LIMITING CONDITIONS FOR OPERATION

3.11 REACTOR FUEL ASSEMBLY

Applicability

The Limiting Conditions for Operation associated with the fuel rods apply to those parameters which monitor the fuel rod operating conditions.

Objective

The Objective of the Limiting Conditions for Operation is to assure the performance of the fuel rods.

Specifications

A. Average Planar Linear Heat Generation Rate (APLHGR)

Nov. 1975

During steady state power operation with both recirculation pumps operating, the APLHGR for each type of fuel as a function of average planar exposure shall not exceed the applicable limiting value shown in Figures 3.11-1 through 3.11-7. During steady state power operation with one recirculation pump operating, the APLHGR for each type of fuel as a function of average planar exposure shall not exceed the applicable limiting value shown in Figures 3.11-9 through 3.11-15. If at any time during steady state operation it is determined by normal surveillance that the limiting value for APLHGR is being exceeded action shall be initiated to restore operation to within the prescribed limits.

Nov. 1975

B. Linear Heat Generation Rate (LHGR)

During steady state power operation, the linear heat generation rate (LHGR) of any rod in any fuel assembly at any axial location shall not exceed the maximum allowable LHGR as calculated by the following equation:

$$LHGR_{max} \leq LHGR_d \left[1 - (\Delta P/P)_{max} (L/LT)\right]$$

$LHGR_d$ = Design LHGR = G kW/ft

$(\Delta P/P)_{max}$ = Maximum power spiking penalty = N

SURVEILLANCE REQUIREMENTS

4.11 REACTOR FUEL ASSEMBLY

Applicability

The surveillance Requirements apply to the parameters which monitor the fuel rod operating conditions.

Objective

The Objective of the Surveillance Requirements is to specify the type and frequency of surveillance to be applied to the fuel rods.

Specifications

A. Average Planar Linear Heat Generation Rate (APLHGR)

The APLHGR for each type of fuel as a function of average planar exposure shall be determined daily during reactor operation at ≥25% rated thermal power.

B. Linear Heat Generation Rate (LHGR)

The LHGR as a function of core height shall be checked daily during reactor operation at ≥25% rated thermal power.

3.11 REACTOR FUEL ASSEMBLY

A. Average Planar Linear Heat Generation Rate (APLHGR)

This specification assures that the peak cladding temperature following the postulated design basis loss-of-coolant accident will not exceed the limit specified in the 10CFR50, Appendix K.

The peak cladding temperature following a postulated loss-of-coolant accident is primarily a function of the average heat generation rate of all the rods of a fuel assembly at any axial location and is only dependent secondarily on the rod to rod power distribution within a fuel assembly. Since expected local variations in power distribution within a fuel assembly affect the calculated peak clad temperature by less than $\pm$ 20°F relative to the peak temperature for a typical fuel design, the limit on the average linear heat generation rate is sufficient to assure that calculated temperatures are within the 10CFR50 Appendix K limit. The limiting value for APLHGR with both recirculation pumps operating is shown in Figures 3.11-1 through 3.11-7. With a single recirculation pump operating, these MAPLHGR's are reduced by a conservative correction factor. The limiting value for APLHGR with one recirculation pump operating is shown in Figures 3.11-9 through 3.11-15.

Nov. 1975

B. Linear Heat Generation Rate (LHGR)

This specification assures that the linear heat generation rate in any rod is less than the design linear heat generation if fuel pellet densification is postulated. The power spike penalty specified is based on the analysis presented in Section 3.2.1 of Reference 1 and in References 2 and 3, and assumes a linearly increasing variation in axial gaps between core bottom and top, and assures with a 95% confidence, that no more than one fuel rod exceeds the design linear heat generation rate due to power spiking. The LHGR as a function of core height shall be checked daily during reactor operation at $\geq$25% power to determine if fuel burnup, or control rod movement has caused changes in power distribution. For LHGR to be a limiting value below 25% rated thermal power, the MTPF would have to be greater than 10 which is precluded by a considerable margin when employing any permissible control rod pattern.

