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August 31, 1981
EF2 - 54,540

Mr. L. L. Kintner
U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Licensing
Washington, D. C. 20555

RECEIVED SEP 04 1981 U.S. NUCLEAR REGULATORY COMMISSION

Dear Mr. Kintner:

References: 1. Enrico Fermi Atomic Power Plant, Unit 2
NRC Docket No. 50-341

2. Edison letter "Reheater Steam Flow", EF2-54,213, August 4, 1981

Subject: Reheater Bypass Flow Analysis

The purpose of this letter is to provide the results of calculations that Edison agreed (Reference 2) to perform at the July 30, 1981 meeting on reheater bypass flow.

Sincerely,

W. F. Colbert

W. F. Colbert
Technical Director
Enrico Fermi 2

WFC:jl
Attachment

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FERMI 2 REHEATER FLOW STUDY

INTRODUCTION

This report provides the results of a series of computer analyses performed with the RETRAN code to confirm that the reheater flow will be equal to or greater than that shown in Figure 15B.0-3 of the FSAR (reprinted here as Figure 1), which was the flow pattern utilized in pressure transient calculations performed with ODYN for FSAR Chapter 15 analyses.

The analyses presented here are mostly variations on the RETRAN model labeled "RETRAN VERSION 2" in Figure 2, and previously discussed with NRC staff.

This work is in response to specific requests made by NRC staff as summarized by Detroit Edison in EF2-54213, August 4, 1981. As agreed, satisfactory results from these analyses should close the reheater steam bypass flow issue.

SHELL-SIDE HEAT TRANSFER MODIFICATION

Uncertainties in the conditions on the shell side of the reheater are resolved by performing a calculation that conservatively ramps the heat transfer from the metal tubes to the shell side to effectively zero in 0.2 seconds. This assumption creates a lower bound to the heat transfer to shell side. The base calculation assumed the shell side flow to depend on turbine response and an intercept valve that completely closes in one second following turbine trip.

The resulting bypass flows to the reheater for both the 0.2 second ramp case and the base case are shown in Figure 3. Little difference is observed between the two cases. However, the 0.2 second ramp assumption is maintained for the nodalization study, including the final reference case, described below.

STEAM LINE NODALIZATION

To resolve staff questions concerning the potential for pressure oscillations adversely interacting with reheater flow, additional nodes were added to the main steam line and to the line connecting the main steam line to the reheater (reheater line). Steam line nodalization in the original model (4 nodes) had taken the propagation of pressure waves into account, but the nodal lengths were somewhat longer than had been used in the Peach Bottom analysis; moreover, there was previously only one node to represent the reheater line. The renodalization uses eight nodes in the steam line and five nodes in the reheater line.

The resulting pressure profiles in the steam line manifold (reheater driving pressure) and reheater flow for both cases are shown in Figures 4 and 5, respectively. Some differences in the pressure profile can be seen but both nodal schemes give the same characteristic shape and exhibit the initial peak observed in the Peach Bottom tests. * The flow to the reheater does reflect the effects of the pressure oscillations, and thus varies little between the two nodal schemes.

The flow rate of Figure 5 using the renodalized model with the 0.2 second heat transfer delay to the shell side represents the reference case for confirming the reheater bypass flow used in the FSAR. The FSAR curve is also included in Figure 5. It can be seen that a rather wide margin exists between the results of the reference model and the FSAR curve, particularly during the important early stages of the transient.

STEAM LINE GEOMETRY

The final staff concern noted that ODYN lumps the reheater flow and flow through the turbine stop valve into a single equivalent junction flow with flow characteristics as shown in Figure 1. A more realistic portrayal would place the reheater junction and turbine stop valve at their actual individual locations and use appropriate individual flow patterns (stop valve ramped to zero in 0.2 seconds; reheater flow maintained at 10% of full NBS for 2 seconds, followed by a ramp to zero at 5 seconds). To assure that the ODYN configuration is adequate, these two flow configurations (Figure 6) properly nodalized were incorporated into a standard NSSS RETRAN turbine trip model to form two different models for comparison runs for the turbine trip without normal bypass transient. Each should give nearly the same peak fuel pin surface heat flux in order to confirm the adequacy of the configuration used by ODYN.

The resulting time dependent power and dome pressure for each configuration are compared in Figures 7 and 8. The results demonstrate that the power and pressure are essentially the same and thus are not sensitive to this modeling variation. This insensitivity to the two configurations is not surprising because they are quite similar since steam line length between the reheater junction and the stop valve is only about 20 ft. Had the reheater line itself been explicitly added to the model, the peak power and heat flux would have been less due to the pressure mitigation provided by the additional flow path and greater steam volume. The ODYN model does not account for the reheater line volume and thus is conservative in that regard.

