs) are provided for additional control of the axial power distribution. The cycle 8 locations of the 69 control rods and the group designations are indicated in Figure 3-3. The core locations are identical to those of the reference cycle. The cycle 8 locations and concentrations of the BPRAs are shown in Figure 3-4.

The system pressure is 2200 psia and the core average densified nominal heat rate is 5.80 kW/ft at the rated power of 2568 MWt for the standard Mark B fuel assemblies.

Figure 3-1. Core Loading Diagram for Oconee 1, Cycle 8

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A						M4 9	K2 9	C8 9**	K14 9	M12 9					
B				L3 9	N3 9	M2 9	10C	M8 9	10C	M14 9	N13 9	L13 9			
C			H9 9	10C	L5 9	10C	B6 8C	10B*	B10 8C	10C	L11 9	10C	K8 9		
D		C10 9	10C	N9 9	10C	R10 8C	10C	P8 8C	10C	R6 8C	10C	K4 9	10C	C6 9	
E		C12 9	E10 9	10C	P12 8C	10C	R9 8C	10C	R7 8C	10C	N2 8C	10C	E6 9	C4 9	
F	D11 9	B11 9	10C	L15 8C	10C	O13 8C	10C	R8 8C	10C	O3 8C	10C	L1 8C	10C	B5 9	D5 9
G	B9 9	10C	F2 8C	10C	K15 8C	10C	N14 8C	D9 9	P4 8C	10C	K1 8C	10C	F14 8C	10C	B7 9
H	H3 9**	H11 9	10B*	H14 8C	10C	H15 8C	G4 9	10A*	K12 9	H1 8C	10C	H2 8C	10B*	H5 9	H13 9**
K	P9 9	10C	L2 8C	10C	G15 8C	10C	B12 8C	N7 9	D2 8C	10C	G1 8C	10C	L14 8C	10C	P7 9
L	N11 9	P11 9	10C	F15 8C	10C	C13 8C	10C	A8 8C	10C	C3 8C	10C	F1 8C	10C	P5 9	N5 9
M		O12 9	M10 9	10C	D14 8C	10C	A9 8C	10C	A7 8C	10C	B4 8C	10C	M6 9	O4 9	
N		O10 9	10C	G12 9	10C	A10 8C	10C	B8 8C	10C	A6 8C	10C	D7 9	10C	O6 9	
O			G8 9	10C	F5 9	10C	P6 8C	10B*	P10 8C	10C	F11 9	10C	H7 9		
P				F3 9	D3 9	E2 9	10C	E8 9	10C	E14 9	D13 9	F13 9			
R						E4 9	G2 9	O8 9**	G14 9	E12 9					

X (top, column 8); Z (bottom, column 8); W — (left, row H); — Y (right, row H)

*Contains gadolinia in 12 pins.
**Mark BZ demonstration assemblies

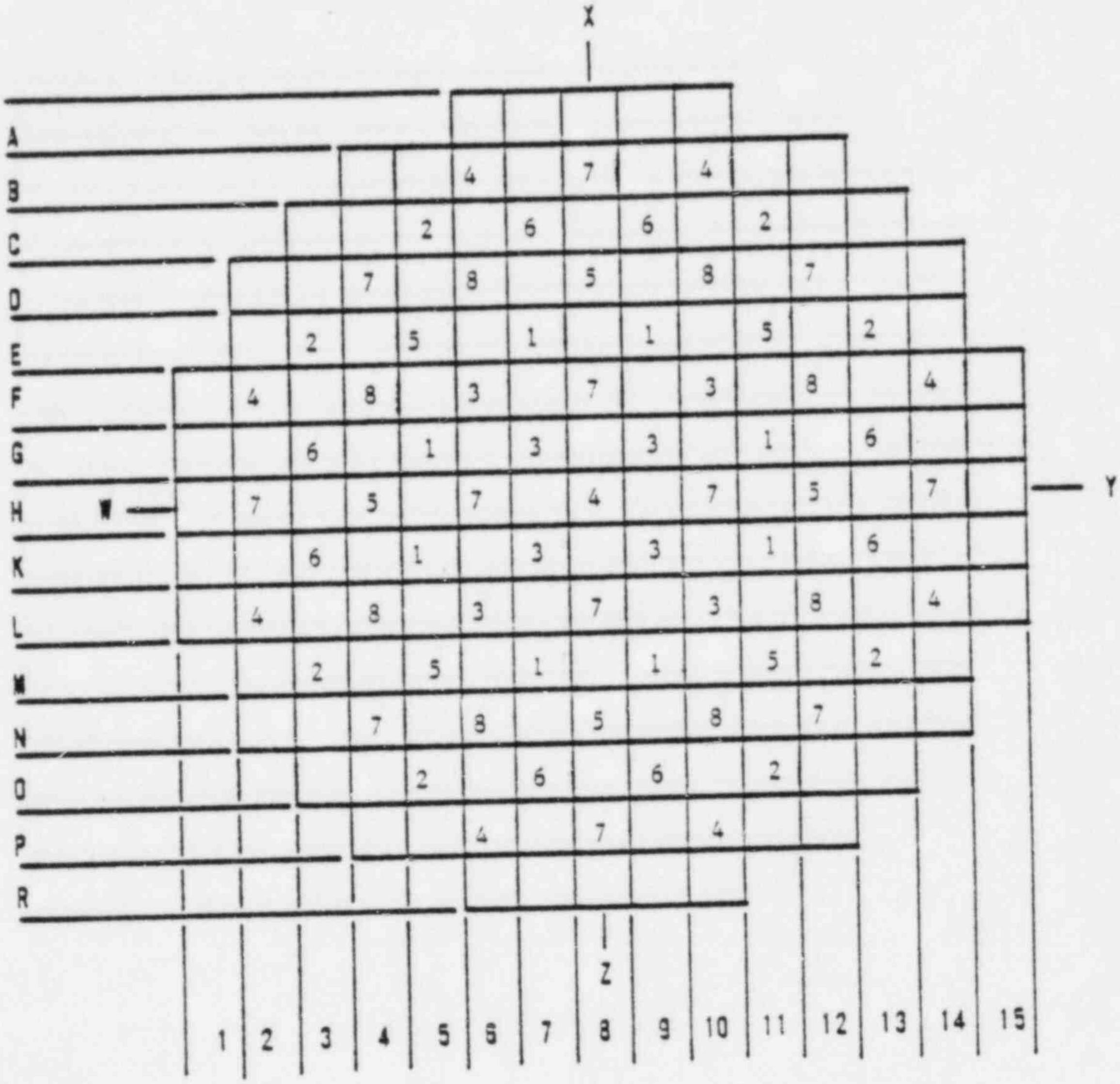
XXX	CY7 Location
XXX	Batch

Figure 3-2. Enrichment and Burnup Distribution for Oconee 1, Cycle 8

	8	9	10	11	12	13	14	15
H	2.46 LTA 0	3.28 17,266	3.07 22,019	3.41 0	3.07 27,420	4.00 LTA 0	3.28 17,407	3.28 Mark-BZ 16,810
K		3.07 18,675	3.41 0	3.07 21,075	3.41 0	3.07 22,831	3.41 0	3.28 14,173
L			3.07 22,138	3.41 0	3.07 20,541	3.41 0	3.28 11,538	3.28 16,849
M				3.07 18,687	3.41 0	3.28 17,352	3.28 13,121	
N					3.28 17,269	3.41 0	3.28 16,257	
O						3.28 15,976		
P								
R								

X.XX	Initial Enrichment
XXXXX	BOC Burnup, MWd/mtU

Figure 3-3. Control Rod Locations for Oconee 1, Cycle 8



X	GROUP NUMBER

GROUP	NO. OF RODS	FUNCTION
1	8	SAFETY
2	8	SAFETY
3	8	SAFETY
4	9	SAFETY
5	8	CONTROL
6	8	CONTROL
7	12	CONTROL
8	8	APSRs
TOTAL	69	

Figure 3-4. BPRA Concentration and Distribution for Oconee 1, Cycle 8

	8	9	10	11	12	13	14	15
H	LTA			1.10		LTA		
K			1.40		1.10		0.20	
L		1.40		1.40		0.50		
M	1.10		1.40		1.40			
N		1.10		1.40		0.20		
O	LTA		0.50		0.20			
P		0.20						
R								

X.XX — BPRA Concentration, wt % B_4C in Al_2O_3

4. FUEL SYSTEM DESIGN

4.1. Fuel Assembly Mechanical Design

The types of fuel assemblies and pertinent fuel design parameters for Oconee 1, cycle 8 are listed in Table 4-1. All the fuel assemblies are mechanically interchangeable. Four once-burned Mark BZ fuel assemblies are included in batch 9B. The Mk BZ uses Zircaloy as the material for the six intermediate spacer grids. The Mark BZ assembly is described in reference 3, which demonstrates that reactor safety and performance are not adversely affected by the presence of the four demonstration assemblies.

The five fuel assemblies in batches 10A and 10B are gadolinia LTAs. The mechanical design of the LTAs is described in reference 2.

Retainer assemblies will be used on the two fuel assemblies that contain regenerative neutron source (RNS) assemblies and on the 60 batch 10C assemblies that contain BPRAs. The justification for the design and use of the retainers is described in references 4 and 5.

4.2. Fuel Rod Design

The mechanical evaluation of the fuel rod is discussed below.

4.2.1. Cladding Collapse

The fuel assemblies of batch 8C are more limiting than those of other batches because of their longer previous incore exposure time. The power history and fuel design parameters for the most limiting batch 8C fuel assembly were compared with those used in the generic Mk-B creep collapse analysis and were found to be enveloped. The generic analysis was based on the methods and procedures described in reference 6 and is applicable to the batch 8C fuel design. The generic analysis predicts a collapse time of more than 35,000 EFPH, which exceeds the maximum projected residence time of 29112 EFPH (Table 4-1).

