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Niagara Mohawk Power Corp Syracuse, N. Y. 13202 P. D. Raymond	1-22-74	1-23-74	X			

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DESCRIPTION:
Ltr notarized 1-22-74, trans the following:

PLANT NAME: Nine Mile Point Unit #1

ENCLOSURES:
Proposed Change to Technical Specifications: Densification Analyses and Related Technical Specifications Changes for Type 5 and Type 6 Fuel

DO NOT REMOVE

ACKNOWLEDGED

(3 Orig & 37 cys rec'd)

FOR ACTION/INFORMATION 1-23-74 GC

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Regulatory Docket File

NIAGARA MOHAWK POWER CORPORATION

NIAGARA MOHAWK

300 ERIE BOULEVARD, WEST
SYRACUSE, N. Y. 13202

January 22, 1974

RECEIVED
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U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

Mr. Dennis L. Ziemann, Chief
Operating Reactors Branch #2
Directorate of Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Ziemann:

Re: Nine Mile Point Unit 1
AEC Docket No. 50-220

Niagara Mohawk Power Corporation has committed in its letter of October 15, 1973 to supply analyses to determine the effects of fuel densification and the appropriate changes to Technical Specifications for the fuel to be inserted during the Spring 1974 refueling. The analyses have been performed using the guidance provided in the enclosure to your December 5, 1973 letter, "Modified GE Model for Fuel Densification".

These analyses and the proposed Technical Specification changes are attached herewith. It is anticipated that these changes will not limit plant power level below its full design rating of 1850 megawatts for power distributions expected during normal operation.

The Site Operations Review Committee and the Safety Review and Audit Board concur with these proposed Technical Specification changes.

Very truly yours,

P D Raymond

P. D. Raymond
Vice President-Engineering

/sq
Attachment

Subscribed and sworn to before me this 22nd day of January, 1974.

Valerie N. Kelly

VALERIE N. KELLY
Notary Public in the State of New York
Qualified in Onon. Co. No. 34-4504729
My Commission Expires March 30, 1975

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Densification Analyses and Related Technical
Specification Changes For
Type 5 and Type 6 Fuel

I. Analyses of Fuel Densification Effects

This section presents results of the effects of densification in the 8x8 reload fuel as determined from application of the models described in Reference 1.

A. Local Power Spiking

An analysis of potential local power spikes due to axial gaps in a fuel pellet column for General Electric BWR's employing an 8x8 fuel lattice design has been performed. This analysis employs the same method and basic assumptions that were reported in Reference 1. Important aspects of this analysis are noted as follows:

1. The equation employed to calculate maximum gap size is that noted in Reference 1:

$$\Delta L = \left\{ \frac{.965 - p_i}{2} + 0.0025 \right\} L$$

where

ΔL = maximum axial gap length

L = fuel column length

p_i = mean value of measured initial pellet density (immersion - .5%)

0.0025 = allowance for irradiation induced cladding growth and axial strain caused by fuel-clad mechanical interaction.

2. The magnitude of the power spike versus gap size for fuel rods of the 8x8 design is shown in Figure 1 for normal operating conditions and Figure 2 for cold zero void conditions.

3. The core power histogram employed was for a 13.4 kW/ft maximum design linear heat generation rate; see Figure 3.

The results from this analysis are shown in Figure 4 with initial fuel density as a parameter. The line shown for an initial fuel density of 95% T.D. is considered to be most representative considering current General Electric data on manufactured fuel pellet densities. The power spike penalty shown in Figure 4 for several mean pellet densities as a function of axial position, is the required margin which must be maintained during normal operation between the actual peak operating condition and the peak design LHGR; i.e., 13.4 kW/ft. Maintaining this margin will assure, with better than 95% confidence, that no more than one rod will exceed the design peak LHGR due to the random occurrence of power spikes resulting from axial fuel column gaps. Consistent with General Electric's position on densification previously discussed in Reference 2 and its supplements, the results of this analysis are considered to be a very conservative representation of the power peaking penalty required to accommodate potential axial fuel column gaps during normal operating conditions in General Electric BWR's.

Since the results of the power spiking analysis for normal operation will be utilized to limit bundle power to assure that the random occurrence of power spikes will not result in exceeding the design peak LHGR, it is not believed necessary to separately consider power spikes in the analysis of transients or accidents which have as an initial condition some form of normal operation. The control rod drop accident is unique in the respect that it begins at the cold condition, and is not affected by normal operating power level. Further, the existence of fuel column gaps can result in power spiking in the cold condition

during a control rod drop which should thus be considered in the evaluation of this accident. For this purpose, a separate power spiking analysis has been performed using the same assumptions as indicated above, but employing a power spike versus gap size calculated to occur in the cold condition with zero voids (Figure 2). This analysis was performed for a conservative maximum gap size calculated employing a pellet average immersion density of 94.5% T.D., and a position near the top of the core in order to maximize the power spiking effect. This analysis yielded a 99% probability that any given fuel rod would have a power spike of <5%.

