CATEGORY 1

REGULATOR INFORMATION DISTRIBUTION S TEM (RIDS)

ACCESSION NBR:9706240150 DOC.DATE: 97/06/03 NOTARIZED: NO DOCKET #
FACIL:50-244 Robert Emmet Ginna Nuclear Plant, Unit 1, Rochester G 05000244
AUTH.NAME AUTHOR AFFILIATION
MECREDY,R.C. Rochester Gas & Electric Corp.
RECIP.NAME RECIPIENT AFFILIATION
VISSING,G.

See Reports

SUBJECT: Provides clarification to license amend request re proposed Low Temp Overpressure Protection (LTOP) TS.Calculation re LTOP analyses,encl.

DISTRIBUTION CODE: A001D COPIES RECEIVED:LTR 1 ENCL 1 SIZE: 3+107
TITLE: OR Submittal: General Distribution

NOTES:License Exp date in accordance with 10CFR2,2.109(9/19/72). 05000244

	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL
	PD1-1 LA	1	1	PD1-1 PD	1	1
	VISSING,G.	1	1			
INTERNAL:	FILE CENTER 01	1	1	NRR/DE/ECGB/A	1	1
	NRR/DE/EMCB	1	1	NRR/DRCH/HICB	1	1
	NRR/DSSA/SPLB	1	1	NRR/DSSA/SRXB	1	1
	NUDOCS-ABSTRACT	1	1	OGC/HDS3	1	0
EXTERNAL:	NOAC	1	1	NRC PDR	1	1

C A T E G O R Y 1 D O C U M E N T

NOTE TO ALL "RIDS" RECIPIENTS:
PLEASE HELP US TO REDUCE WASTE! CONTACT THE DOCUMENT CONTROL DESK, ROOM OWFN 5D-5(EXT. 415-2083) TO ELIMINATE YOUR NAME FROM DISTRIBUTION LISTS FOR DOCUMENTS YOU DON'T NEED!

TOTAL NUMBER OF COPIES REQUIRED: LTTR 13 ENCL 12

ROCHESTER GAS AND ELECTRIC CORPORATION • 89 EAST AVENUE, ROCHESTER, N.Y. 14649-0001 AREA CODE 716 546-2700

ROBERT C. MECREDY
Vice President
Nuclear Operations

June 3, 1997

U.S. Nuclear Regulatory Commission
Document Control Desk
Attn: Guy Vissing
Project Directorate I-1
Washington, D.C. 20555

Subject: Clarifications to Proposed Low Temperature Overpressure Protection (LTOP) Technical Specification
R.E. Ginna Nuclear Power Plant
Docket No. 50-244

Reference: (a) Letter from R.C. Mecredy, RG&E, to G.S. Vissing, NRC, Subject: "Revision to RCS Pressure and Temperature Limits Report (PTLR) Administrative Controls Requirements," dated April 24, 1997.

Dear Mr. Vissing:

The purpose of this letter is to clarify several issues related to the previously submitted license amendment request (LAR) concerning LTOP. Specifically, the following clarifications are provided:

a. The specific use of ASME Code Case N-514 in the LTOP methodology is to calculate LTOP enable temperature only; we do not intend to use Code Case N-514 to increase the maximum pressure in the reactor vessel to 110% of Appendix G limits. A clarification to the methodology stating this is attached.

b. A clarification to the methodology of determining minimum boltup temperature is proposed. Using 10 CFR 50, Appendix G as the basis for minimum boltup temperature results in a reference temperature value of -52°F. RG&E's use of 60°F, as suggested in WCAP-14040-NP-A, provides significant margin to account for instrument uncertainty with respect to the Appendix G limit.

c. Based on questions received with respect to the previously submitted LTOP analysis, a set of responses is being provided for NRC review (Enclosure 3). The results of our revised analyses are provided in Enclosure 4.

A001

Based on these clarifications, several attachments to the April 24th LAR are being updated. These are listed in Enclosure 1 to this letter. First, the Technical Specifications contained in Attachments II and III are revised to reference this document for the methodology and first use of the methodology for LTOP calculations. Second, Section 5.0 of the PTLR (Attachment IV) is updated for the same reasons. Finally, a revised Section 3.3 of the methodology (Attachments V and VI) is provided. These revised pages should be substituted for the ones submitted in the April 24 LAR.

Very truly yours,

Thomas A. Marlow for

Robert C. Mecredy

Enclosures
GJW/462

xc: Mr. Guy Vissing (Mail Stop 14B2)
Project Directorate I-1
Washington, D.C. 20555

U.S. Nuclear Regulatory Commission
Region I
475 Allendale Road
King of Prussia, PA 19406

Ginna Senior Resident Inspector

Mr. F. William Valentino
Corporate Plaza West
286 Washington Ave. Extension
Albany, NY 12203-6399

Enclosure 1 to June 3, 1997 Letter

Replacement Pages for April 24, 1997 LAR

1. Attachment II - page 5.0-22
2. Attachment III - page 5.0-22
3. Attachment IV - pages 3 and 5
4. Attachment V - pages 3-8 and 3-9
5. Attachment VI - page 3-7

9706240150

LOW TEMPERATURE OVERPRESSURE ANALYSES

SUMMARY REPORT

Prepared for

Rochester Gas & Electric Corporation

Prepared by : N. Vasudevan Date : 9th June 97
N.Vasudevan, Principal Engineer

Reviewed by: M V Parece Date : 6/10/97
M.V.Parece, Senior Supervisory Engineer

Approved by: JJCudlin Date : 6/10/97
J.J.Cudlin, Manager, Analysis Services Unit

FRAMATOME TECHNOLOGIES INC.,
LYNCHBURG, VA.

RECORD OF REVISIONS

REVISION NO.	DESCRIPTION	DATE
00	Original issue	March 1995
01	Complete revision to integrate additional runs and conclusions based on the additional runs -all pages revised	June 1997

TABLE OF CONTENTS

1.0 INTRODUCTION

Framatome Technologies Inc. (FTI) (formerly B&W Nuclear Technologies) updated the analysis of the low temperature overpressure (LTOP) events for the Rochester Gas and Electric (RGE) R.E. Ginna Nuclear Power Station (hereafter referred to as the Ginna plant).

The analyses shown in this document become the new analyses of record for the Ginna Station. The results of the analyses of the limiting LTOP events were compared with 10CFR50 Appendix G and residual heat removal system(RHR) overpressure limits. In all cases, the peak reactor vessel and RHR system pressures were within the applicable limits.

The purpose of this revision is to present the results of additional cases that show the effects of various combinations of reactor coolant (RC) pump and RHR pump operation.

2.0 DISCUSSION OF LTOP EVENTS

The United States Nuclear Regulatory Commission (USNRC) Regulatory Guide 1.99, Revision 2, dated May 1988 (Reference 1) discusses the effects of neutron irradiation embrittlement of low alloy steels used in the reactor vessel. Appendix G of Chapter 10, Part 50 of the Code of Federal Regulations gives the fracture toughness requirements for the reactor vessel under low temperature conditions. During LTOP events, the reactor vessel temperatures and pressures approach the Appendix G limits. The LTOP system is designed to ensure that the reactor vessel embrittlement limits are not exceeded.

LTOP events can occur during cold shutdown, heatup or cooldown. To provide protection against exceeding the Appendix G limits, the Power Operated Relief Valves (PORV) on the pressurizer are reset to a low setpoint, whenever the reactor coolant system temperature is less than 322°F. Two types of overpressurization events are considered. The first type of event is a mass addition event and the second type of event is a heat addition event.

2.1 LTOP EVENTS INITIATED BY MASS ADDITION

The mass addition events are characterized by addition of mass to a water-solid primary system. This can occur during a shutdown situation, if the charging pumps or if the safety injection(SI) pumps are started inadvertently. Technical Specification limits on SI pump operability and discharge valve position eliminate the mass injection case due to a high head SI pump start, unless protection is provided by a vent path of at least 1.1 square inches. With no vent, with three SI pumps inoperable by Technical Specification limits, an inadvertent SI signal will not cause an SI pump start. Since the

possibility of the startup of three charging pumps with letdown isolated can be postulated, this case is analyzed as a mass-addition event, when protection is provided by only the PORVs.

The lower limit of the primary temperature for mass addition by charging pump operation is 60°F. With operational limits on starting the charging pumps, with an RC pump running, one charging pump startup can cause a mass addition event and this event is analyzed to show that the Appendix G limits are not violated. This is the most limiting mass addition case for Appendix G criterion.

Operating procedural limits on RC pumps will prevent the running of two pumps at primary temperatures lower than 135°F. Above this temperature, the possibility exists that two RC pumps may be running and three charging pumps may be inadvertently started. This case also has been analyzed, with a conservative primary temperature of 60°F and compared with the Appendix G limit at 135°F, to show acceptability.

With a primary vent of size 1.1 square inches open to the atmosphere, startup of one SI pump is allowed. This mass addition event is analyzed at primary temperatures of 60°F and 212°F to bound the range of possible RC conditions in this configuration with no RC pumps running. When the vent is open, the PORVs are not credited as pressure limiting devices.

2.2 LTOP EVENTS INITIATED BY HEAT ADDITION

The heat addition events are characterized by an addition of heat to a water-solid primary system. Heat can be added to the primary system by the actuation of pressurizer heaters, loss of the residual heat removal system (RHR) cooling, or two types of reactor coolant (RC) pump startups while a temperature asymmetry exists in the RC loops.

The inadvertent actuation of the pressurizer heaters when the pressurizer is water solid will cause a slow rise in the water temperature and increase in pressure, if the installed automatic pressure control equipment is not in service. Since this pressure transient is very slow, the operator should recognize and terminate the transient before an unacceptable pressure is reached. If the operator does not terminate the transient, the pressure will increase and will be terminated by the PORV with little or no overshoot above the PORV setpoint. This case is not significant to the design of the LTOP system.

The loss of RHR cooling when the reactor coolant system(RCS) is water solid could be caused by a loss of flow malfunction in the component cooling water or service water systems, or the closure of the RHRs inlet isolation valves. This would cause a slow rise in temperature and pressure since there would be a continual release of core residual heat into the reactor coolant with no heat removal. This transient is also very slow and the operator has sufficient

time to mitigate the event.

The first type of temperature asymmetry can occur if the reactor coolant is at a relatively warm temperature with little or no natural circulation and cold reactor coolant pump seal injection water continues to enter the system. The cooler injection water will settle in a pool in the loop seal. The pressure transient is initiated by starting one reactor coolant pump. As the pump comes up to speed, the reactor coolant flowrate slowly increases in the active loop and the pool of cold water will be drawn up into the pump and discharged out the cold leg piping. Simultaneously, the pool of cold water in the inactive loop will flow backward through the steam generator at a flowrate significantly less than that of the active loop. As this pool of cold water flows through the steam generator, the temperature will increase due to heat transfer from the secondary side of the steam generator. This causes expansion of the primary side water and an increasing pressure transient.

The second type of temperature asymmetry occurs when the RCS has been cooled without sufficient circulation. This could occur when the RHR system is used to cool the RCS without use of any reactor coolant pumps. Under these conditions, the water in the steam generator secondary side and the primary side will be in thermal equilibrium at a temperature higher than that of the reactor coolant. If one RC pump is inadvertently started under these conditions, the RCS flowrate increases and the cold water from the RCS enters the SG tubes. This results in the transfer of heat from the secondary to the primary system, causing the primary system liquid to expand and the primary system to pressurize. This is a relatively fast event and, because of the transfer of heat from the secondary system to the primary system, this event is the most limiting heat addition transient.

In the heat addition events, both RHR pumps or only one may be operating. Therefore events with one and two RHR pumps are analyzed at various initial primary temperatures, to bound the limits of operation.

3.0 EVENTS ANALYZED

A spectrum of mass addition cases were analyzed. The mass addition cases have a range of initial primary temperatures and mass additions, simulating charging and safety injection pump operation at various possible initial temperature conditions, with assumptions on RC pump operation, and operation of RCS vent.

The limiting mass addition case, the inadvertent startup of one charging pump, was analyzed at a primary temperature of 60°F with one RC pump operating . The inadvertent startup of three charging pumps, was analyzed at 85° F with no RC pump operating.

In addition, two cases with SI pump startup were analyzed, one with the primary system at 60°F and one with a temperature of 212°F. In these cases, the PORV is not credited for preventing overpressurization. Instead, a 1.1 square inch vent was modeled on top of the pressurizer, because SI pump operability is controlled by procedure when the vent is open. The upper temperature limit of 212°F is based on saturation temperature at atmospheric conditions. Sixty degrees is the lower limit of the Appendix G curves.

To show that at 135°F the Appendix G limit is not violated, with two RC pumps operating and with three charging pumps started inadvertently, a case with this configuration but at a lower temperature of 60°F is run and the results compared with 135°F allowable limit.

The limiting heat addition case is the inadvertent start of a reactor coolant pump following RCS cooldown solely with the RHR system. This event was analyzed at RCS temperatures of 60°F, 85 °F, 280°F and 320 °F with the SG liquid temperature 50 degrees hotter than the RCS. The various combinations of RHR system were modeled. The transient is analyzed at 60 °F since it is the lower limit of the Appendix G limits and has the lowest pressure limit for the acceptance criterion. The event is analyzed at 320°F because this is the maximum credible temperature at which a secondary-to-primary temperature difference of 50°F can be achieved. Specifically, the reactor coolant pumps may be tripped at 350°F. With instrument uncertainties, the temperature could be as high as 370°F. If the RCS is subsequently cooled to obtain the maximum allowed temperature difference (50°F), the RC pump start could occur at 320°F. This heat addition event is the most limiting for the RHR overpressurization.

The various cases run are shown in Table 1 for easy reference.

4.0 ACCEPTANCE CRITERIA

The acceptance criteria for the LTOP events are:

1. The pressure and temperature of the reactor vessel can not exceed the the steady-state Appendix G limits, which are depicted in Table 2. This table is obtained from Reference 2.