* It should be noted that the pressure oscillations in the steam line from earlier RETRAN analyses are not as pronounced as the current analyses or as found with Peach Bottom. This is partly due to the assumption of no delay between stop valve closure and bypass valve opening in the earlier analyses. All of the current analyses assume the conservative (longest) delay of 0.1 seconds between initiation of stop valve closure and initiation of bypass valve opening as used in the ODYN analysis. Actual delays for Fermi 2 are expected to be about 0.02 seconds. Peach Bottom delays varied between 0.07 and 0.33 seconds depending on the tests. Such delays in bypass action accentuate the sudden drop in steam flow and thus increases the magnitude of pressure oscillations. Thus, the reheater flow itself in Fermi 2 would tend to reduce the initial pressure oscillations relative to those observed in Peach Bottom.

CONCLUSIONS

These analyses indicate that the bypass flow to the reheater assumed in the turbine trip analyses is conservative by a wide margin and that the configuration employed by ODYN to account for this reheater bypass is also conservative.

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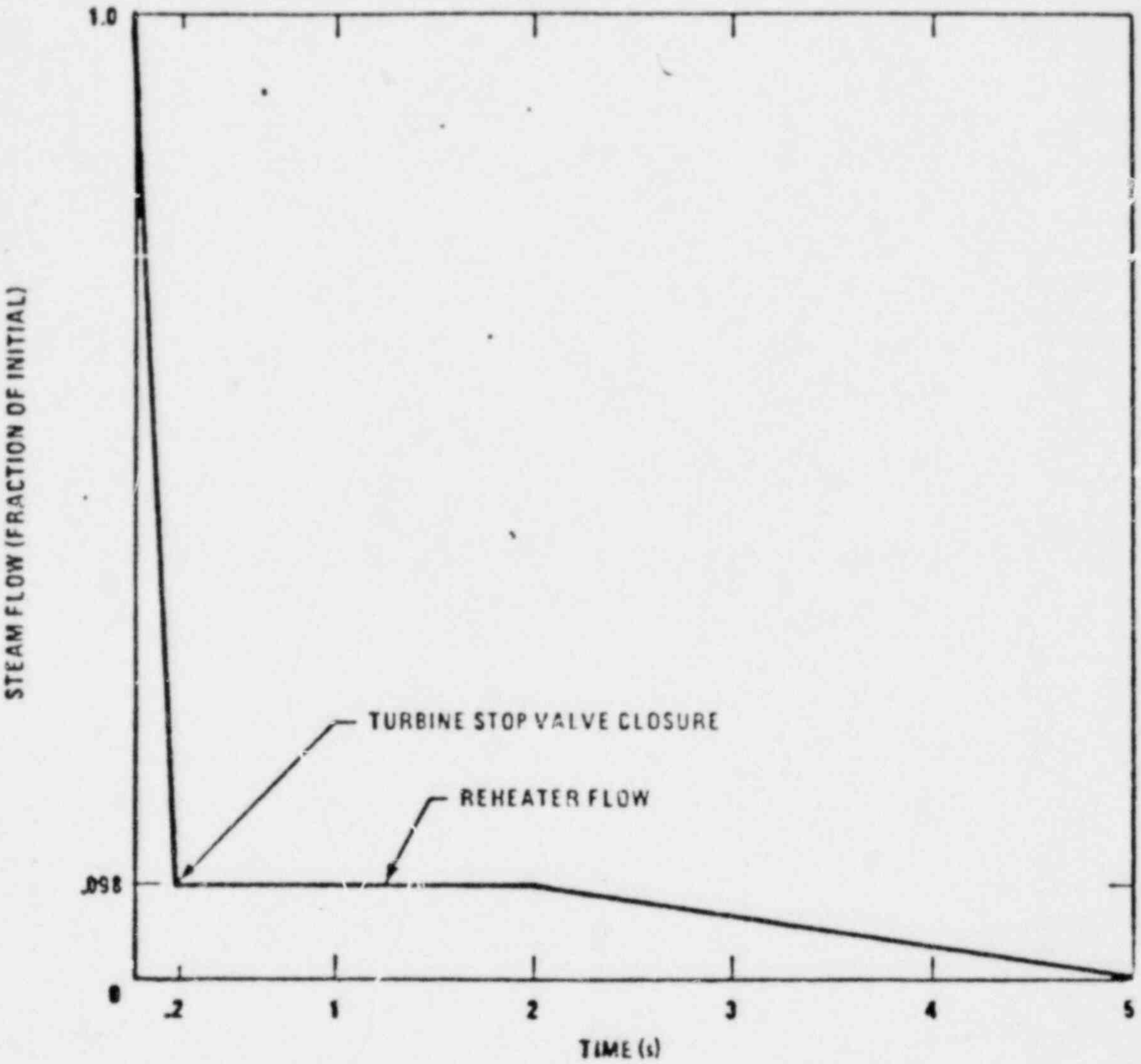


