

CURVE	REACTOR COOLANT FLOW (GPM)
1	374,880
2	280,035
3	184,441

ARKANSAS POWER AND LIGHT
CORE PROTECTION SAFETY LIMITS

9b

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469

Figure 2.1-2

The power level trip set point produced by the power-to-flow ratio provides both high power level and low flow protection in the event the reactor power level increases or the reactor coolant flow rate decreases. The power level trip set point produced by the power to flow ratio provides overpower DNB protection for all modes of pump operation. For every flow rate there is a maximum permissible power level, and for every power level there is a minimum permissible low flow rate. Typical power level and low flow rate combinations for the pump situations of Table 2.3-1 are as follows:

1. Trip would occur when four reactor coolant pumps are operating if power is 106.0 percent and reactor flow rate is 100 percent or flow rate is 94.3 percent and power level is 100 percent.
2. Trip would occur when three reactor coolant pumps are operating if power is 79.1 percent and reactor flow rate is 74.7 percent or flow rate is 70.7 percent and power level is 75 percent.
3. Trip would occur when one reactor coolant pump is operating in each loop (total of two pumps operating) if the power is 52.3 percent and reactor flow rate is 49.2 percent or flow rate is 46.2 percent and the power level is 49.0 percent.

The flux/flow ratios account for the maximum calibration and instrumentation errors and the maximum variation from the average value of the RC flow signal in such a manner that the reactor protective system receives a conservative indication of the RC flow.

No penalty in reactor coolant flow through the core was taken for an open core vent valve because of the core vent valve surveillance program during each refueling outage. For safety analysis calculations the maximum calibration and instrumentation errors for the power level were used.

The power-imbalance boundaries are established in order to prevent reactor thermal limits from being exceeded. These thermal limits are either power peaking kW/ft limits or DNBR limits. The reactor power imbalance (power in top half of core minus power in the bottom half of core) reduces the power level trip produced by the power-to-flow ratio so that the boundaries of Figure 2.3-2 are produced. The power-to-flow ratio reduces the power level trip associated reactor power-to-reactor power imbalance boundaries by 1.060 percent for a 1 percent flow reduction.

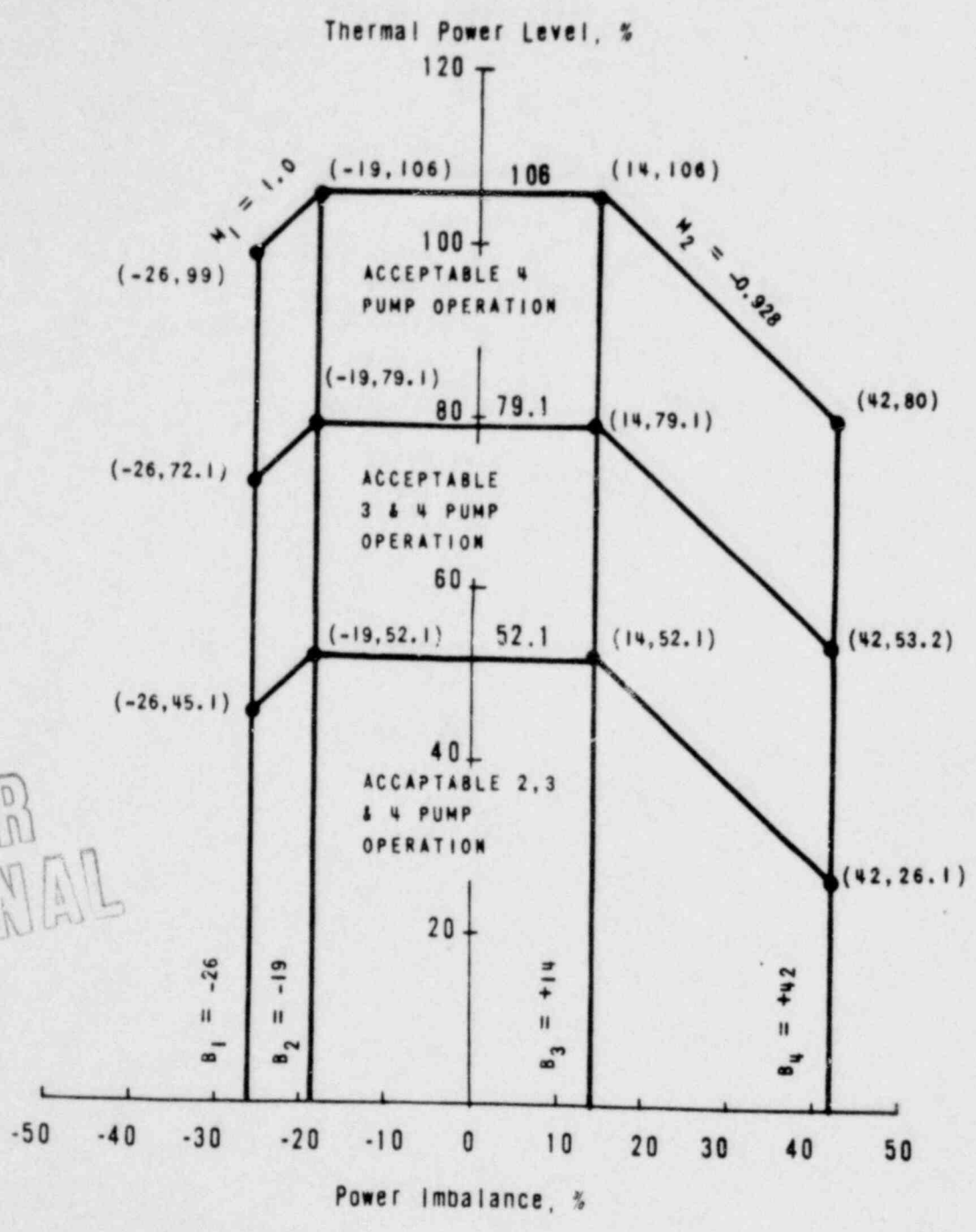
B. Pump monitors

In conjunction with the power imbalance/flow trip, the pump monitors prevent the minimum core DNBR from decreasing below 1.3 by tripping the reactor due to the loss of reactor coolant pump(s). The pump monitors also restrict the power level for the number of pumps in operation.

C. RCS Pressure

During a startup accident from low power or a slow rod withdrawal from high power, the system high pressure trip set point is reached before the nuclear overpower trip set point. The trip setting limit

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ARKANSAS POWER AND LIGHT COMPANY-UNIT 1
PROTECTIVE SYSTEM MAXIMUM ALLOWABLE
SETPOINTS

Figure 2.3-2

- b. If a control rod in the regulating or axial power shaping groups is declared inoperable per Specification 4.7.1.2, operation above 60 percent of the thermal power allowable for the reactor coolant pump combination may continue provided the rods in the group are positioned such that the rod that was declared inoperable is contained within allowable group average position limits of Specification 4.7.1.2 and the withdrawal limits of Specification 3.5.2.5.3.

3.5.2.3 The worth of single inserted control rods during criticality are limited by the restrictions of Specification 3.1.3.5 and the Control Rod Position Limits defined in Specification 3.5.2.5.

3.5.2.4 Quadrant tilt:

1. Except for physics tests, if quadrant tilt exceeds 4.92% power shall be reduced immediately to below the power level cutoff (see Figures 3.5.2-1A and 3.5.2-1B). Moreover, the power level cutoff value shall be reduced 2% for each 1% tilt in excess of 4.92% tilt. For less than 4 pump operation, thermal power shall be reduced 2% of the thermal power allowable for the reactor coolant pump combination for each 1% tilt in excess of 4.92%.