2. The pressure in the RHR system can not exceed 110 percent of the design pressure of 600 psig, or 660 psig.

TABLE 1

LIST OF CASES

Case no.	Description	Primary temp. °F	RHR flow rate gpm	RC pump status 0/1/2	Secondary temp. °F	Charging pump 0/1/2/3	SI pump status 0/1/2	RCS vent status open/close
1.	Mass addition case Primary Press. 329.7 psia	85.0	1700.00	0	n/a	3	0	closed
2.	Mass addition case Primary Press. 329.7 psia 3 gpm RC pump seal return	60.0	2000.00	1	n/a	1	0	closed
2a.	Mass addition case Primary pressure 329.7 psia	60.0	2000.00	2	n/a	3	0	closed
3.	Mass addition case Primary pressure 14.7 psia. No seal return.	60.0	2000.00	0	n/a	0	1	open
4.	Mass addition case Primary pressure 14.7 psia. No seal return.	212.0	2000.0	0	n/a	0	1	open

(continued)

TABLE 1(continued)

LIST OF CASES

Case no.	Description	Primary temp. °F	RHR flow rate gpm	RC pump status 0/1/2	Secondary temp. °F	Charging pump 0/1/2/3	SI pump status 0/1/2	RCS vent status open/close
5.	Heat addition case Primary pressure 329.7 psia No seal return.	60.0	2000.0	1	110.0	0	0	closed
6.	Heat addition case Primary pressure 329.7 psia No seal return.	85.0	2000.0	1	135.0	0	0	closed
7.	Heat addition case Primary pressure 329.7 psia.	280.0	2000.0	1	330.0	0	0	closed
8.	Heat addition case Primary pressure 329.7 psia.	85.0	1700.0	1	135.0	0	0	closed
9.	Heat addition case Primary pressure 329.7 psia.	320.0	1700.0	1	370.0	0	0	closed

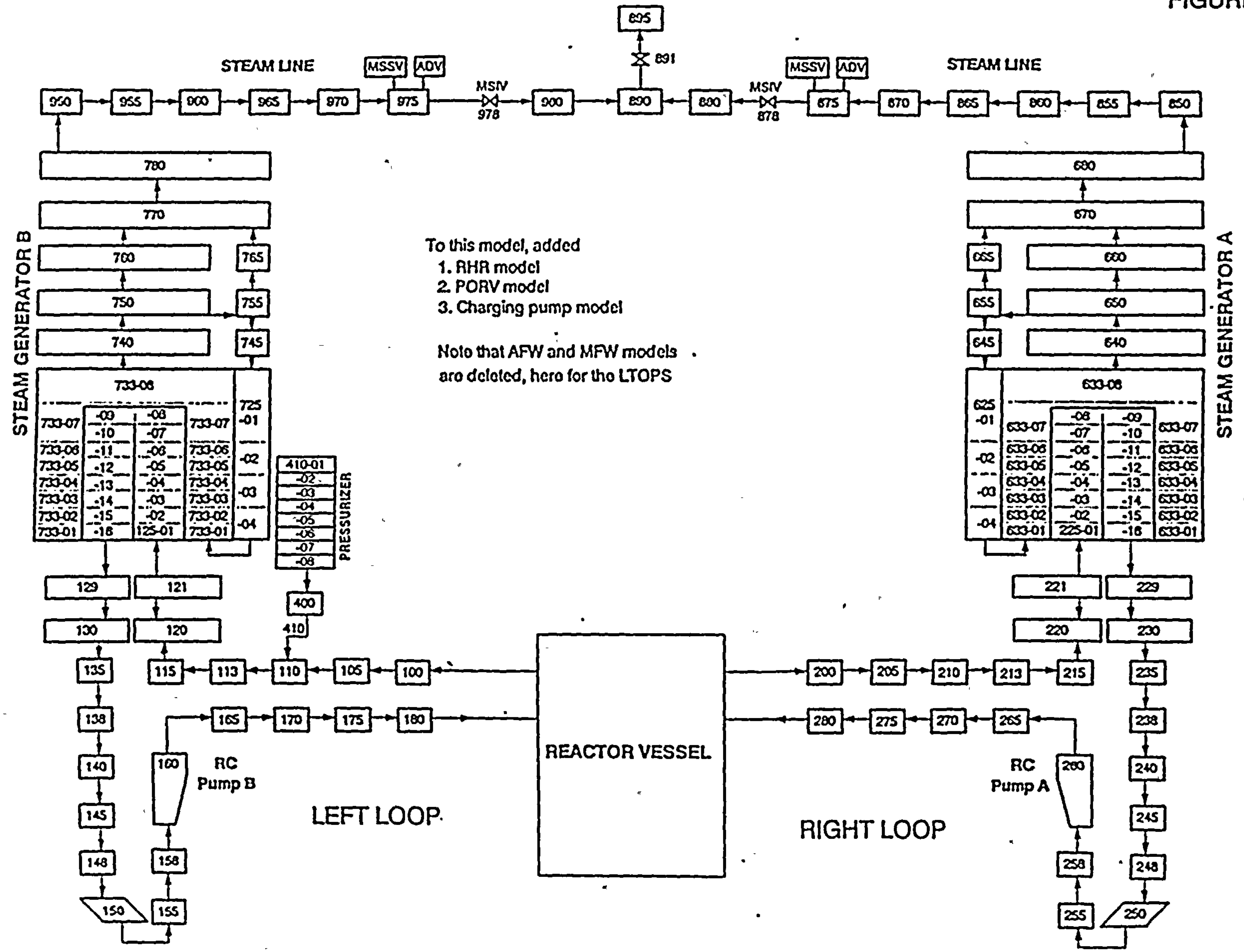
Note: In the mass addition cases, the RHR system is not modeled explicitly. The pressure in the RHR system is evaluated by adding a conservative ΔP to the suction pressure at the hot leg.
Case 2a peak RV pressure is compared with allowable Appendix G limit at 135°F.

TABLE 2
R.E.Ginna 24 EFPY Cooldown Curve Data Points

Cooldown Curves Steady State		20F		40F		60F		100F	
T	P	T	P	T	P	T	P	T	P
60	540	60	515	60	489	60	462	60	408
65	542	65	516	65	490	65	463	65	409
70	544	70	518	70	492	70	465	70	410
75	545	75	519	75	493	75	466	75	412
80	547	80	521	80	495	80	468	80	414
85	549	85	523	85	497	85	470	85	415
90	551	90	525	90	499	90	472	90	418
95	554	95	528	95	501	95	474	95	420
100	556	100	530	100	504	100	477	100	422
105	559	105	533	105	506	105	480	105	425
110	562	110	536	110	509	110	483	110	428
115	565	115	539	115	512	115	486	115	431
120	568	120	542	120	516	120	489	120	435
125	572	125	546	125	519	125	493	125	438
130	576	130	550	130	523	130	497	130	442
135	580	135	554	135	528	135	501	135	447
140	584	140	558	140	532	140	506	140	452
145	589	145	563	145	537	145	511	145	457
150	594	150	568	150	542	150	516	150	463
155	599	155	574	155	548	155	522	155	469
160	605	160	580	160	554	160	529	160	476
165	612	165	587	165	561	165	536	165	483
170	619	170	594	170	568	170	543	170	491
175	626	175	601	175	576	175	551	175	500
180	634	180	609	180	585	180	560	180	509
185	642	185	618	185	594	185	569	185	519
190	652	190	628	190	603	190	579	190	530
195	661	195	638	195	614	195	590	195	542
200	672	200	649	200	625	200	602	200	554
205	683	205	661	205	637	205	615	205	568
210	696	210	673	210	651	210	628	210	583
215	709	215	687	215	665	215	643	215	599
220	723	220	701	220	680	220	659	220	616
225	738	225	717	225	696	225	676	225	634
230	754	230	734	230	714	230	694	230	654
235	772	235	752	235	733	235	714	235	676
240	791	240	772	240	753	240	735	240	699
245	811	245	793	245	775	245	758	245	724
250	833	250	816	250	799	250	783	250	751
255	856	255	840	255	825	255	809	255	780
260	881	260	866	260	852	260	838	260	811
265	908	265	895	265	881	265	869	265	845
270	937	270	925	270	913	270	902	270	881
275	968	275	957	275	947	275	937	275	920
280	1002	280	993	280	983	280	975	280	962
285	1038	285	1030	285	1023	285	1016	285	1007
290	1077	290	1070	290	1065	290	1061	290	1056
295	1118	295	1114	295	1110	295	1108	295	1108
300	1163	300	1160	300	1159	300	1159		
305	1211	305	1211						
310	1262								
315	1318								
320	1377								
325	1440								
330	1509								
335	1581								
340	1660								
345	1744								
350	1834								
355	1931								
360	2034								
365	2144								
370	2262								
375	2388								

GINNA RELAP5 MODEL

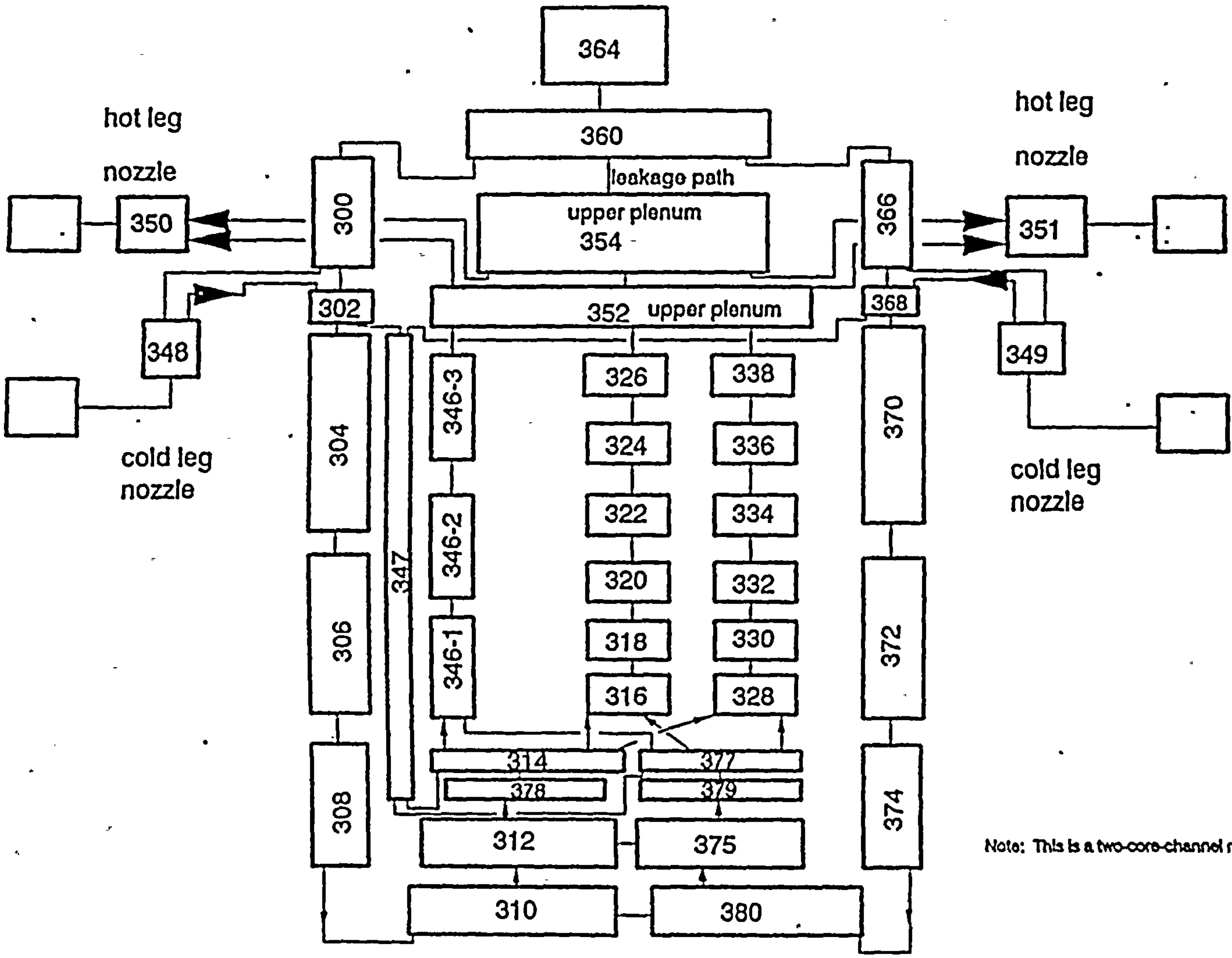
FIGURE 1



86-1234820-01

FIGURE 2

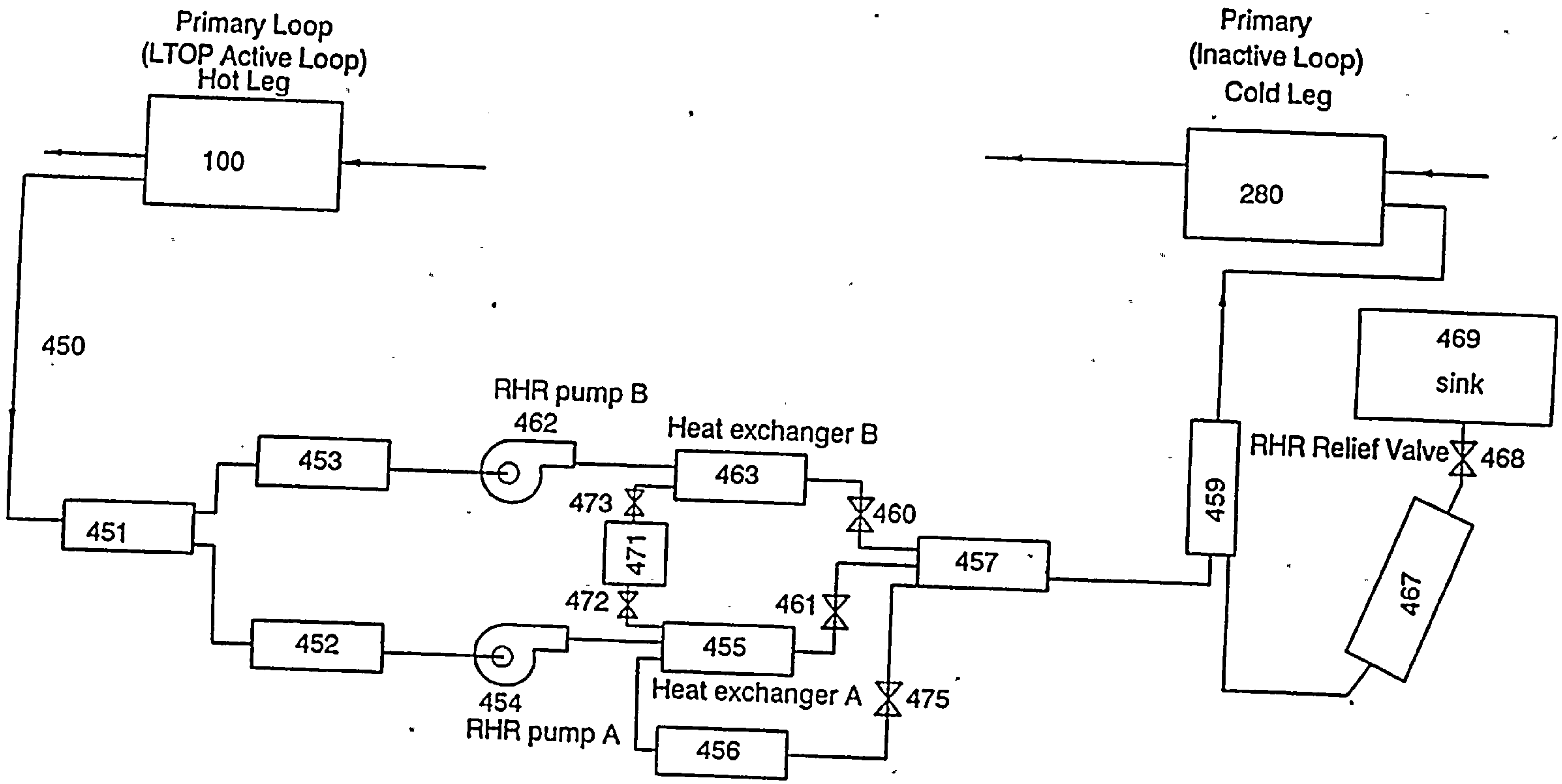
GINNA REACTOR VESSEL AND CORE MODEL



Note: This is a two-core-channel model - both average cores

FIGURE 3

RHR SYSTEM MODEL



FTI Non-Proprietary

86-1234820-01

5.0 METHODOLOGY

The LTOP transient analyses were performed using the RELAP5/MOD2-B&W Version 20 (Reference 5) computer code, which has received full certification at Framatome Technologies Incorporated(FTI). RELAP5/MOD2 B&W is a two-fluid, six equation, nonhomogeneous, nonequilibrium thermal-hydraulic code developed for best-estimate transient analysis of pressurized water reactors and associated systems. The code has options to consider equilibrium, homogeneous hydrodynamic control volumes and a limited ability to calculate conditions for co-existing noncondensibles. The numerical solution technique is semi-implicit finite differencing. RELAP5 is a highly flexible code that, in addition to calculating NSS behavior, can be used for simulation of a wide variety of thermal-hydraulic transients.