FIGURE 1

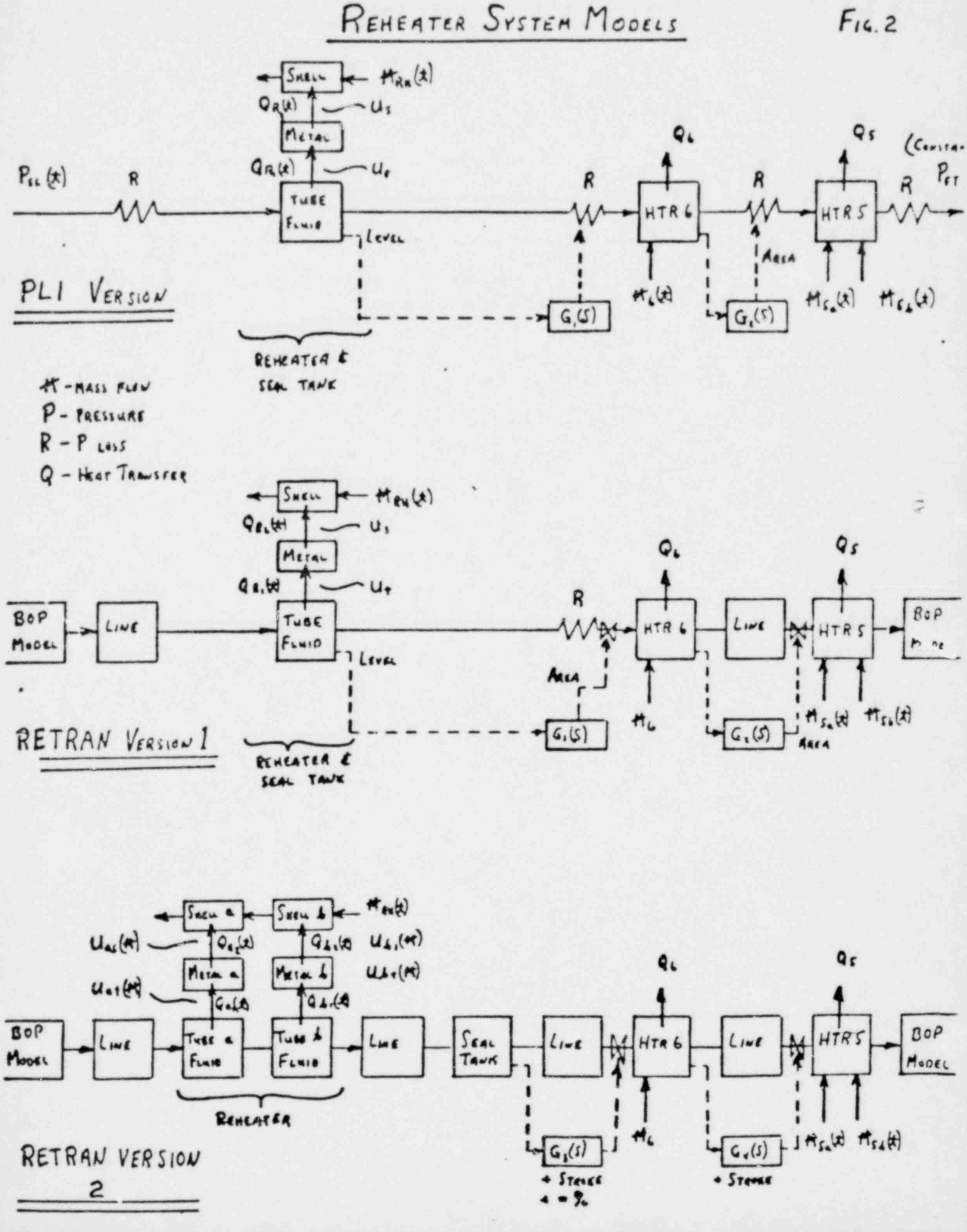
ENRICO FERMI ATOMIC POWER PLANT
UNIT 2
FINAL SAFETY ANALYSIS REPORT

FIGURE 15B.0-3

MAIN STEAM FLOW AFTER TURBINE TRIP, ALLOWING NO FLOW THROUGH BYPASS VALVES

AMENDMENT 22 – APRIL 1979

FIGURE 2


REHEATER SYSTEM MODELS
FIG. 2
PLI Version
Shell
Metal
Tube Fluid
Level
HTR 6
HTR 5
R
Area
G1(S)
G2(S)
Reheater & Seal Tank
M - Mass Flow
P - Pressure
R - P Loss
Q - Heat Transfer
RETRAN Version 1
BOP Model
Line
Area
RETRAN Version 2
Shell a
Shell b
Metal a
Metal b
Tube a Fluid
Tube b Fluid
Reheater
Seal Tank
G3(S)
G4(S)
+ Stroke
+ = %