B. Cladding Creep Collapse

Using the same conservative bases presented in References 1 and 2, the critical pressure ratio; i.e., ratio of collapse pressure to actual coolant pressure, was calculated. Figure 5 presents the clad mid-wall temperature versus time for the 8x8 reload fuel. No credit is taken for internal gas pressure due to released fission gas or volatiles. The internal pressure due to helium backfill at 1 atmosphere during fabrication is considered. The fuel characteristics for creep collapse calculations are as follows:

Clad O.D., in.	0.493
Clad Thickness, in.	0.034 ± 0.003
Peak LHGR, kW/ft	13.4
Fast Flux >1 Mev. n/cm^2-sec	4.37×10^{13}

Figure 6 gives the calculated critical pressure ratio. As evidenced by the curve, the calculated critical pressure ratio is always >1.0.

C. Increased Linear Heat Generation Rate

The following expression was employed to calculate the decrease in fuel column length due to densification in calculation of a penalty in linear heat generation rate:

$$\Delta L = \frac{0.965 - \rho_i}{2} L$$

Where ΔL = decrease in fuel column length

L = fuel column length

p_i = mean value of measured initial pellet density (immersion - .5%)

The length reduction due to densification as calculated by the above equation requires knowledge of the mean immersion density (p_i) obtained from the QC data. A correction of 0.5% T.D. is applied to convert the immersion density to a geometric density. The mean pellet immersion density for Nine Mile Point 1 8x8 reload fuel is 95.29% T.D. This results in:

$$\frac{\Delta L}{L} = \frac{0.965 - 0.9529 - 0.005}{2} = \frac{0.01709}{2} = 0.009$$

$$\text{or } \frac{\Delta L}{L} = 0.9\%$$

Due to thermal expansion, an 8x8 pellet normally expands in going from the cold to hot condition, an amount equal to 1.2% for a pellet at 13.4 kW/ft. This increase in length from the cold to hot condition is not taken credit for in either design calculations or in the process of core performance analysis during reactor operations. The cold pellet length is assumed for these conditions.

Therefore, the decrease in pellet length due to densification is more than offset by pellet axial thermal expansion.

D. Decreased Pellet-Clad Thermal Conductivity

Figure 7 provides plots of Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) versus exposure, for Nine Mile Point 8x8 reload fuel. The Ω (omega) curve is suitable for incorporation into the plant technical specifications.

The LOCA analyses were performed using the approved Interim Acceptance Criteria Model with gap conductance values as calculated per the new GEGAP III model with AEC modifications.[1]

REFERENCES

1. Hinds, J.A., (General Electric) letter to V.A. Moore (USAEC), "Plant Evaluations with GEGAP III," December 12, 1973.

2. "Generic Design Information for General Electric Reload Fuel", NEDO-20103, September 1973.

