

**Detroit
Edison**

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April 27, 1982
EF2 - 57,134



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

Dear Mr. Kintner:

- References: (1) Enrico Fermi Atomic Power Plant, Unit 2
NRC Docket No. 50-341
- (2) NUREG-0798, "Safety Evaluation Report,
Enrico Fermi Atomic Power Plant, Unit
No. 2", Supplement No. 1, Section 15.1,
September, 1981

Subject: Reheater Bypass Flow Analysis

The purpose of this letter is to provide the results of analyses that address NRC concerns with regard to the adequacy of steam flow to the reheater during the conditions of turbine trip without bypass and to request the removal of the associated licensing condition (Reference 2).

The attached analyses address the adequacy of such bypass steam flow by providing additional conservatism that responds to NRC concerns.

Therefore, Detroit Edison requests that the condition that measurements for reheater steam flow, as described in Reference 2, be removed from the Operating License.

Sincerely,

Attachment

cc: Mr. B. Little

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5/1/1

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SUPPLEMENT TO FERMI-2
REHEATER FLOW STUDY

INTRODUCTION

This report provides the results of a series of RETRAN analyses to supplement an earlier study¹ performed to demonstrate that the reheater steam flow during a turbine trip will be equal to or greater than that showing in Figure 15B.0-3 of the Fermi-2 FSAR and reproduced here as Figure 1. That FSAR flow pattern was utilized in pressure transient calculations performed with ODYN for FSAR Chapter 15 analyses.

The current analyses were performed to respond to NRC concerns that the previous work was not sufficiently conservative with regard to certain modeling assumptions.² Therefore, the most conservative analyses performed in the previous submittal¹ is defined here as the reference model; then modifications are made to this reference model to address the most recent NRC concerns and the results reported in this submittal.

REFERENCE MODEL

The basic model configuration is that labeled "RETRAN VERSION 2" in Figure 2 of the earlier report¹ and reprinted here. The results of the most conservative analyses performed with this configuration in the earlier study is that labeled "8 NODE/5 NODE" and shown in Figure 5 of that report.

The assumptions and analyses leading to this reheater flow constitute the reference model in the current study.

MODEL MODIFICATIONS

NRC has expressed the following concerns regarding certain assumptions implicit in the reference model.

1. The homogeneous equilibrium two phase flow assumption incorporated in all the flow paths of the RETRAN model would tend to allow too much steam flow from the reheater into the seal tank during the overpressurization transient. This in turn could lead to an overestimate of the steam flow to the reheater.
2. There are uncertainties in the flow dependent heat transfer from steam in the reheater tubes to the tube metal. If the initial heat transfer coefficient were actually higher than assumed, then the initial metal temperature would also be higher than previously assumed to maintain the same steady-state heat transfer rate from steam to metal. The higher initial metal temperature would then effectively reduce the capacity of the tube metal to receive heat from the steam during the transient, reducing the rate of condensation and causing pressure to increase and impede steam flow.

The following modifications were made to address the foregoing two concerns respectively.

1. The total flow out of the reheater to the seal tank was ramped to zero within 0.2 seconds of the initiation of the transient. Therefore, effectively no steam is allowed to flow to the seal tank during the transient.
2. The flow dependent heat transfer coefficient from tube side steam to metal tubing used for initial conditions was arbitrarily doubled to produce a conservative (high) initial metal temperature. However, as soon as the transient was initiated, the coefficient was ramped back to its normal value within 0.2 seconds to maintain a conservative (lower) transfer of heat from steam to metal as the transient progresses.

Both of the conservative assumptions described above were added to the reference model, and runs were performed for full power turbine trips with 0%, 13% and 26% nominal bypass conditions. The resulting steam flows to the reheater for all three cases are shown in Figure 3.

SENSITIVITY TO REHEATER FLOW PATTERNS

It is evident from the results of ODYN calculations performed by General Electric as well as from RETRAN calculations that the peak fission power occurs within one second of the start of the turbine trips of interest. Therefore, the reheater steam flow of primary effect is that during the very early stages of the transient, probably within the first second. Thus, the expected early peaks in reheater flow as shown in Figure 3 for all three cases would be expected to have a greater effect in reducing peak reactor power and heat flux than the lower but sustained reheater flow shown in Figure 1.