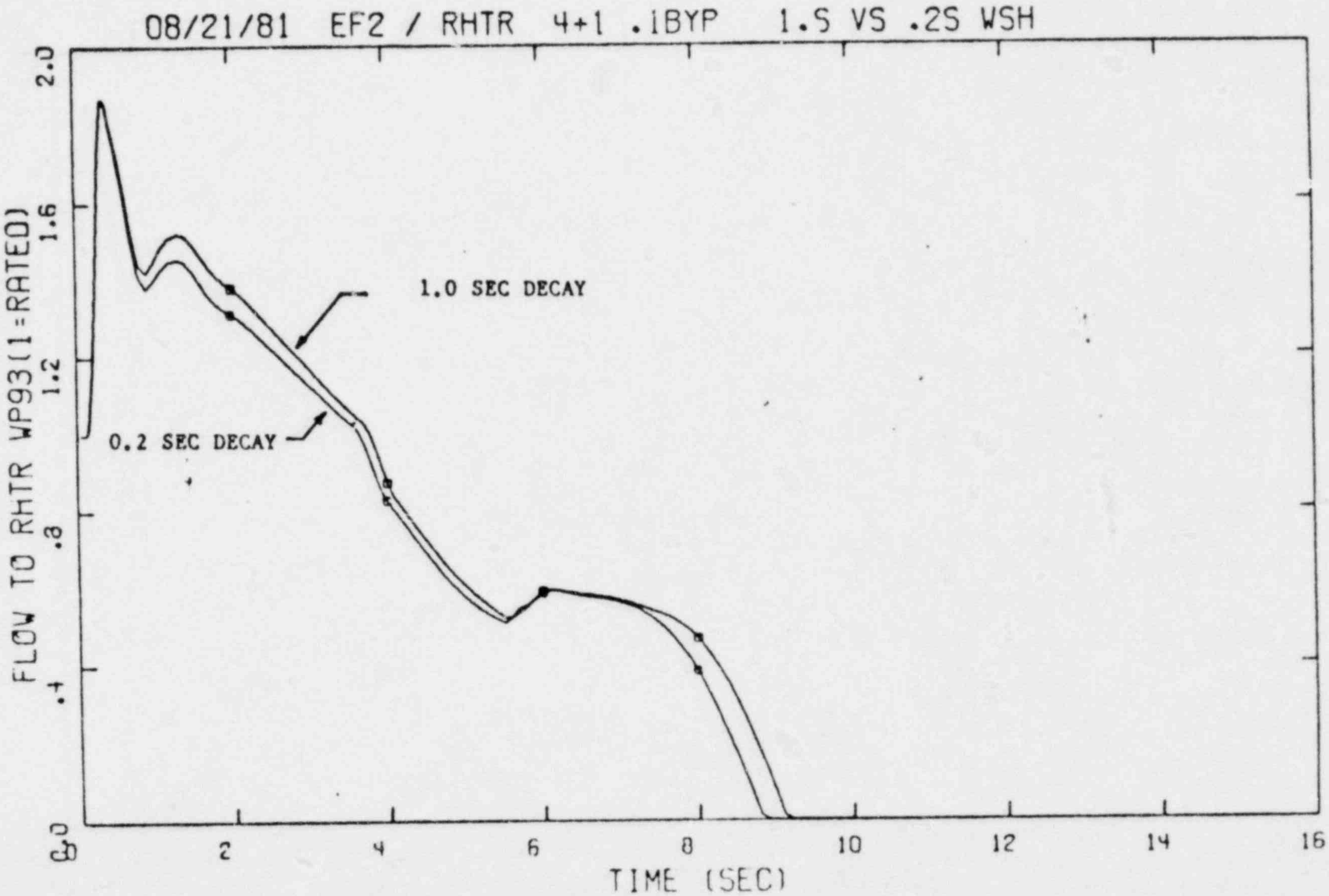


FIGURE 3

REHEATER FLOW FOR 0.2 SEC AND 1.0 SEC DECAY OF SHELL SIDE HEAT TRANSFER