3. NEDM-10735, Supplement 6, "Fuel Densification Effects on General Electric Boiling Water Reactor Fuel," August 1973.

FIGURE 1

8x8 POWER SPIKE VERSUS GAP SIZE - NORMAL OPERATION

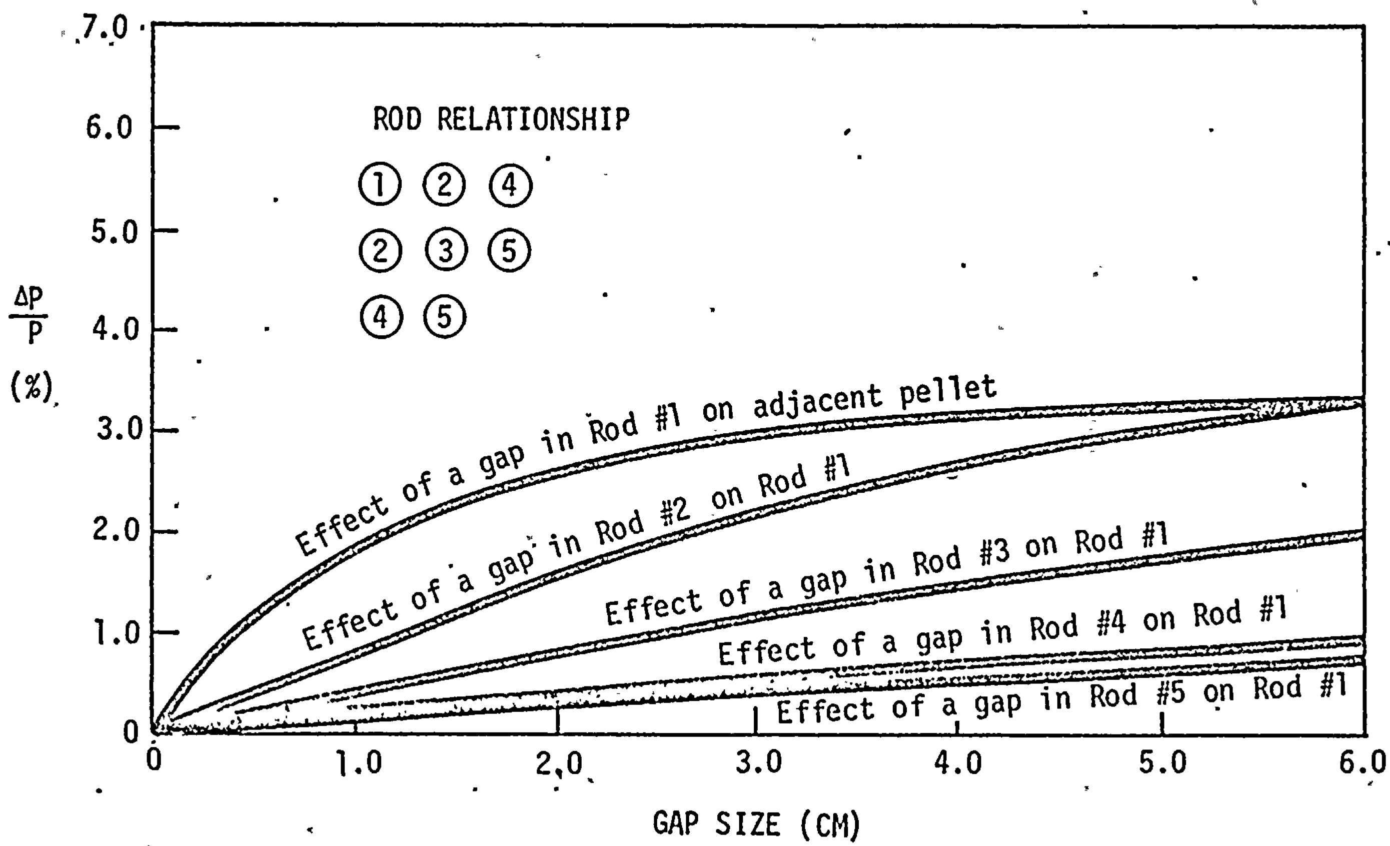


FIGURE 2

8x8 POWER SPIKE VERSUS GAP SIZE - COLD ZERO VOID CONDITION