RELAP5/MOD2-B&W has special process models that are not available in the industry version of the code (Reference 3). The only such process model used in these LTOP analyses is the Henry-Fauske extended subcooled critical flow model. For those instances when the pressurizer PORV experienced critical flow, the extended Henry-Fauske critical flow model is used rather than the Ransom-Trapp model. The extended Henry-Fauske model was used because it is widely accepted for use over the range of conditions experienced in these analyses and because the Ransom-Trapp model overpredicts the test data using a discharge coefficient of 1.0 (Reference 3).

The plant model that was employed for the LTOP analyses included two complete reactor coolant loops including RC pumps and steam generators. The secondary side included steam lines, main steam safety valves (MSSVs), main steam isolation valves (MSIVs), and turbine stop valves. A noding diagram of the RELAP5/MOD2 model is shown in Figure1. The steam generator model used for the analyses is a simulation of the U-tube replacement steam generator designed by BWI. The feedwater systems and the auxiliary feedwater systems were not modeled since these are not functioning during the LTOP events.

The primary system has a reactor vessel model with two equal and parallel core paths for adjusting the mixing of loop flows in the lower plenum. This feature was not used in the LTOP analyses as this is not required. The core had six axial nodes and a core bypass with three nodes. The upper and the lower plenum volumes were common to both the loops, whereas the downcomer was split into two parallel set of volumes. A noding diagram of the reactor vessel is shown in Figure 2.

The pressurizer was modeled as a ten node vertical pipe component and was initialized liquid solid. One PORV was attached to the top node of the pressurizer. Only one PORV was modeled because the other PORV was

assumed to fail closed. The PORV was set to lift when the pump suction pressure on the loop with the pressurizer exceeded 430 psig, consistent with the location of the pressure transmitters and instrument error. The PORV was sized to deliver 49.722 lbm/s saturated steam at 2335 psig. The opening stroke time was 1.0 second using the C_V characteristics in Table 3. The model contained the piping from the PORV to the pressurizer relief tank (PRT) as well as the PRT with a rupture disc. The nitrogen blanket on the PRT was modeled.

The RC pumps were modeled as centrifugal pumps with the homologous curves representing the performance under various conditions. The pump performance curves shown in the UFSAR were used as the basis for the active octants in this pump model.

The passive metal of the whole system was modeled for the LTOP analyses. The passive metal includes the reactor vessel walls, the reactor internals, the fuel end fittings, the hot and cold leg pipe walls, pressurizer walls, the steam generator primary side metal and the steam generator secondary side metal. The steam generator tube metal was modeled as part of the active heat structures. The steam line metal and the RHR system passive metal were not modeled.

The RHR system was modeled as two parallel trains with two separate pumps and cross connects. Two heat exchangers were modeled as control volumes with no heat removal since the heat exchangers were assumed to maintain a constant temperature in the RCS during the LTOP analyses. The RHR relief valve was attached to the RHR system near the cold leg connection. The RHR relief valve was benchmarked for flow under the design conditions. A noding diagram of the RHR system is shown in Figure 3.

For the mass addition cases, the primary system was initialized at 60, 85, & 212 °F, and at a pressure of 315. At less than 135°F, running of both the RC pumps is prohibited by operating procedures. The primary and secondary systems are decoupled since there is no heat transfer in this case. The event was initiated by starting one or three charging pumps, or one SI pump. The flow capacity of each charging pump is 60 gpm. To show that above 135°F, with two RC pumps operating and with mass addition due to three charging pumps, one case was run with this scenario but at a lower temperature of 60°F. The peak pressures at lower temperature will be higher in the mass addition case and hence, the results from this run were compared with the allowable Appendix G limit at 135°F to prove that it was acceptable. In the SI pump cases, the flow rate used for one SI pump is shown in Table 4. In cases with the 1.1 sq.in. vent open, RC pumps were not run, because the RCS is at near atmospheric pressure and there is insufficient NPSH to operate the pumps. SI injection is used as the initiating event in the vent cases. The analysis was terminated after the PORV opens or an equilibrium pressure was obtained,. The peak RCS pressure was compared

with the acceptance criteria. Different cases have different assumptions. See Table 1 for details.

TABLE 3

C_v versus position

Copes Vulcan Valve - Model Number D-100-160

Stroke %	C_v normalized
0.0	0.0
1.9	0.016
7.9	0.067
14.0	0.143
20.0	0.231
26.1	0.346
32.2	0.474
38.2	0.626
44.3	0.734
50.3	0.823
56.4	0.878
62.5	0.924
68.5	0.957
73.6	0.970
78.3	0.977
84.5	0.985
91.6	0.992
98.6	0.999
100.00	1.0

For the heat addition cases, the primary system was initialized to isothermal conditions at the required temperature with no reactor coolant pump operating. The secondary and primary fluid in the steam generators were initialized at a temperature 50 degrees above the primary system. The RHR system was assumed to be operating with a capacity of 1700 gpm with one pump running (320°F case as specified in Attachment C of Reference 4) or 2000 gpm with two pumps running (60°F and the 85°F cases, consistent with minimum flow rates under these conditions). The transient was initiated by starting a reactor coolant pump in the loop that contains the pressurizer. The pump startup characteristics of Table 5 were used to bring the pump to full speed in 17.4 seconds. The analysis was run until the peak pressure was obtained. The peak pressures in the reactor vessel and the RHR system were compared with the acceptance

criteria.

TABLE 4

FLOW VERSUS RCS PRESSURE FOR ONE SI PUMP AT THE R.E.GINNA STATION

RCS Pressure, psig	SI Flow, gpm
600	413
500	440
400	466
300	490
200	514
100	536
0	558

TABLE 5

RC PUMP STARTUP PROFILE

Time, sec	Speed, rpm
0.0	0
3.50	240
6.60	480
9.7	720
13.3	960
15.8	1080
17.4	1189(full speed)

6.0 ANALYSIS

The following sections describe the initial and boundary conditions as well as the results for each of the events analyzed. All values were taken from References 4, 6 & 7. The case numbers correspond to those shown in Table 1.

6.1 Mass Addition Cases

6.1.1 Case 1

The mass addition case identified as Case 1 is initialized at a primary temperature of 85°F and a primary pressure of 315 psig. Using the initial pressure of 315 psig assures that the transient is well defined by the time the PORV is actuated. The reactor coolant pumps are not running and the pressurizer is water solid. It is assumed that the RHR system is removing decay

heat, so it is not modelled. The event is initiated by starting three pump charging flow (180 gpm or 25 lb/s). The analysis is run for ten minutes. The sequence of events for this case is shown in Table 6. Plots of the reactor vessel pressure and pressure at RHR system suction point in the hot leg are shown on Figures 4 & 5, respectively (Reference 4).

The peak reactor vessel pressure was 480.2 psia. The allowable pressure, according to the Appendix G limit at 85° F is 540 psig or 554.7 psia. Therefore, there is 74.5 psi margin to the Appendix G acceptance criterion.

To compare the peak pressure in the RHR system with the acceptance criterion, the pressure drop from the hot leg to the RHR pump discharge (128.1 psi, from Reference 4) was added to the peak hot leg pressure. This case yielded a peak RHR pressure of 598.4 psia. The peak allowable pressure in the RHR system is 674.7 psia. This results in a 76.3 psi margin to the acceptance criterion. The RHR flow is assumed to be 1700 gpm in this case, for the calculation of peak RHR pressure.

TABLE 6
SEQUENCE OF EVENTS- MASS ADDITION CASE WITH THREE CHARGING PUMPS, 85°F PRIMARY TEMPERATURE

EVENT	TIME IN SECONDS
3 Charging pumps started	0.0
Charging pumps reach full flow	1.0
Peak pressure of 480.2 psia reached in the bottom of the reactor vessel	534.0
Peak pressure of 470.3 psia reached in the hot leg connection to RHR	534.0

6.1.2 Case 2

Case 2 is a mass addition case with the primary pressure at 329.7 psia and with a primary temperature of 60 °F. One RC pump is running at steady-state in this transient. There is 3 gpm RC pump seal return flow. The transient is initiated with starting of one charging pump. No pressurizer vent is open and no SI pump is started. This case also has the secondary system disconnected from the primary in the model as in all mass addition cases. No RHR system is modeled .

With the starting of one charging pump, the primary system pressurizes rapidly and the PORVs open to relieve the pressure. The reactor vessel reaches a peak pressure of 554.32 psia. The Appendix G allowable pressure at this temperature is 554.70 psia. The peak pressure in the RHR system is calculated by adding

138.03 psi to the highest pressure reached in the hot leg connection of the RHR system. This value is based on a total of 2000 gpm RHR flow rate. The peak RHR system pressure thus calculated is 656 psia as compared with the structural allowable peak pressure of 674.70 psia.

Figures 6 & 7 show the pressure in the reactor vessel, and the pressure in the hot leg RHR connection point, respectively.

This case passes the Appendix G limit and the RHR system has margin to the acceptance limit. The sequence of events is shown in Table 7.

TABLE 7
SEQUENCE OF EVENTS - MASS ADDITION CASE WITH ONE CHARGING PUMP, 60°F PRIMARY TEMPERATURE

EVENT	TIME,SECS
One charging pump started	0.0
Charging pump reaches full flow	1.0
Peak pressure of 517.97 psia reached at RHR suction point	19.1
Peak pressure of 554.32 psia reached in reactor vessel downcomer	19.1

6.1.3 Case 3

Case 3 is a mass addition case with the primary pressure and temperature at 14.7 psia and 60 °F respectively. No RC pump is running in this transient. The transient is initiated by starting one SI pump. A pressurizer vent of 1.1 square inches is open. The primary and secondary systems are oin thermal equilibrium. No RHR system is modeled. Instead, the pressure difference between the RHR pump discharge and the RHR system inlet was added to obtain the calculated results.

With the starting of one SI pump, the primary system pressurizes. The primary pressure reaches a steady-state pressure at a level where the SI flow and the flow through the vent are equal. The PORVs do not have to open to relieve the pressure. The PORVs are not credited in the analysis. The reactor vessel reaches a peak pressure of 414.82 psia. The Appendix G allowable pressure at this temperature is 554.70 psia. The peak pressure in the RHR system is calculated by adding 138.03 psi to the highest pressure reached in the hot leg connection of the RHR system. This value is based on a total of 2000 gpm RHR flow rate. The peak RHR system pressure thus calculated is 542.96 psia as compared with the structural allowable peak pressure of 674.70 psia.

Figures 8 & 9 show the pressure in the reactor vessel and the hot leg RHR connection point, respectively.

This case passes the Appendix G limit for acceptance with a sizeable margin. The RHR system has margin to acceptance limit. The sequence of events is shown in Table 8.

TABLE 8
SEQUENCE OF EVENTS - MASS ADDITION CASE WITH 1.1 SQ.INCH VENT AND ONE SI PUMP INJECTION, PRIMARY TEMP. 60°F

EVENT	TIME,SEC
One safety injection pump started	0.0
Safety injection pump reaches full flow	1.0
Peak pressure of 404.93 psia reached at RHR inlet	166.00
Peak pressure of 414.82 psia reached in reactor vessel	175.00

6.1.4 Case 4

Case 4 is a mass addition case with the primary pressure at 14.7 psia and with a primary temperature of 212 °F. No RC pump is running in this transient. The transient is initiated by starting one SI pump. A pressurizer vent of 1.1 square inches area is open. This case also has the secondary system disconnected from the primary in the model. No RHR system is modeled .

Since the primary system is at atmospheric pressure at the top of the pressurizer, the steam generator top-most region inside the tubes will experience pressures lower than atmosphere and hence, steam bubbles can form in this region at 212°F. Steam voids in the system could yield non-conservative results by increasing the compressibility of the reactor coolant. To prevent void formation, the steam generator was initialized separate from the primary system and at a temperature below the saturation temperature.

The transient is initiated by connecting the steam generators to the RCS and by starting an SI pump. With the starting of one SI pump, the primary system pressurizes until the flow out of the vent balances the flow from the SI pump. The peak pressure reached is below the PORV setpoint. The PORVs are not credited in this case.

The reactor vessel reaches a peak pressure of 397.38 psia. The Appendix G allowable pressure at this temperature is approximately 710.7 psia. The peak pressure in the RHR system is calculated by adding 138.03 psi to the highest pressure reached in the hot leg connection of the RHR system. This value is

based on a total of 2000 gpm RHR flow rate. The peak RHR system pressure thus calculated is 525.91 psia as compared with the structural allowable peak pressure of 674.70 psia.

Figures 10 & 11 show the pressure in the reactor vessel, and the pressure in the hot leg RHR connection point, respectively.

The peak reactor vessel pressure is less than the Appendix G limit and the RHR system has margin to the acceptance limit. The sequence of events is shown in Table 9.

TABLE 9
MASS ADDITION CASE- VENT OF 1.1 SQ.INCHES AREA OPEN, ONE SI PUMP START, PRIMARY TEMPERATURE 212°f

EVENT	TIME,SECS
One safety injection pump started	0.0
Safety injection pump reaches full flow	1.0
Peak pressure of 387.88 psia reached at RHR system suction point	200.0
Peak pressure of 397.38 psia reached in reactor vessel	200.0

6.1.5 Case 2a

Case 2a is a mass addition case with the primary pressure at 329.7 psia and with a primary temperature of 60 °F. Two RC pumps are running at steady-state in this transient. There is no RC pump seal return flow modeled. The transient is initiated by starting three charging pumps. No pressurizer vent is open and no SI pump is started. No RHR system is modeled .

With the starting of three charging pumps, the primary system pressurizes and the PORVs open to relieve the pressure. The reactor vessel reaches a peak pressure of 587.44 psia. Since this case is run in lieu of a 135°F case, the peak reactor vessel pressure obtained is compared with the Appendix G allowable pressure at 135°F. The Appendix G allowable pressure at this temperature is 597.70 psia. Since the primary system is less compressible at lower temperatures, the peak pressure obtained at 60°F is higher than the value that would be obtained at 135°F. The peak pressure in the RHR system is calculated by adding 138.03 psi to the highest pressure reached in the hot leg connection of the RHR system. This value is based on a total of 2000 gpm RHR flow rate. The peak RHR system pressure thus calculated is 663.49 psia as compared with the structural allowable peak pressure of 674.70 psia.

Figures 57 & 58 show the pressure in the reactor vessel, and the pressure in the hot leg RHR connection point, respectively.

The peak reactor vessel pressure is less than the Appendix G limit and the RHR system also has margin to the acceptance limit. The sequence of events is shown in Table 7a.

TABLE 9a
SEQUENCE OF EVENTS - MASS ADDITION CASE WITH THREE CHARGING PUMPS, 60°F PRIMARY TEMPERATURE

EVENT	TIME,SECS
Three charging pumps started	0.0
Charging pumps reache full.flow	1.0
Peak pressure of 525.46 psia reached at RHR suction point	7.45
Peak pressure of 587.44 psia reached in reactor vessel downcomer	7.45

6.2 Heat Addition Cases

6.2.1 Case 5

Case 5 is a heat addition case with the primary system initialized to 60°F and 329.7 psia. The secondary system is at a temperature 50°F higher than the primary system. The RHR system is running at a capacity of 2000 gpm total. The RHR system is modeled explicitly for the heat addition cases. No pressurizer vent or seal return flow is modeled.