This assertion is borne out by the following series of RETRAN calculations.

- o A standard NSSS RETRAN turbine trip model employing the identical steam line nodding as used in the Chapter 15 ODYN analyses (Figure 4) was used to calculate base case responses for three turbine trips at full power (0%, 13%, 26% bypass). As in Chapter 15 of the FSAR, the reheater flow was portrayed as an additional steam flow to the turbine stop valve with the flow pattern given in Figure 1.
- o A second series of three turbine trip cases using the same model and for the same bypass conditions were run with the only change being the replacement of the Figure 1 reheater flow with the appropriate reheater flows previously computed as described above and shown in Figure 3.

- o A final calculation is performed for the 0% bypass case that uses a reheater flow similar to that assumed in the FSAR but modified so that the 10% flow value is maintained for only one second (rather than two) before ramping to zero in three additional seconds. See dashed curve of Figure 1.

The resulting peak fission power, heat flux, and reactor dome pressure for the three base cases and their counterparts using the computed reheater flows are shown in Table 1. In all three bypass cases, the peak values for the parameters of interest are lower when using the explicitly calculated reheater flows of Figure 3 than for the assumed FSAR reheater flow of Figure 1.

The effects on peak fission power, heat flux, and dome pressure when the FSAR reheater flow pattern of Figure 1 is replaced by the reheater flow shown by the dashed curve of Figure 1 is also shown in Table 1 for the 0% bypass case. The significant result is that all of those peak parameters are essentially identical (Case 1 vs. Case 7 of Table 1) and thus insensitive to the nature of the reheater steam flow after one second.

DISCUSSION

The model and assumptions used in the current analyses in the calculation of reheater steam flow during a turbine trip employ many conservative assumptions as summarized below:

- o Essentially no credit is taken for heat transfer from the reheater tubes to shell side steam.
- o Essentially no credit is taken for steam flow from the reheater to the seal tank.
- o The initial condition heat transfer coefficient from tube side steam to metal tubing is made conservatively high, and yet no credit is taken for the higher value during the transient.

Moreover, nodalization studies were performed for the steam line, reheater line, and reheater itself to assure that sufficient nodes were employed in the modeling. The resulting composite model is felt to produce a very conservative (low) steam flow to the reheater during the first few seconds of a turbine trip transient.

The only turbine trip situation during the first fuel cycle that depends on bypass steam flow through the reheater to maintain sufficiently low ΔCPR is for nominal 0% bypass conditions near the end of the cycle. Despite the conservative model employed, the calculated reheater steam flow for this 0% bypass case greatly exceeds the constant flow assumed in the FSAR for the first two seconds of the transient. Moreover, it should be noted that since the calculated flows for all of the bypass cases are quite high during

the first second of the transient, they result in lower calculated maximum fuel pin heat fluxes (Table 1) than obtained by assuming the FSAR reheater steam flows shown in Figure 1. This is simply due to the fact that with fission power and heat flux peaking within one second (as shown by both RETRAN and ODYN), the reheater bypass flow within about the first second produces the dominant effect on peak fuel pin heat flux, and of course reheater flows beyond about two seconds are irrelevant.

CONCLUSIONS

Only the 0% bypass case requires credit for any reheater bypass flow to achieve an acceptable Δ CPR for end of cycle one conditions. A very conservative modeling scheme for the 0% bypass turbine trip results in greater reheater bypass flow during the first two seconds than portrayed in the FSAR. However, for all bypass condition's (0%, 13%, 26%), the conservatively calculated reheater flows lead to lower peak fuel pin heat fluxes than obtained by using the assumed reheater flow patterns portrayed in the FSAR even though the calculated reheater flows for the 13% and 26% bypass conditions drop below the curve used in the FSAR as the transient progresses. The more favorable results obtained for the calculated reheater flow are to be expected since the bypass steam flow in about the first second of the transient is by far the most important with regard to effects on peak reactor power and heat flux. This assertion is further supported by the analyses that show essentially no differences in peak power and heat flux when the reheater steam flow is assumed constant at 10% for two seconds as in the FSAR or for just one second. (Case 1 vs. Case 7 of Table 1).