2. Within a period of 4 hours, the quadrant power tilt shall be reduced to less than 4.92% except for physics tests, or the following adjustments in setpoints and limits shall be made:

a. The protection system maximum allowable setpoints (Figure 2.3-2) shall be reduced 2% in power for each 1% tilt.

b. The control rod group and APSR withdrawal limits shall be reduced 2% in power for each 1% tilt in excess of 4.92%.

c. The operational imbalance limits shall be reduced 2% in power for each 1% tilt in excess of 4.92%.

3. If quadrant tilt is in excess of 25%, except for physics tests or diagnostic testing, the reactor will be placed in the hot shutdown condition. Diagnostic testing during power operation with a quadrant power tilt is permitted provided the thermal power allowable for the reactor coolant pump combination is restricted as stated in 3.5.2.4.1 above.

4. Quadrant tilt shall be monitored on a minimum frequency of once every two hours during power operation above 15% of rated power.

3.5.2.5 Control rod positions:

1. Technical Specification 3.1.3.5 (safety rod withdrawal) does not prohibit the exercising of individual safety rods as required by Table 4.1-2 or apply to inoperable safety rod limits in Technical Specification 3.5.2.2.

2. Operating rod group overlap shall be 25% \pm 5 between two sequential groups, except for physics tests.

3. Except for physics tests or exercising control rods, a) the control rod withdrawal limits are specified on Figures 3.5.2-1A, 3.5.2-1B and 3.5.2-1C for four pump operation and on Figures 3.5.2-2A, 3.5.2-2B and 3.5.2-2C for three or two pump operation and b) the axial power shaping control rod withdrawal limits are specified on Figures 3.5.2-4A, 3.5.2-4B and 3.5.2-4C. If any of these control rod position limits are exceeded, corrective measures shall be taken immediately to achieve an acceptable control rod position. Acceptable control rod positions attained within four hours.
 4. Except for physics tests, power shall not be increased above the power level cutoff (see Figures 3.5.2-1) unless the xenon reactivity is within 10 percent of the equilibrium value for operation at rated power and asymptotically approaching stability.
- 3.5.2.6 Reactor Power Imbalance shall be monitored on a frequency not to exceed two hours during power operation above 40 percent rated power. Except for physics tests, imbalance shall be maintained within the envelopes defined by Figures 3.5.2-3A, 3.5.2-3B and 3.5.2-3C. If the imbalance is not within the envelopes defined by Figures 3.5.2-3A, 3.5.2-3B and 3.5.2-3C corrective measures shall be taken to achieve an acceptable imbalance. If an acceptable imbalance is not achieved within four hours, reactor power shall be reduced until imbalance limits are met.
- 3.5.2.7 The control rod drive patch panels shall be locked at all times with limited access to be authorized by the superintendent.

Bases

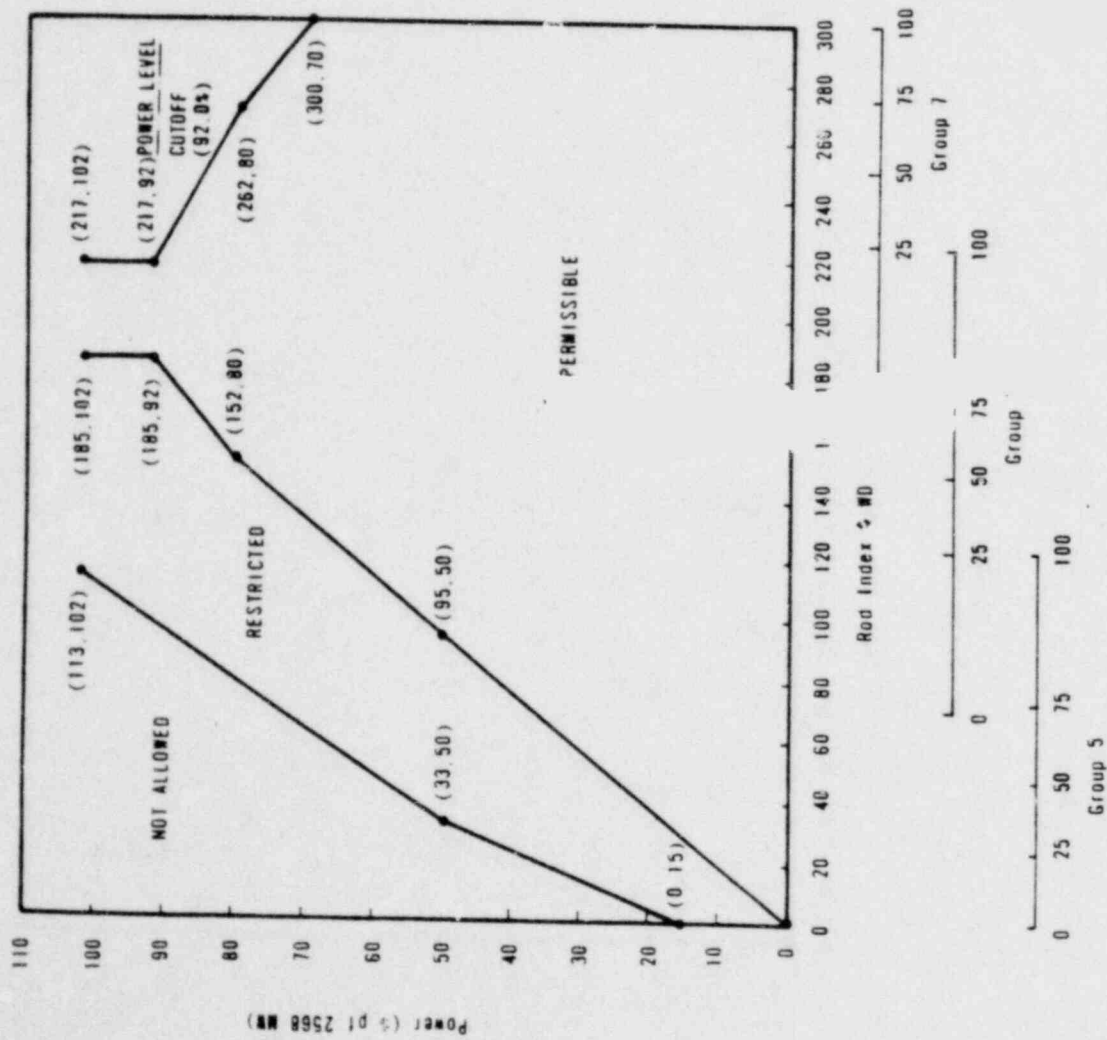
The power-imbalance envelopes defined in Figures 3.5.2-3A, 3.5.2-3B and 3.5.2-3C are based on 1) LOCA analyses which have defined the maximum linear heat rate (See Fig. 3.5.2-4) such that the maximum clad temperature will not exceed the final Acceptance Criteria and 2) the Protective System Maximum Allowable Setpoints (Figure 2.3-2). Corrective measures will be taken immediately should the indicated quadrant tilt, rod position or imbalance be outside their specified boundary. Operation in a situation that would cause the final acceptance criteria to be approached should a LOCA occur is highly improbable because all of the power distribution parameters (quadrant tilt, rod position, and imbalance) must be at their limits while simultaneously all other engineering and uncertainty factors are also at their limits.* Conservatism is introduced by application of:

- a. Nuclear uncertainty factors
- b. Thermal calibration
- c. Fuel densification effects
- d. Hot rod manufacturing tolerance factors
- e. Fuel rod bowing

