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CLASS I
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SUPPLEMENT 1
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# PILGRIM NUCLEAR POWER STATION UNIT I

## AMENDMENT FOR SINGLE-LOOP OPERATION

## WITH BYPASS HOLES PLUGGED

BOILING WATER REACTOR PROJECTS DEPARTMENT -- GENERAL ELECTRIC COMPANY
SAN JOSE, CALIFORNIA 95125

5. Departure from nucleate boiling is conservatively assumed at 0.1 second after the accident (at least one-to-two seconds of nucleate boiling is expected, even if there is no recirculation pump coastdown) after which the Ellion pool boiling correlation, which has been approved for use during low flow periods during the blowdown is assumed until hot node uncovery. No credit is taken for the improved heat transfer which will result from lower plenum flashing.

2.2.4 MAPLHGR Reduction Factor

The calculated MAPLHGR reduction factors for the selected plants are shown in Figure 1. Curves for both suction and discharge breaks are presented because the onset of boiling transition occurs significantly later for discharge breaks. Therefore, MAPLHGR's limited by the discharge break are more severely reduced for one pump operation.

As explained in Subsection 2.2.3, the MAPLHGR reduction factor is calculated at certain invervals of reflooding time for the BWR/3's and BWR/4's with the longest time to boiling transition for two-pump operation. Points 3 (suction break) and 7 (discharge break), shown in Figure 1, are evaluated for plants with shorter boiling transition times relative to the plants used to calculate the recommended curves for MAPLHGR reduction. The MAPLHGR reduction factors for points 3 and 7 are approximately 3% higher than those predicted by the conservative curves in Figure 1. This demonstrates the conservatism in the MAPLHGR reduction factor for plants with shorter boiling transition times.

The MAPLHGR correction factor in Figure 1 is assumed to be constant for suction break reflooding times greater than 341 sec and discharge break reflooding times greater than 298 sec. These are the longest reflooding times for which specific calculations were performed for the respective cases. This assumption results in conservatively low one-pump MAPLHGR's in this region of constant MAPLHGR reduction because the MAPLHGR reduction is not as severe for longer reflood times.

The correction factor (F) plotted in Figure 1 is calculated from the results of the one-pump and two pump heatup analysis (MAPLHGR and PCT) according to:

# 4. ABNORMAL OPERATIONAL TRANSIENTS

## 4.1 TRANSIENTS AND CORE DYNAMICS

Since operation with one recirculation loop results in a maximum power output which is 20 to 30% below that from which can be attained for two-pump operation, the consequences of abnormal operational transients from one-loop operation will be considerably less severe than those analyzed from a two-loop operational mode.

For pressurization, cold water and flow decrease, transients previously transmitted Reload/FSAR results bound both the thermal and overpressure consequences of one-loop operation. Figure 3 shows the consequences of a typical pressurization transient (turbine trip) as a function of power level. As can be seen, the consequences of one-loop operation are considerably less because of the associated reduction in operating power level. The thermal (MCPR) consequences from cold water events and flow decrease transients are also bounded by the full power analysis. For example, a single pump trip from one-loop operation is obviously less severe than a two-pump trip from full power because of the reduced initial power level. It can, therefore, be concluded that the transient consequence from one-loop operation is bounded by previously submitted full power analysis. The maximum power level that can be attained on one-loop operation is only restricted by the MCPR and overpressure limits established from a full power analysis.