July, 1975

C. Minimum Critical Power Ratio (MCHR)

At core thermal power levels less than or equal to 25%, the reactor will be operating at minimum recirculation pump speed and the moderator void content will be very small. For all designated control rod patterns which may be employed at this point, operating plant experience and thermal hydraulic analysis indicate that the resulting MCPR value is in excess of requirements by a considerable margin. With this low void content, any inadvertent core flow increase would only place operation in a more conservative mode relative to MCHR. The daily requirement for calculating MCHR above 25% rated thermal power is sufficient since power distribution shifts are very slow when there have not been significant power or control rod changes. The requirement for calculating MCPR when a limiting control rod pattern is approached ensures that MCPR will be known following a change in power or power shape (regardless of magnitude) that could place operation at a thermal limit.

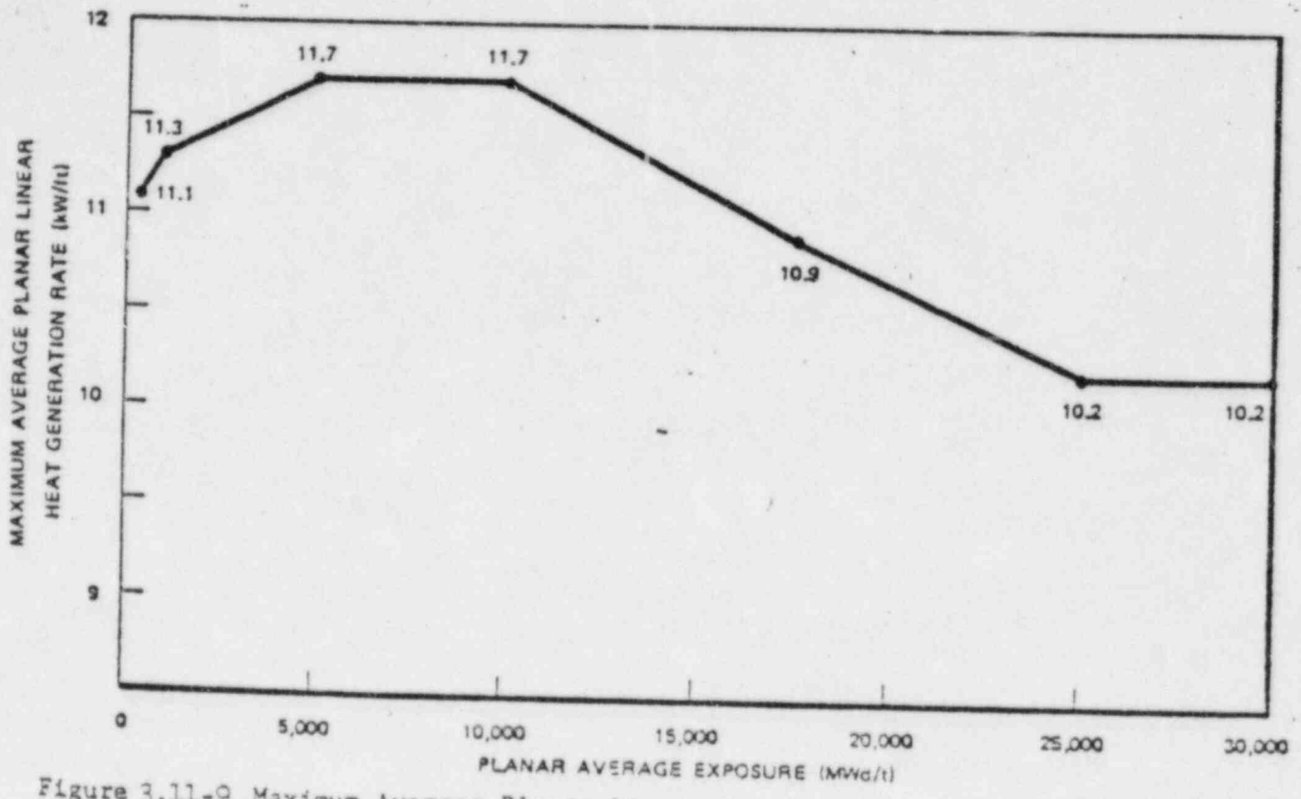

Figure 3.11-9 Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) versus Planar Average Exposure, Pilgrim NPS Unit 1, Initial Core - No Curtains, Single-Loop Operation, Plugged Bypass Holes

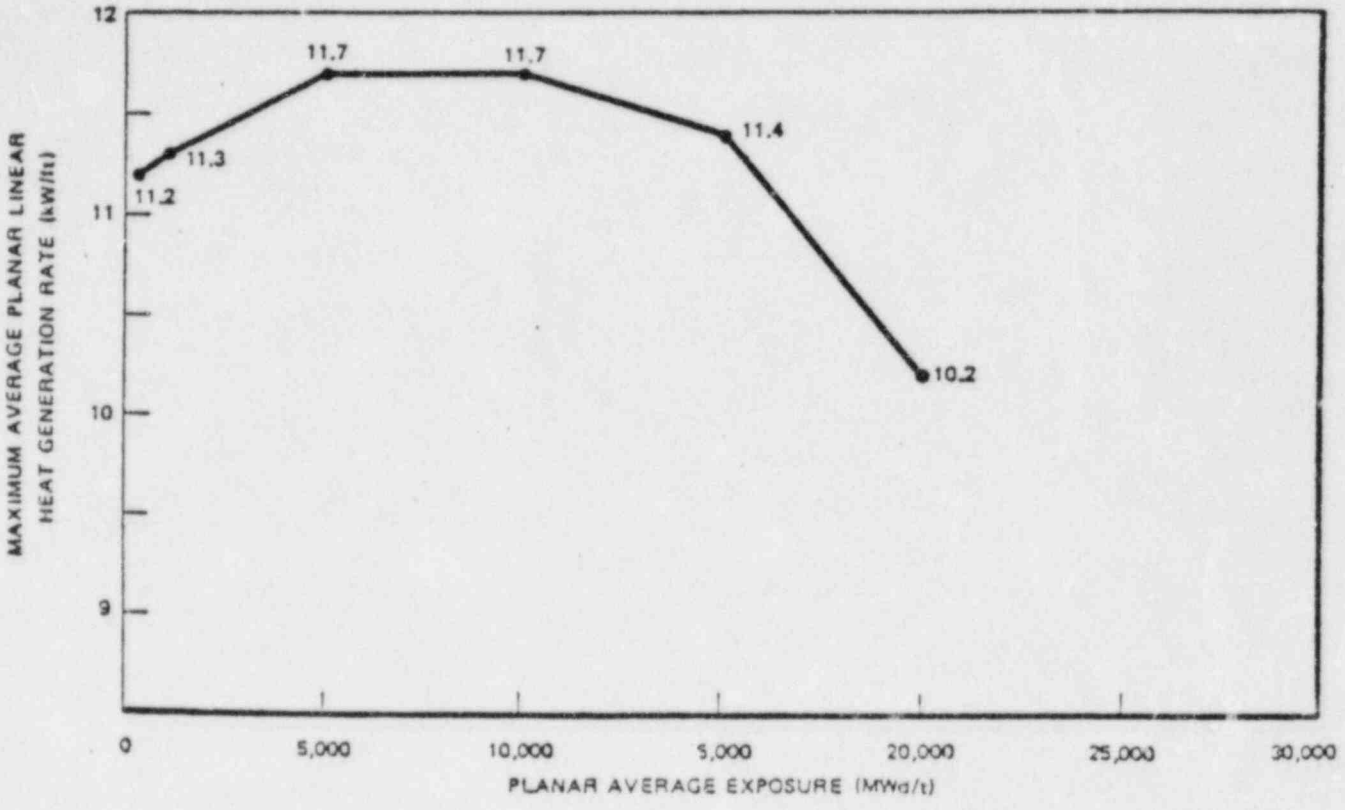

Figure 3.11-10 Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) versus Planar Average Exposure, Pilgrim NPS Unit 1, Initial Core - 1 Strong Curtain, Single-Loop Operation, Plugged Bypass Holes