The 25 ± 5 percent overlap between successive control rod groups is allowed since the worth of a rod is lower at the upper and lower part of the stroke. Control rods are arranged in groups or banks defined as follows:

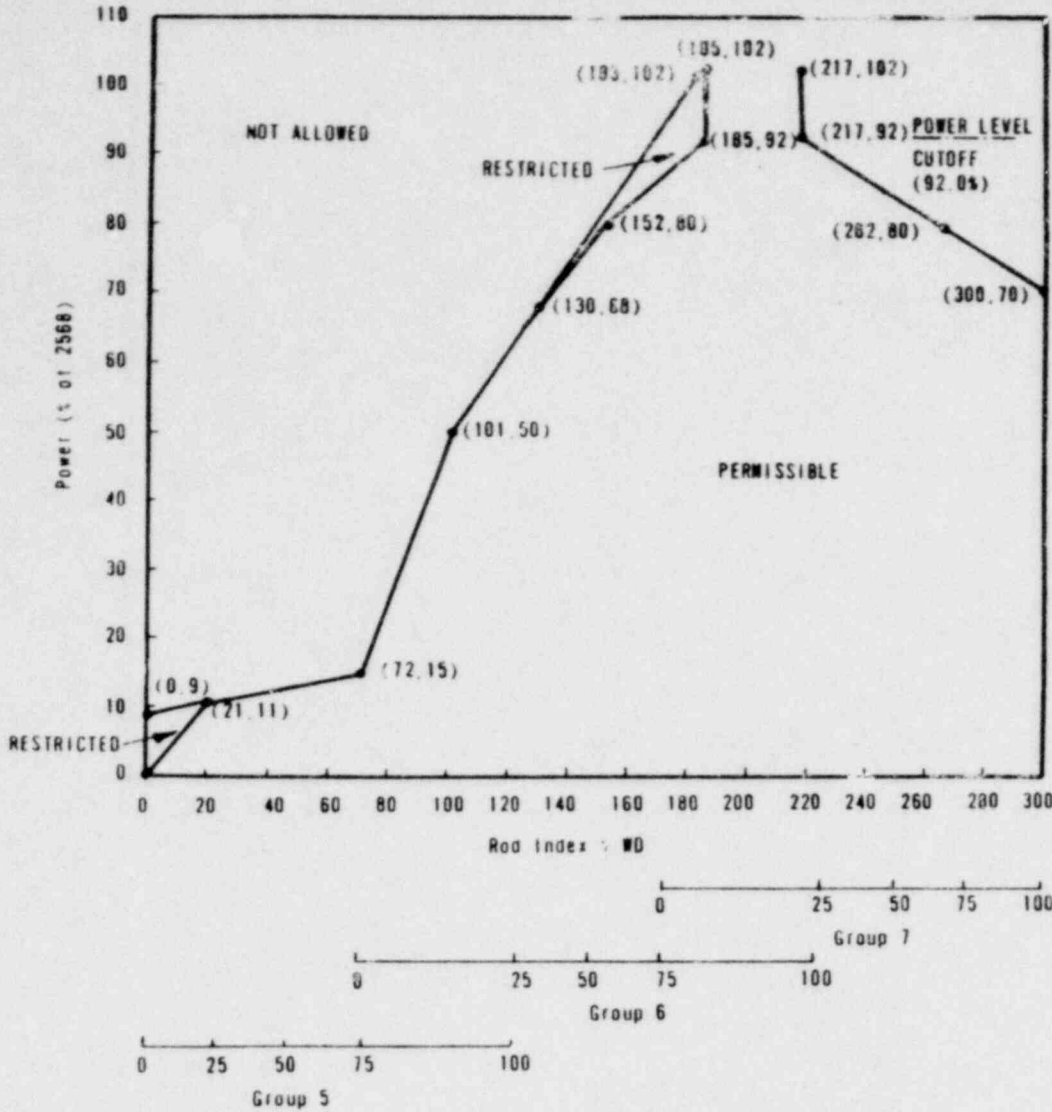
*Actual operating limits depend on whether or not incore or excore detectors are used and their respective instrument and calibration errors. The method used to define the operating limits is defined in plant operating procedures.

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ROD POSITION LIMITS FOR 4 PUMP OPERATION FROM 0 TO 100 ± 10 EFPO ARKANSAS CYCLE 3
Figure 3.5.2-1A

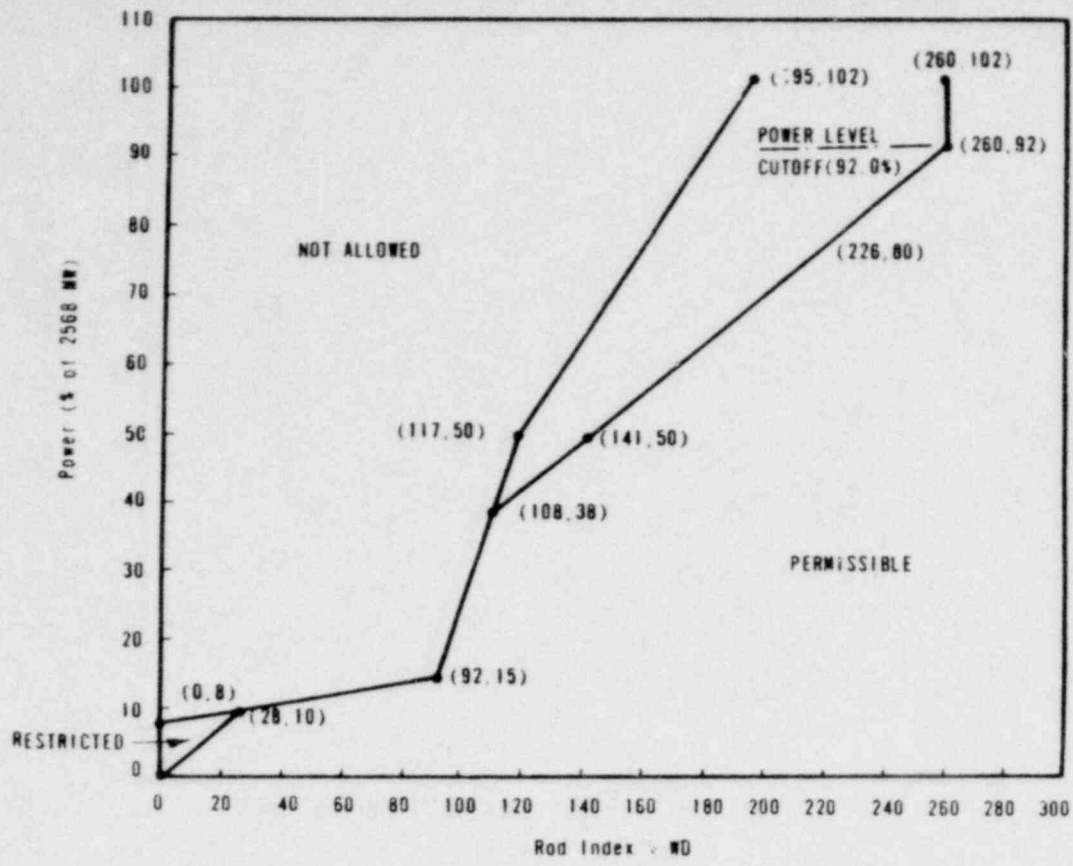
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ROD POSITION LIMITS FOR 4 PUMP OPERATION FROM 100 ± 10 TO 250 ± 10 EFPD ARKANSAS CYCLE 3