The transient is initiated by starting the reactor coolant pump in the loop in which the pressurizer is attached. The reactor coolant pump forces flow through the loops, thus allowing the secondary side to heat the primary side. This results in an expansion of the primary system fluid. Since the pressurizer is water-solid, the pressure rises until the PORV opens to relieve the pressure. This case is run until the PORV cycles a few times to assure that the peak pressure is declining with every cycle.

The peak pressure reached in the reactor vessel is 551.26 psia. The Appendix G allowable for this temperature is 554.7 psia. Hence, this case passes the Appendix G limit.

The peak RHR system pressure reached in this case is 650.05 psia. The allowable value for this system is 674.70 psia. Hence, the RHR system also passes the pressure acceptance criterion.

Figures 12 through 20 show the reactor vessel pressure, RHR system pressure, the primary system temperatures in the two loops, flow rates in the two loops, the secondary system temperatures in the two loops, and the PORV flow rate. Table 10 shows the sequence of events for this case.

TABLE 10
HEAT ADDITION CASE-PRIMARY TEMPERATURE 60°F, 2000 GPM RHR, ONE RC PUMP STARTED

EVENT	TIME,SECS
One RC pump started	0.0
RC pump reaches full flow	17.4
PORV opens for the first time	46.00
Peak pressure of 551.26 psia reached in the reactor vessel	46.00
Peak pressure of 650.05 psia reached in the RHR system	46.00

6.2.2 Case 6

Case 6 is a heat addition case with the primary system initialized to 85°F and 329.7 psia. The secondary system is at a temperature 50°F higher than the primary system. The RHR system is running at a capacity of 2000 gpm total. The RHR system is modeled explicitly for the heat addition cases. No pressurizer vent or seal leakage is modeled.

The transient is initiated by starting the reactor coolant pump in the loop in which the pressurizer is attached. The reactor coolant pump forces flow through the loops, thus allowing the secondary side to heat the primary side. This results in an expansion of the primary system fluid. Since the pressurizer is water-solid, the pressure rises until the PORV opens to relieve the pressure. This case is run until the PORV cycles a few times to assure that the peak pressure is declining with every cycle.

The peak pressure reached in the reactor vessel is 558.04 psia. The Appendix G allowable for this temperature is 563.7 psia. Hence, this case passes the Appendix G limit.

The peak RHR system pressure reached in this case is 656.34 psia. The allowable value for this system is 674.70 psia. Hence, the RHR system also passes the pressure acceptance criterion.

Figures 21 through 29 show the reactor vessel pressure, RHR system pressure, the primary system temperatures in the two loops, flow rates in the two loops, and the secondary system temperatures in the two loops. Table 11 shows the sequence of events for this case.

TABLE 11
HEAT ADDITION CASE- PRIMARY TEMPERATURE 85°F, 2000 GPM RHR, ONE RC PUMP STARTED

EVENT	TIME,SECS
One RC pump started	0.0
RC pump reaches full flow	17.4
PORV opens for the first time	22.5
Peak pressure of 558.04 psia reached in the reactor vessel	22.5
Peak pressure of 656.34 psia reached in the RHR system	22.5

6.2.3 Case 7

Case 7 is a heat addition case with the primary system initialized at 280°F and 329.7 psia. The secondary system is at a temperature 50°F higher than the primary system. The RHR system is running at a capacity of 2000 gpm total. The RHR system is modeled explicitly for the heat addition cases. No pressurizer vent or seal leakage is modeled.

The transient is initiated by starting the reactor coolant pump in the loop in which the pressurizer is attached. The reactor coolant pump forces flow through the loops, thus allowing the secondary side to heatup the primary side. This results in an expansion of the primary system fluid. Since the pressurizer is water-solid, the pressure rises until the PORV opens to relieve the pressure. This case is run until the PORV cycles a few times to assure that the peak pressure is declining with every cycle.

The peak pressure reached in the reactor vessel is 569.33 psia. The Appendix G allowable for this temperature is 1016.7 psia. Hence, this case passes the Appendix G limit.

The peak RHR system pressure reached in this case is 663.66 psia. The allowable value for this system is 674.70 psia. Hence, the RHR system also passes the pressure acceptance criterion.

Figures 30 through 38 show the reactor vessel pressure, RHR system pressure, the primary system temperatures in the two loops, flow rates in the two loops,

the secondary system temperatures in the two loops and the PORV flow rate. Table 12 shows the sequence of events for this case.

TABLE 12
HEAT ADDITION CASE-PRIMARY TEMPERATURE 280°f, 2000 GPM RHR FLOW, ONE RC PUMP STARTED

EVENT	TIME, SECS
One RV pump started	0.0
PORV opens for the first time	10.0
RC pump reaches full flow	17.4
Peak pressure of 663.66 psia reached in the RHR system	46.00
Peak pressure of 569.33 psia reached in the reactor vessel	46.00

6.2.4 Case 8

Case 8 is a heat addition case with the primary system initialized to 85°F and 329.7 psia. The secondary system is at a temperature 50°F higher than the primary system. The RHR system is running at a capacity of 1700 gpm total. The RHR system is modeled explicitly for the heat addition cases. No pressurizer vent or seal return is modeled.

The transient is initiated by starting the reactor coolant pump in the loop in which the pressurizer is attached. The reactor coolant pump forces flow through the loops, thus allowing the secondary side to heat the primary side. This results in an expansion of the primary system fluid. Since the pressurizer is water-solid, the pressure rises until the PORV opens to relieve the pressure. This case is run until the PORV cycles a few times to assure that the peak pressure is declining with every cycle.

The peak pressure reached in the reactor vessel is 546.79 psia. The Appendix G allowable for this temperature is 563.7 psia. Hence, this case passes the Appendix G limit.

The peak RHR system pressure reached in this case is 640.78 psia. The allowable value for this system is 674.70 psia. Hence, the RHR system also passes the pressure acceptance criterion.

Figures 39 through 47 show the reactor vessel pressure, RHR system pressure, the primary system temperatures in the two loops, flow rates in the two loops, the secondary system temperatures in the two loops and the PORV flow rate. Table 13 shows the sequence of events for this case.

TABLE 13
HEAT ADDITION CASE- PRIMARY TEMPERATURE 85°f, RHR FLOW AT 1700 GPM, ONE RC PUMP STARTED

EVENT	TIME,SECS
One RC pump started	0.0
RC pump reaches full flow	17.4
PORV opens(first time)	23.2
Peak RV pressure of 546.79 psia reached	23.2
Peak RHR pressure of 640.78 psia reached	23.2

6.2.5 Case 9

Case 9 is a heat addition case with the primary system initialized to 320°F and 329.7 psia. The secondary system is at a temperature 50°F higher than the primary system. The RHR system is running at a capacity of 1700 gpm total. The RHR system is modeled explicitly for the heat addition cases. No pressurizer vent or seal leakage is modeled.

The transient is initiated by starting the reactor coolant pump in the loop in which the pressurizer is attached. The reactor coolant pump forces flow through the loops, thus allowing the secondary side to heat the primary side. This results in an expansion of the primary system fluid. Since the pressurizer is water-solid, the pressure rises until the PORV opens to relieve the pressure. This case is run until the PORV cycles a few times to assure that the peak pressure is declining with every cycle.

The peak pressure reached in the reactor vessel is 563.83 psia. The Appendix G allowable for this temperature is 1391.70 psia. Hence, this case passes the Appendix G limit.

The peak RHR system pressure reached in this case is 655.66 psia. The allowable value for this system is 674.70 psia. Hence, the RHR system also passes the pressure acceptance criterion.

Figures 48 through 56 show the reactor vessel pressure, RHR system pressure, the primary system temperatures in the two loops, flow rates in the two loops, the secondary system temperatures in the two loops and the PORV flow rate. Table 14 shows the sequence of events for this case.

TABLE 14
HEAT ADDITION CASE - PRIMARY TEMPERATURE 320°F,RHR 1700 GPM FLOW RATE, ONE RC PUMP STARTED

EVENT	TIME,SECS
One RC pump started	0.0
PORV opens(first time)	8.81
RC pump reaches full flow	17.4
Peak pressure in RHR system of 655.66 psia reached	10.5
Peak pressure of 563.82 psia reached in the RV	21.3

7.0 SUMMARY AND CONCLUSIONS

Framatome Technologies Incorporated (FTI) updated the analysis of the low temperature overpressure events for the Rochester Gas and Electric (RGE) Robert E.Ginna Nuclear Power Station. This analysis becomes the new analysis of record for RGE. In this effort, a spectrum of LTOP events to bound all possible operational configurations was analyzed and the results compared to the acceptance criteria of the Appendix G limits for embrittlement and the RHR overpressure structural design limit.

The most limiting mass addition case analyzed is a case with one charging pump turned on when the primary system is at 60°F with one RC pump running. This resulted in a peak pressure in the reactor vessel of 554.32 psia, which is marginally lower than the Appendix G limit at this temperature. The peak pressure in the RHR system in this case with 2000 gpm of RHR flow(i.e. two RHR pumps running) is 656 psia. The RHR system passes the structural acceptance criterion set for the RHR system by a margin of 18.7 psi. Note that below 135°F primary temperature, only one RC pump is allowed to run, by operating procedures.

Above 135°F, two RC pumps can be running and three charging pumps can start, resulting in a mass addition event. In this case, the primary pressure was at 329.7 psia, initially. The peak reactor vessel pressure reached was 587.44 psia. This case was run at a conservative primary temperature of 60°F and the results compared with limits at 135°F. The Appendix G limit for this temperature is 597.70 psia. This gives a margin of 10.26 psi. The calculated peak RHR system pressure in this case was 663.50 psia against an allowable pressure value of 674.70 psia, giving a margin of 11.20 psi.

The most limiting heat addition case is the start of a reactor ccolant pump with the primary system at 60 °F. The peak reactor vessel pressure reached in this transient was 551.25 psia. The Appendix G limit is 554.7 psia. Hence, this case passes with a margin of 3.45 psi. The peak pressure at the RHR pump

discharge for this case was 649.96 psia as compared with an acceptance limit of 674.7 psia. The margin in the RHR system is 24.74 psi.

For the RHR system, the limiting event is a reactor coolant pump start with both the RHR pumps running and the primary initial temperature at 280°F. In this case, the peak RHR pressure reached is 663.66 psia as compared with an allowable of 674.70 psia. Above 280°F primary temperature, only one RHR pump will be running, yielding a greater margin to the pressure limit..

When the plant is in a configuration in which the pressurizer vent(1.1 sq.inches) is open, the primary system pressure will be at atmospheric pressure in the pressurizer. No RC pump will be allowed to run under vented conditions since NPSH will not be available to run any pump. The most limiting mass addition for this plant condition is the start of an SI pump when the initial primary temperature is at 60°F. This case has a peak reactor vessel pressure of 414.82 psia, which is less than the Appendix G limit by 139.88 psi. The peak RHR pressure in this case is 542.96 psia as compared with the allowable presssure of 674.70 psia. Consequently, this case bounded by start of a charging pump at 60°F with the pressurizer vent closed and PORV operable.

The summary of results of all LTOP cases is shown in Table 15.

TABLE 15
SUMMARY OF RESULTS

RESULTS OF THE MASS ADDITION CASES

Case ID	Description	Peak pressure in reactor vessel,psia	Allowable per Appendix G in psia	Margin in psi	Peak press. in RHR system in psia	Structural allowable in psia	Margin in psi
Case 1 .	85°F, three charging pumps started, no RC pump running, primary pressure 329.7 psia No RC pump seal leakage 1700 gpm RHR	480.19	563.70	+83.51	598.43	674.70	76.27
Case 2	60°F, one charging pump started, one RC pump running, primary pressure 329.7 psia 3 gpm RC pump seal leakage 2000 gpm RHR	554.32	554.70	0.38	656.00	674.70	18.7

(continued)

TABLE 15(continued)

RESULTS OF THE MASS ADDITION CASES

Case ID	Description	Peak pressure in reactor vessel,psia	Allowable per Appendix G in psia	Margin in psi	Peak press. in RHR system in psia	Structural allowable in psia	Margin in psi
Case 3	60°F, 14.7 psia primary pressure 1.1 sq.inch vent open, one SI pump on, no RCpumps on. 2000 gpm RHR	414.82	554.70	139.88	542.96	674.70	131.74
Case 4	212°F primary,no RC pumps, 14.7 psia initial primary pressure, one SI pump turned on. 2000 gpm RHR	397.38	≅710.7	313.32	525.91	674.70	148.79
Case 2a	60°F primary, two RC pumps, 329.7 psia initial pressure three charging pumps turned on. 2000 gpm RHR	587.44	597.70 @ 135°F	10.26	663.49	674.70	11.21

Note: The RHR peak pressure is calculated by adding to the peak pressure at hot leg a value of 138.03 psi, which is the pressure drop between node 100 and node 455 in the 85°F heat addition case, Case 6.
(continued)

TABLE 15(continued)

RESULTS OF HEAT ADDITION CASES

Case ID	Description	Peak pressure in reactor vessel,psia	Allowable per Appendix G in psia	Margin in psi	Peak press. in RHR system in psia	Structural allowable in psia	Margin in psi
Case 5	60°F primary, 2000 gpm RHR, one RC pump started. Primary pressure 329.7 psia	551.25	554.7	3.45	649.96	674.70	24.74
Case 6	85°F primary,2000 gpm RHR, one RC pump started. Primary pressure 329.7 psia	558.04	563.7	5.66	656.34	674.70	18.36
Case 7	280°F primary, 2000 gpm RHR, one RC pump started Primary pressure 329.7 psia	569.33	1016.7	447.37	663.66	674.70	11.04
Case 8	85°F primary, 1700 gpm RHR, one RC pump started Primary pressure 329.7 psia	546.79	563.7	16.91	640.78	674.70	33.92

TABLE 15(continued)

RESULTS OF HEAT ADDITION CASES

Case ID	Description	Peak pressure in reactor vessel,psia	Allowable per Appendix G in psia	Margin in psi	Peak press. in RHR system in psia	Structural allowable in psia	Margin in psi
Case 9	320.0°F primary, 1700 gpm RHR, one RC pump started Primary pressure 329.7 psia	563.82	1391.7	827.88	655.66	674.70	19.04

Note: Appendix G allowables shown here are from Table 2. Reference 4 had an earlier Appendix G curve from the UFSAR of Ginna plant and the values were slightly different.

8.0 REFERENCES

1. U.S.Nuclear Regulatory Commission Regulatory Guide 1.99, "Embrittlement of Reactor Vessel Materials", Revision 2, May 1988.
2. WCAP-14684, "R.E.Ginna Heatup and Cooldown Limit Curves for Normal Operation," June 1996.
3. NUREG/CR-5194 EGG-2531 R4,"RELAP5/MOD2 Models and Correlations", August 1988.
4. FTI Document 32-1232650-00, "Low Temperature Overpressure Analysis for RGE - Ginna Plant" February 1995.
5. BAW-10164P-A, "RELAP5/MOD2-B&W - An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analysis," Code Topical Report, Revision 3, July 1996.
6. FTI Doc. 32-1266167-00, "Additional LTOP Heat Addition Cases", June 1997.
7. FTI Doc. 32-1266168-00,,"Ginna LTOP Mass.Add.", June 1997.