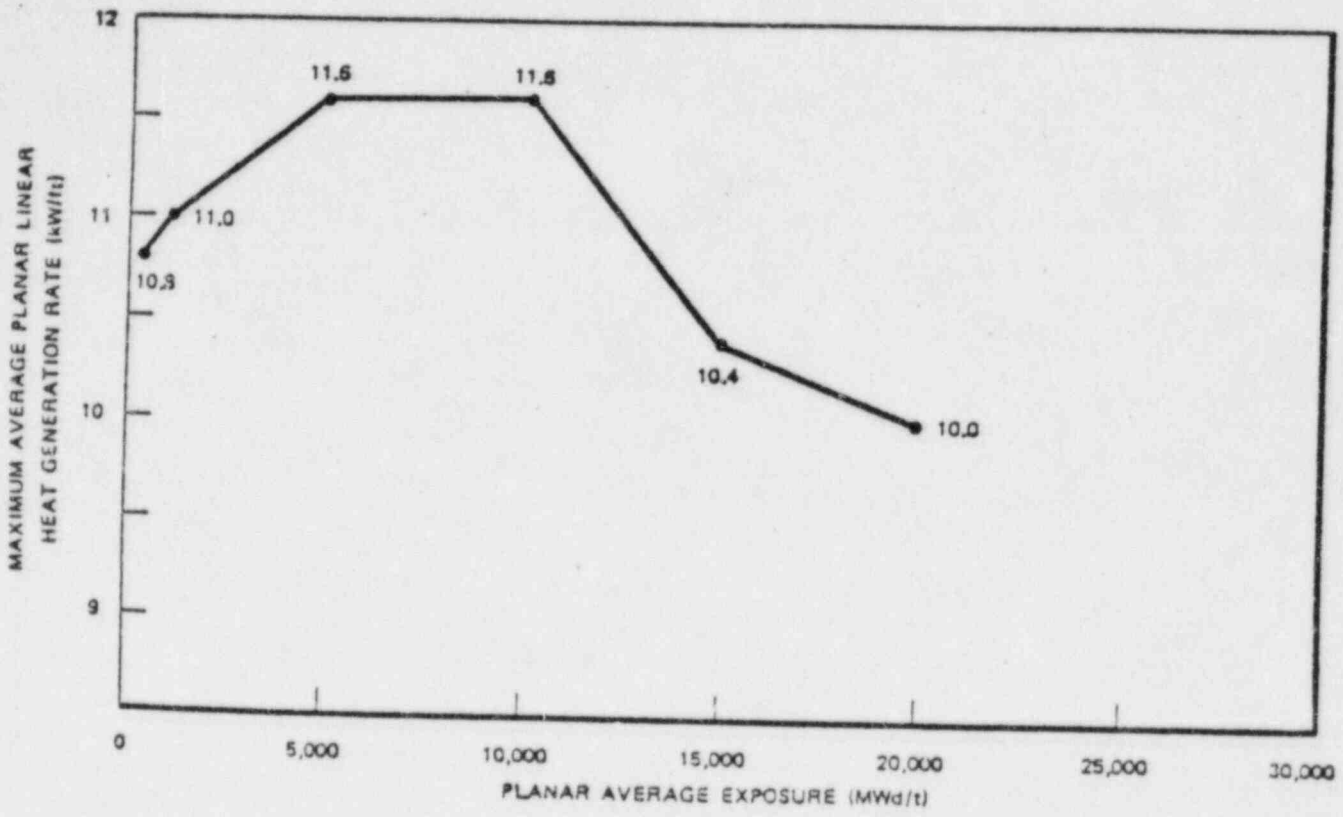

Figure 3.11-11 Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) versus Planar Average Exposure, Pilgrim NPS Unit 1, Initial Core - 2 Strong Curtains, Single-Loop Operation, Plugged Bypass Holes