Figure 3.5.2-1B

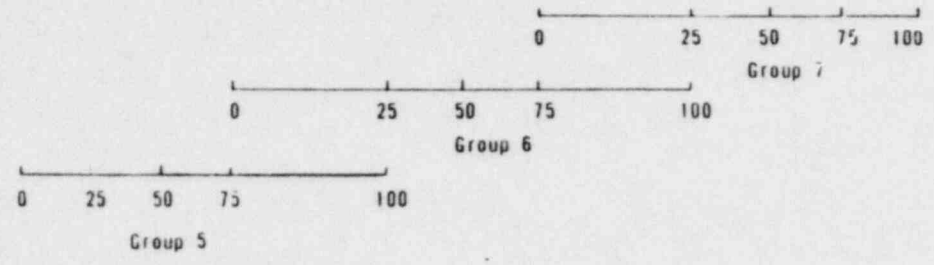


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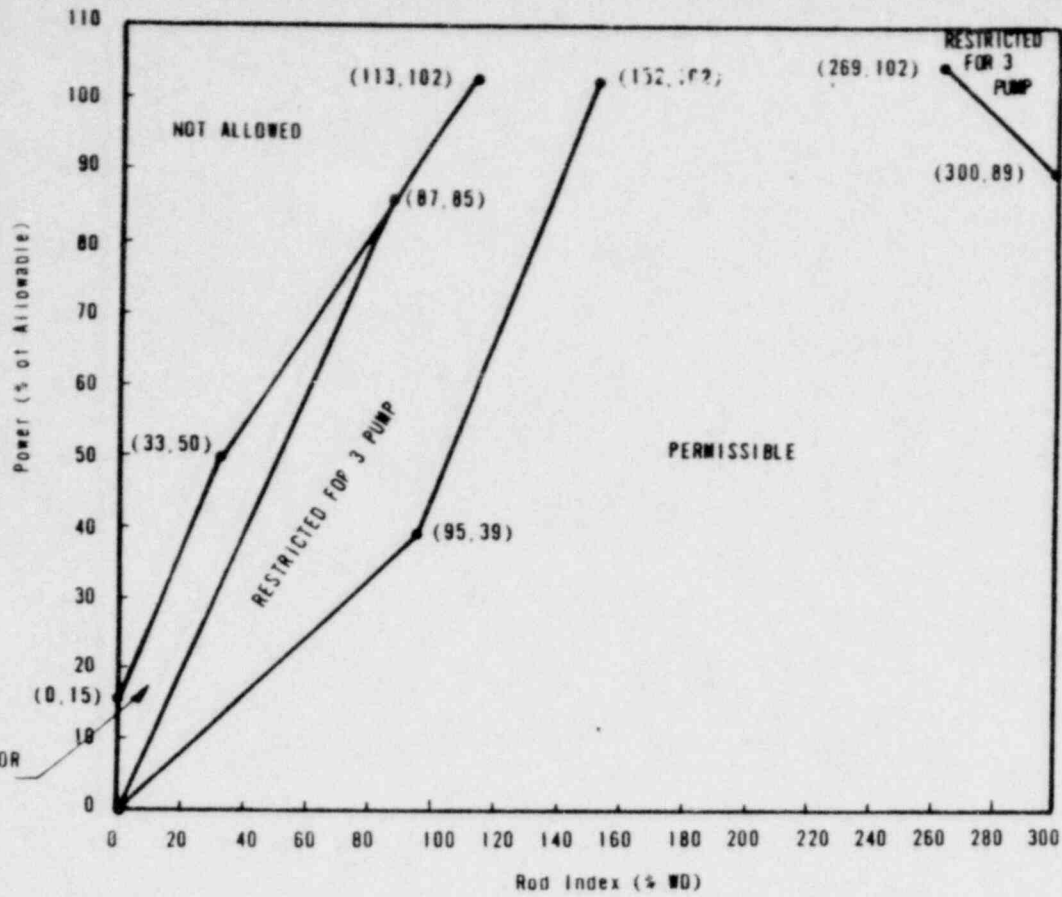
ROD POSITION LIMITS FOR 4 PUMP OPERATION AFTER 250 ± 10 EFPD ARKANSAS CYCLE 3

Figure 3.5.2-1C

48bbb



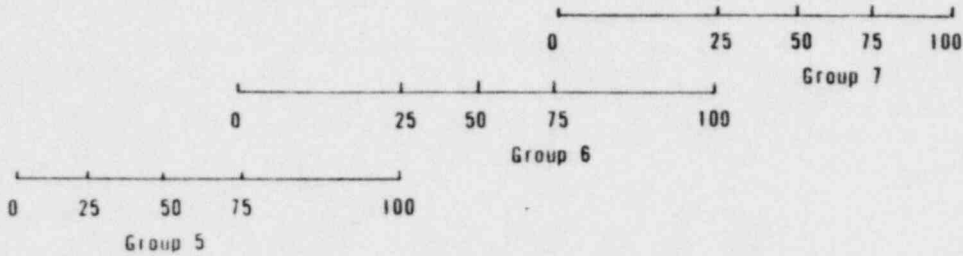
48C



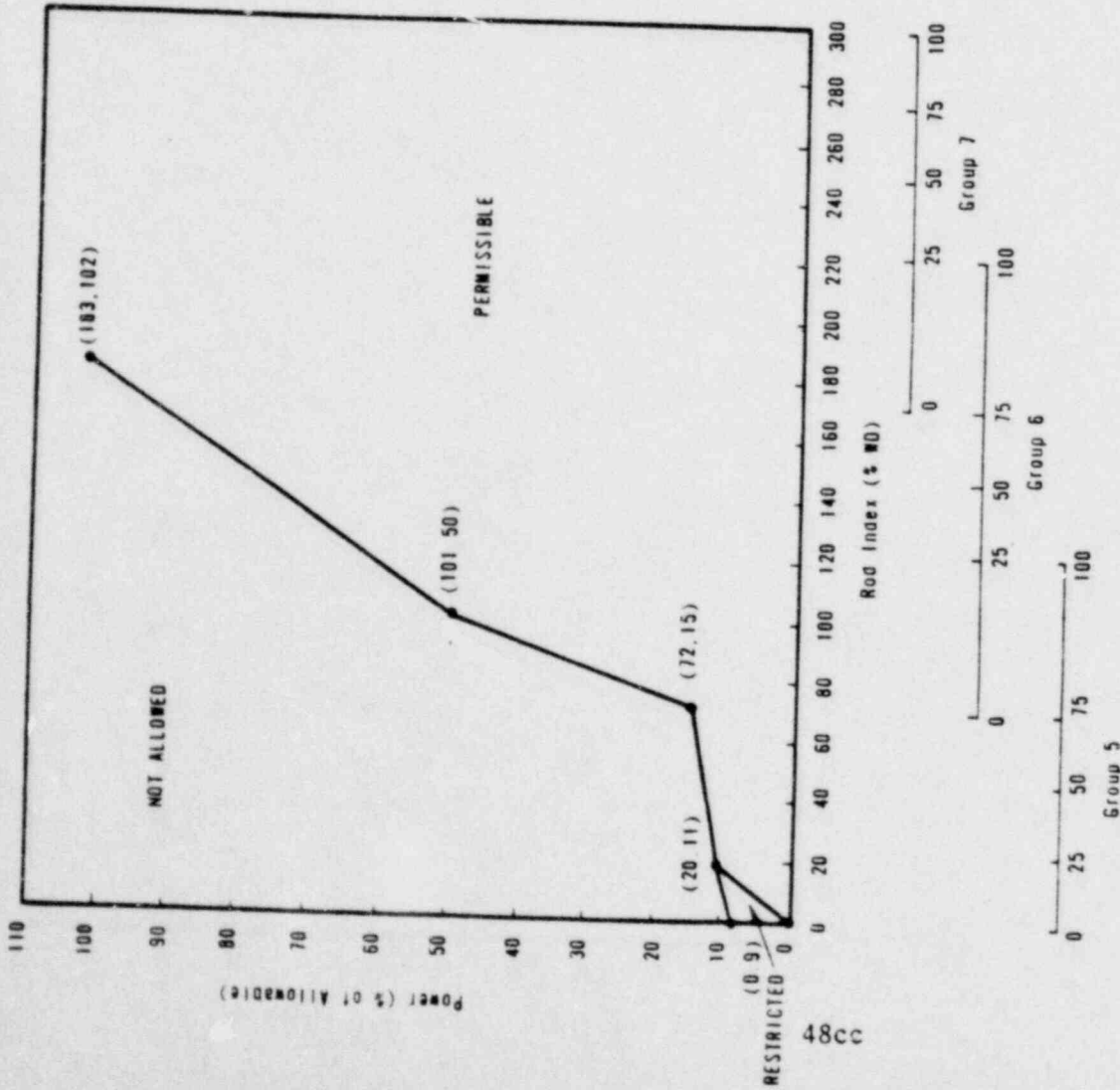
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ROD POSITION LIMITS FOR 2 & 3 PUMP OPERATION FROM 0 TO 100 ± 10 EFPD ARKANSAS CYCLE 3