A detailed creep analysis was performed on the gadolinia bearing fuel rods in the LTAs. The collapse time for these rods was greater than the maximum projected residence time.

4.2.2. Cladding Stress

The stress parameters for the Oconee 1 standard fuel rods and the gadolinia bearing fuel rods are enveloped by a conservative fuel rod stress analysis. The following four assumptions were used in this analysis:

1. A lower post-densification internal pressure.
2. A lower initial pellet density.
3. A higher system pressure.
4. A higher thermal gradient across the cladding.

For design evaluation, the primary membrane stress must be less than two-thirds of the minimum specified unirradiated yield strength, and all stresses (primary and secondary) must be less than the minimum specified unirradiated yield strength. In all cases, the margin is in excess of 30%.

4.2.3. Cladding Strain

The fuel design criteria specify that the cladding average circumferential strain is not to exceed 1.0% inelastic strain. The pellet design is established for plastic cladding strain of less than 1% at maximum design local pellet burnup and heat generation rate values that are higher than the values the Oconee 1 UO_2 fuel is expected to see. Strain analysis of the gadolinia fuel showed that the calculated strains for these rods are also below design limits. Thus, fuel rod cladding strain will not affect cycle 8 fuel performance.

4.3. Thermal Design

All fuel in the cycle 8 core is thermally similar except the five LTAs. The fresh batch 10C fuel inserted for cycle 8 operation introduces no significant differences in fuel thermal performance relative to the fuel remaining in the core. The fresh batch 10A and 10B fuel containing the gadolinia LTA demonstration assemblies have different fuel performance characteristics, but are not more limiting than the remainder of the core.

The cycle 8 thermal analyses represent a change in analytical method in that the fresh batches of fuel have been analyzed with the TACO2[7] code using the methodology described in reference 8. As shown in Table 4-2, the analysis uses nominal undensified input parameters. The TACO2 code densification model accounts for densification effects. TACO2 analyses also apply to reinserted batch 8C and 9 fuel since this fuel is identical in design to batch 10C.

Results of the thermal design evaluation for the cycle 8 core are summarized in Table 4-2. The TACO2 fuel performance code was used to determine linear heat rate to melt capabilities for batch 8C, 9, and 10 fuel (95% TD nominal initial density). Maximum linear heat rate to centerline melt was determined as a function of fuel burnup. The lowest maximum linear heat rate was 20.5 kW/ft for 8C, 9, and 10C batches of fuel. The lowest maximum linear heat rate for the batch 10A and 10B LTA gadolinia fuel is 17.6 kW/ft.

The maximum fuel rod burnup at EOC 8 is predicted to be 40,238 MWd/mtU. Fuel rod internal pressure was evaluated with the TACO2 computer code for the highest burnup fuel rod and is predicted to be less than the nominal RC system pressure of 2200 psia.

4.4. Material Design

The batch 10 fuel assemblies are not new in concept, nor do they utilize different component materials, except for the Zircaloy grids of the four Mark BZ assemblies and the UO_2 -Gd_2O_3 pellets in the LTAs. Therefore, the chemical compatibility of all possible fuel-cladding-coolant-assembly interactions for the batch 10 fuel assemblies is acceptable.

4.5. Operating Experience

B&W operating experience with the Mark B 15-by-15 fuel assembly has verified the adequacy of its design. As of October 31, 1982, the following experience has been accumulated for the eight operating B&W 177-fuel assembly plants using the Mark B fuel assembly:

Reactor	Current cycle	Max assembly burnup[a], MWd/mtU Incore	Discharged	Cumulative net electrical output,[b] MWh
Oconee 1	7	44,850	40,000	38,723,077
Oconee 2	6	23,750	36,800	34,354,735
Oconee 3	7	20,200	35,450	36,772,920
TMI-1	5	25,000	32,400	23,840,053
ANO-1	5	36,429	33,220	32,834,786
Rancho Seco	5	35,821	37,730	28,636,196
Crystal River 3	4	24,360	29,900	19,803,456
Davis Besse	3	25,742	25,326	12,021,378

[a] As of October 31, 1982.

[b] As of May 31, 1982.

Table 4-1. Fuel Design Parameters and Dimensions

	Batch 8C	Batch 9	Batch 10A/10B/10C
FA type	Mark B4	Mark B4/ Mark BZ	Mark GdB/Mark GdB/ Mark B4
No. of FAs	44	64/4	1/4/60
Fuel rod OD, in.	0.430	0.430	0.430
Fuel rod ID, in.	0.377	0.377	0.377
Flex spacers, type	Spring	Spring	Spring
Rigid spacers, type	Zr-4	Zr-4	Zr-4
Undensified active fuel length (nominal), in.	141.38	141.8	141.8/143.5/141.8
Fuel pellet initial density (nominal), % TD	95	95	95
Fuel pellet OD (mean specification), in.	0.3686	0.3686	0.3686
Initial fuel enrichment, wt % ^{235}U	3.07	3.28	2.46/4.0/3.41
BOC burnup (avg), MWd/mtU	21,622	15,488	0
Cladding collapse time, EFPH	>35,000	>35,000	>35,000
Estimated residence time, (max), EFPH	29,112	19,920	10,080

Table 4-2. Fuel Thermal Analysis Parameters — Oconee 1, Cycle 8

	Batch				
	8C	9[a]	10A[b]	10B[c]	10C
No. of assemblies	44	68	1	4	60
Nominal pellet density % TD	95	95	95	95	95
Pellet diameter, in.	0.3686	0.3686	0.3686	0.3686	0.3686
Stack height, in.	141.38	141.8	141.8	143.5	141.8
Nominal LHR @ 2568 MWt kW/ft	5.76	5.74	5.74	5.68	5.74
LHR to ℄ fuel melt, kW/ft	20.5	20.5	17.6[d]	17.6[d]	20.5

(a) Includes four Mark BZ demonstration assemblies.

(b) One gadolinia LTA.

(c) Four gadolinia LTAs.

(d) Gadolinia bearing rods only. Uranium rods have limits $\geq$ 20.5 kW/ft.

5. NUCLEAR DESIGN

5.1. Physics Characteristics

Table 5-1 compares the core physics parameters of design cycle 8 with those of the reference cycle 7. The values for both cycles were generated using PDQ07[9-11]. Because of its shorter length, the average cycle 8 burnup will be lower than that of design cycle 7. Figure 5-1 illustrates a representative relative power distribution for the beginning of cycle 8 at full power with equilibrium xenon and normal rod positions.

Since the core has not yet reached an equilibrium cycle, differences in core physics parameters are to be expected between the cycles. The critical boron concentrations for cycle 8 are lower because of the shorter cycle length and the higher average burnable poison enrichment. The control rod worths differ between cycles due to changes in radial flux and burnup distributions. This also accounts for the larger ejected and stuck rod worths in cycle 8 compared to cycle 7 values. Calculated ejected rod worths and their adherence to criteria are considered at all times in life and at all power levels in the development of the rod position limits presented in section 8. These rod worths meet all safety criteria. The adequacy of the shutdown margin with cycle 8 stuck rod worths is demonstrated in Table 5-2. The following assumptions were applied for the shutdown calculations:

1. Poison material depletion allowance.
2. 10% uncertainty on net rod worth.
3. Flux redistribution penalty.

Flux redistribution was accounted for since the shutdown analysis was calculated using a two-dimensional model. The reference fuel cycle shutdown margin is presented in the reload report for Oconee 1, cycle 7[12]. The cycle 8 power deficits, differential boron worths, and effective delayed neutron fractions differ from those for cycle 7 because of the shorter cycle length and lower critical boron concentrations.

5.2. Analytical Input

The constants used to compute core power distributions from incore detector measurements were obtained in the same manner for cycle 8 as for the reference cycle 7. The monitoring of power distributions in the LTAs is discussed in reference 2.

5.3. Changes in Nuclear Design

There are five fresh fuel assemblies, with 12 gadolinia fuel pins each, that are fully described in reference 2. Their effect on the core design is not significant, because the cycle 8 design meets all criteria including those applicable to radial power peaking, ejected rod worths, and shutdown margin.

Table 5-1. Oconee 1 Physics Parameters[a]

	Cycle 7[b]	Cycle 8[c]
Cycle length, EFPD	427	410
Cycle burnup, MWd/mtU	13,363	12,858
Average core burnup, EOC, MWd/mtU	22,505	24,183
Initial core loading, mtU	82.1	82.1
Critical boron, BOC (no Xe), ppm		
HZP[d], group 8 inserted	1628	1602
HFP[d], group 8 inserted	1464	1365
Critical boron, EOC (eq Xe), ppm		
HZP, group 8 inserted	380	401
HFP, group 8 inserted	68	60
Control rod worths, HFP, BOC, % Δk/k		
Group 6	0.97	0.98
Group 7	1.45	1.47
Group 8	0.47	0.42
Control rod worths, HFP, EOC, % Δk/k		
Group 7	1.54	1.54
Group 8	0.53	0.49
Max ejected rod worth, HZP, % Δk/k[e]		
BOC (N-12)	0.55	0.59
EOC (N-12)	0.62	0.48
Max stuck rod worth, HZP, % Δk/k		
BOC (N-12)	1.44	1.68
EOC (N-12)	1.65	1.72
Power deficit, HZP to HFP, % Δk/k		
BOC	1.35	1.62
EOC	2.25	2.36
Doppler, coeff., 10^{-5} (Δk/k/F)		
BOC, 100% power, no Xe	-1.52	-1.54
EOC, 100% power, eq Xe	-1.62	-1.78
Moderator coeff, HFP, 10^{-4} (Δk/k/F)		
BOC (0 Xe, crit ppm, gp 8 ins)	-0.48	-0.67
EOC (eq Xe, 17 ppm, gp 8 ins)	-2.87	-2.85
Boron worth, HFP. ppm/% Δk/k		
BOC (1300 ppm)	123	129
EOC (17 ppm)	105	110

Table 5-1. (Cont'd)

	Cycle 7[b]	Cycle 8[c]
Xenon worth, HFP, % Δk/k		
BOC (4 EFPD)	2.58	2.54
EOC (equilibrium)	2.74	2.67
Eff delayed neutron fraction, HFP		
BOC	0.00626	0.00625
EOC	0.00520	0.00526

[a] Cycle 8 data are for the conditions stated in this report. The cycle 7 core conditions are identified in reference 12.