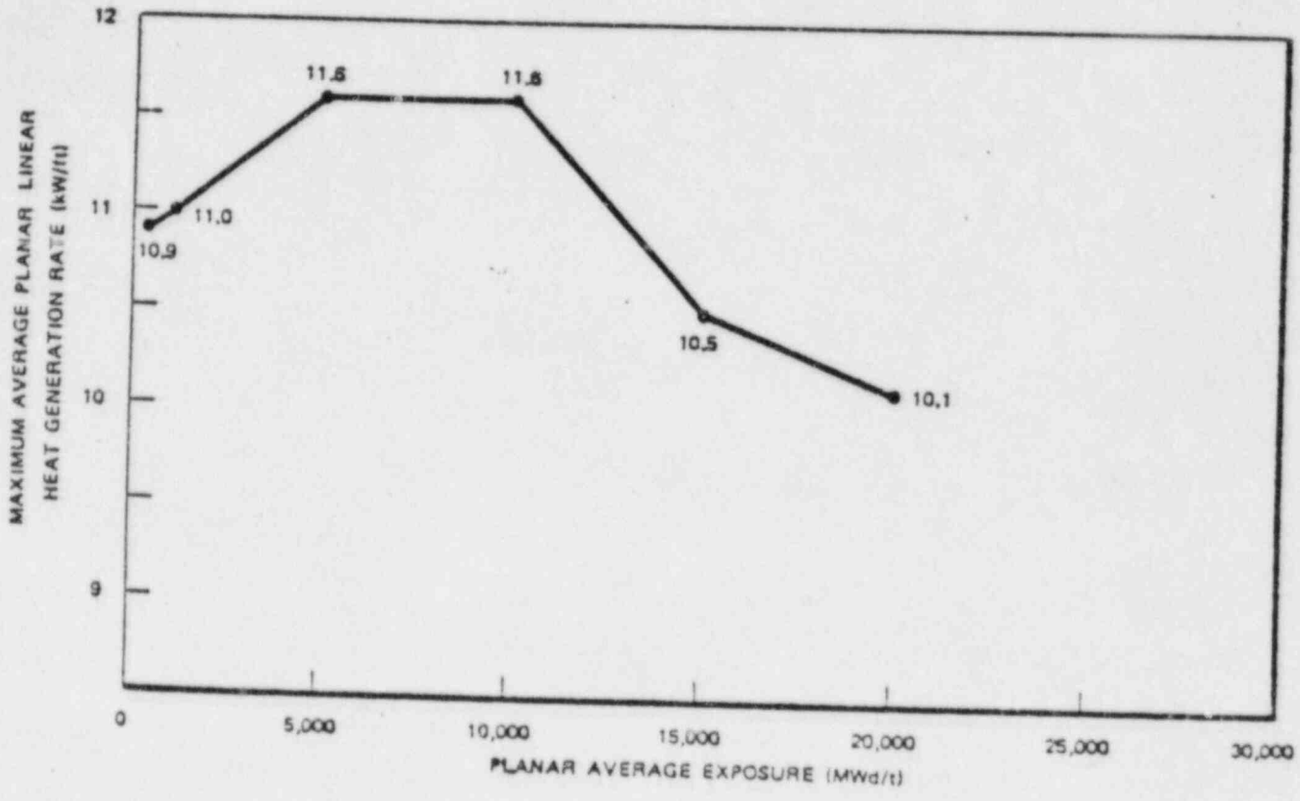

Figure 3.11-12 Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) versus Planar Average Exposure, Pilgrim NPS Unit 1, Initial Core - 1 Weak Curtain, 1 Strong Curtain, Single-Loop Operation, Plugged Bypass Holes