Therefore, the Δ CPR computed by General Electric for all turbine trip conditions remain conservative and there should be no need for reheater steam flow measurements to be made during startup as currently called for in the Fermi-2 Safety Evaluation Report (Supplement 1).²

REFERENCES

1. Edison letter, "Reheater Bypass Flow Analysis," EF2-54,540, August 31, 1981.
2. Safety Evaluation Report, Enrico Fermi Atomic Power Plant, Unit No. 2, NUREG-0798, Supplement 1, September 1981 (Section 15.1, p.15-1).

TABLE 1

Effect of Reheater Flow Patterns on Safety Parameters for Fermi-2 Full Power
Turbine Trips

CASE	INPUT		RESULTS					
	<u>% ByPass</u>	<u>Reheater Flow Assumption</u>	<u>Peak Power</u>		<u>Peak Heat Flux</u>		<u>Peak Dome Pressure Rise</u>	
			<u>%</u>	<u>t(sec)</u>	<u>%</u>	<u>t(sec)</u>	<u>psi</u>	<u>t(sec)</u>
1	0	FSAR	252	0.9	117	1.1	153	2.5
2	13	FSAR	196	0.9	109	1.1	142	2.9
3	26	FSAR	155	0.9	105	1.2	129	3.4
4	0	Fig. 3	182	0.9	108	1.2	145	2.9
5	13	Fig. 3	147	0.9	105	1.2	134	3.4
6	26	Fig. 3	124	0.9	102	1.2	122	4.4
7	0	Fig. 1 (dashed curve)	252	0.9	117	1.1	153	2.5