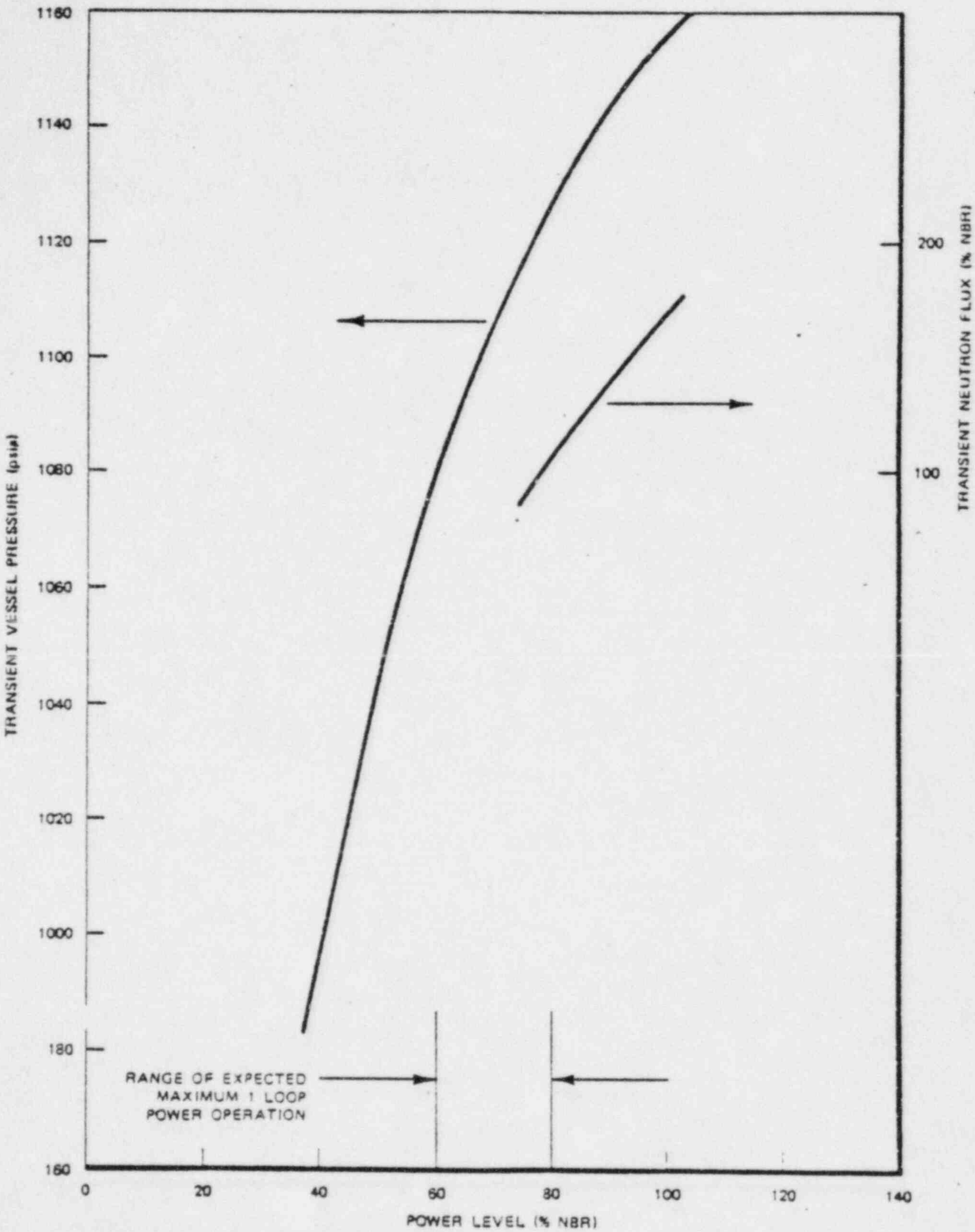



Figure 3. Main Turbine Trip with Bypass Manual Flow Control

## 4.2 ROD WITHDRAWAL ERROR

The rod withdrawal error at rated power is given in reload licensing submittals (see Reference 5 for an example). These analyses demonstrate that even if the operator ignores all indications and alarm which could occur during the course of the transient, the rod block system will stop rod withdrawal at a critical power ratio which is higher than the 1.06 safety limit. The MCPR requirement for one-pump operation will be equal to that for two-pump operation because the nuclear characteristics are independent of whether the core flow is attained by one- or two-pump operation. The only exceptions to this independence are possible flow asymmetries which might result from one-pump operation. Flow asymmetries were shown to be of no concern by tests conducted at Quad Cities. Under conditions of one-pump operation and equalizer valve closed, flow was found to be uniform in each bundle (see Reference 6).

One-pump operation results in backflow through ten of the twenty jet pumps while the flow is being supplied into the lower plenum from the ten active jet pumps. Because of the backflow through the inactive jet pumps, the present rod block equation shown in the Technical Specifications must be modified.

The procedure for modifying the rod block equation for one-pump operation is given in the following subsections.

a. The two-pump rod block equation in the existing Technical Specification is of the form:

$$RB = (mW + K)\% \qquad (4.2\text{-}1)$$

where:

RB = power at rod block in %

m = flow reference slope for the rod block monitor (RBM)

W = drive flow in % of rated

K = power at rod block in % when W = 0.

For the case of top level rod block at 100% flow, denoted $RB_{100}$:

$$RB_{100} = m(100) + K$$

$$\text{or} \quad K = RB_{100} - m(100)$$

Substituting for K in Equation 4.2-1, the two pump equation becomes:

$$RB = mW + [RB_{100} - m(100)] \qquad (4.2\text{-}2)$$

b. Next, the core flow ($F_c$) versus drive flow (W) curves are determined for the two-pump and one-pump cases. For the two-pump case the core flow and drive flow are derived by measuring the differential pressures in the jet pumps and recirculation loop, respectively. Core flow for one pump operation must be corrected for the backflow through the inactive jet pumps thus:

Actual core flow (one pump) = Active jet pump flow - inactive jet pump flow.