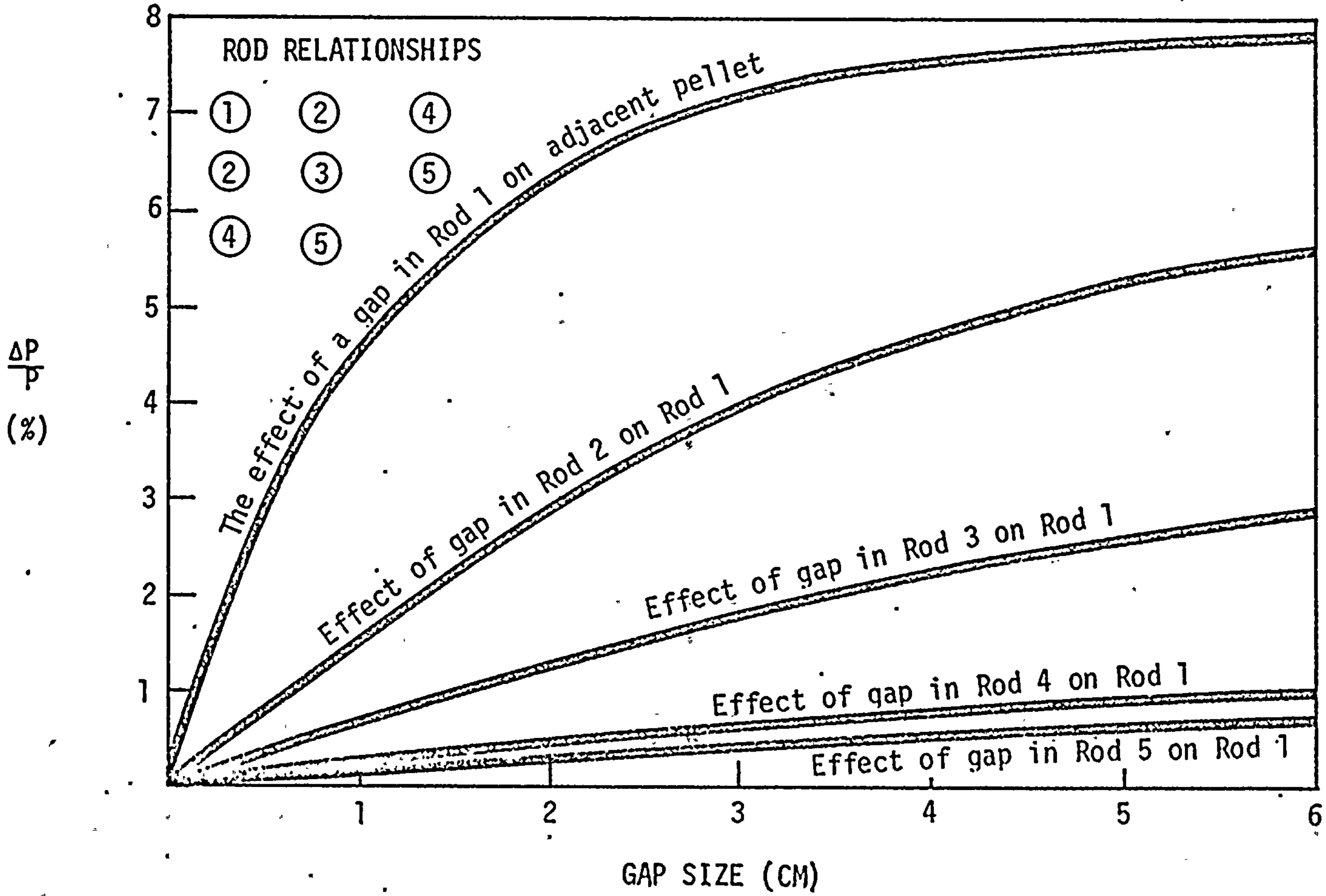
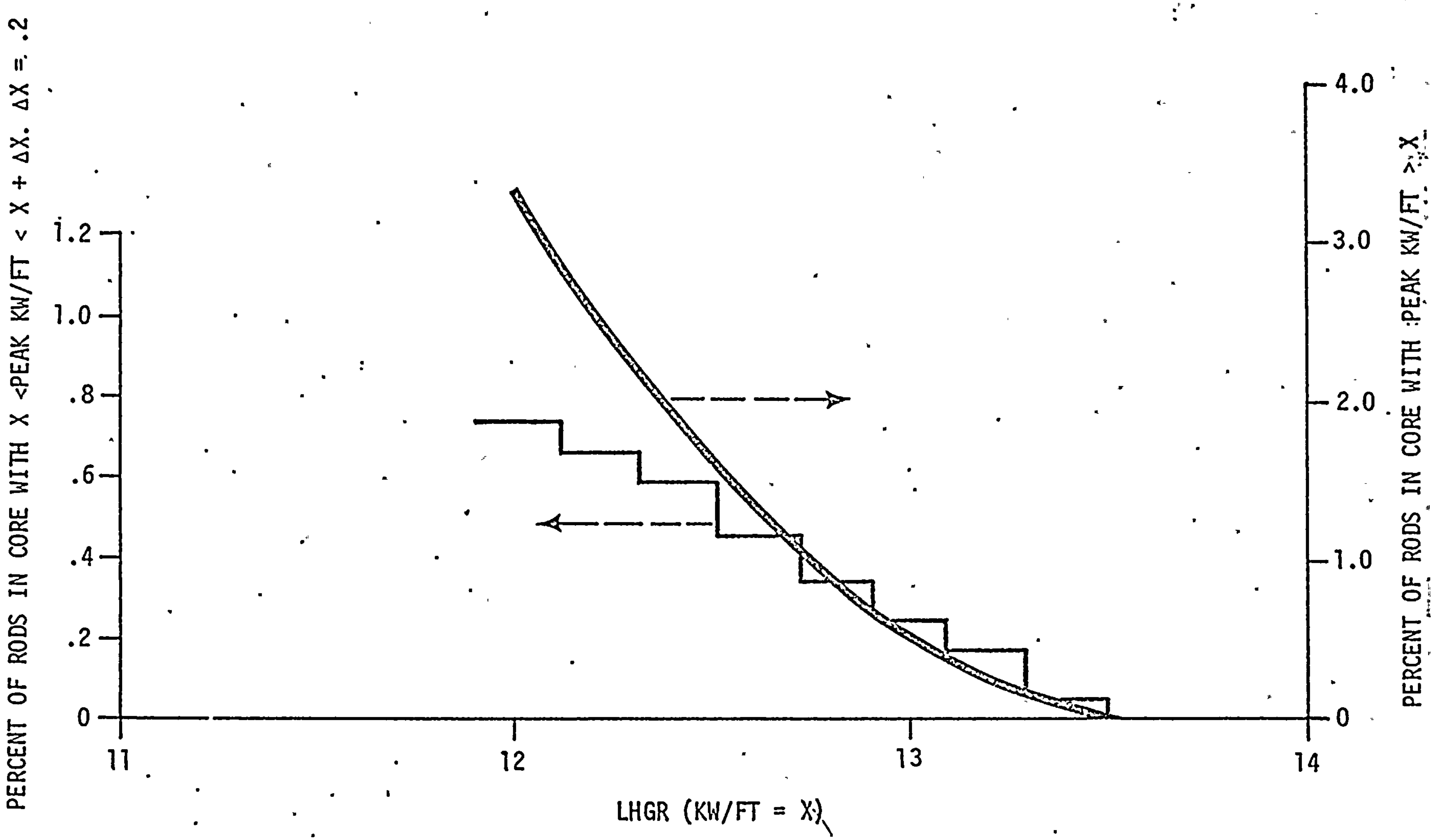


FIGURE 3



PERCENT OF RODS IN CORE WITH X <PEAK KW/FT < X + ΔX. ΔX = .2
1.2
1.0
.8
.6
.4
.2
0
11
12
13
14
LHGR (KW/FT = X)
4.0
3.0
2.0
1.0
0
PERCENT OF RODS IN CORE WITH PEAK KW/FT > X