Figure 3 5 2-2A



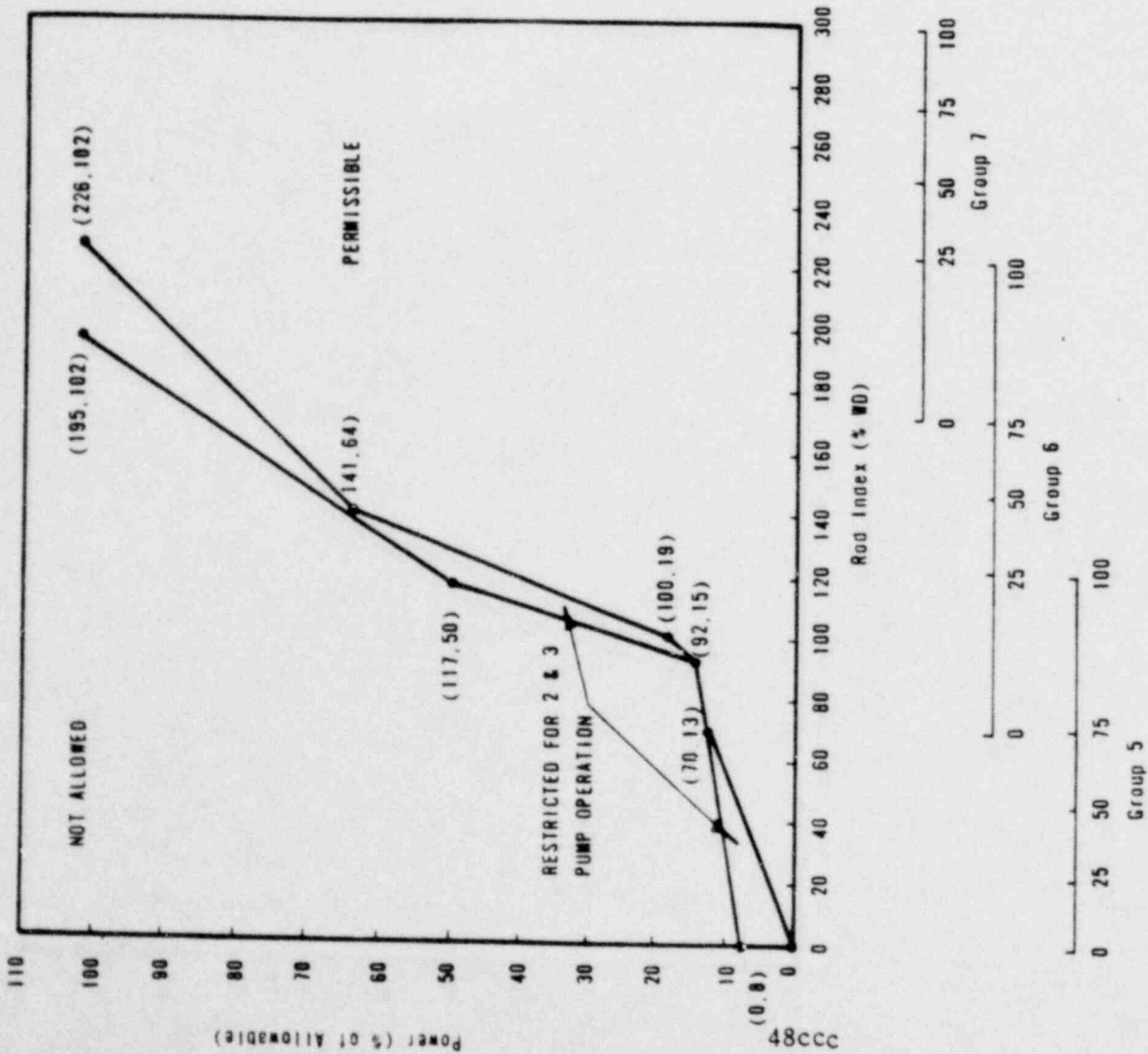
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ROD POSITION LIMITS FOR 2 & 3 PUMP OPERATION FROM
100 ± 10 TO 250 ± 10 EFPD ARKANSAS CYCLE 3