Both the active and inactive flows are derived from the jet pump differential pressures. The drive flow is derived from the differential pressure measurement in the active recirculation loop. These two curves are plotted from Pilgrim Unit 1 data in Figure 4. The maximum difference between the one pump and two pump core flow is determined graphically. This occurs at about 35% drive flow which is denoted W.

c. Next, a horizontal line is drawn from the 35% drive flow point on the one pump curve to the two pump curve and the corresponding flow, $W_2$, is determined. Thus, $\Delta W = W_1 - W_2$.

The rod block equation corrected for one pump flow is:

$$RB = mW + [RB_{100} - m(100)] - \Delta RB$$

where $\Delta RB = RB_1 - RB_2 = m\Delta W$

$$\Delta RB = mW + RB_{100} - m(100 + \Delta W) \qquad (4.2\text{-}3)$$

d. For Pilgrim Unit 1 application, the constants from the Technical Specifications are:

$$m = 0.58$$

$$RB_{100} = 107$$

From Figure 4:

$$\Delta W = W_1 - W_2 = 35 - 30 = 5$$

Evaluating in Equation 4.2-3, the one-pump rod block equation becomes:

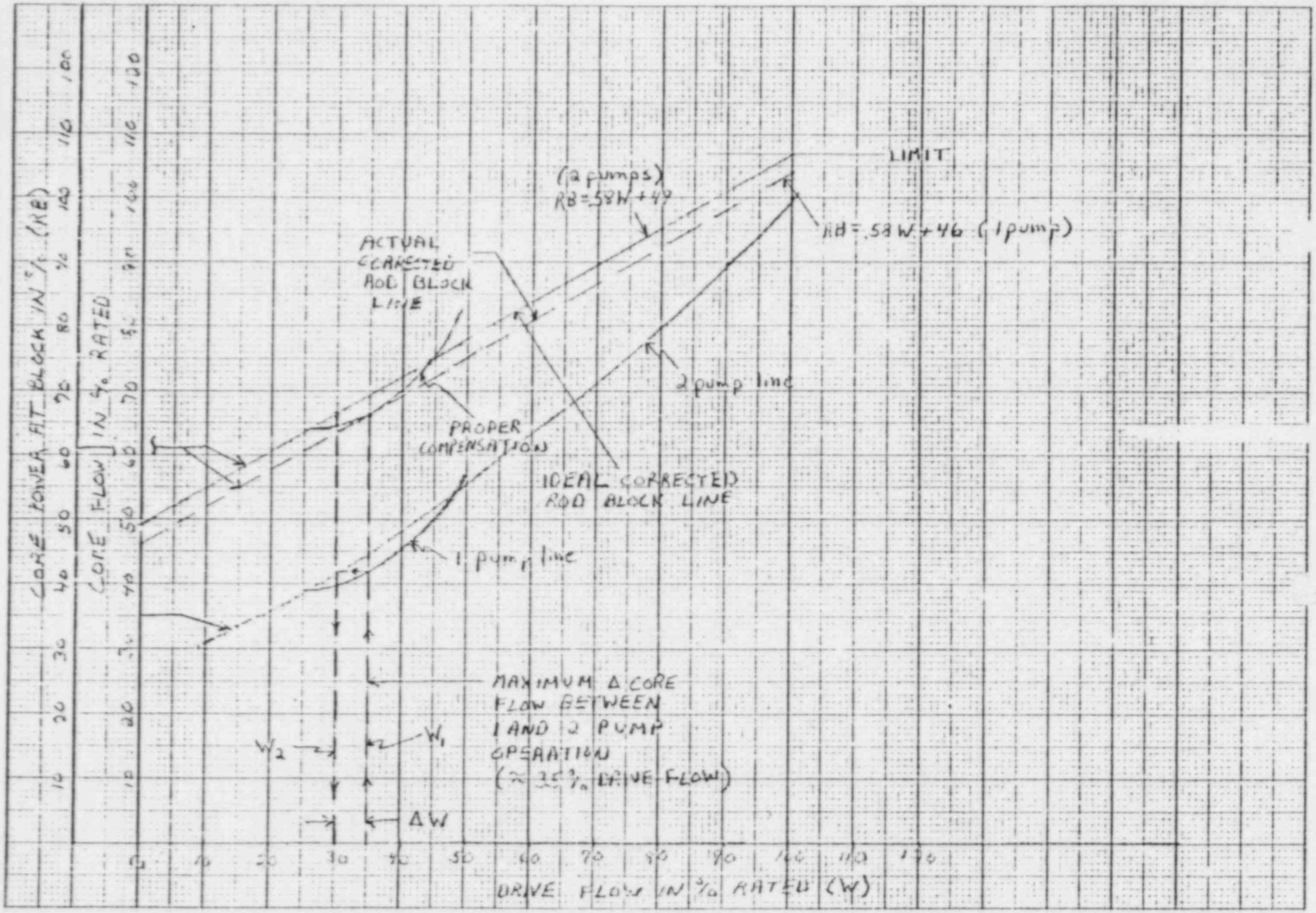
$$RB = 0.58 + 107 - 0.58(100+5) =$$

$$0.58W + 46 \qquad (4.2\text{-}4)$$

This line is depicted in Figure 4 as the future corrected rod block line for one-pump operation.

## 4.3 APRM TRIP SETTING

The APRM trip settings are flow biased in the same manner as the rod block monitor trip setting. Therefore, the APRM rod block and scram trip settings are subject to the same procedural changes as the rod block monitor trip setting discussed in Section 4.2.


LIMIT
(2 pumps)
RB = .58W + 49
RB = .58W + 46 (1 pump)
ACTUAL CORRECTED ROD BLOCK LINE
PROPER COMPENSATION
2 pump line
IDEAL CORRECTED ROD BLOCK LINE
1 pump line
MAXIMUM Δ CORE FLOW BETWEEN 1 AND 2 PUMP OPERATION (≈ 35% DRIVE FLOW)
W2
W1
ΔW
CORE POWER AT BLOCK IN % (RB)
CORE FLOW IN % RATED
DRIVE FLOW IN % RATED (W)

# 5. STABILITY ANALYSES

The least stable power/flow condition attainable under normal conditions is at natural circulation with control rods set for rated power and flow. This condition might be reached following loss of both recirculation pumps. However, the plant is quite stable even at this condition. Operations with one recirculation pump running would be more stable although not as stable as with both pumps running. With the bypass holes plugged, only manual flow control should be used.