PLOTS OF THE RESULTS

FIGURE 4

CASE 1 MASS ADDITION CASE PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
3CHARGING PUMPS NO RC PUMP RUNNING
NO SEAL LEAKAGE

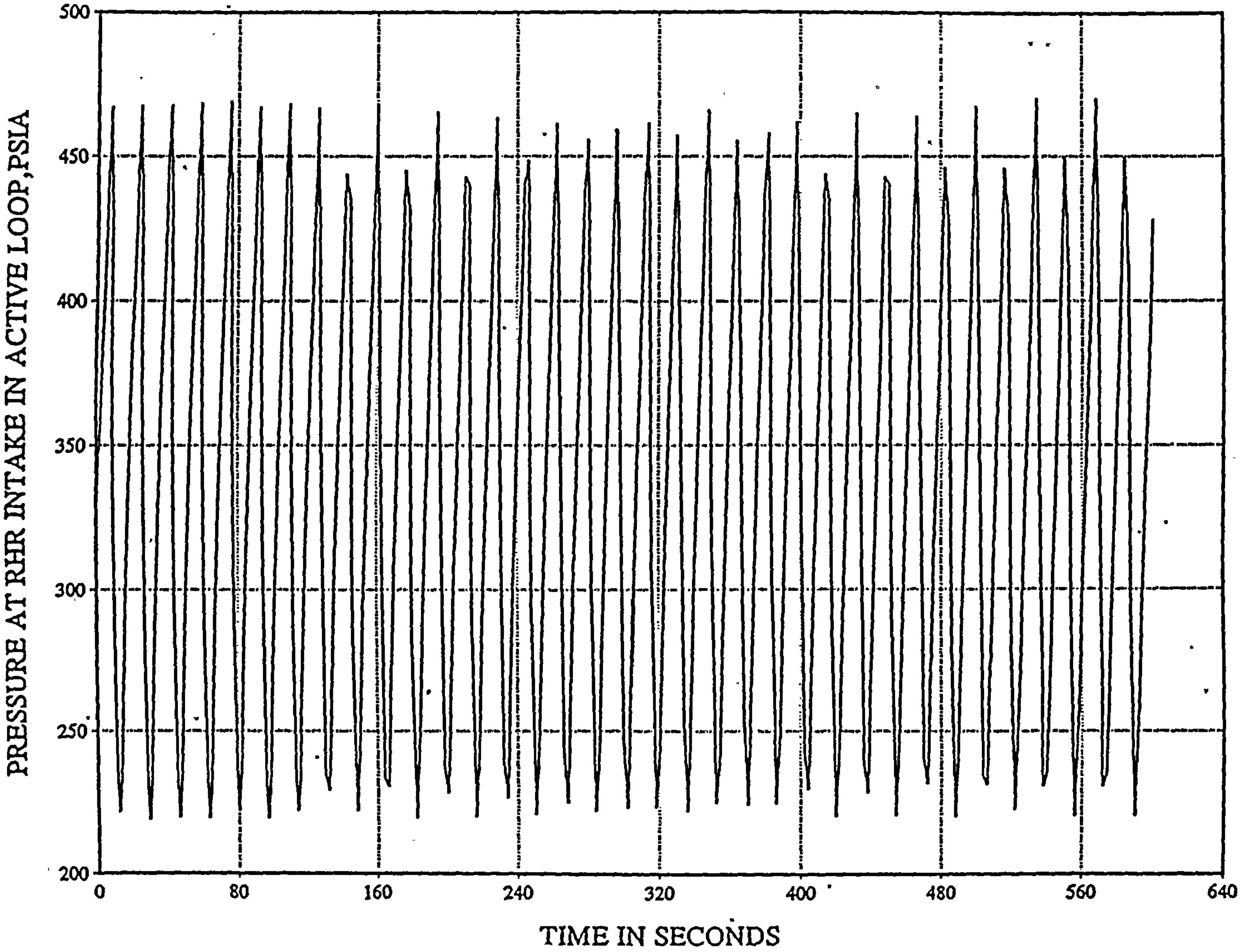


FIGURE 5

CASE 1 MASS ADDITION CASE PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
3 CHARGING PUMPS NO RC PUMP RUNNING
NO SEAL LEAKAGE

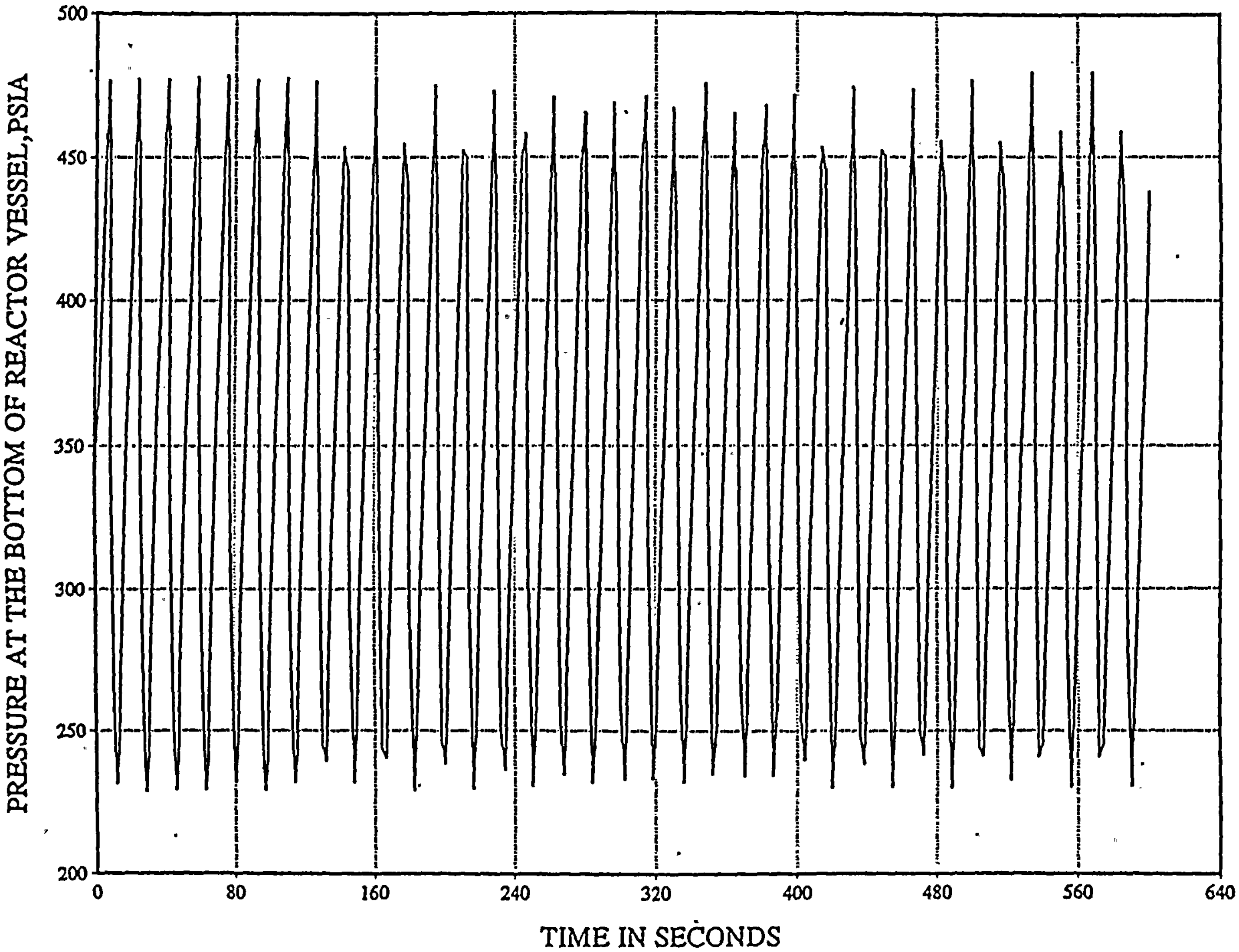


FIGURE 6

CASE 2 MASS ADDITION CASE PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 329.7 PSIA
1 CHARGING PUMP ONE RC PUMP RUNNING
3 GPM SEAL LEAKAGE

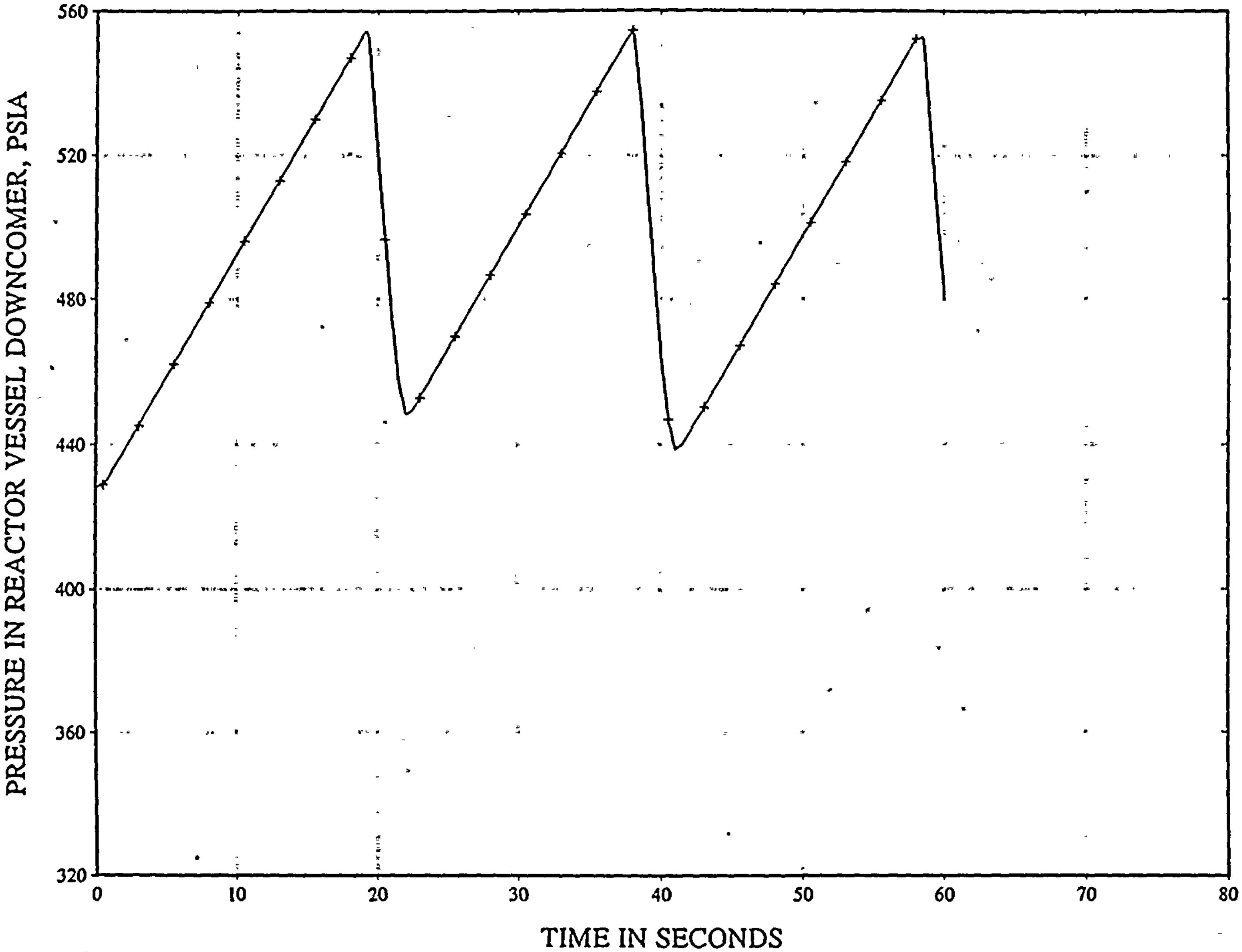


FIGURE 7

CASE 2 MASS ADDITION CASE PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 329.7 PSIA
1 CHARGING PUMP ONE RC PUMP RUNNING
3 GPM SEAL LEAKAGE

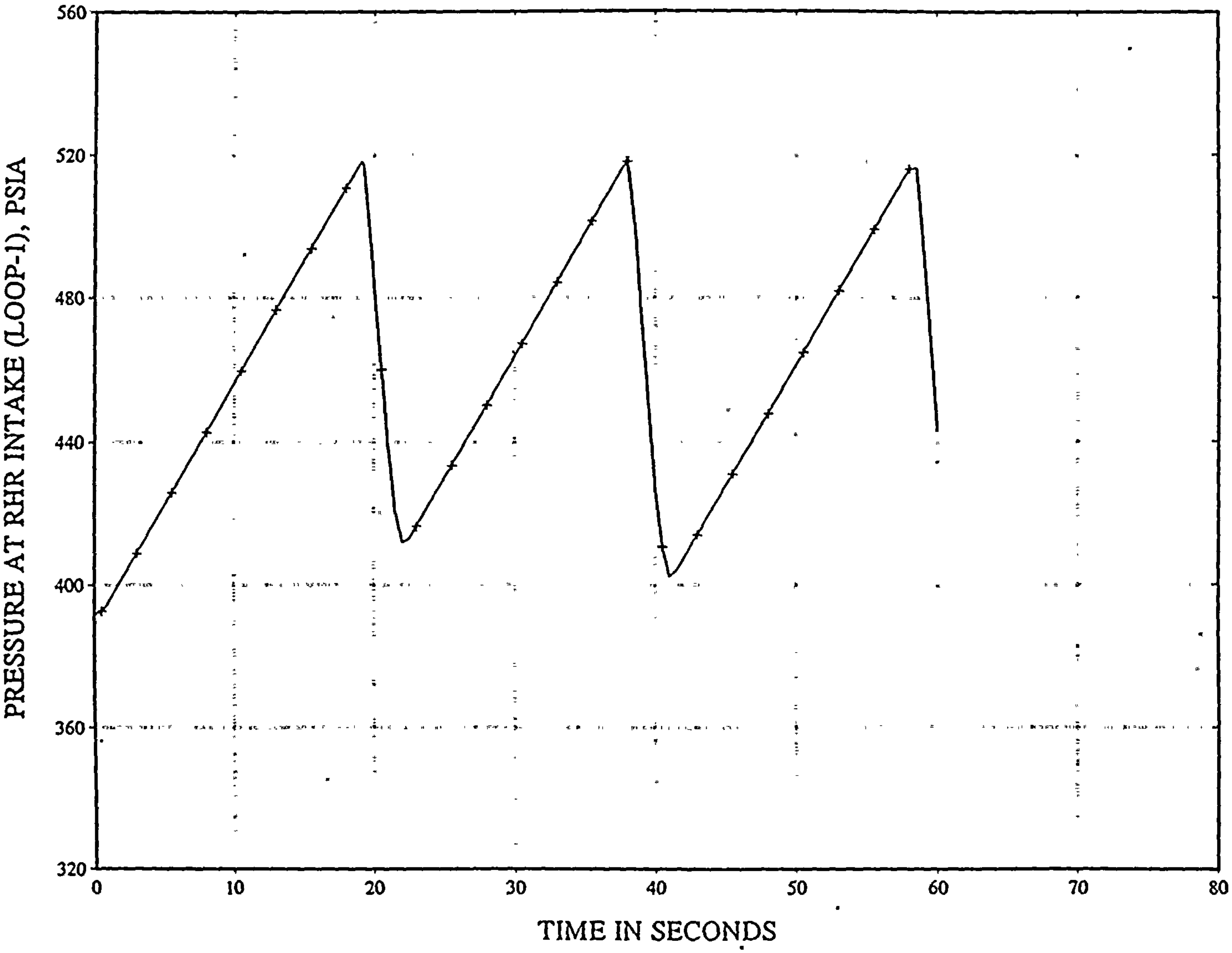


FIGURE 8

CASE 3 MASS ADDITION CASE

PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 14.7 PSIA
NO RC PUMP RUNNING
NO SEAL LEAKAGE