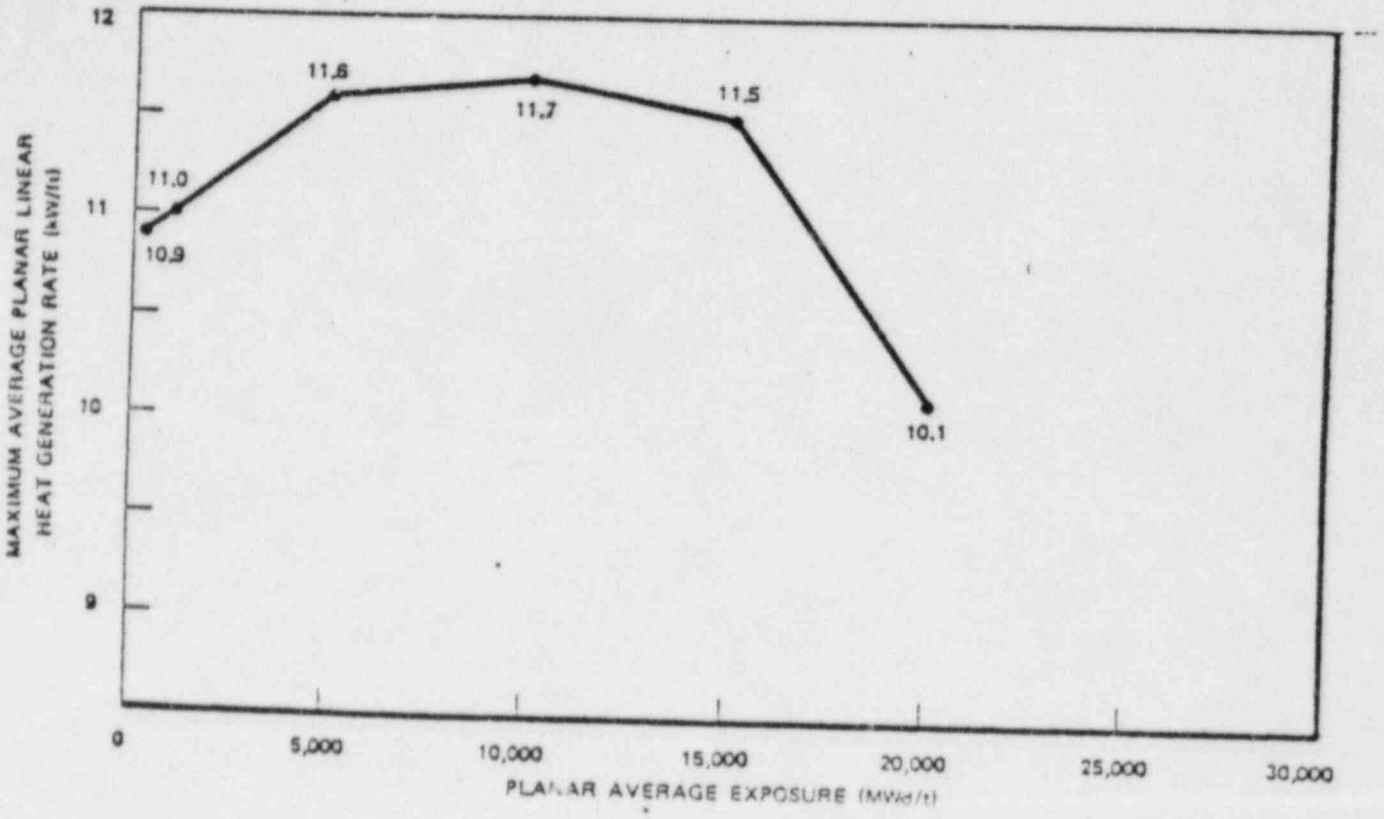

Figure 3.11-13 Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) versus Planar Average Exposure, Pilgrim NPS Unit 1, Initial Core - 2 Weak Curtains, Single-Loop Operation, Plugged Bypass Holes