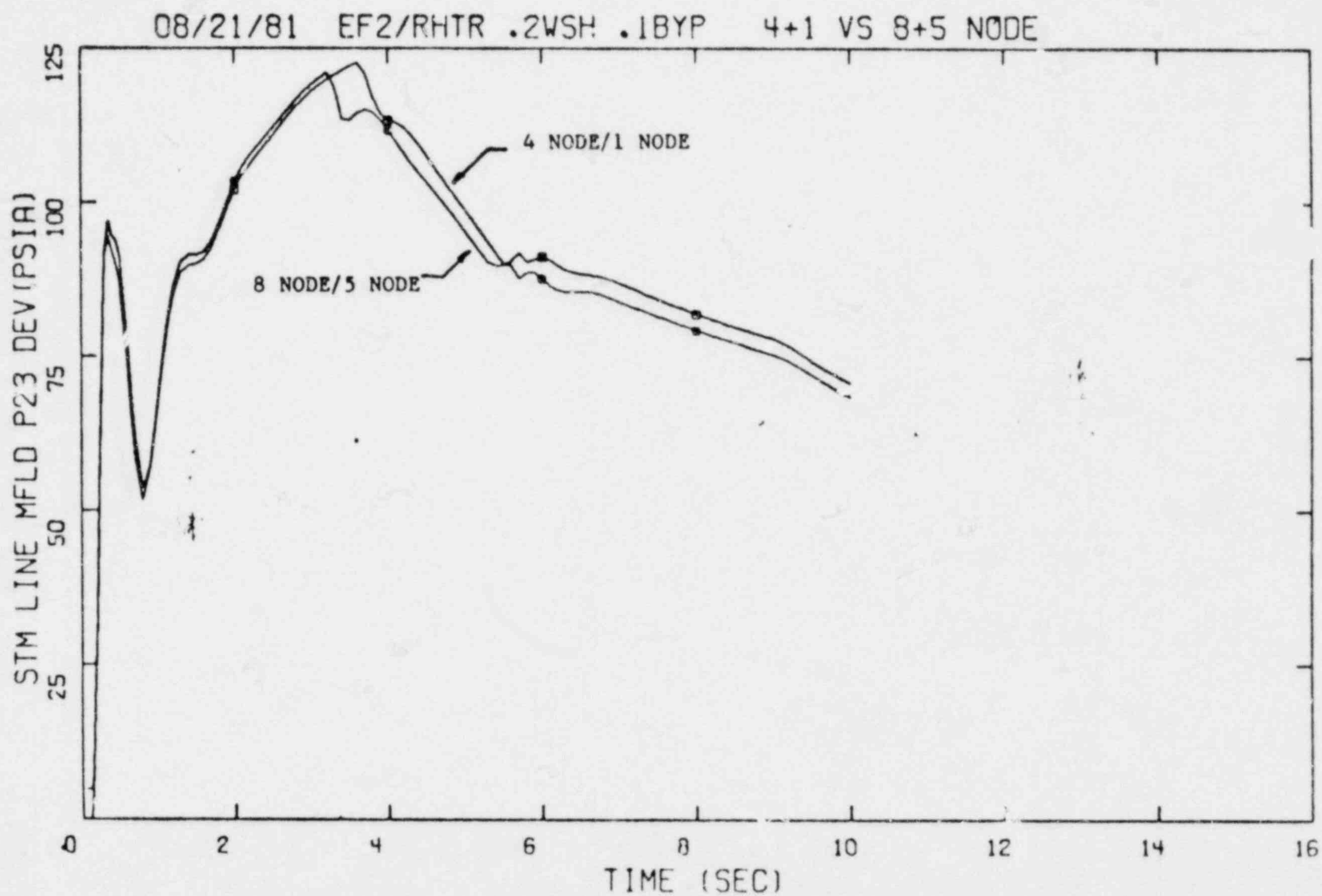


FIGURE 4

MANIFOLD PRESSURE FOR 4 NODE/1 NODE AND 8 NODE/5 NODE STEAM/REHEATER LINES