[b] Based on 372 EFPD at 2568 MWt, cycle 6.

[c] Cycle 8 data are based on a cycle 7 length of 420 EFPD.

[d] HZP denotes hot zero power (532F T_{avg}); HFP denotes hot full power (579F T_{avg}).

[e] Ejected rod worth for groups 5 through 8 inserted.

Table 5-2. Shutdown Margin Calculation for Oconee 1, Cycle 8

	BOC, % Δk/k	EOC, % Δk/k
Available Rod Worth		
Total rod worth, HZP	8.53	9.19
Worth reduction due to burnup of poison material	-0.42	-0.42
Maximum stuck rod, HZP	-1.68	-1.72
Net worth	6.43	7.05
Less 10% uncertainty	-0.64	-0.71
Total available worth	5.79	6.34
Required Rod Worth		
Power deficit, HFP to HZP	1.62	2.36
Max allowable inserted rod worth	0.30	0.50
Flux redistribution	0.76	1.20
Total required worth	2.68	4.06
Shutdwon margin (total available worth minus total required worth)	3.11	2.28

Note: Required shutdown margin is 1.00% Δk/k.

Figure 5-1. Oconee 1, Cycle 8 BOC (4 EFPD) Two-Dimensional Relative Power Distribution — Full Power, Equilibrium Xenon, Normal Rod Positions

	8	9	10	11	12	13	14	15
H	0.968 LTA	1.120	1.063	1.287	0.979	1.159 LTA	1.015	0.567 Mark-BZ
K		1.065	1.270	1.088	1.236	1.016	1.173	0.574
L			1.082	1.259	0.980 (rod group 8)	1.287	0.962	0.420
M				1.128	1.266	1.097	0.718	
N					1.190	1.071	0.466	
O						0.579		
P								
R								

Legend: X — INSERTED ROD GROUP NO.; X.XXX — RELATIVE POWER DENSITY

6. THERMAL-HYDRAULIC DESIGN

Incoming batch 10 fuel is hydraulically and geometrically similar to the fuel remaining in the core from previous cycles. Thermal-hydraulic design evaluation supporting cycle 8 operation used the methods and models described in references 3, 4, and 13.

Cycle 8 maximum design conditions remain unchanged from cycle 7 and are shown in Table 6-1. The four Mark BZ demonstration assemblies and five LTA demonstration assemblies will be conservatively limited to a design peak of 1.61 (6% peaking reduction) to ensure that they are not thermally limiting. A 1.71 design radial-local peak remains valid for all other assemblies in this cycle.

A rod bow penalty has been calculated according to the procedure approved in reference 14. The maximum fuel assembly burnup of the batch that contains the limiting (maximum radial-local peak) fuel assembly is used. For cycle 8, this burnup is 17,511 in a batch 10C assembly. The resultant net rod bow penalty, after inclusion of the 1% flow area reduction factor credit, is 0.2% reduction in DNBR. Thermal-hydraulic design for cycle 8 includes a margin greater than 0.2% above the minimum DNBR of 1.30.

Table 6-1. Thermal-Hydraulic Design Conditions

	Cycle 7	Cycle 8
Power level, MWt	2568	2568
System pressure, psia	2200	2200
Reactor coolant flow, % design flow	106.5	106.5
Vessel inlet coolant temp, 100% power, F	555.6	555.6
Vessel outlet coolant temp, 100% power, F	602.4	602.4
Ref design axial flux shape	1.5 cos	1.5 cos
Ref design radial-local power peaking factor	1.71	1.71
Active fuel length, in.	(a)	(a)
Average heat flux, 100% power, 10^3 Btu/h-ft^2	176[b]	176[b]
CHF correlation	BAW-2	BAW-2
Hot channel factors		
Enthalpy rise	1.011	1.011
Heat flux	1.014	1.014
Flow area	0.98	0.98
Minimum DNBR with densification penalty	2.05	2.05

[a] See Table 4-2.

[b] Based on densified length of 140.3 in.

7. ACCIDENT AND TRANSIENT ANALYSIS

7.1. General Safety Analysis

Each FSAR[1] accident analysis has been examined with respect to changes in cycle 8 parameters to determine the effect of the cycle 8 reload and to ensure that thermal performance during hypothetical transients is not degraded.

The effects of fuel densification on the FSAR accident results have been evaluated and are reported in BAW-1388.[13] Since batch 10 reload fuel assemblies contain fuel rods with higher theoretical density than those considered in the reference 13 report, the conclusions in that reference are still valid.

7.2. Accident Evaluation

The key parameters in determining the outcome of a transient can typically be classified in three major areas: core thermal parameters, thermal-hydraulic parameters, and kinetics parameters, including the reactivity feedback coefficients and control rod worths.

Core thermal properties used in the FSAR accident analysis were design operating values based on calculational values plus uncertainties. Fuel thermal analysis values for each batch in cycle 8 are compared in Table 4-2. The cycle 8 thermal-hydraulic maximum design conditions are compared to the previous cycle 7 values in Table 6-1. These parameters are common to all of the accidents considered in this report. The key kinetics parameters from the FSAR and cycle 8 are compared in Table 7-1.

A generic LOCA analysis for the B&W 177-FA, lowered-loop NSS has been performed using the final acceptance criteria ECCS evaluation model. This study is reported in BAW-10103, Rev. 1.[15] The analysis in BAW-10103 is generic since the limiting values of key parameters for all plants in this category were used. Furthermore, the combination of average fuel temperature as a function of LHR and the lifetime pin pressure data used in the BAW-10103 LOCA limits analysis is conservative compared to those calculated for this reload. Thus, the analysis and the LOCA limits reported in BAW-10103 provide conservative results for the operation of Oconee 1, cycle 8 fuel.

Table 7-2 shows the bounding values for allowable LOCA peak LHRs for Oconee 1, cycle 8 fuel after 50 EFPD. The LOCA kW/ft limits have been reduced for the first 50 EFPDs in order to account for mechanistic fuel densification. The reduction will ensure that conservative limits are maintained while a transition is being made in the performance codes that provide input to the ECCS analysis[16]. The reduced limits for the first 50 EFPD are shown in Table 7-3.

The Oconee 1, cycle 8 core contains four Mark BZ demonstration assemblies and five gadolinia LTAs. As a result of material and geometrical differences, these nine assemblies have LOCA kW/ft limits that are lower in some cases than the standard Mark B limits. Both the Mark BZ assemblies and LTAs are being loaded in the core in a manner to ensure that there is sufficient margin to offset any negative impact on the LOCA kW/ft limits.

It is concluded from the examination of cycle 8 core thermal and kinetics properties, with respect to acceptable previous cycle values, that this core reload will not adversely affect the ability of the Oconee 1 plant to operate safely during cycle 8. Considering the previously accepted design basis used in the FSAR and subsequent cycles, the transient evaluation of cycle 8 is considered to be bounded by previously accepted analyses. The initial conditions for the transients in cycle 8 are bounded by the FSAR[1], the fuel densification report[13], and/or subsequent cycle analyses.

The radiological dose consequences of the accidents presented in chapter 15 of the FSAR were recalculated using the specific parameters applicable to cycle 8. The bases used in the dose calculations are identical to those in the FSAR except that updated dose conversion factors were used. The use of the updated dose conversion factors resulted in reduced whole body dose values.

Table 7-4 compares the revised FSAR dose values with those calculated specifically for cycle 8. As can be seen from the table, some cycle 8 doses vary slightly from the FSAR values. However, all cycle 8 doses are either bounded by the values presented in the FSAR or are a small fraction of the 10 CFR 100 limits, i.e. below 30 REM to the thyroid or 2.5 REM to the whole body. Thus, the radiological impact of the accidents during cycle 8 are not significantly different than those described in chapter 15 of the FSAR.

Table 7-1. Comparison of Key Parameters for Accident Analysis

Parameter	FSAR and densification report value	Predicted cycle 8 value
Doppler coeff, 10^{-5} Δk/k/F		
BOC	-1.17	-1.54
EOC	-1.33	-1.78
Moderator coeff, 10^{-4} Δk/k/F		
BOC	+0.5	-0.67
EOC	-3.0	-2.85
All-rod group worth at HZP, % Δk/k	10	8.53
Initial boron conc'n at HFP, ppm	1400	1365
Boron reactivity worth at 70F, ppm/1% Δk/k	75	91
Max ejected rod worth at HFP, % Δk/k	0.65	0.35
Dropped rod worth (HFP), % Δk/k	0.46	0.20

Table 7-2. LOCA Limits, Oconee 1, Cycle 8, After 50 EFPD

Elevation, ft	LHR limits, kW/ft
2	15.5
4	16.6
6	18.0
8	17.0
10	16.0

Table 7-3. LOCA Limits, Oconee 1, Cycle 8, 0-50 EFPD

Elevation, ft	LHR limits, kW/ft
2	14.5
4	16.1
6	17.5
8	17.0
10	16.0

Table 7-4. Comparison of FSAR and Cycle 8 Accident Doses

	FSAR doses,[a] rem	Cycle 8 doses, rem
1. Fuel Handling Accident		
Thyroid dose at EAB, 2 h	0.50	0.51
Whole body dose at EAB, 2 h	0.028	0.010
2. Steam Line Break		
Thyroid dose at EAB, 2 h	0.20	0.20
Whole body dose at EAB, 2 h	0.002	0.001
3. Steam Generator Tube Failure		
Thyroid dose at EAB, 2 h	0.31	0.32
Whole body dose at EAB, 2 h	0.058	0.027
4. Waste Gas Tank Rupture		
Thyroid dose at EAB, 2 h	0.27	0.28
Whole body dose at EAB, 2 h	0.17	0.079
5. Control Rod Ejection Accident		
Thyroid dose at EAB, 2 h	1.44	1.38
Whole body dose at EAB, 2 h	0.004	0.002
Thyroid dose at LPZ, 30 days	1.57	1.53
Whole body dose at LPZ, 30 days	(b)	0.002
6. Loss of Coolant Accident		
Thyroid dose at EAB, 2 h	5.0	4.94
Whole body dose at EAB, 2 h	0.010	0.005
Thyroid dose at LPZ, 30 days	5.5	5.48
Whole body dose at LPZ, 30 days	0.010	0.007
7. Maximum Hypothetical Accident		
Thyroid dose at EAB, 2 h	193	193
Whole body dose at EAB, 2 h	1.4	1.12
Thyroid dose at LPZ, 30 days	180	180
Whole body dose at LPZ, 30 days	0.62	0.44

(a) FSAR changed since cycle 7 reload.