1 SI PUMP STARTED
1.1 SQ.INCH VENT

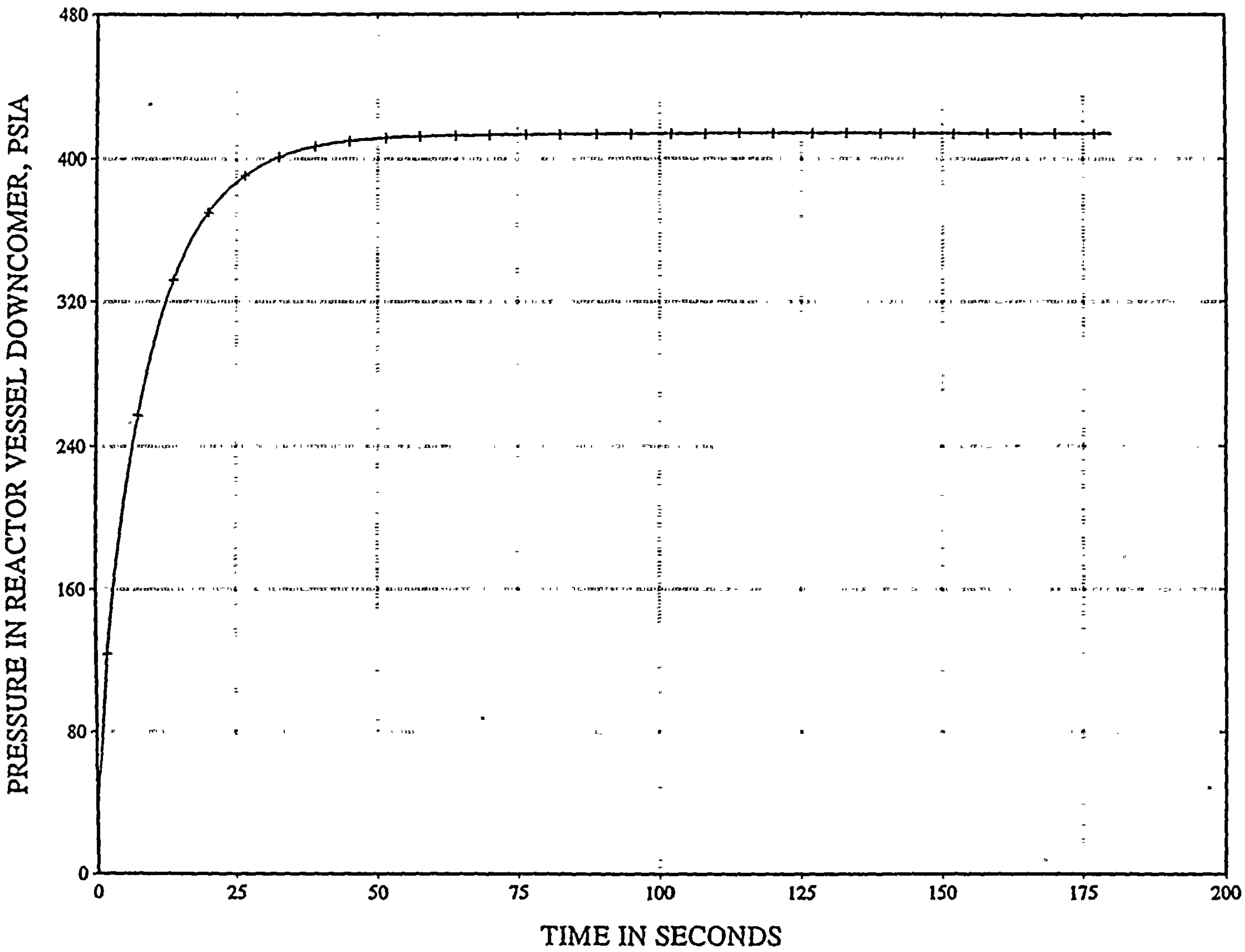


FIGURE 9

CASE 3 MASS ADDITION CASE PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 14.7 PSIA
1 SI PUMP STARTED NO RC PUMP RUNNING
1.1 SQ.INCH VENT NO SEAL LEAKAGE

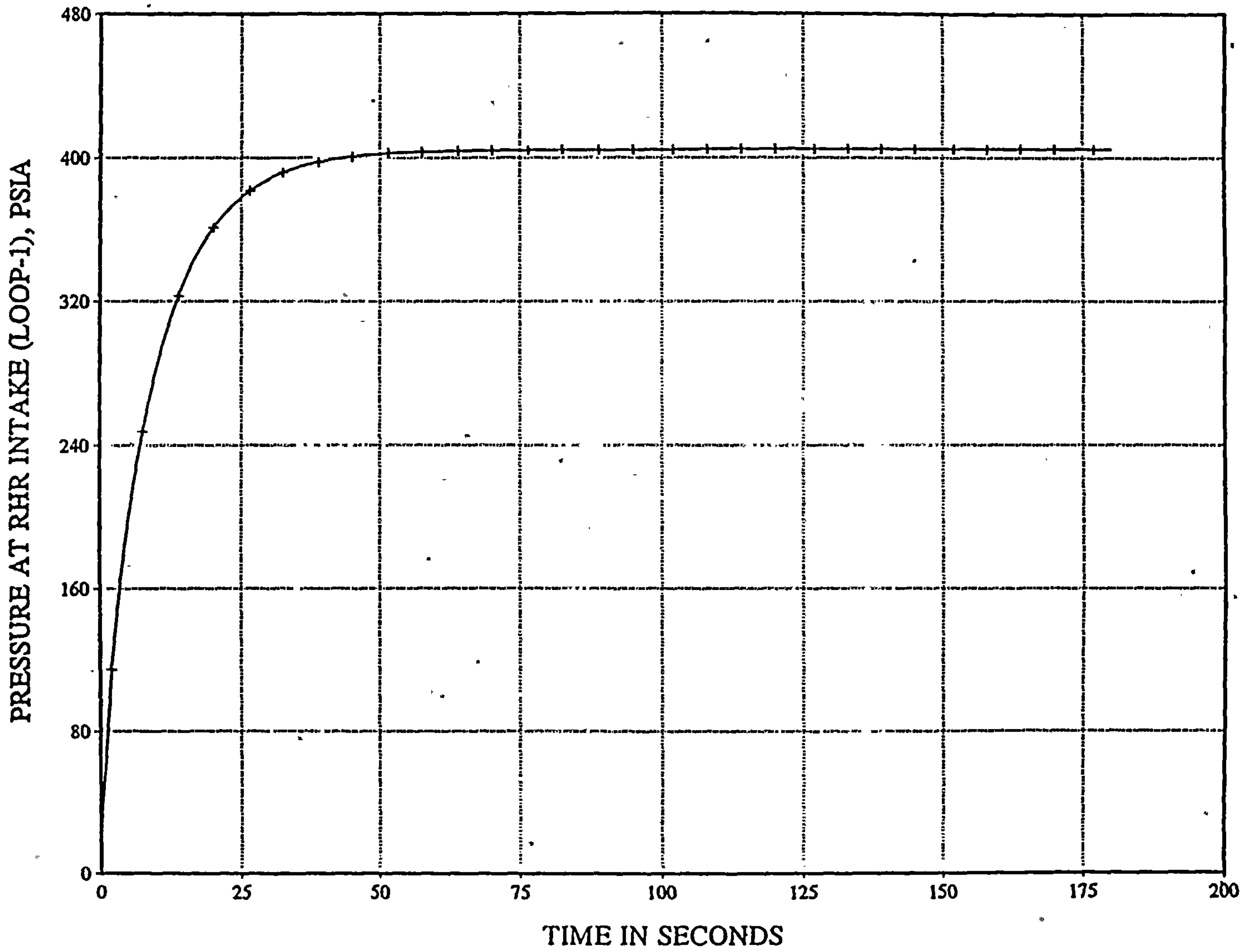


FIGURE 10
CASE 4 MASS ADDITION CASE PRIMARY TEMPERATURE 212°F
PRIMARY PRESSURE 14.7 PSIA
1 SI PUMP STARTED NO RC PUMP RUNNING
1.1 SQ.INCH VENT NO SEAL LEAKAGE

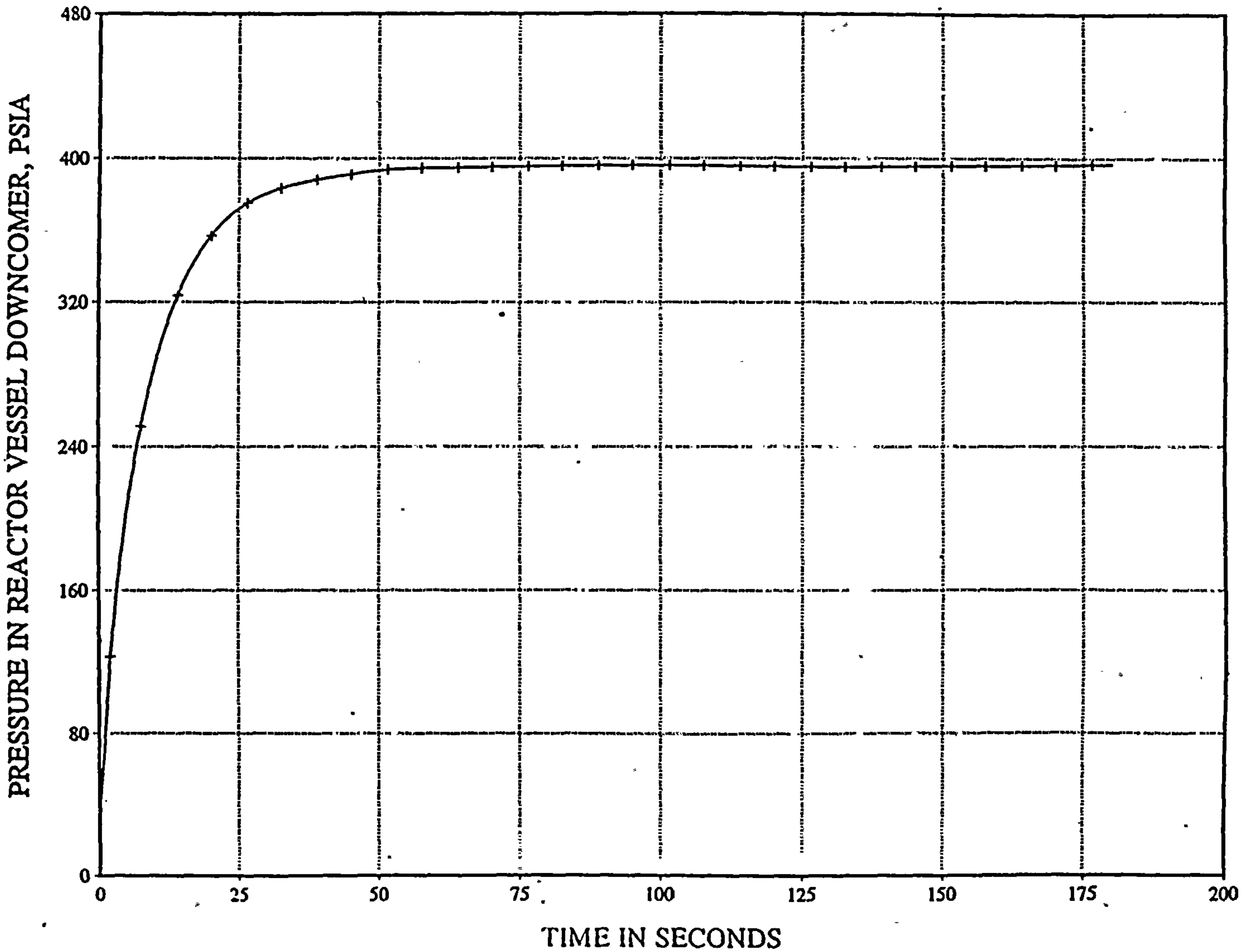


FIGURE 11

CASE 4 MASS ADDITION CASE PRIMARY TEMPERATURE 212°F
PRIMARY PRESSURE 14.7 PSIA
1 SI PUMP STARTED NO RC PUMP RUNNING
1.1 SQ.INCH VENT NO SEAL LEAKAGE