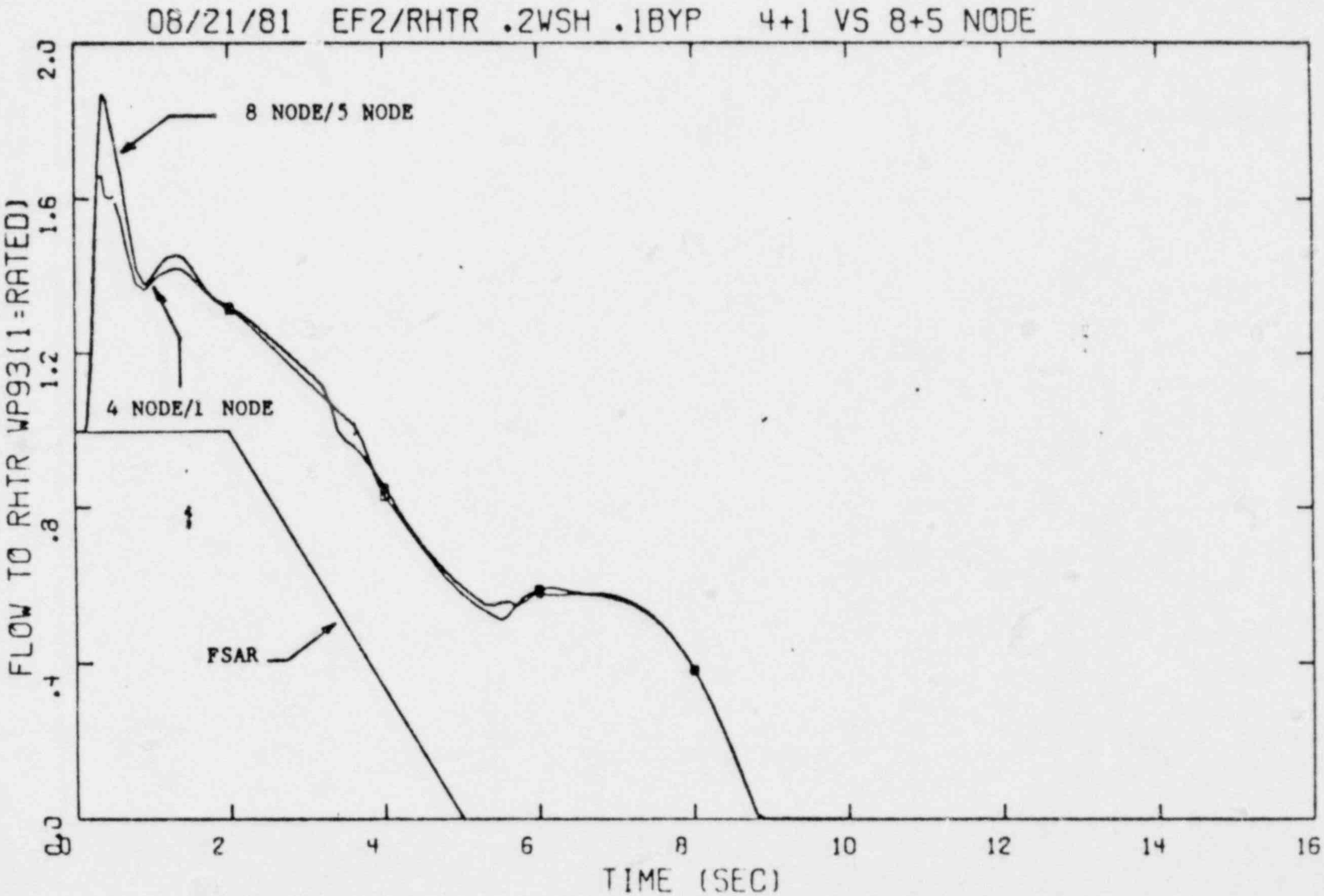
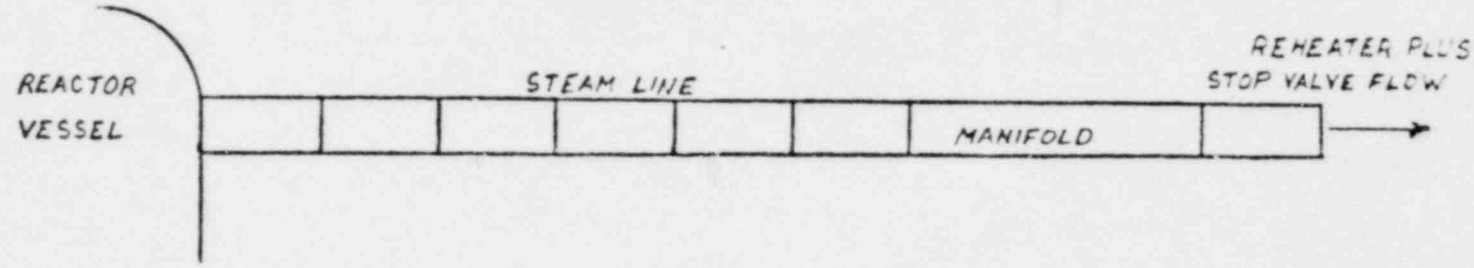
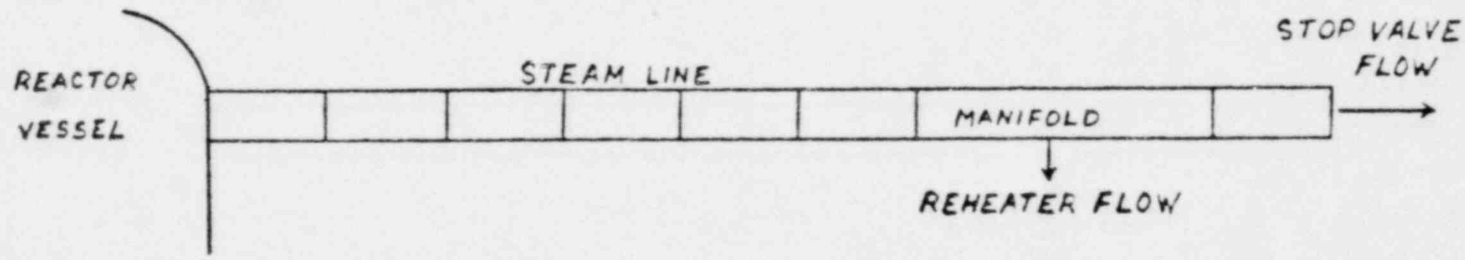