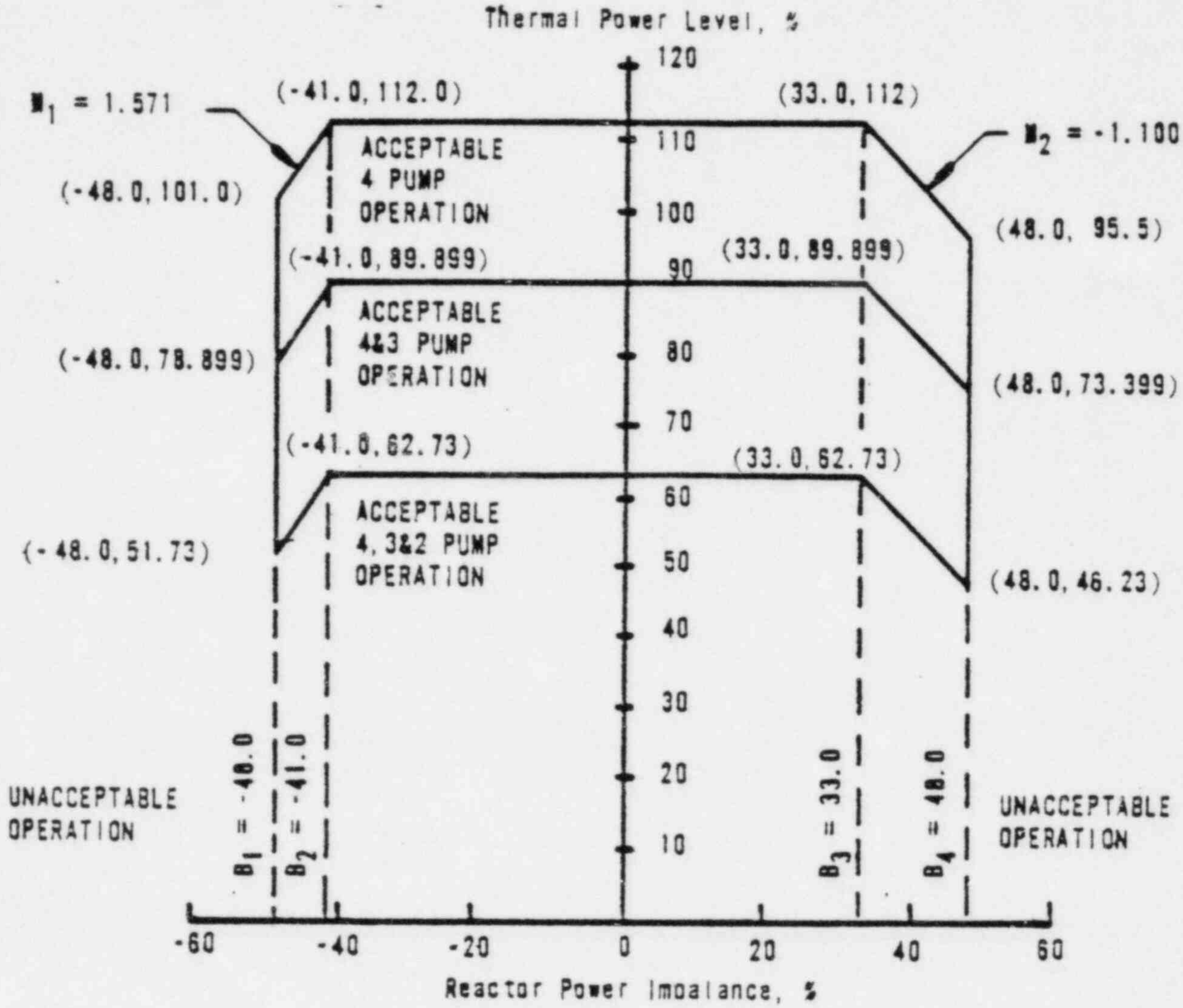
(b) Not listed in FSAR.

8. PROPOSED MODIFICATIONS TO TECHNICAL SPECIFICATIONS

The Technical Specifications have been revised for cycle 8 operation in accordance with the methods of references 17-19 to account for changes in power peaking and control rod worths.

Based on the Technical Specifications derived from the analyses presented in this report, the final acceptance criteria ECCS limits will not be exceeded, and the thermal design criteria will not be violated. Figures 8-1 through 8-12 are revisions to previous Technical Specification limits.

Figure 8-1. Core Protection Safety Limits for Oconee Unit 1



CURVE	RC FLOW (GPM)
1	374,880
2	280,035
3	183,690

Figure 8-2. Protective System Maximum Allowable Setpoints for Oconee Unit 1

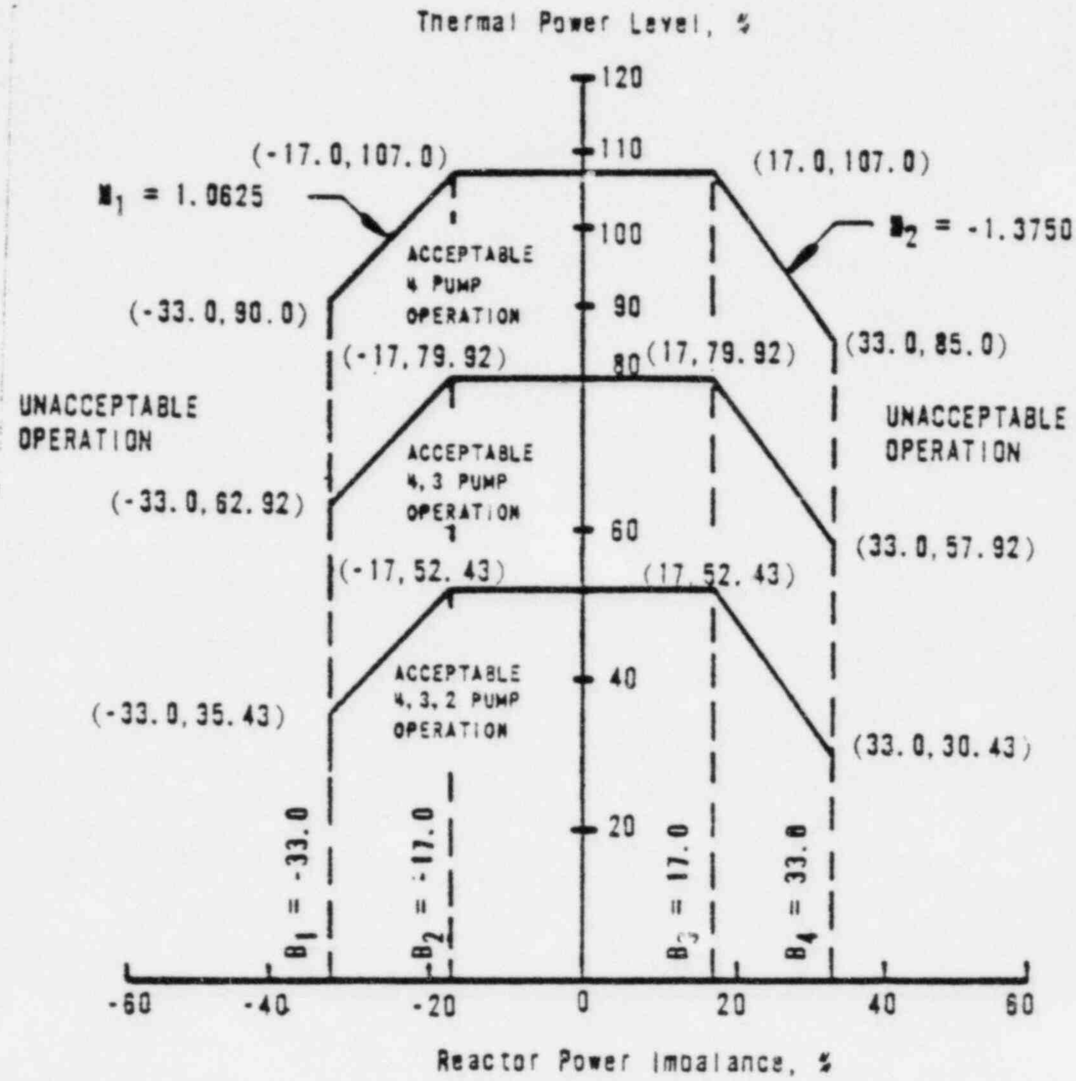


Figure 8-3. Rod Position Limits for Four-Pump Operation, 0-50 EFPD, Oconee 1, Cycle 8