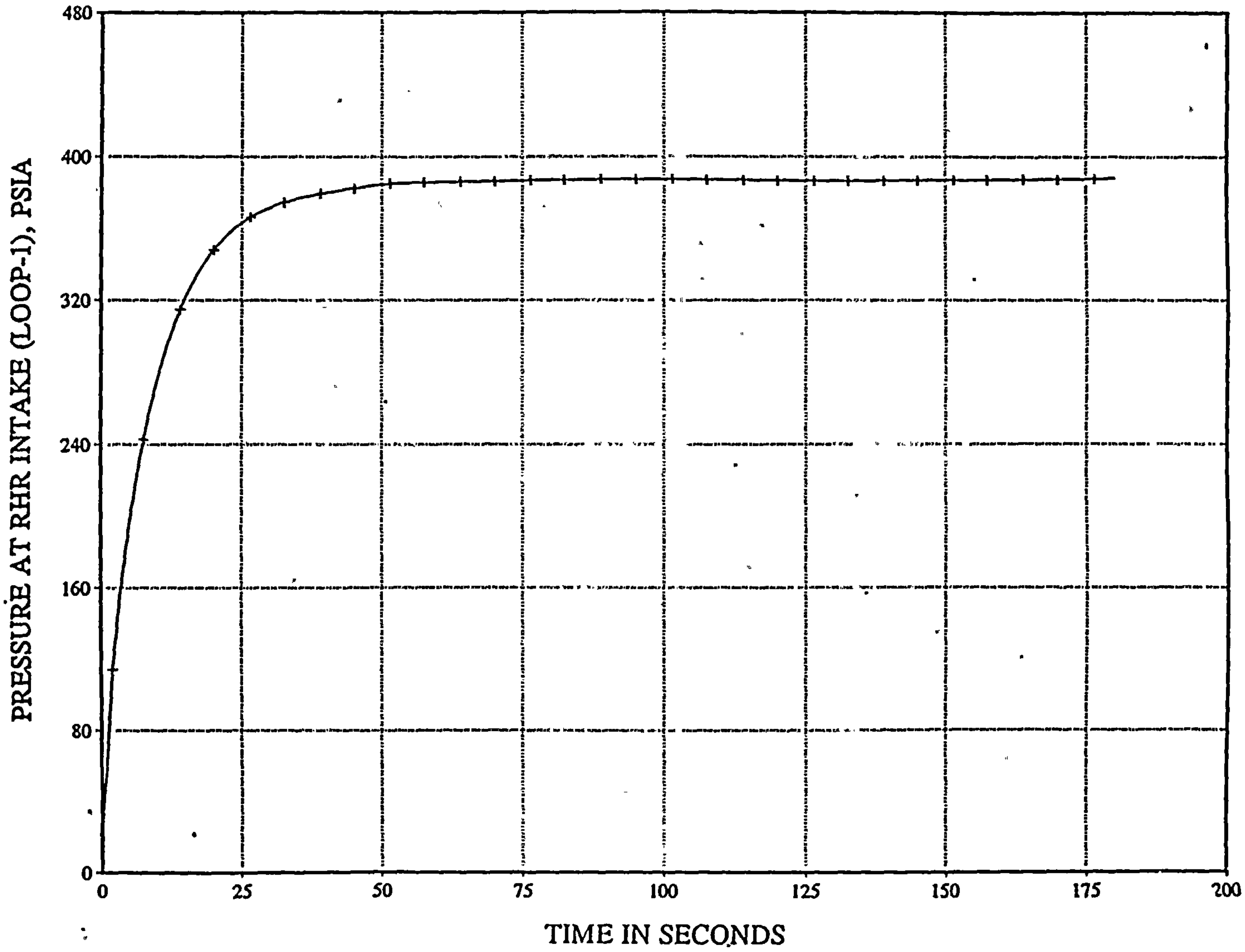


FIGURE 12

CASE 5 HEAT ADDITION CASE PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

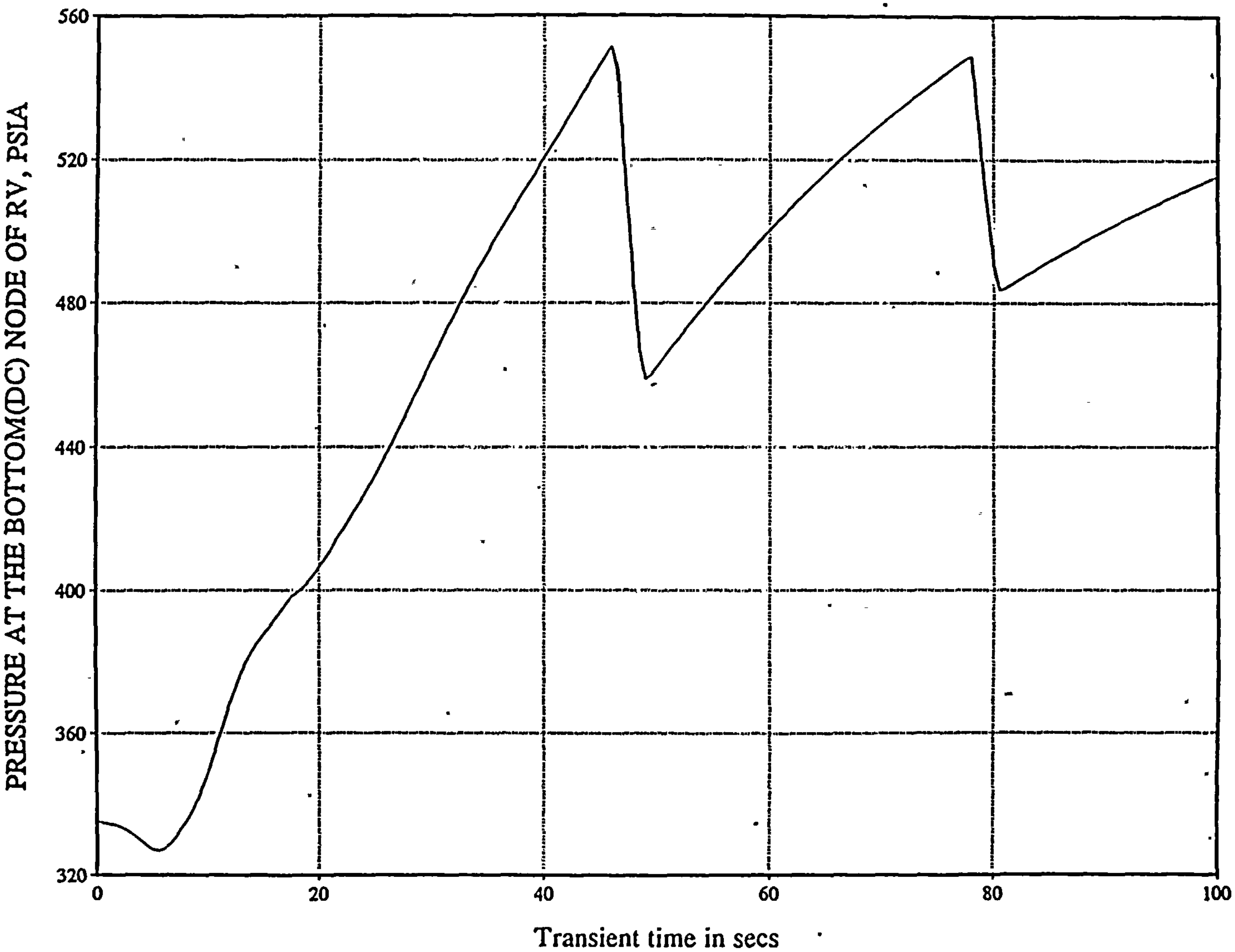


FIGURE 13

CASE 5 HEAT ADDITION CASE PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP.
ONE RC PUMP STARTED
2000 GPM RHR

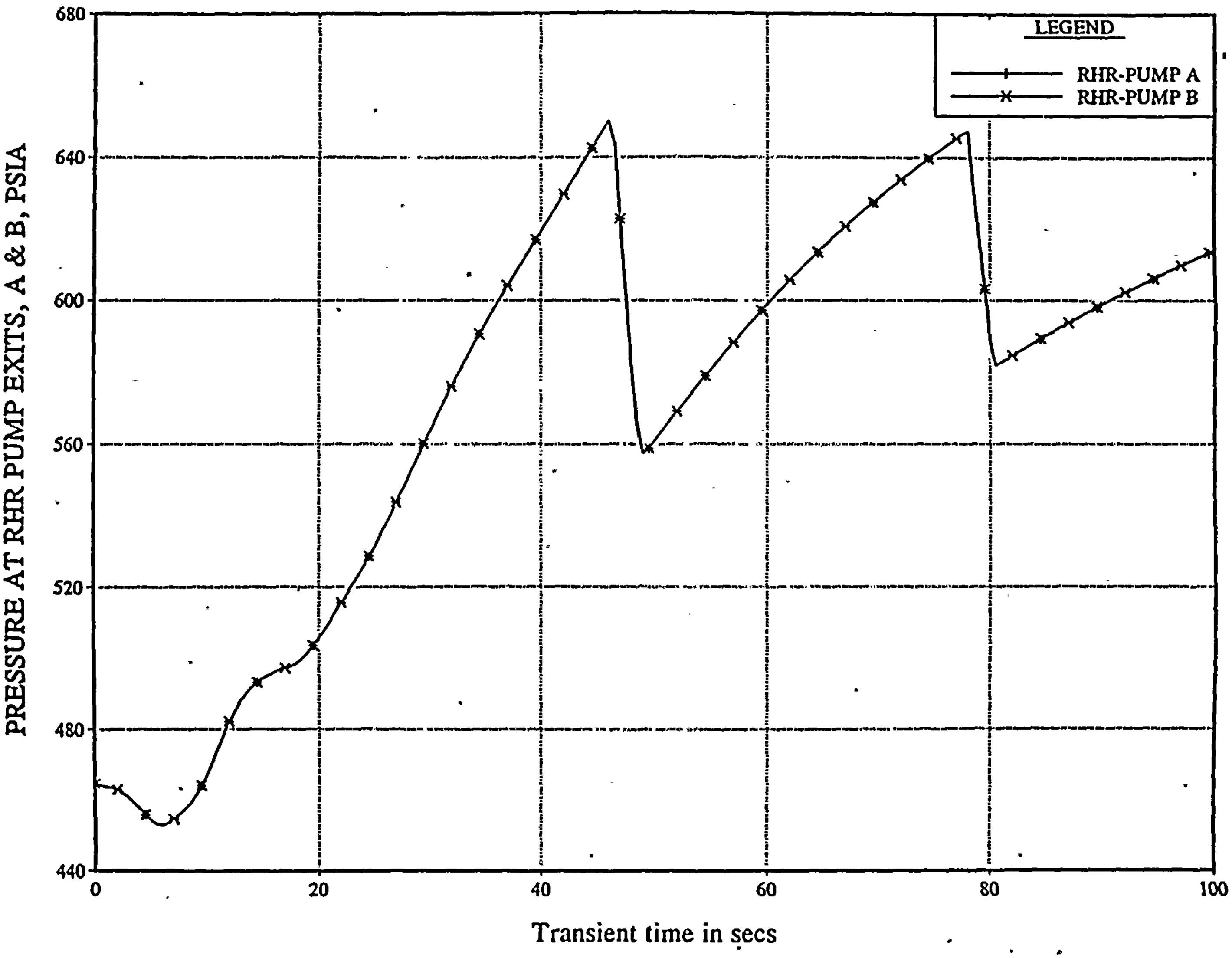
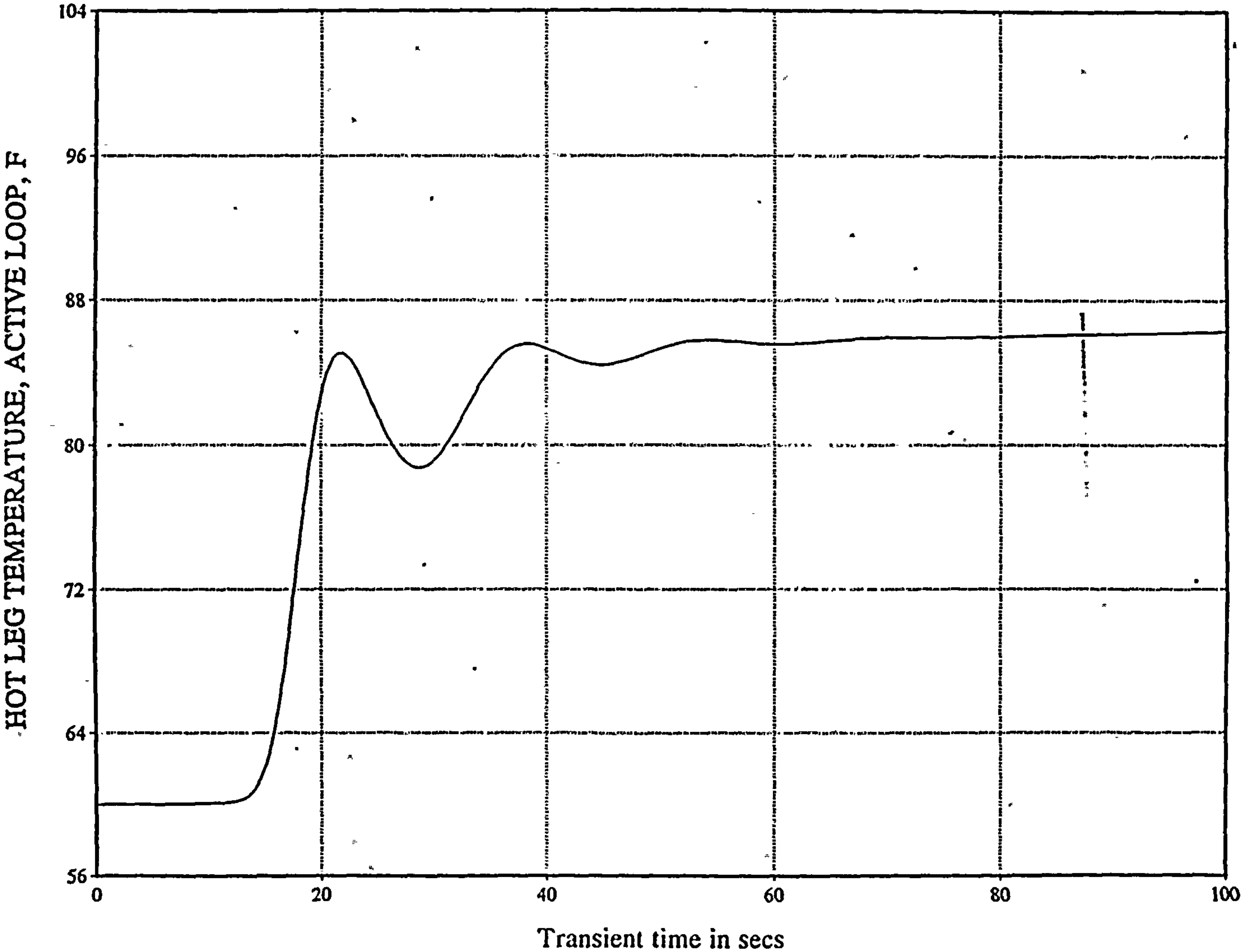


FIGURE 14

CASE 5 HEAT ADDITION CASE PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR



FTI Non-Proprietary

86-1234820-01

FIGURE 15
CASE 5 HEAT ADDITION CASE PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