FIGURE 5

REHZATER FLOW FOR 4 NODE/1 NODE AND 8 NODE/5NODE STEAM/REHEATER LINES



LUMPED FLOW MODEL (ODYN APPROACH)



SEPARATE FLOW MODEL

FIGURE 6

STEAM LINE GEOMETRY FOR TURBINE TRIP

WITHOUT BYPASS

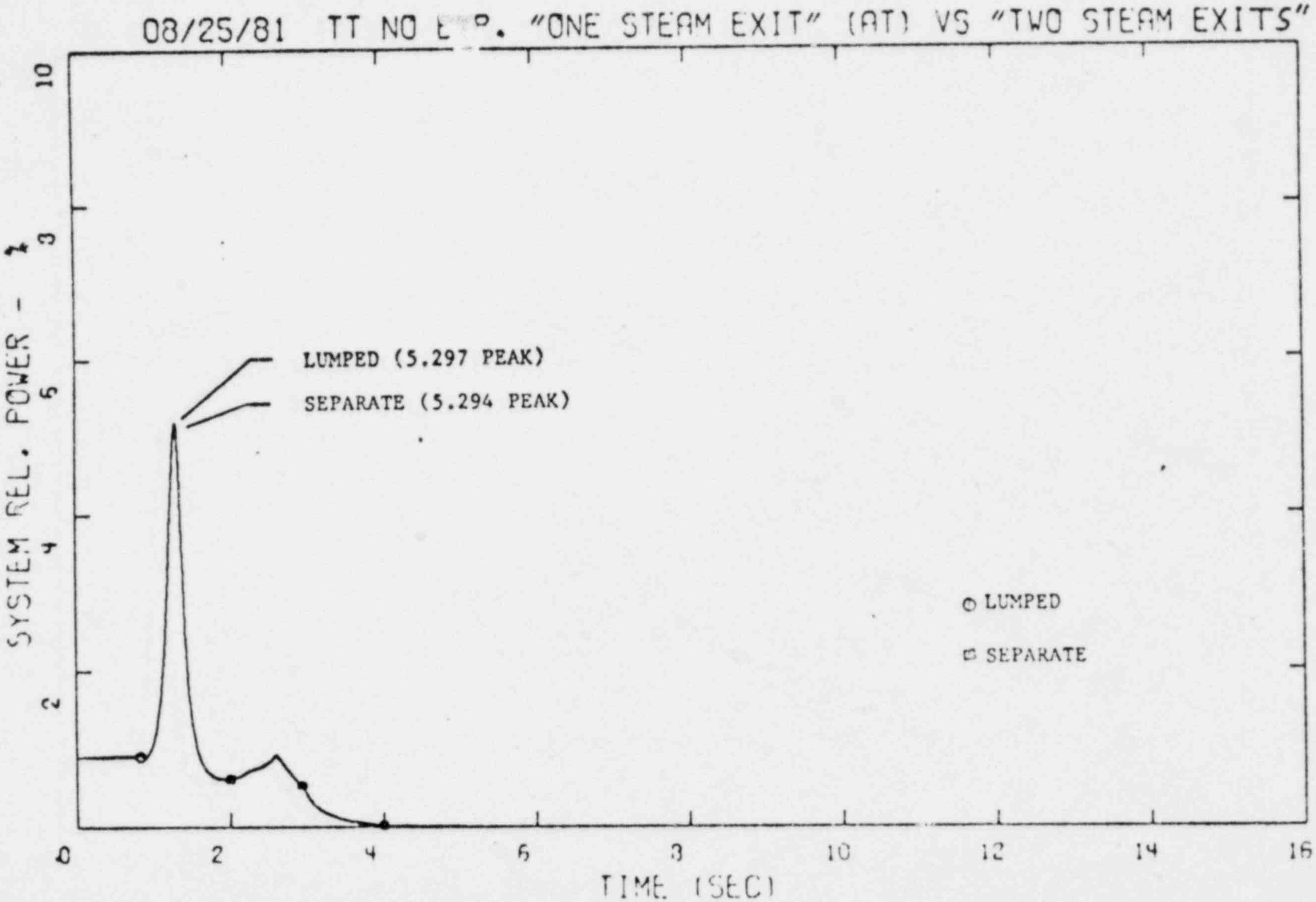


FIGURE 7

REACTOR POWER FOR LUMPED AND SEPARATE REHEATER FLOW JUNCTION

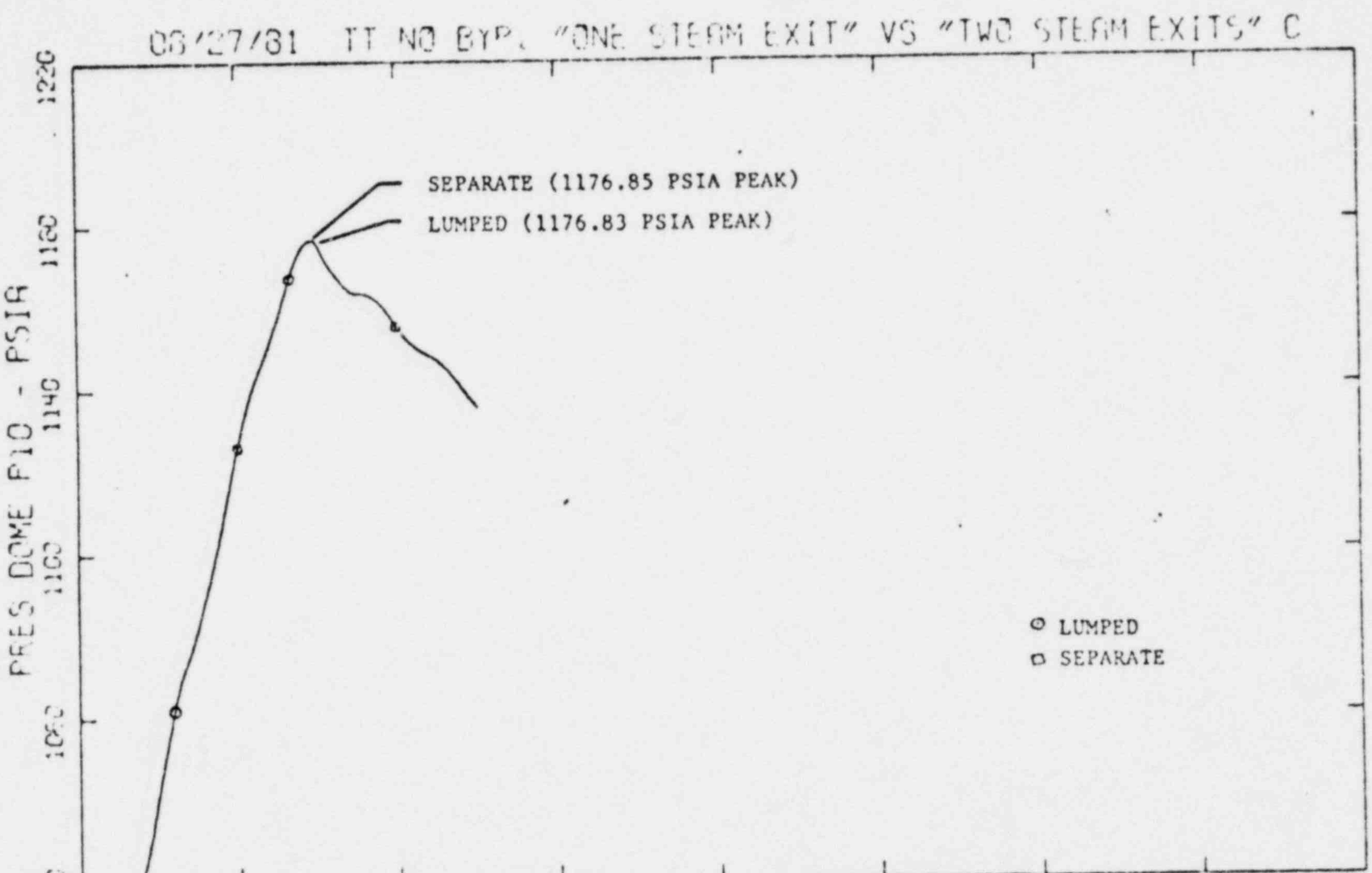


FIGURE 8

DOME PRESSURE FOR LUMPED AND SEPARATE REHEATER FLOW JUNCTION