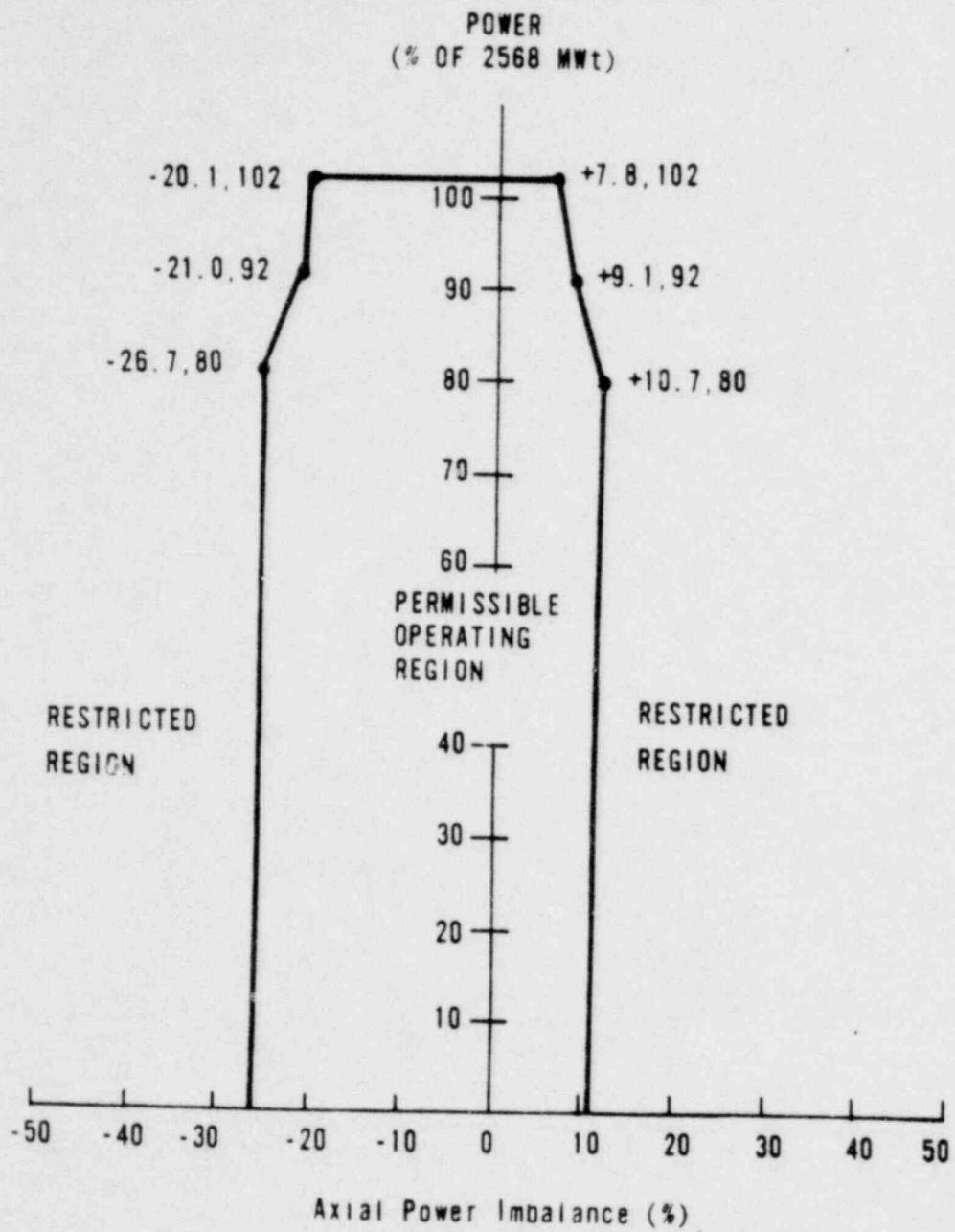
Figure 3 5 2-28

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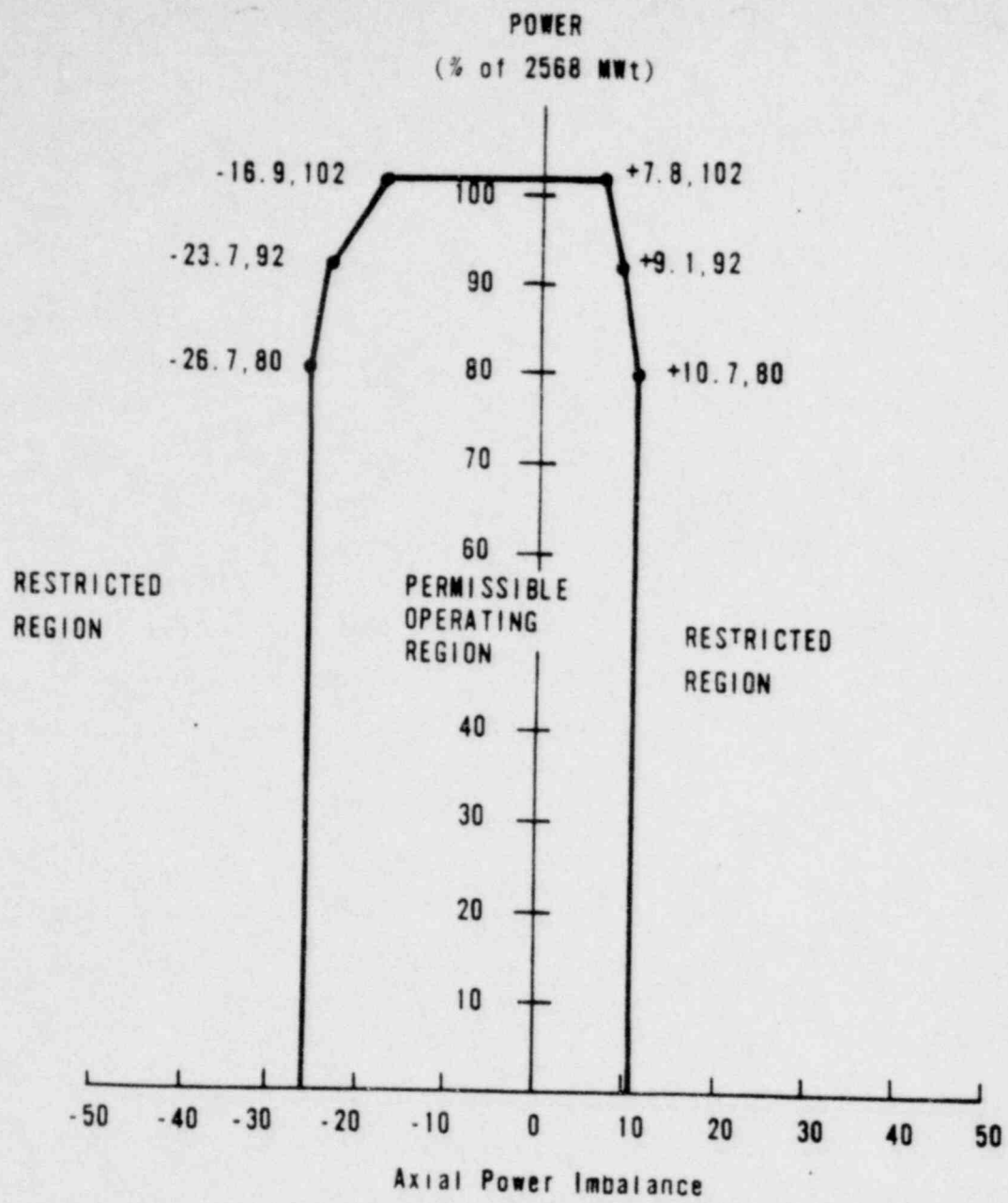
ROD POSITION LIMITS FOR 2 & 3 PUMP OPERATION AFTER 250 ± 10 EFPD ARKANSAS CYCLE 3