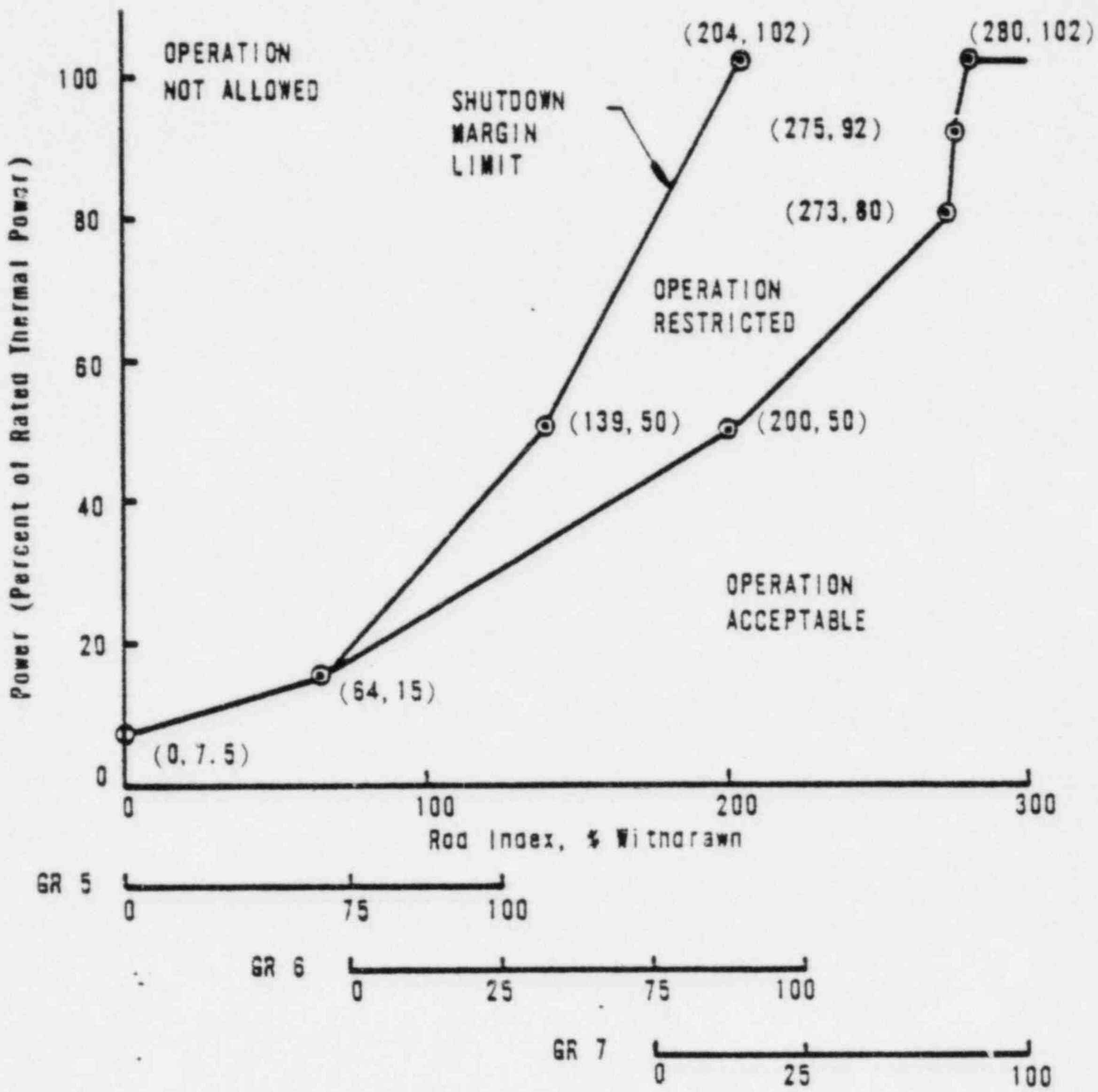


Figure 8-4. Rod Position Limits for Four-Pump Operation After 50 EFPD, Oconee 1, Cycle 8

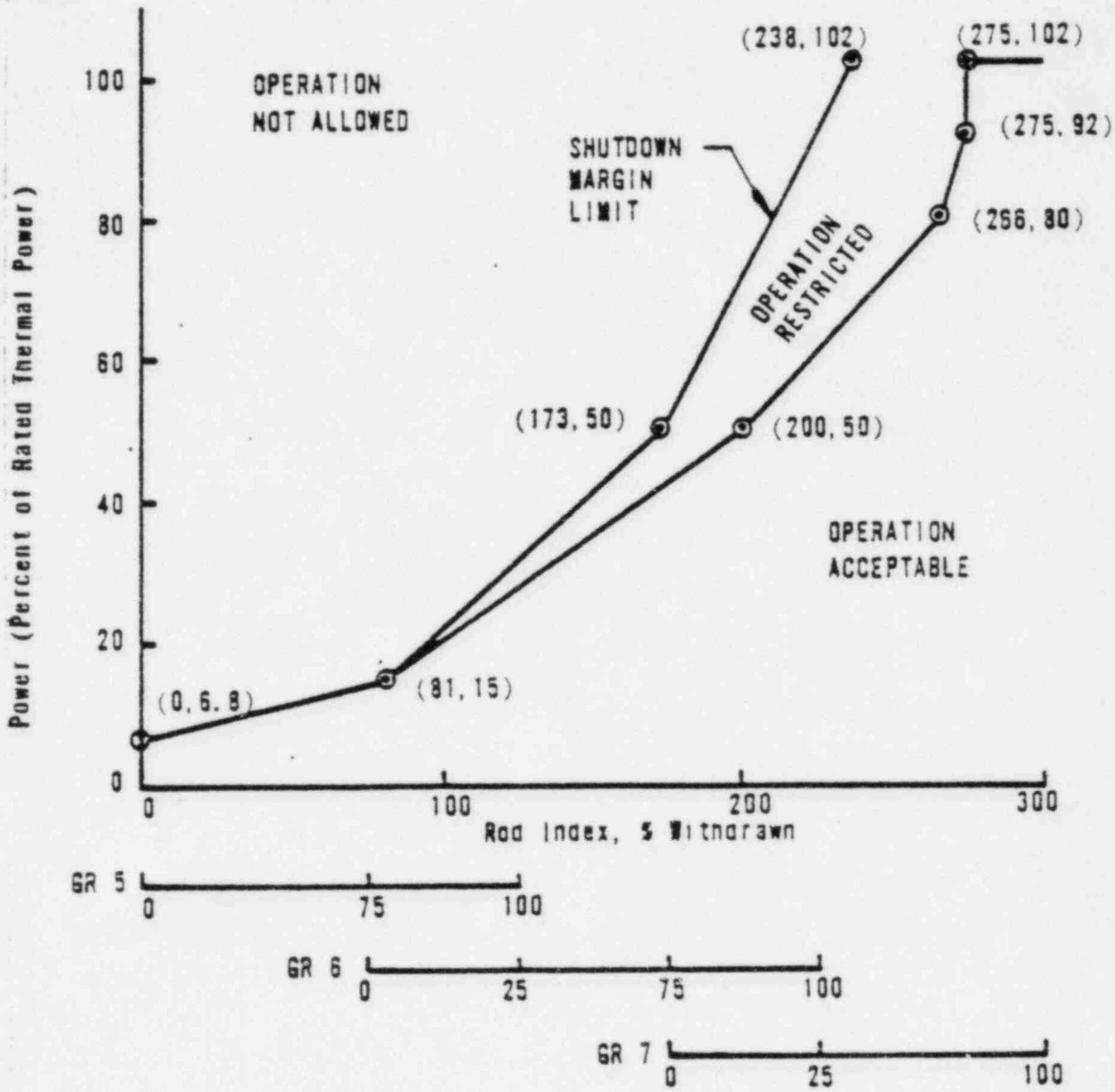


Figure 8-5. Rod Position Limits for Three-Pump Operation, 0-50 EFPD, Oconee 1, Cycle 8