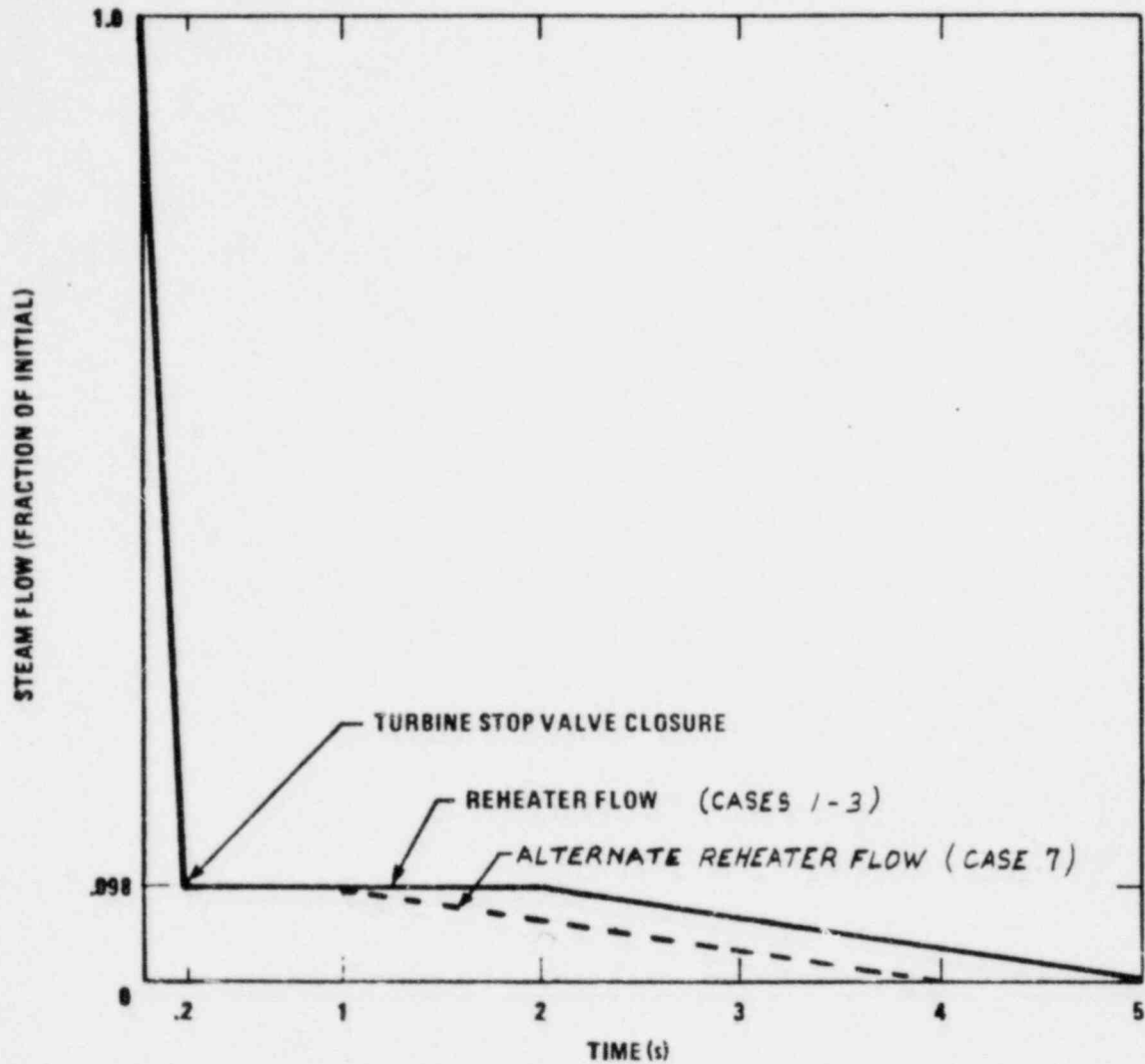


FIGURE 1

ENRICO FERMI ATOMIC POWER PLANT
UNIT 2
FINAL SAFETY ANALYSIS REPORT

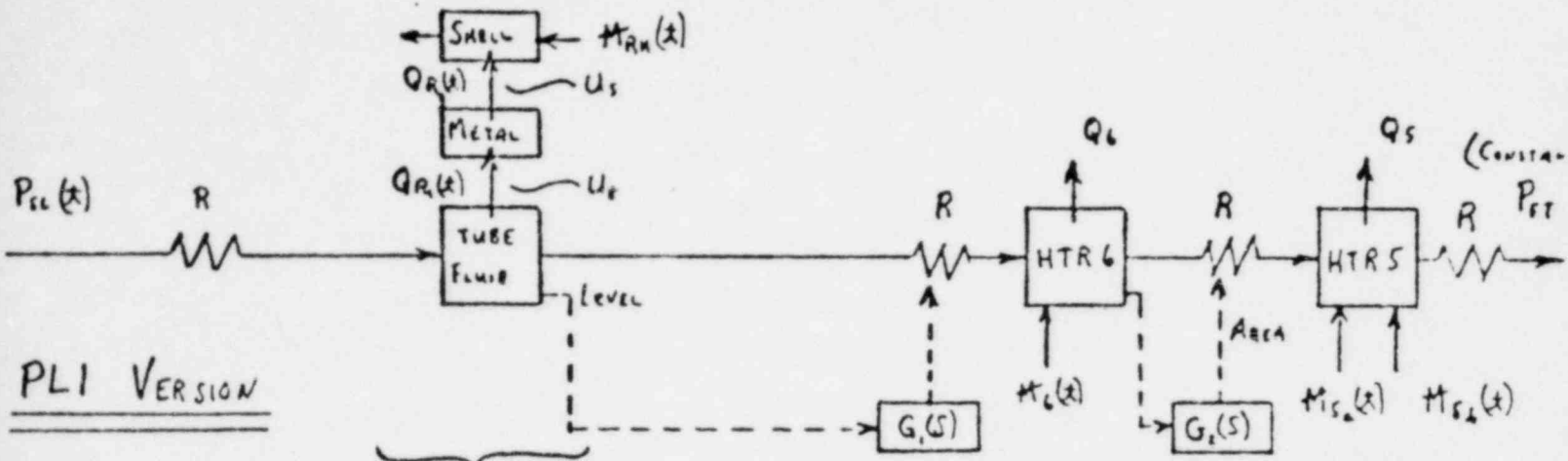
" FIGURE 15B.0-3 "