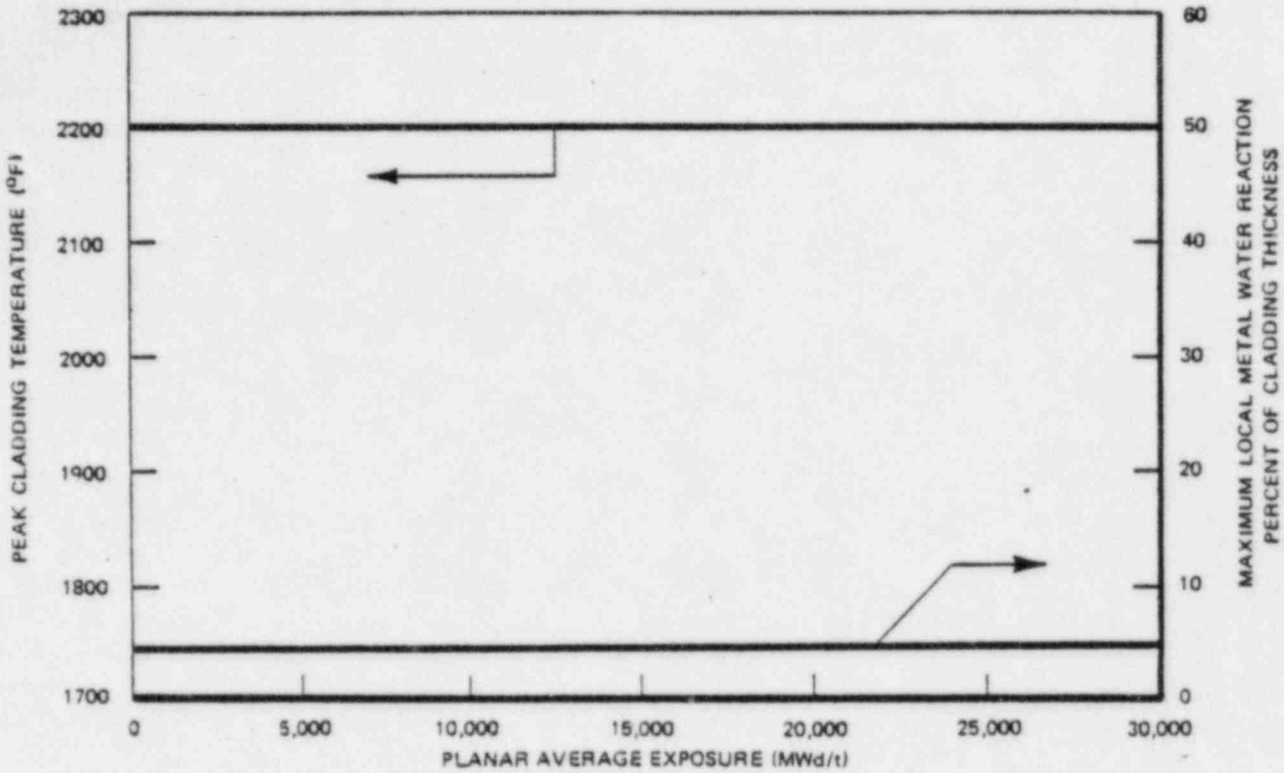



Figure 2A.7. Peak Cladding Temperature and Maximum Local Metal-Water Reaction versus Planar Average Exposure, Pilgrim NPS Unit 1, 8D262 Fuel, Single-Loop Operation, Plugged Bypass Holes, Recirculation Equalizer Valve Closed