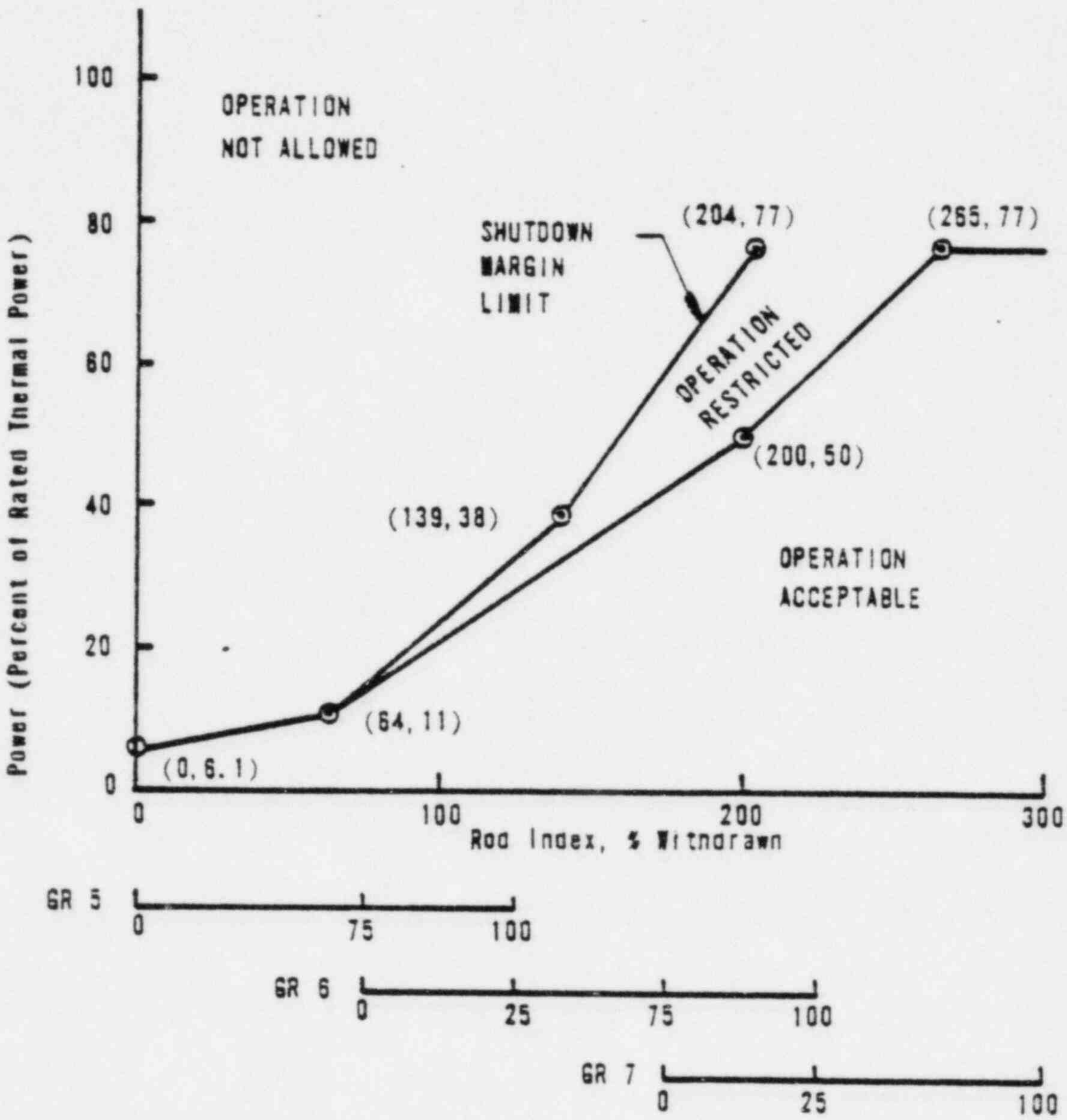


Figure 8-6. Rod Position Limits for Three-Pump Operation After 50 EFPD, Oconee 1, Cycle 8

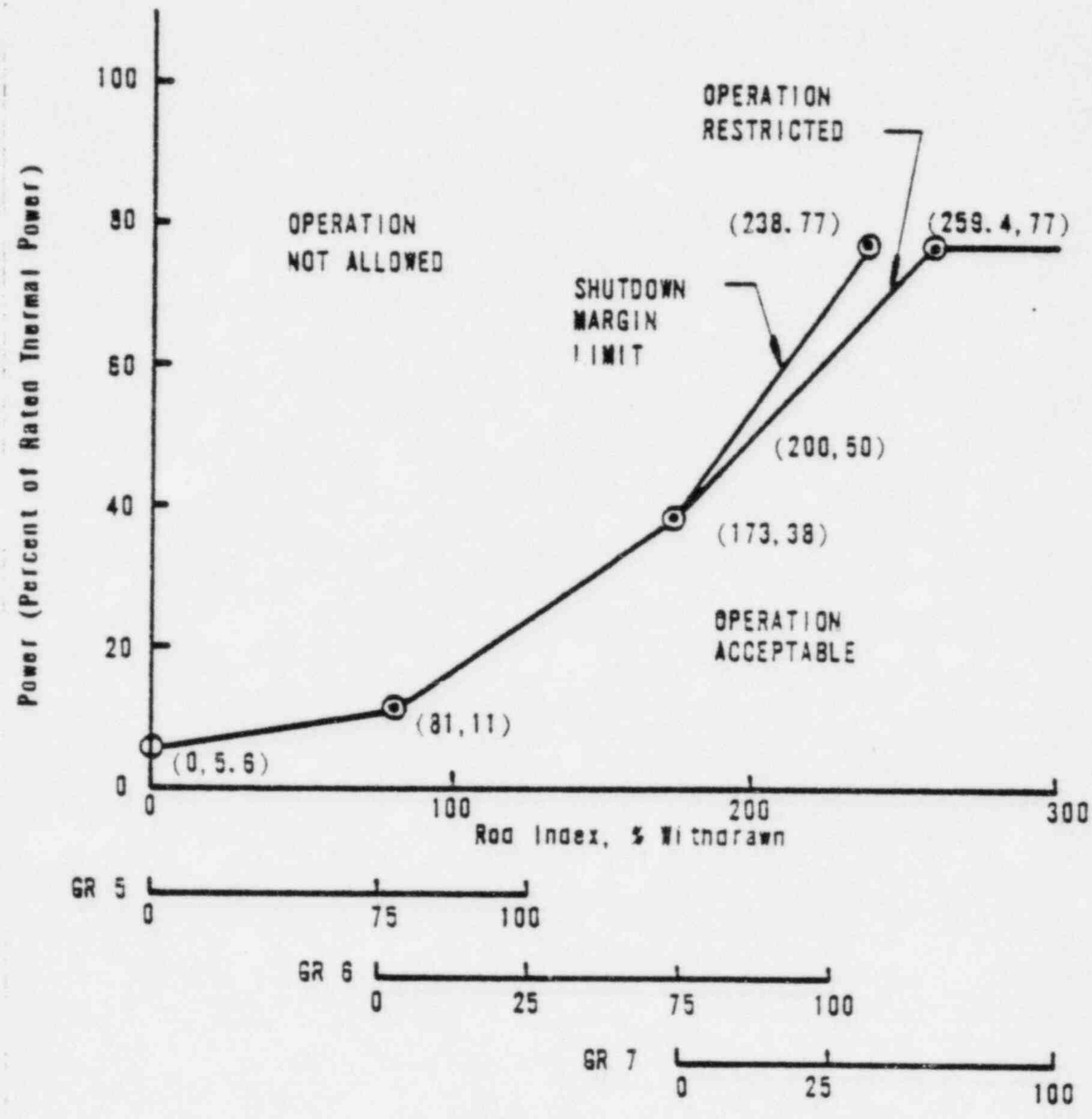


Figure 8-7. Rod Position Limits for Two-Pump Operation, 0-50 EFPD, Oconee 1, Cycle 8

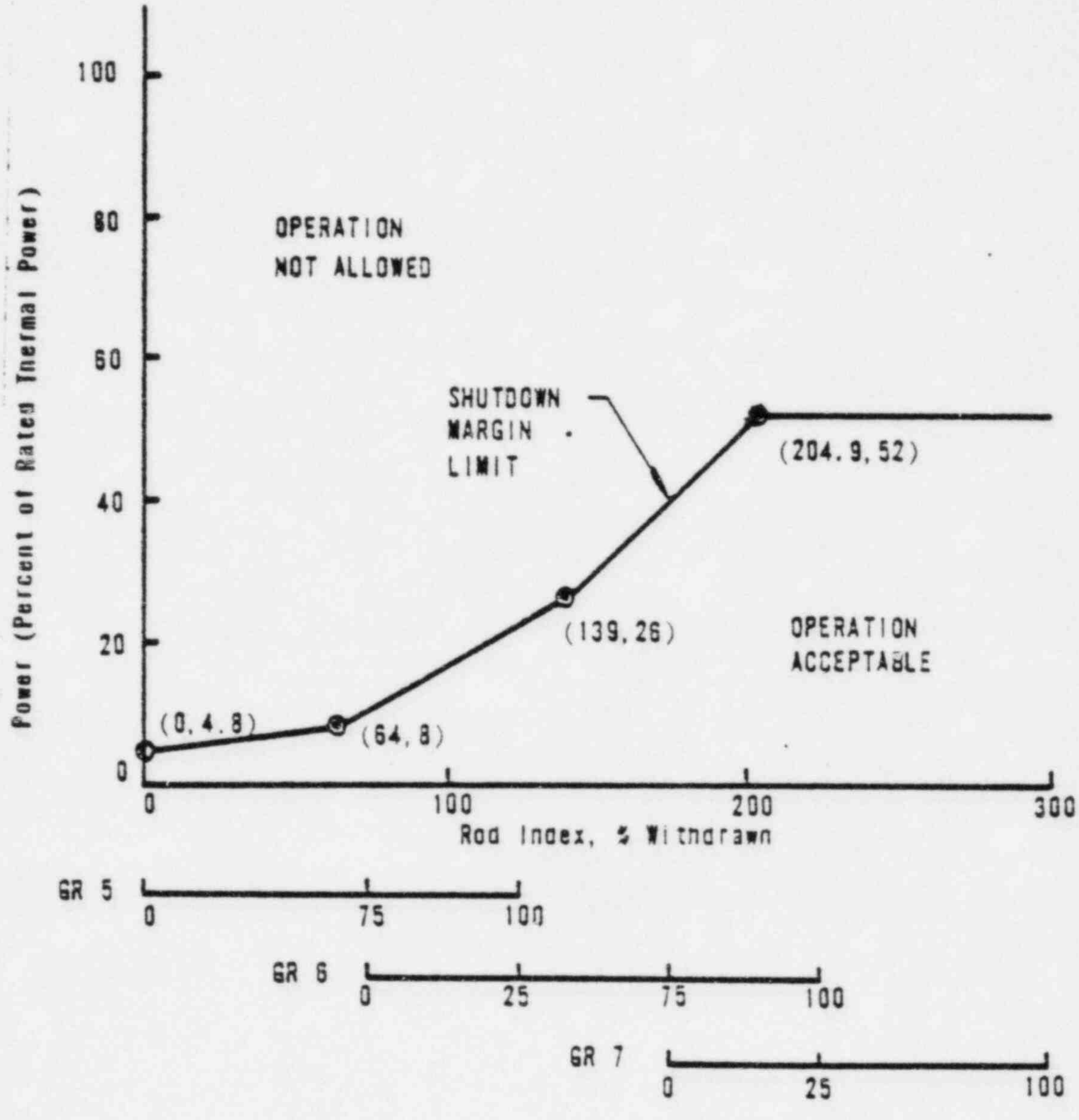


Figure 8-8. Rod Position Limits for Two-Pump Operation After 50 EFPD, Oconee 1, Cycle 8