FIGURE 4

8x8 POWER SPIKE PENALTY VS AXIAL POSITION - NORMAL OPERATION

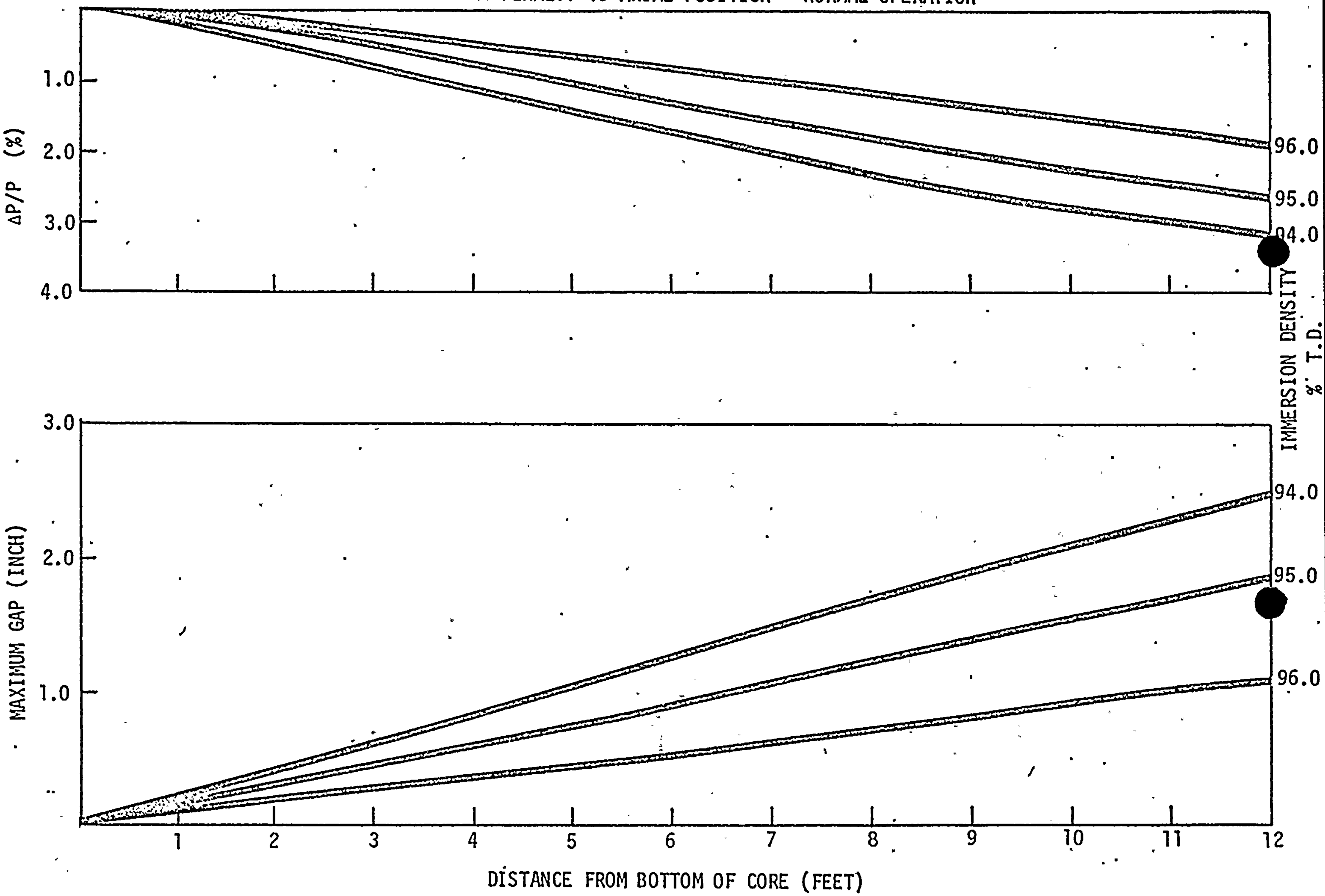


FIGURE 5
CLADDING AVERAGE TEMPERATURE AT A
FUEL COLUMN AXIAL GAP

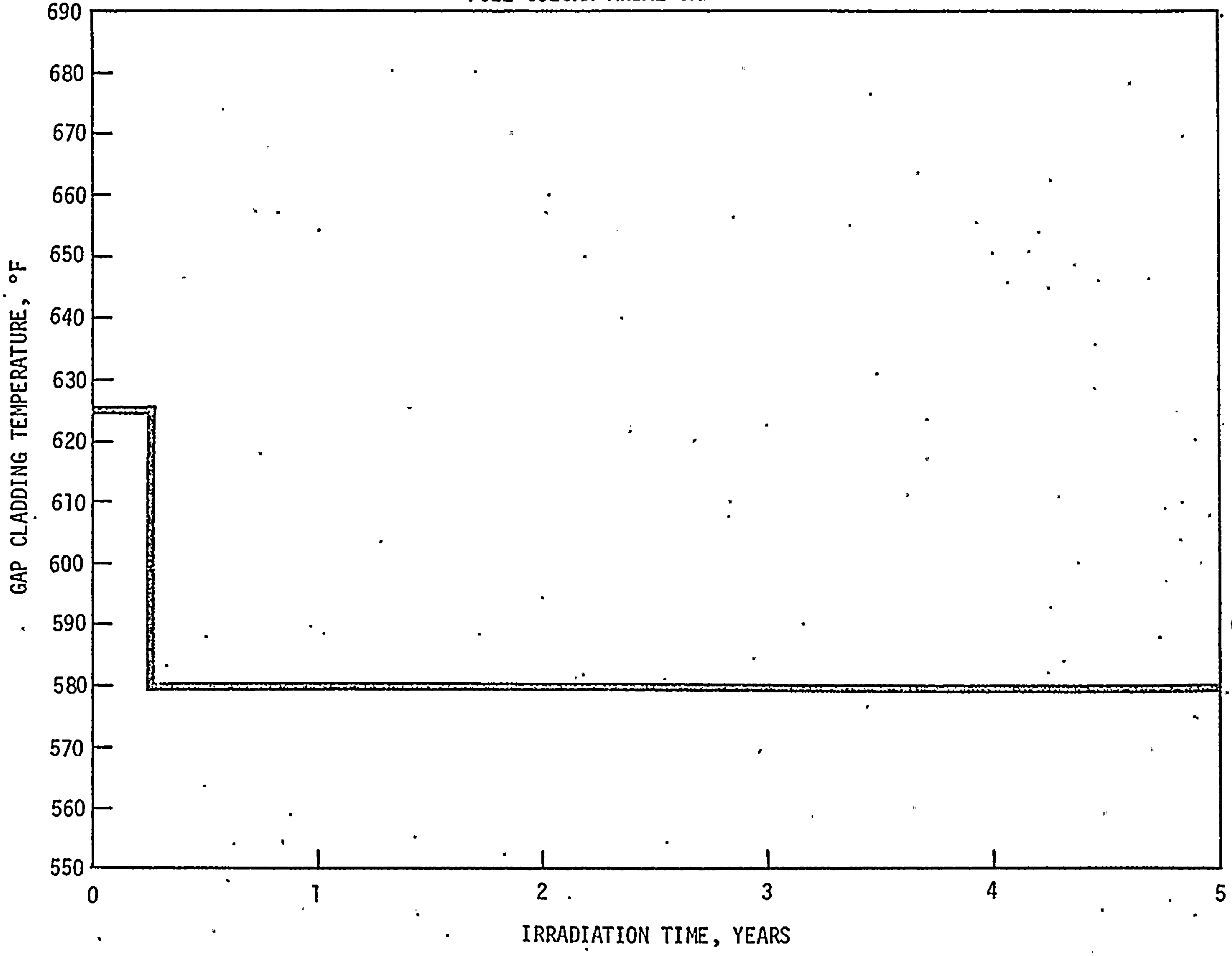


FIGURE 6