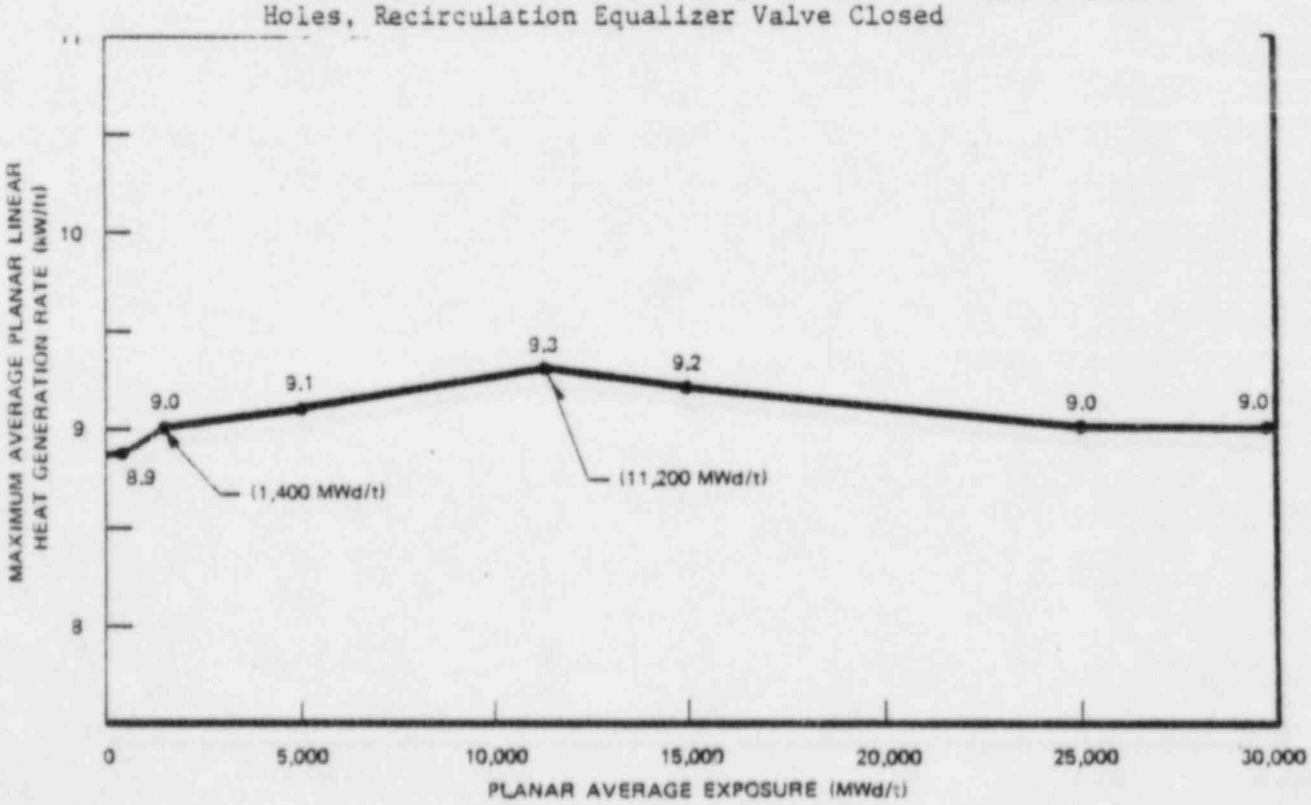



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Figure 2B.7. Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) versus Planar Average Exposure, Pilgrim NPS Unit 1, 8D262 Fuel, Single-Loop Operation, Plugged Bypass Holes, Recirculation Equalizer Valve Closed