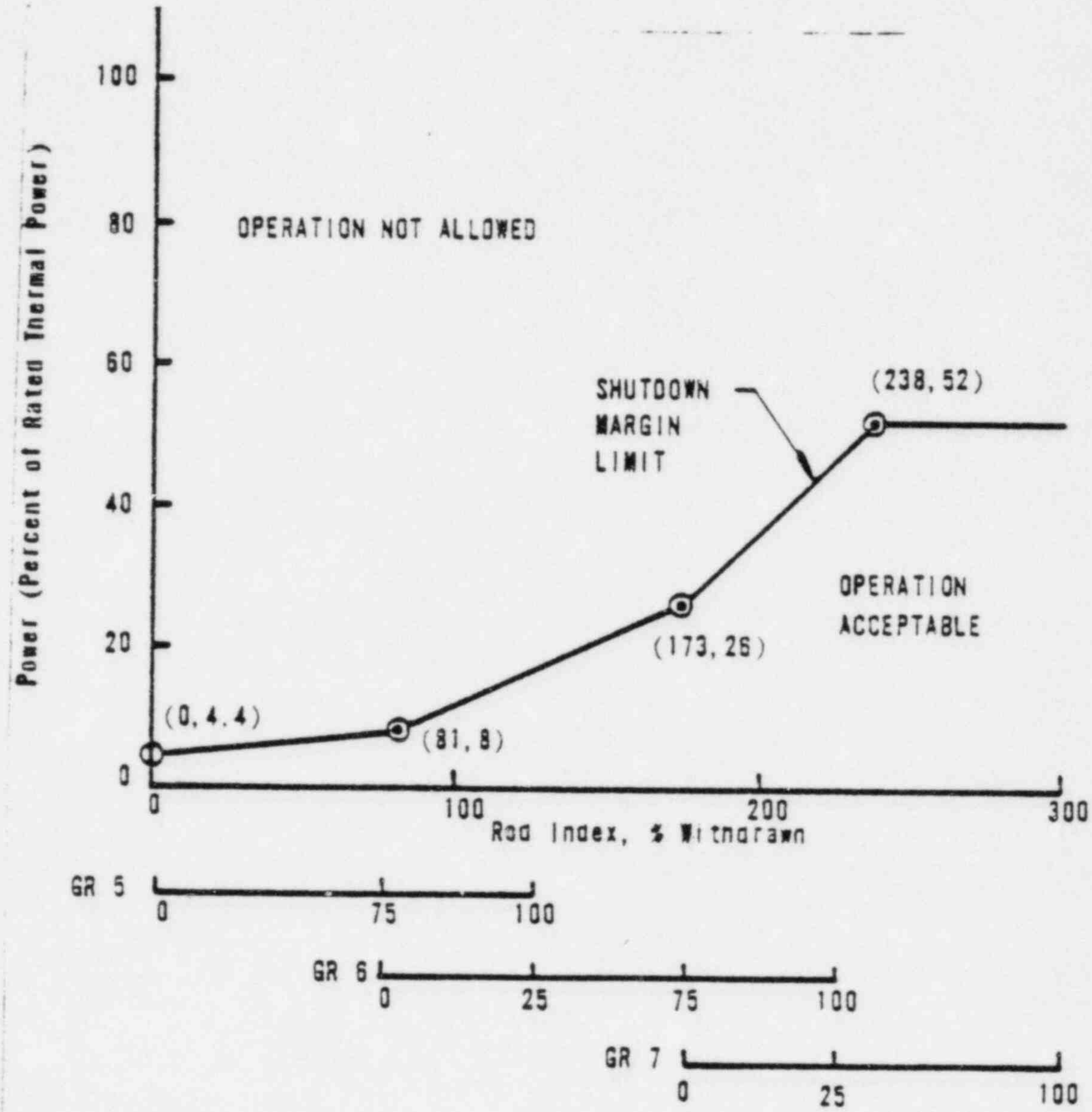


Figure 8-9. Power Imbalance Limits for 0-50 EFPD, Oconee 1, Cycle 8

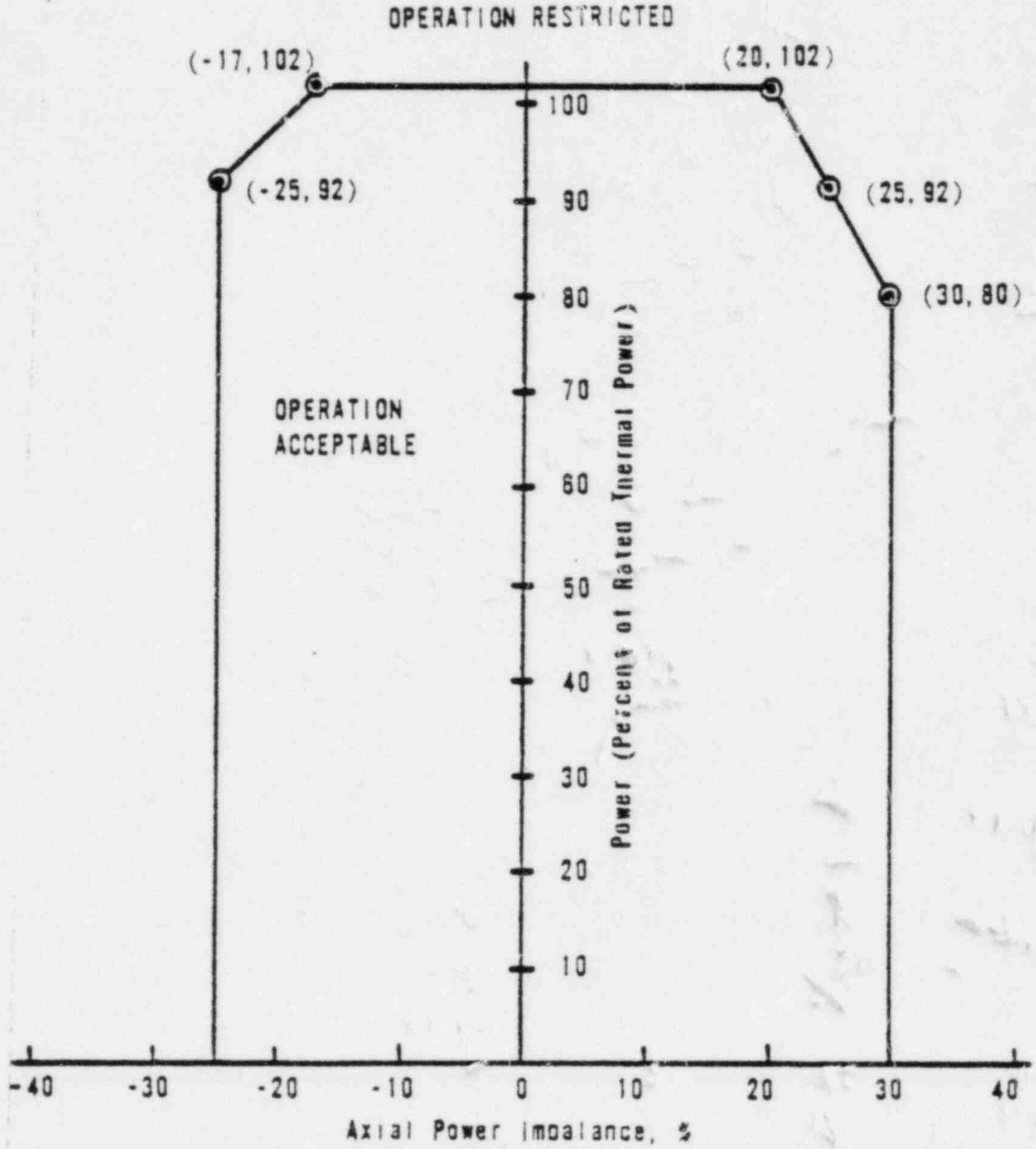


Figure 8-10. Power Imbalance Limits After 50 EFPD, Oconee 1, Cycle 8

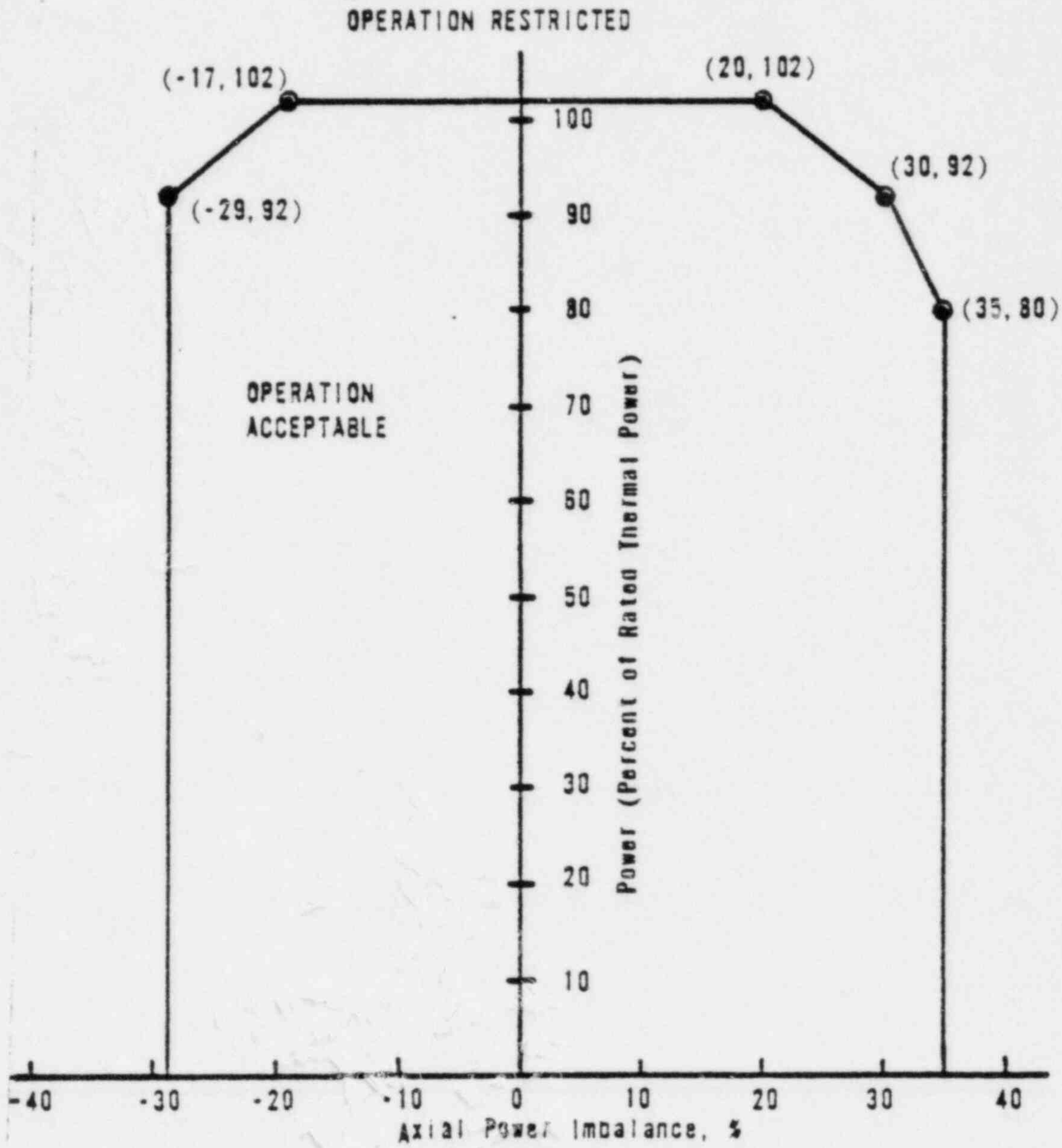