CLAD CRITICAL COLLAPSE PRESSURE RATIO VERSUS TIME
8x8 RELOAD FUEL

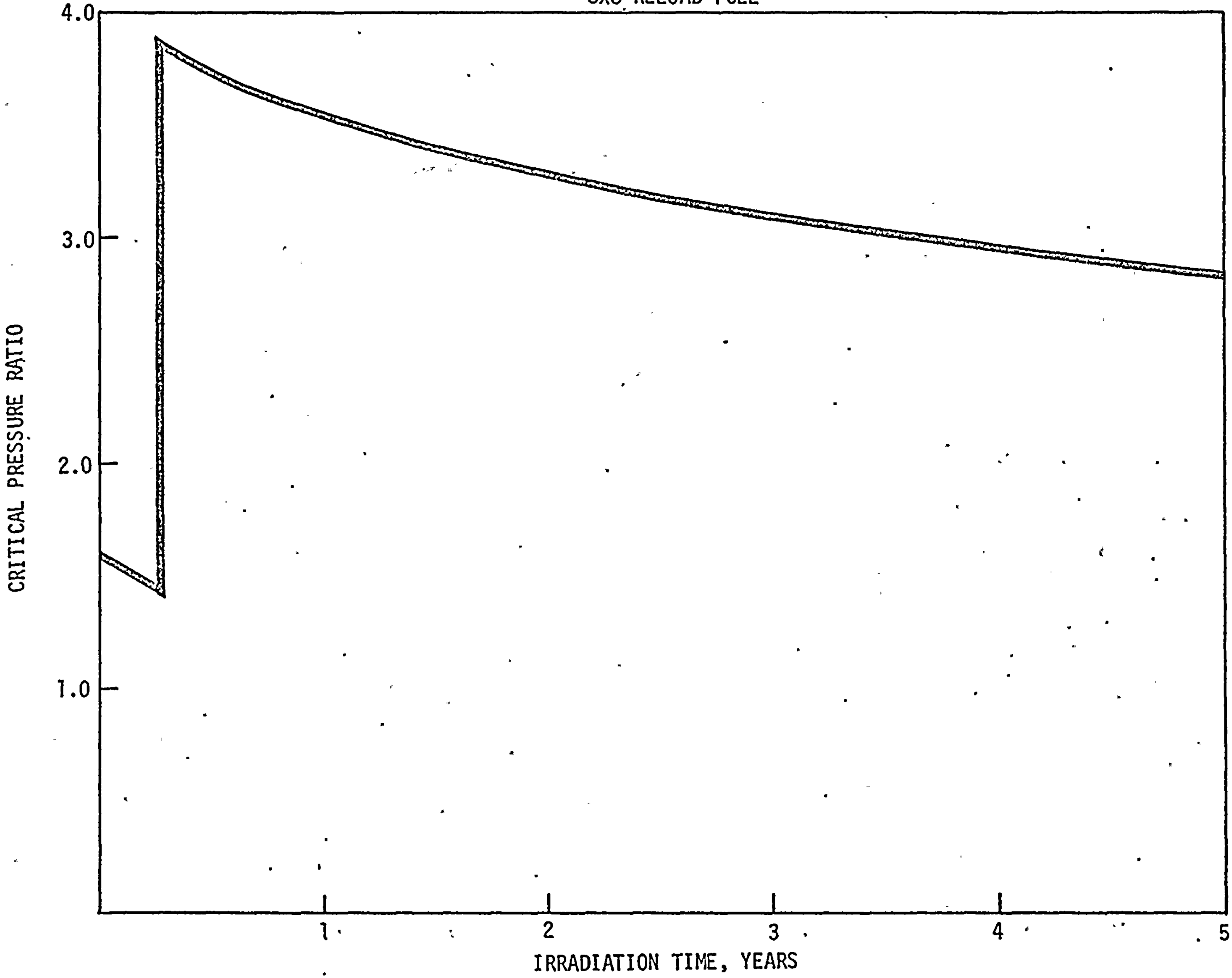
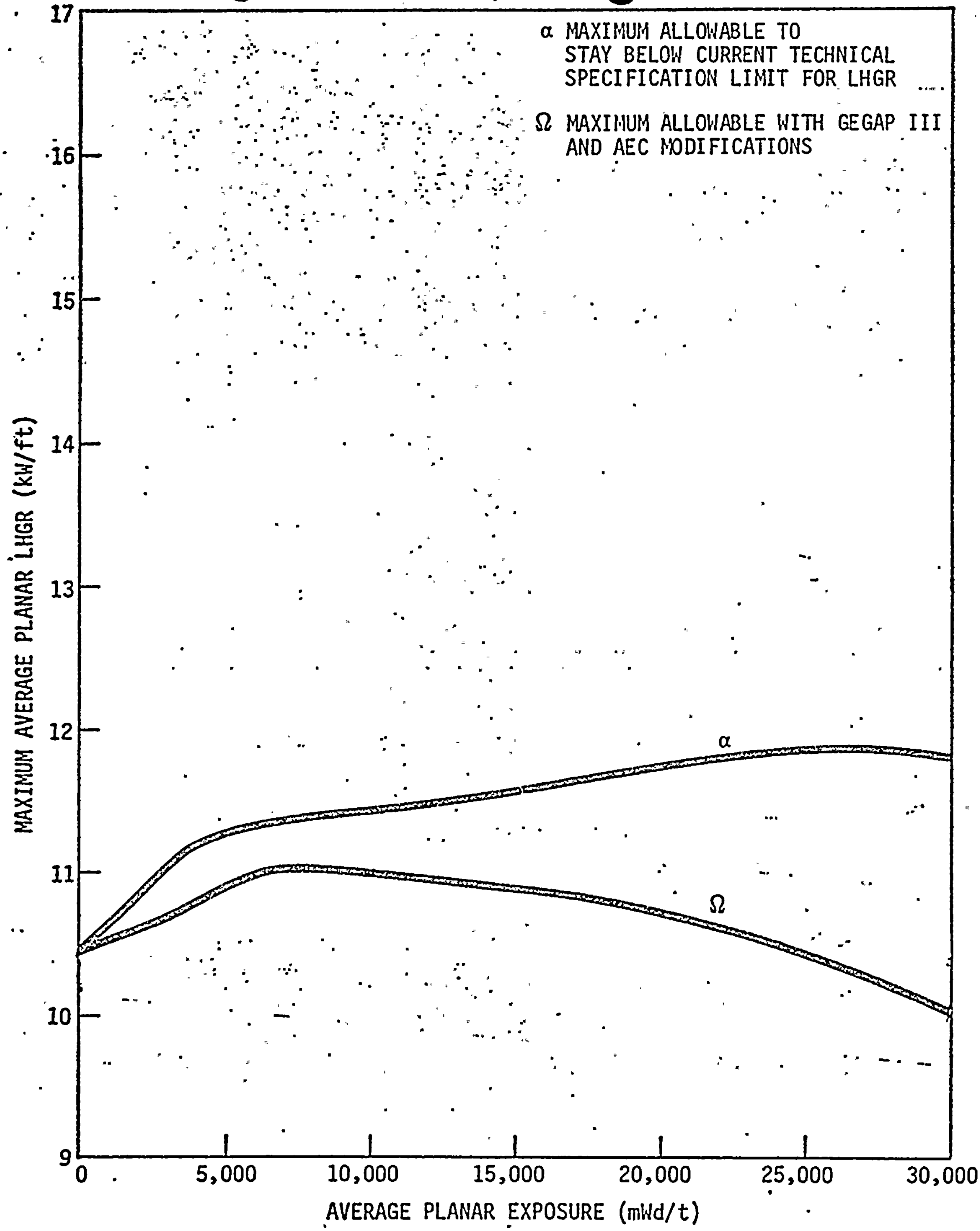


FIGURE 7

MAPLHGR VERSUS EXPOSURE



II. Proposed Changes to Technical Specifications

Change pages 37a, 37b, 37c, etc. as follows:

Change A

Add the attached Figure 3.1.7e to the Technical Specification. Under the Limiting Condition for Operation 3.1.7, add Figure 3.1.7e to the list of figures at the end of the last sentence in paragraph a.