Figure 3.5.2-2C



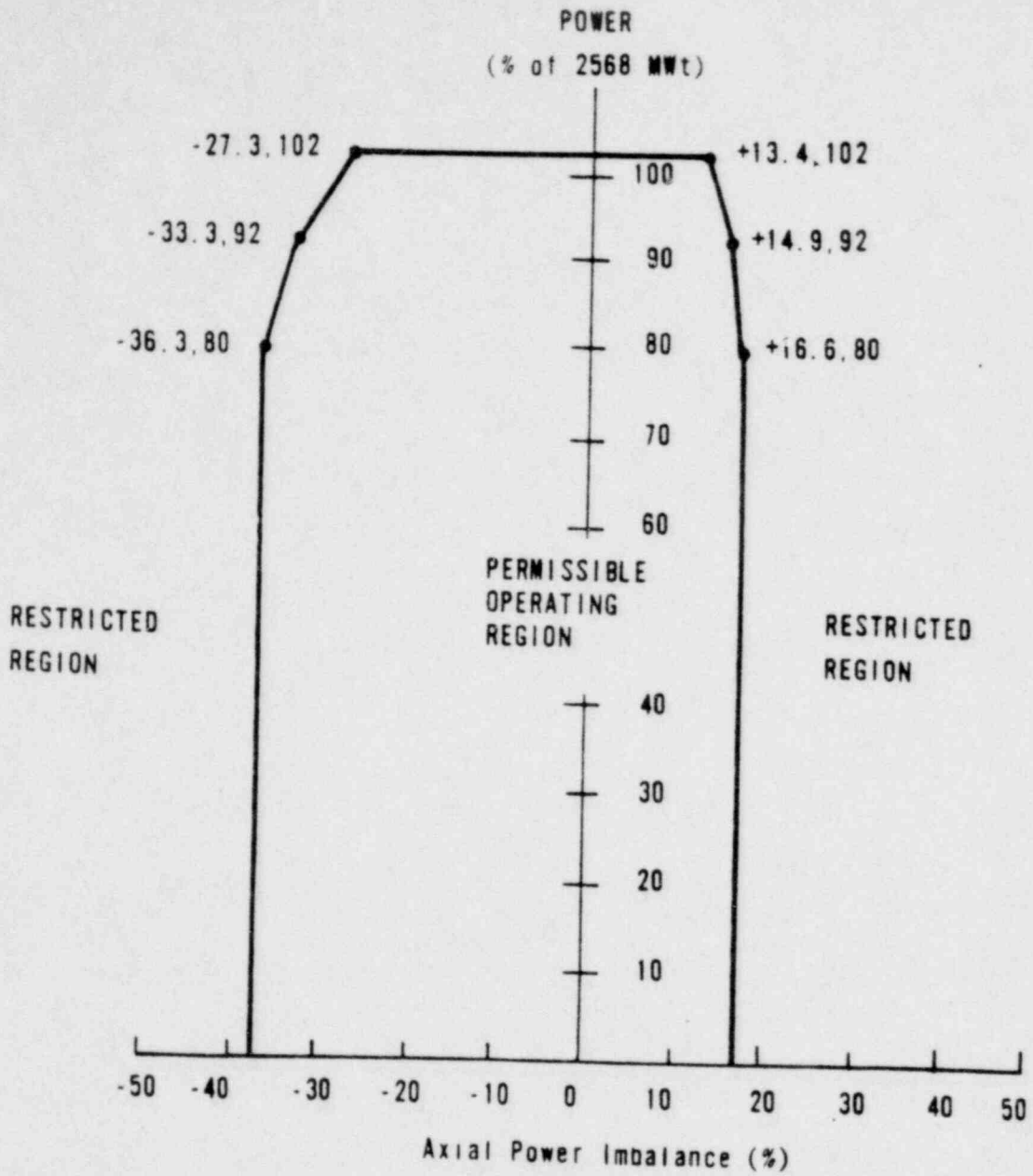
OPERATION POWER IMBALANCE ENVELOPE
FOR OPERATION FROM 0 TO 100 ± 10 EFPD
ARKANSAS CYCLE 3

Figure 3.5.2-3A



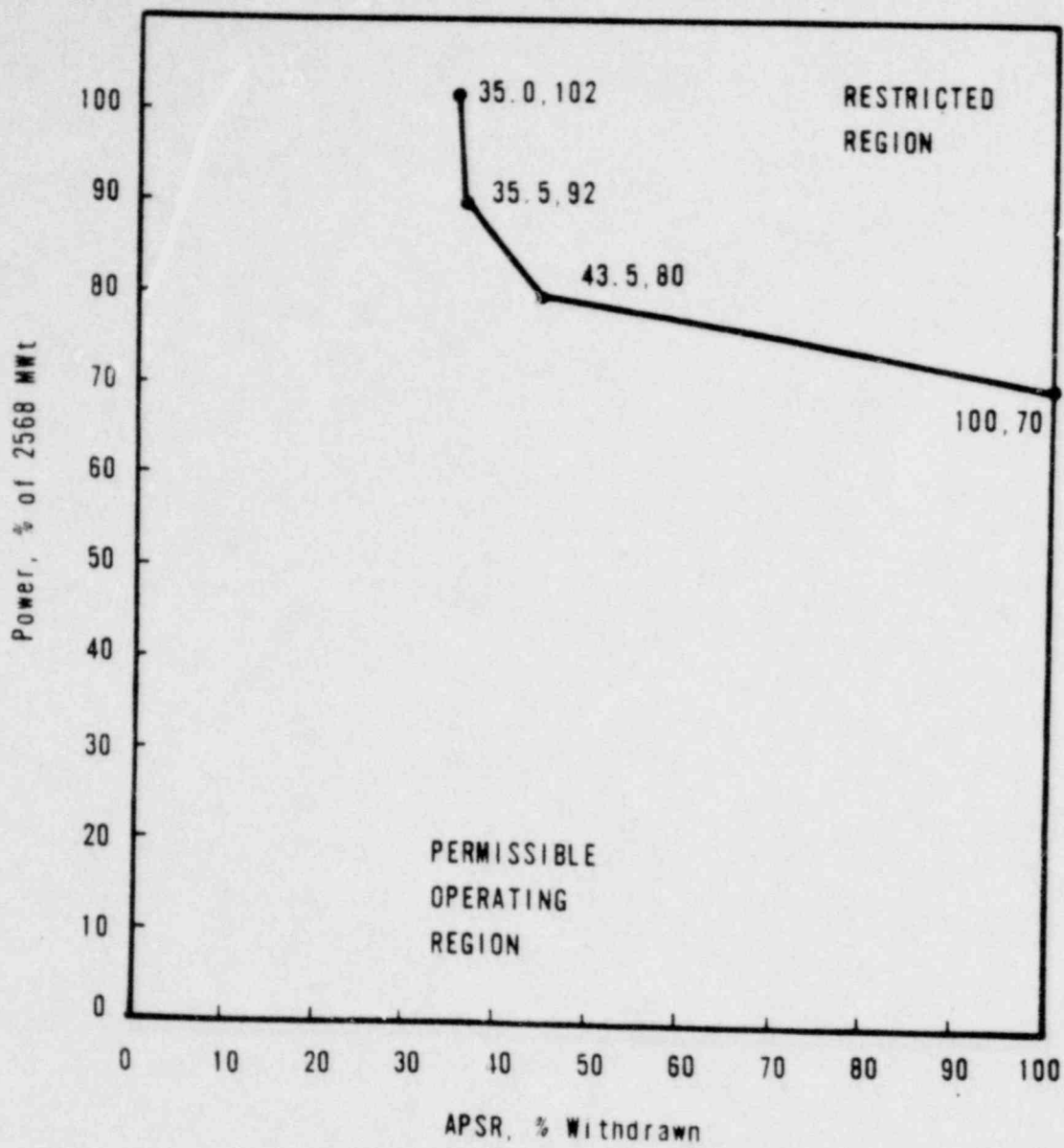
OPERATIONAL POWER IMBALANCE ENVELOPE
FOR OPERATION FROM 100 ± 10 TO 250 ± 10 EFPD
ARKANSAS CYCLE 3