Figure 8-11. APSR Position Limits for 0-50 EFPD, Oconee 1, Cycle 8

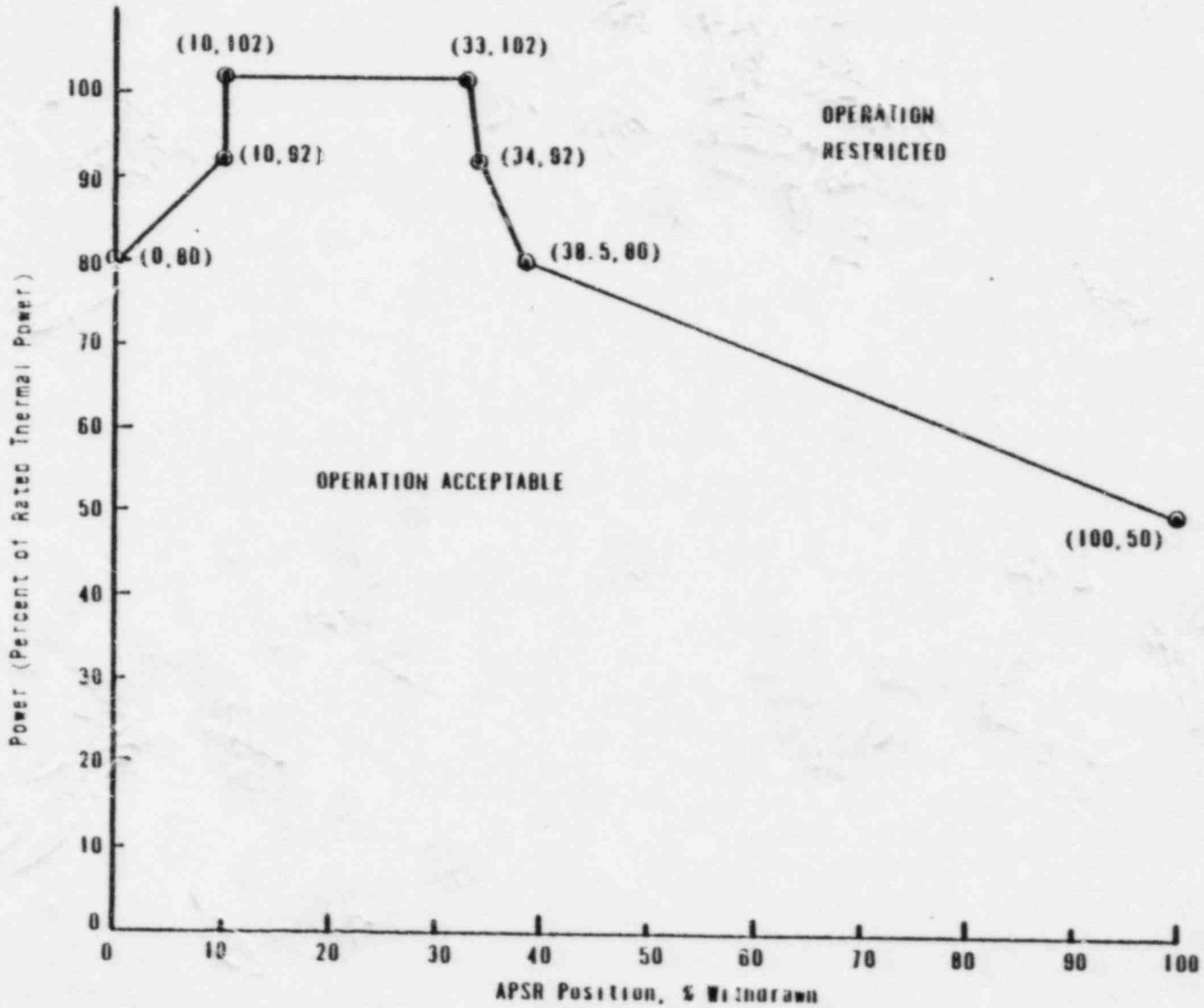
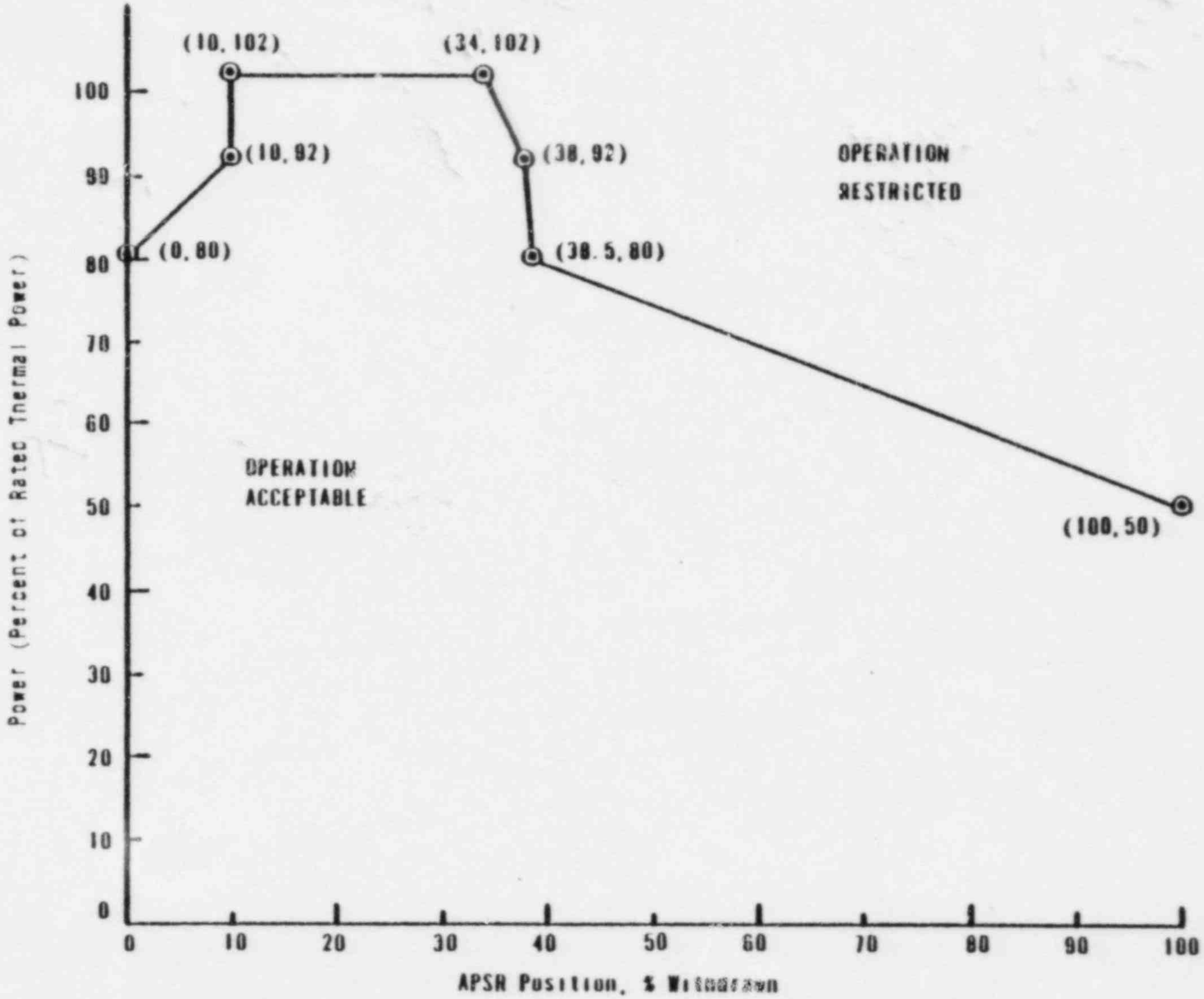


Figure 8-12. APSR Position Limits After 50 EFPD, Oconee 1, Cycle 8



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