Change B

Replace the notes to the equation in Limiting Conditions for Operation 3.1.7b with the following:

" $LHGR_d$ = Design LHGR = 17.5 kw/ft for 7x7 fuel or 13.4 kw/ft for 8x8 fuel

$(\Delta p/p)_{MAX}$ = Maximum power spiking penalty = 0.040 for 7x7 fuel or 0.027 for 8x8 fuel.

LT = Total Core length = 12 ft.

L = Axial position above botton of core "

Change C

Add Figure 3.1.7e to the list of figures in the third paragraph of the Bases 3.1.7a.

Reasons for Changes A, B & C

The results of analyses performed for 8x8 reload fuel has indicated that limits on MAPLHGR and power spiking penalties due to densification are required. These limits as they apply to Type 5 and Type 6 fuel are presented for incorporation into Nine Mile Point Unit 1 Technical Specifications.

Similar limits for previously loaded 7x7 fuel are already part of the Technical Specifications.

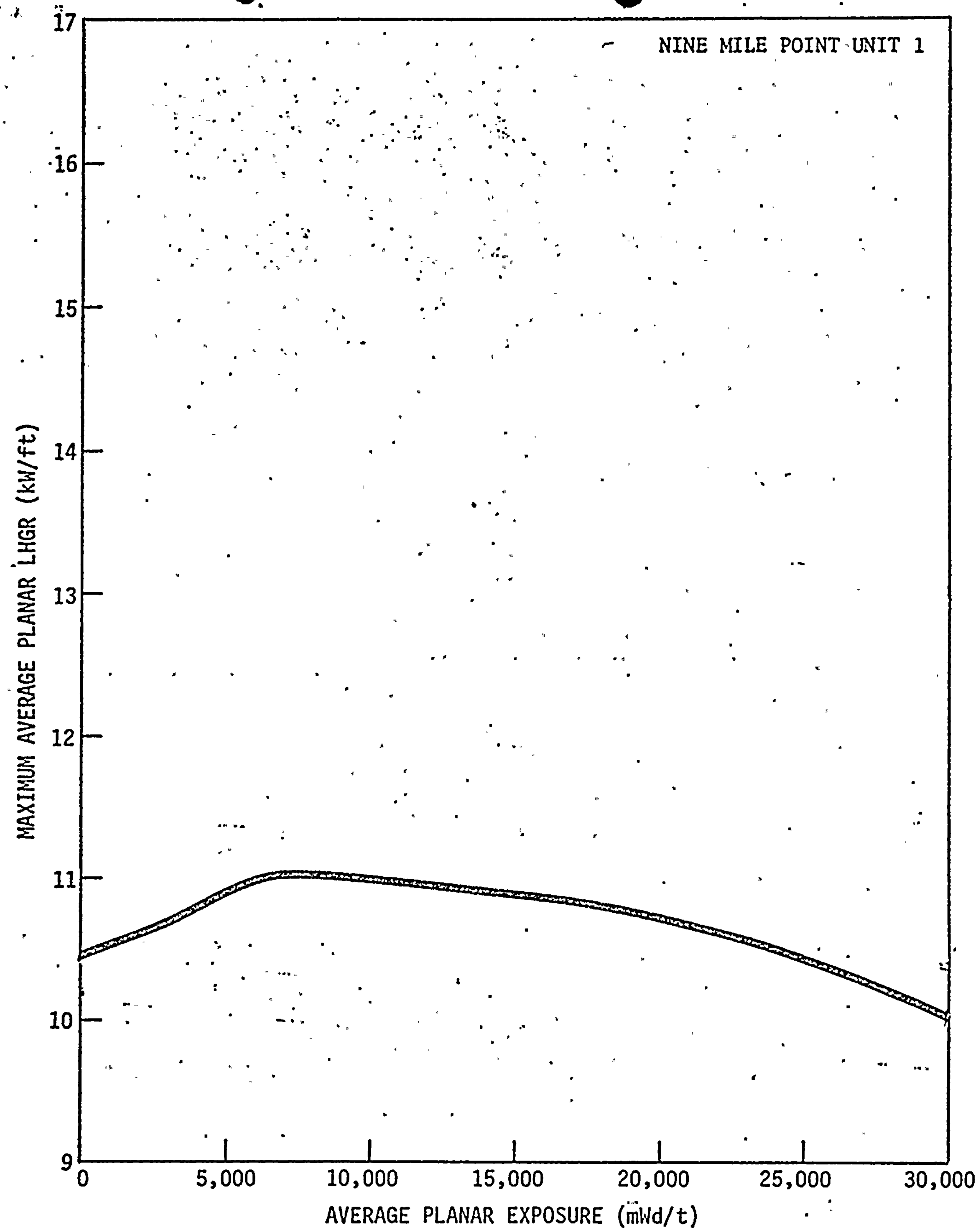


FIGURE 3.1.7.e MAXIMUM ALLOWABLE AVERAGE PLANAR LHGR
APPLICABLE TO FUEL TYPE 5 and 6