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

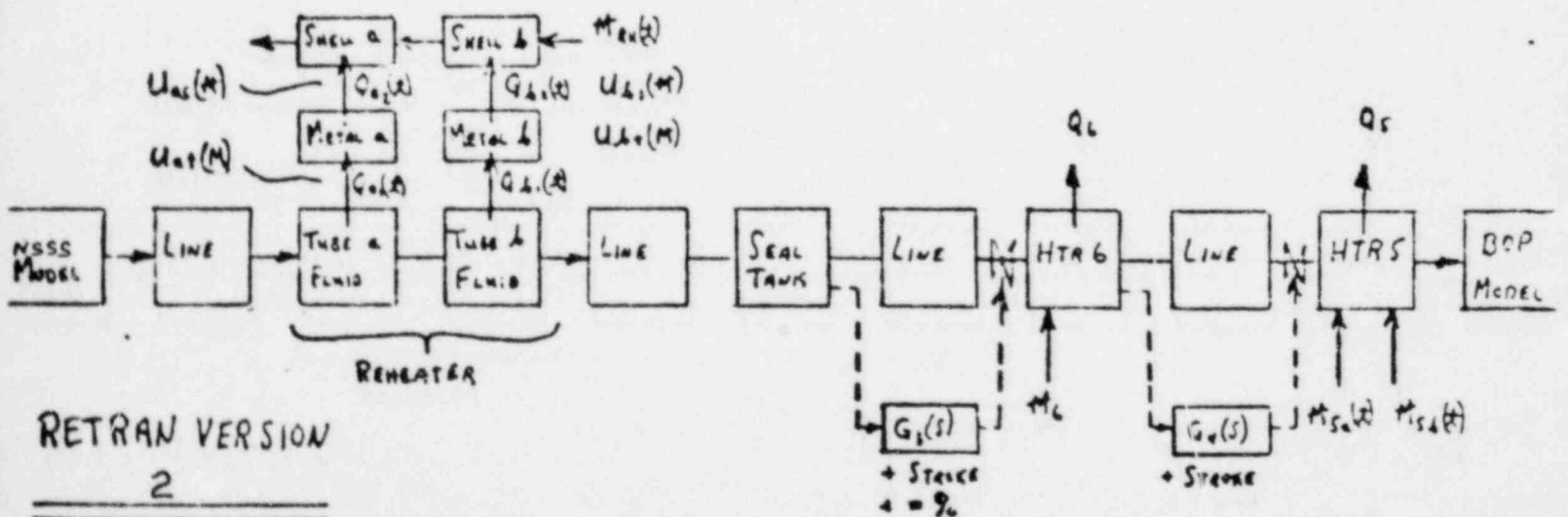
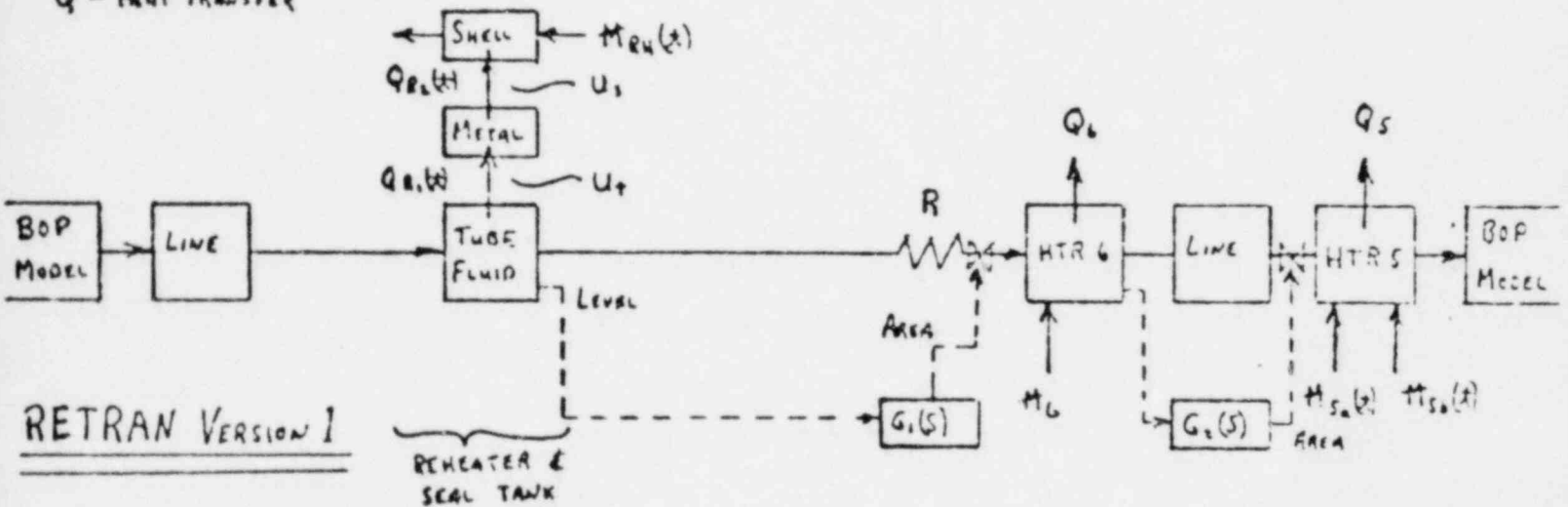
AMENDMENT 22 - APRIL 1979