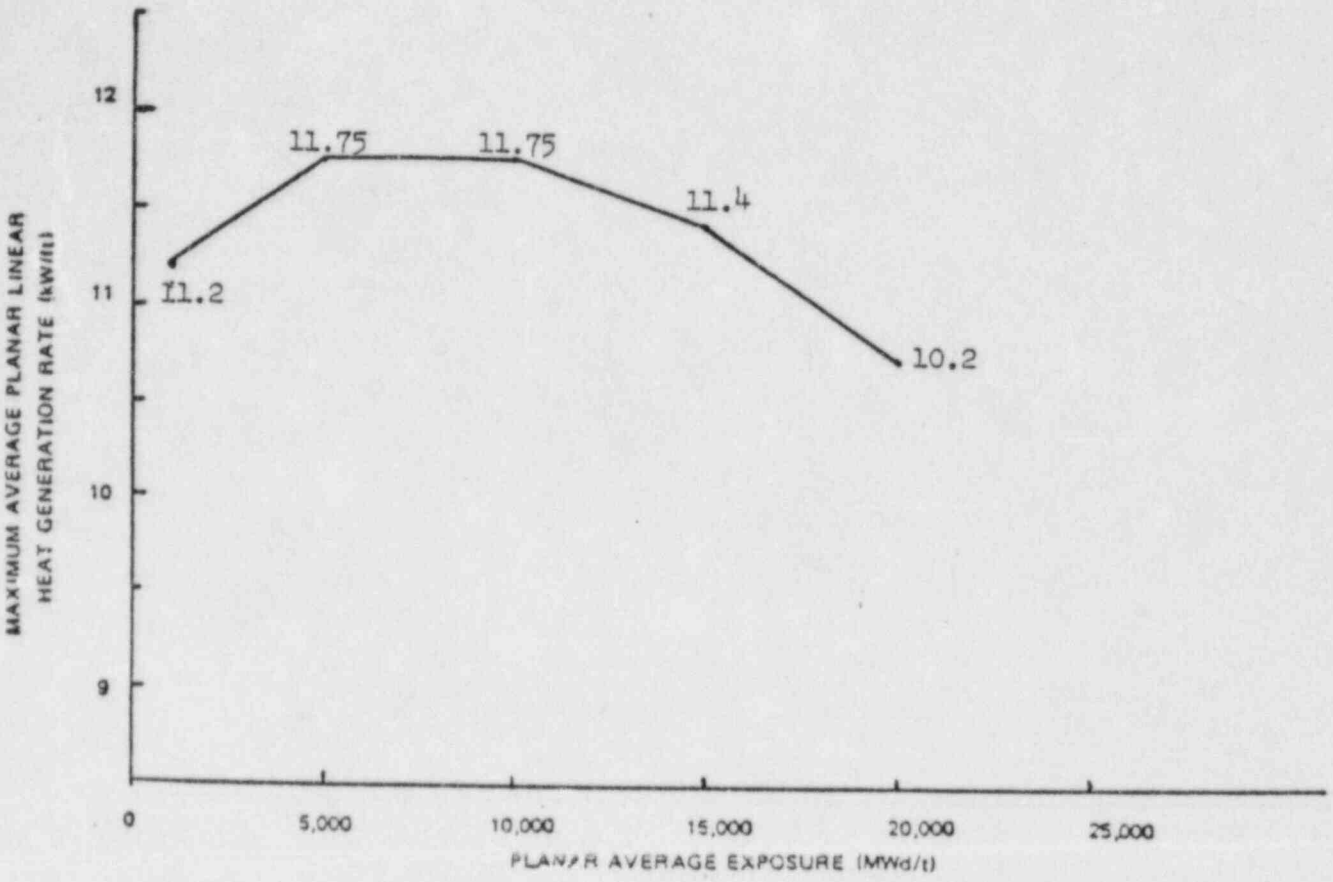

Figure 3.11-14 Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) versus Planar Average Exposure, Pilgrim NPS Unit 1, Initial Core - 1 Weak Curtain, Single-Loop Operation, Plugged Bypass Holes