Figure 3.5.2-3B



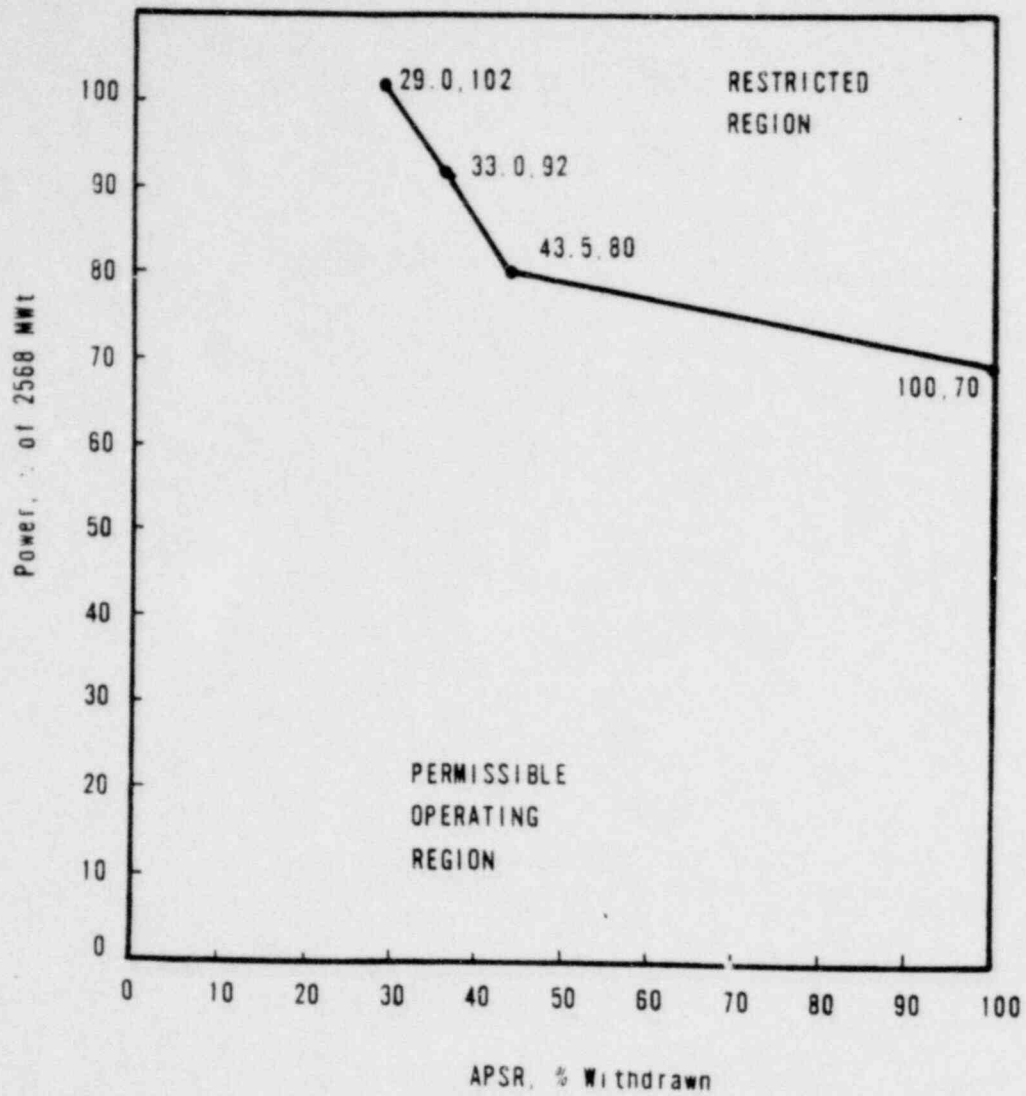
OPERATIONAL POWER IMBALANCE ENVELOPE
FOR OPERATION AFTER 250 ± 10 EFPD
ARKANSAS, CYCLE 3

Figure 3.5.2-3C



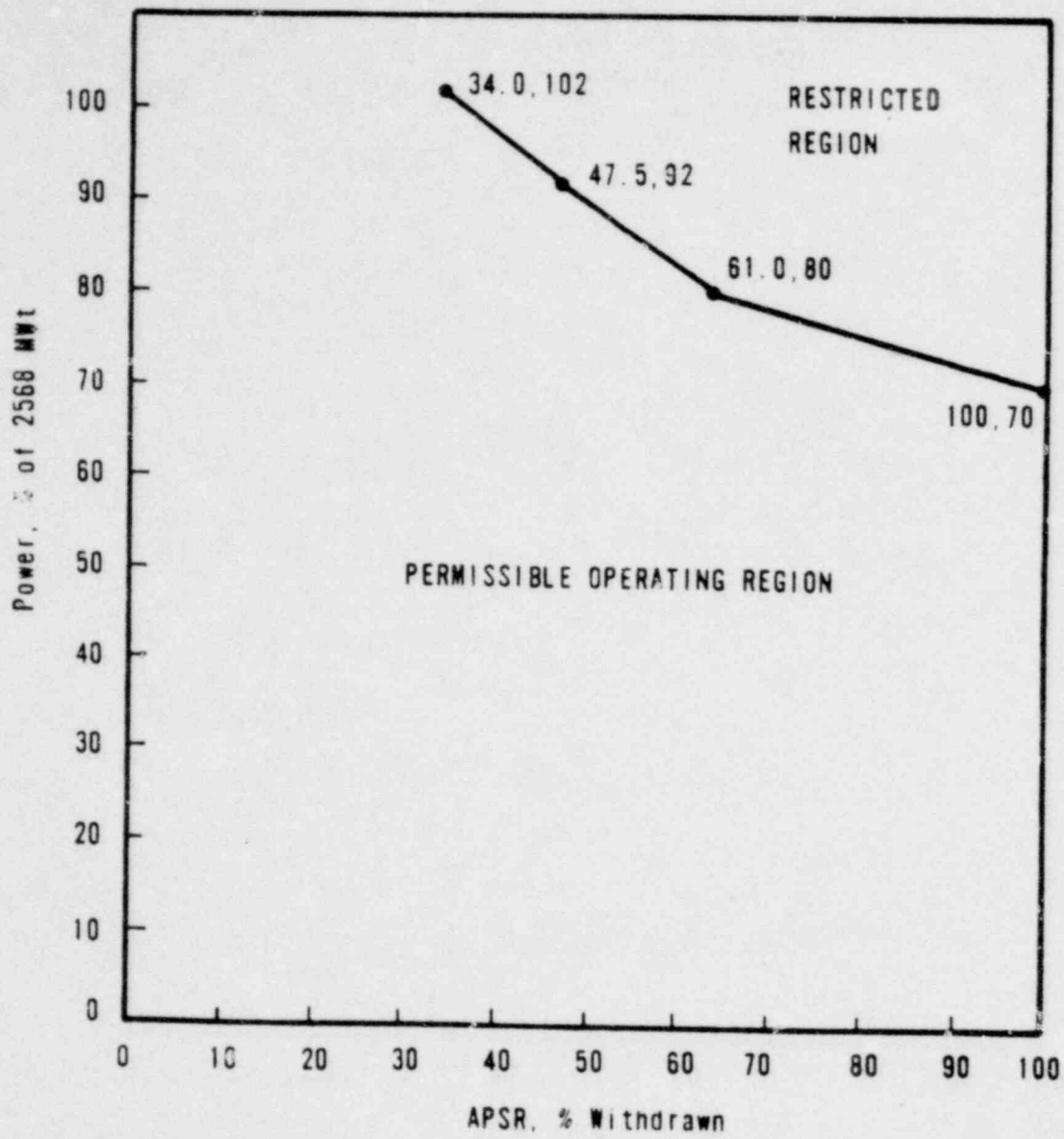
APSR POSITION LIMITS FOR OPERATION FROM 0 TO 100 ± 10 EFPD AND, CYCLE 3

Figure 3.5.2-4A



APSR POSITION LIMITS FOR OPERATION
 FROM 100 ± 10 TO 250 ± 10 EFPD AND, CYCLE 3

Figure 3.5.2-4B



APSR POSITION LIMITS FOR OPERATION
AFTER 250 ± 10 EFPD - ANO, CYCLE 3

Figure 3.5.2-4C