REHEATER SYSTEM MODELS

FIG. 2



M - MASS FLOW
P - PRESSURE
R - P LOSS
Q - HEAT TRANSFER



02/16/82 EF2 / RHTR 2+5 2WSH TURB TRIP 0.13.261BP RCALC9

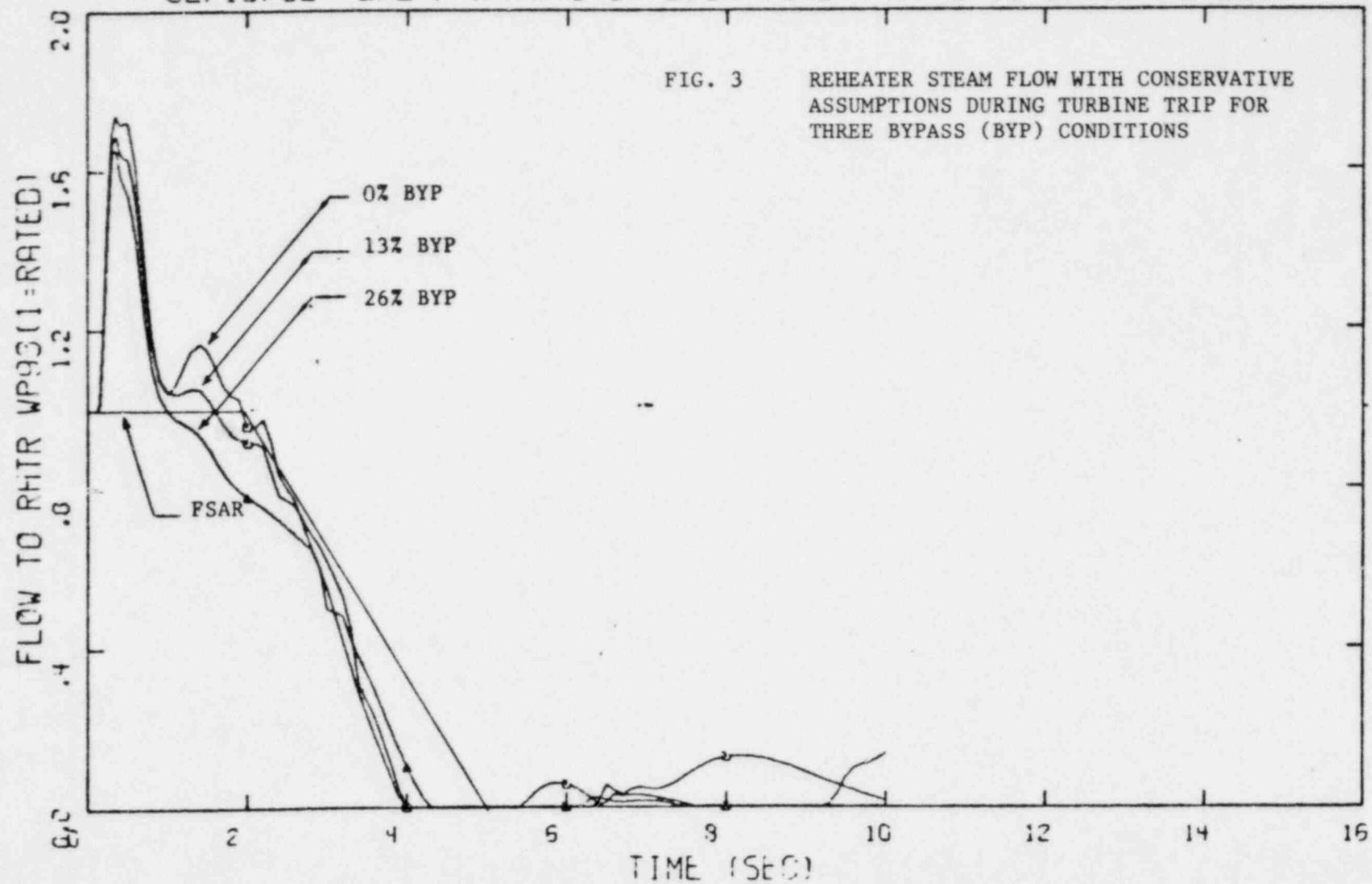
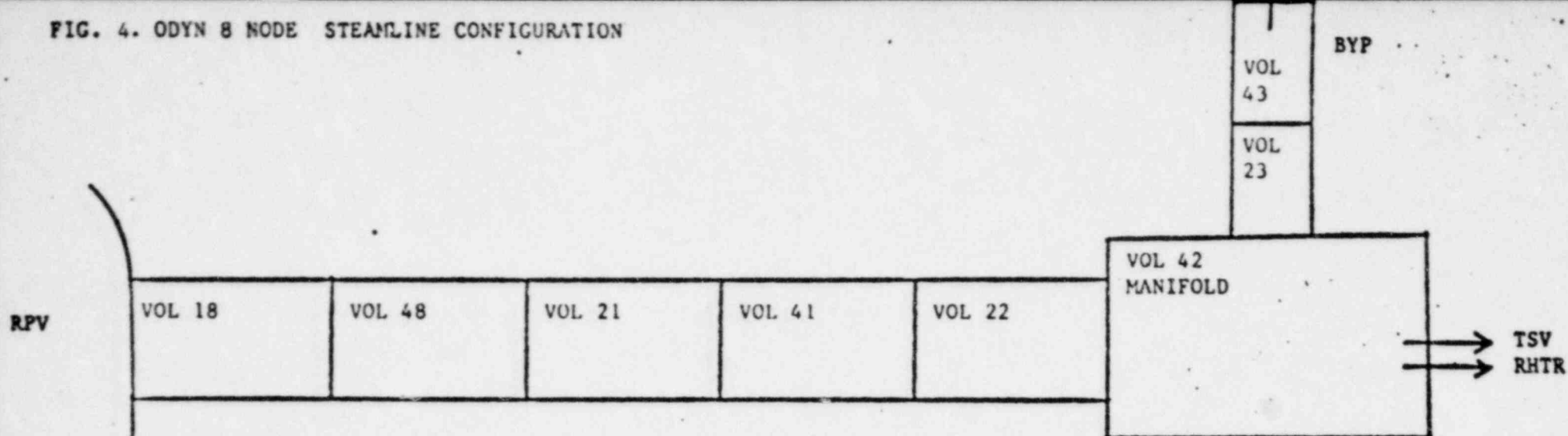


FIG. 4. ODYN 8 NODE STEAMLINE CONFIGURATION



<u>NODE #</u>	<u>VOLUME (CU FT)</u>	<u>PRESSURE (PSIA)</u>
18	839.34	1011.00
48	428.06	1002.00
21	713.28	993.00
41	608.81	984.00
22	608.81	974.00
42	1408.54	966.00
23	25.56	963.00
43	25.56	961.00