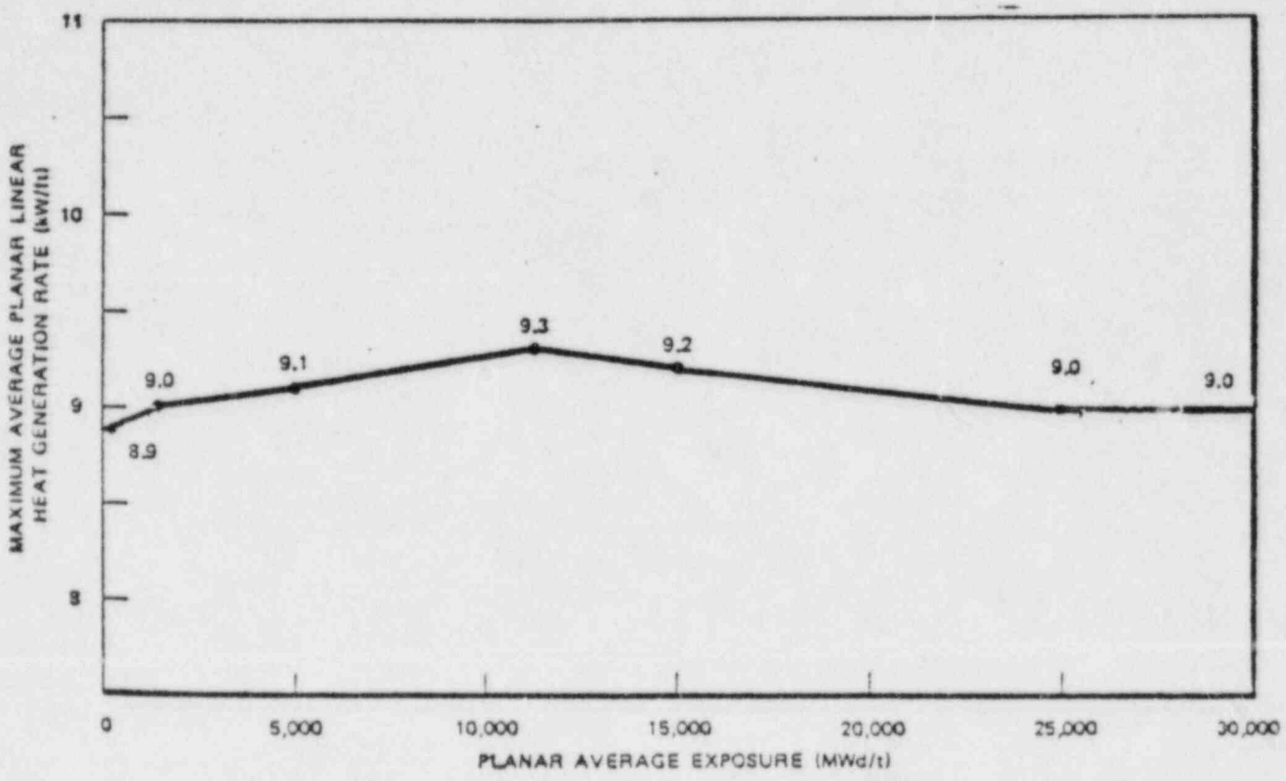

Figure 3.11-15 Maximum Average Planar Linear Heat Generation Rate (MAPLGHR) versus Planar Average Exposure, Pilgrim NPS Unit 1, 8D262 Fuel, Single-Loop Operation, Plugged Bypass Holes