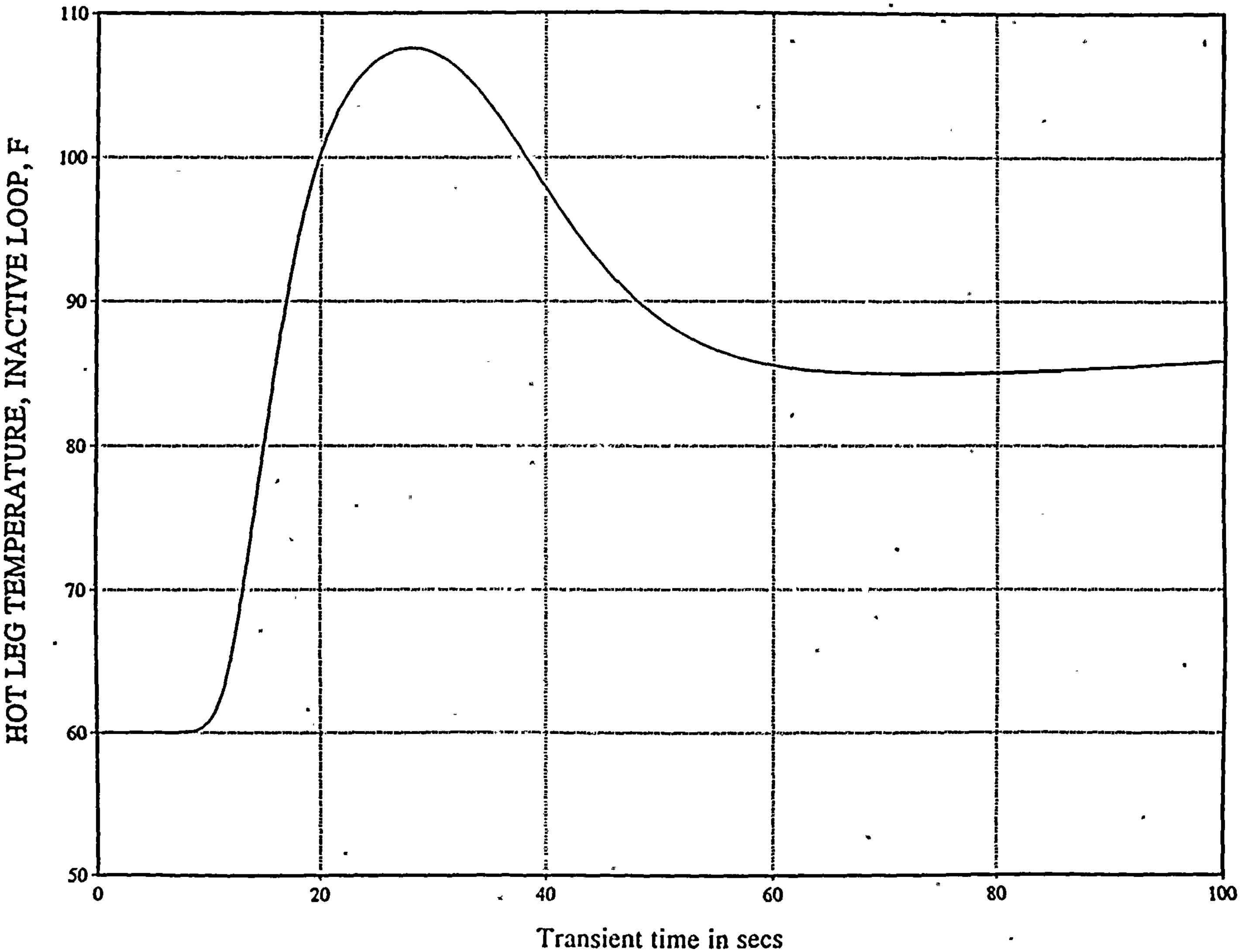


FIGURE 16

CASE 5 HEAT ADDITION CASE PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

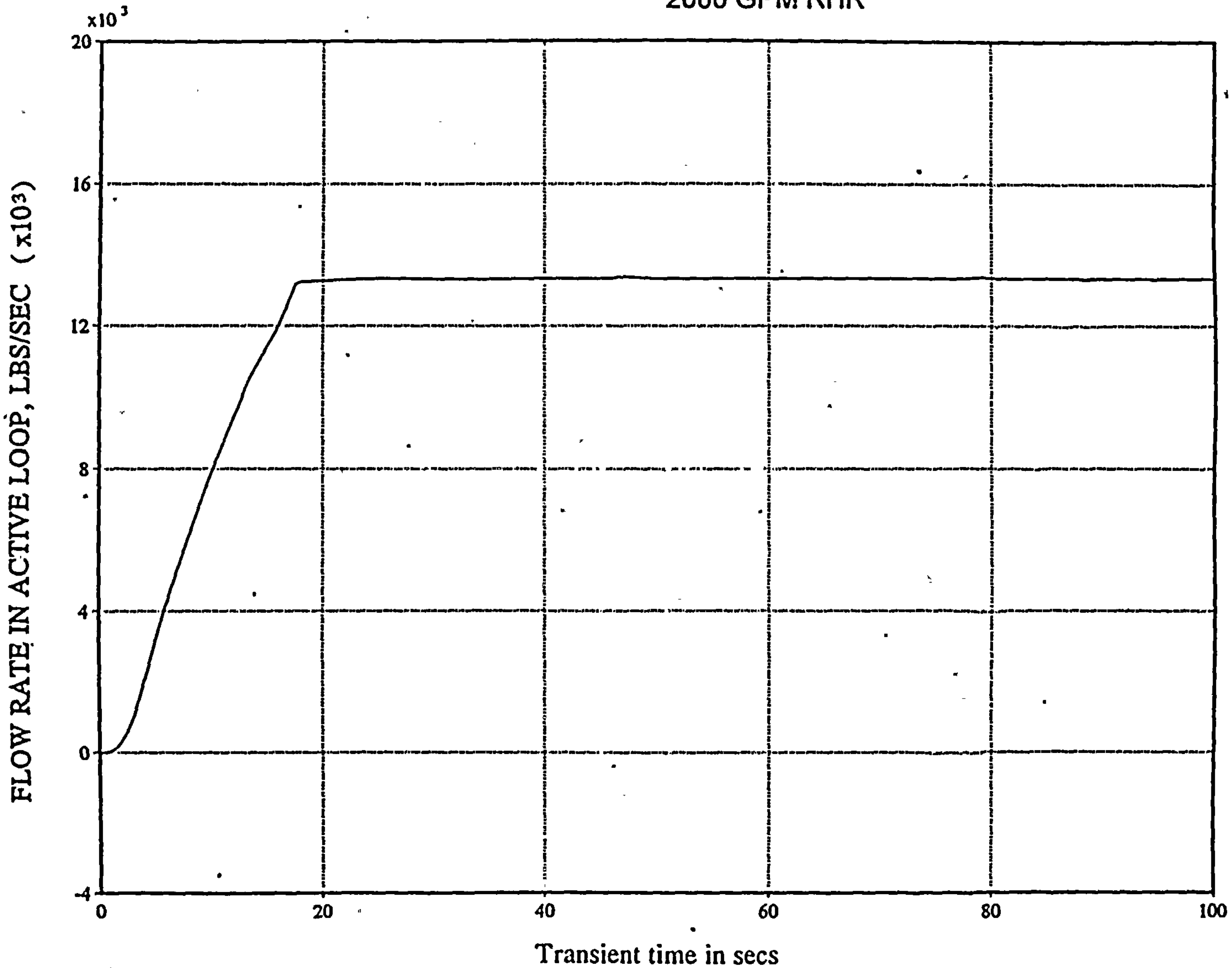


FIGURE 17

CASE 5 HEAT ADDITION CASE PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

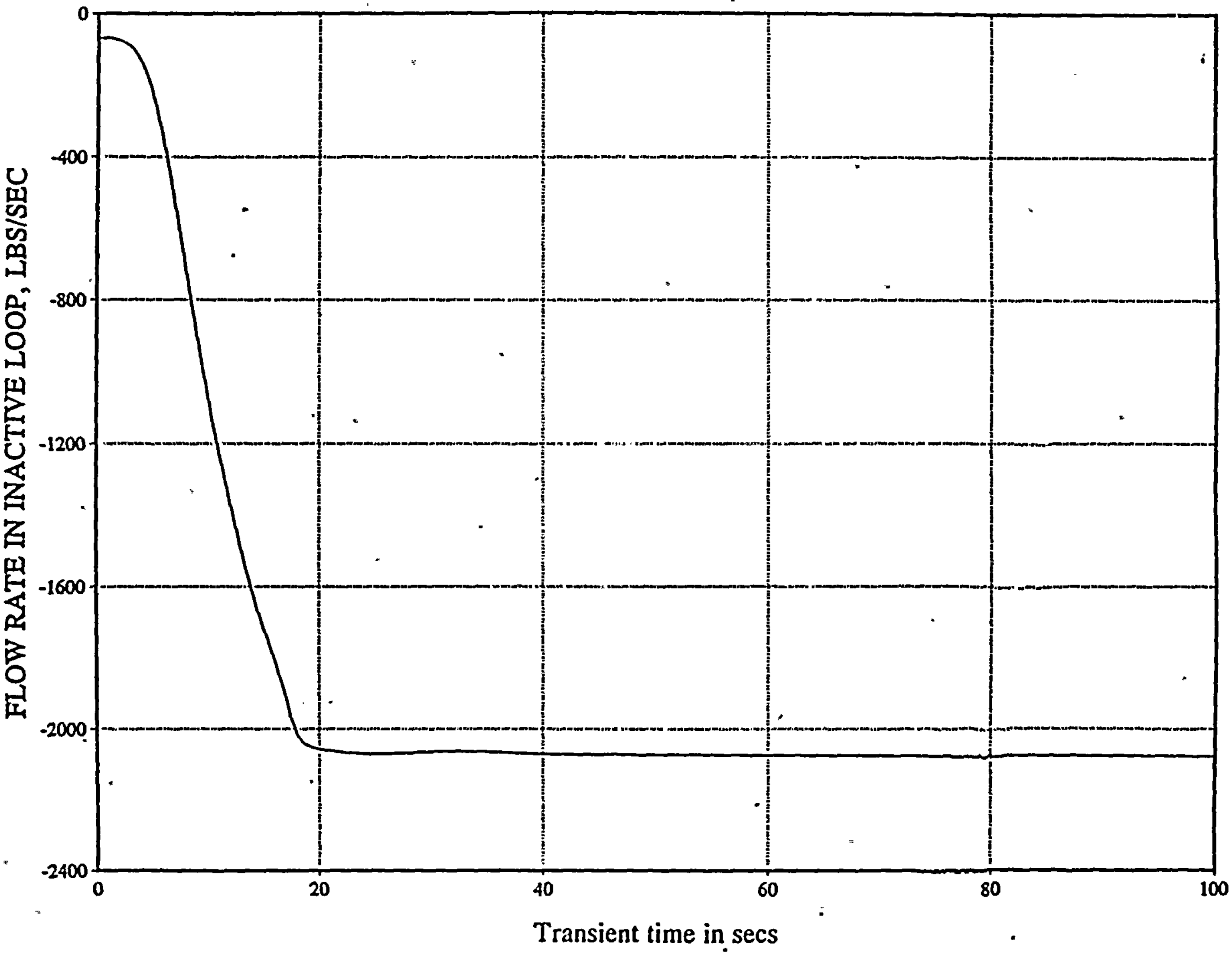


FIGURE 18

CASE 5 HEAT ADDITION CASE

PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

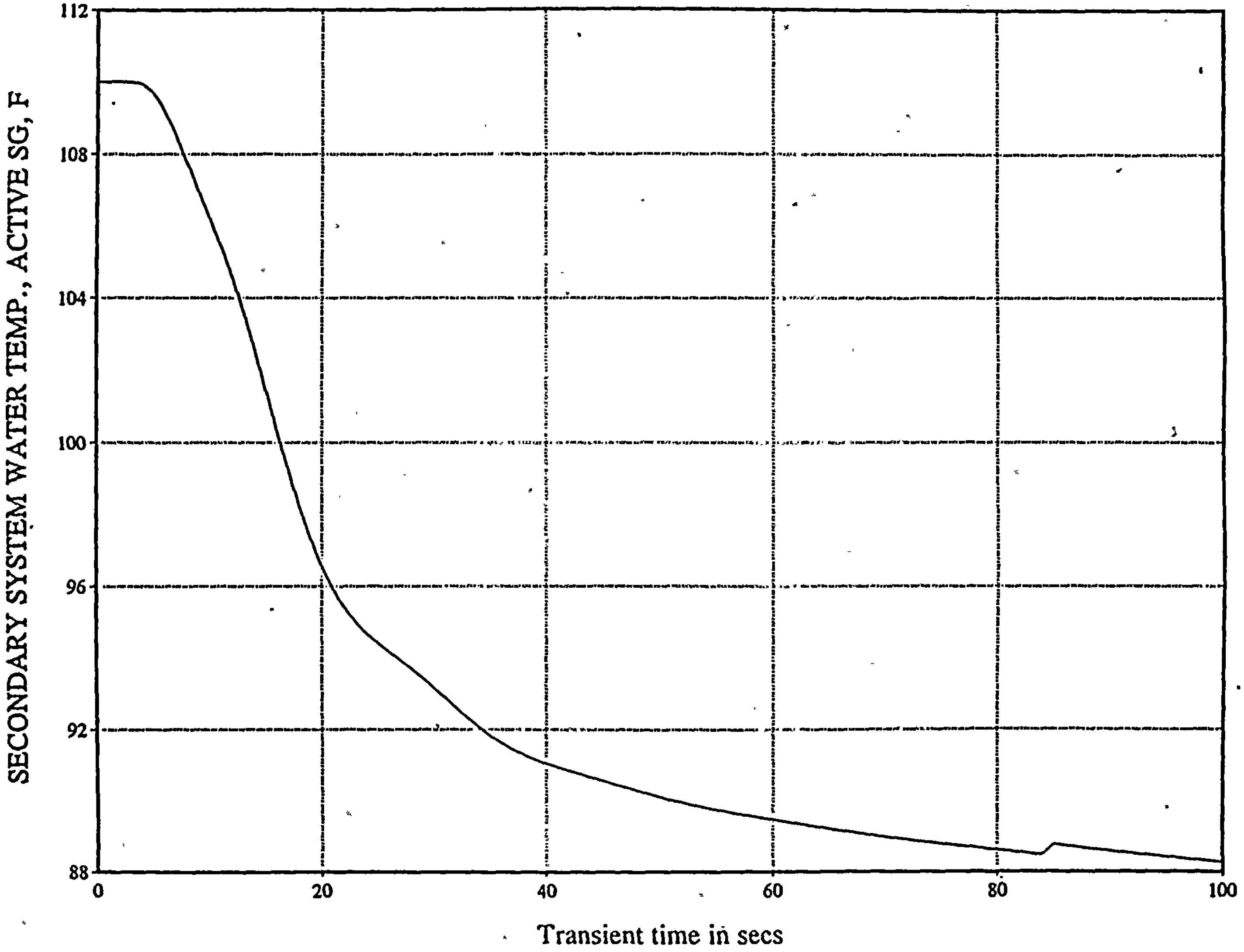


FIGURE 19

CASE 5 HEAT ADDITION CASE. PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

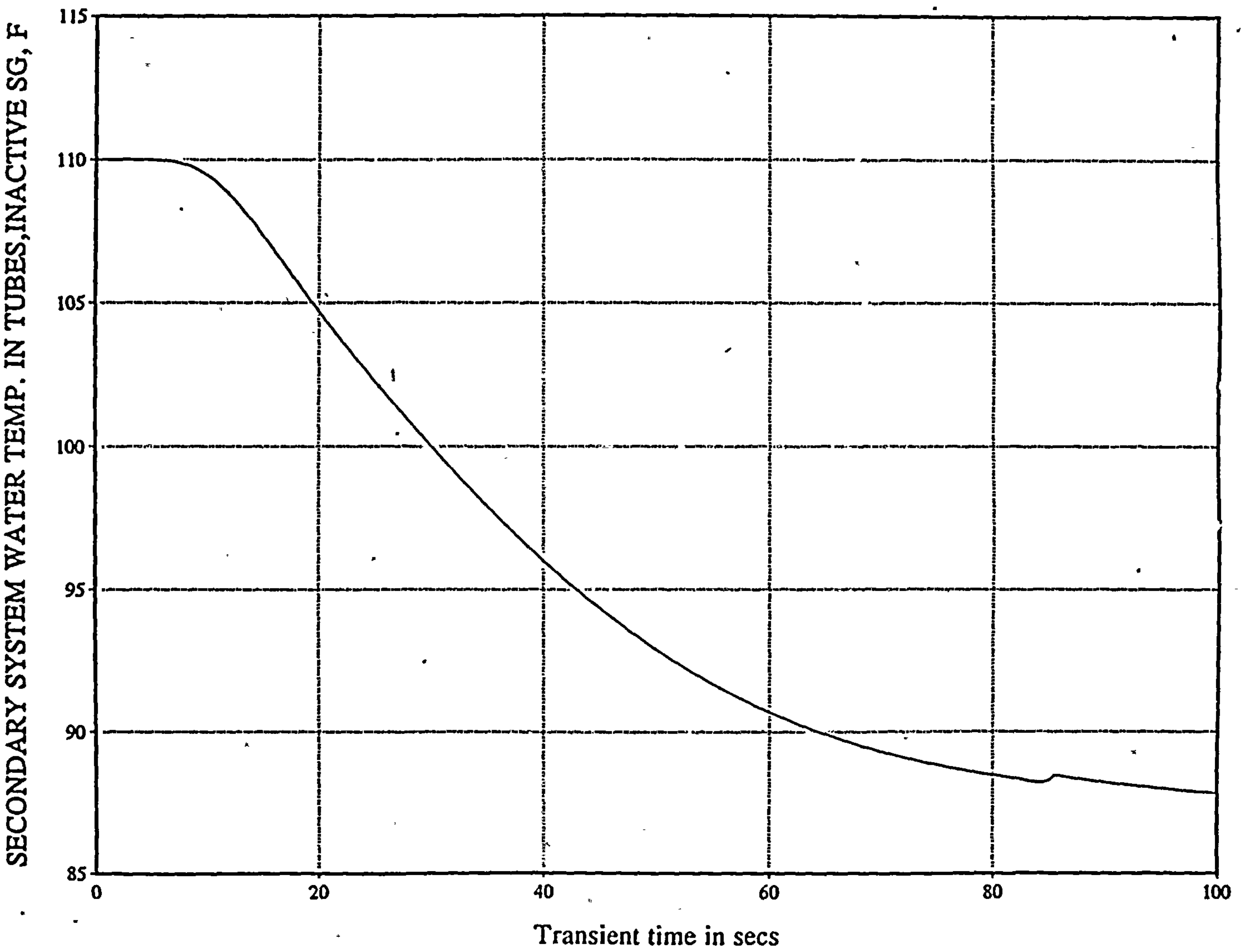


FIGURE 20

CASE 5 HEAT ADDITION CASE PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

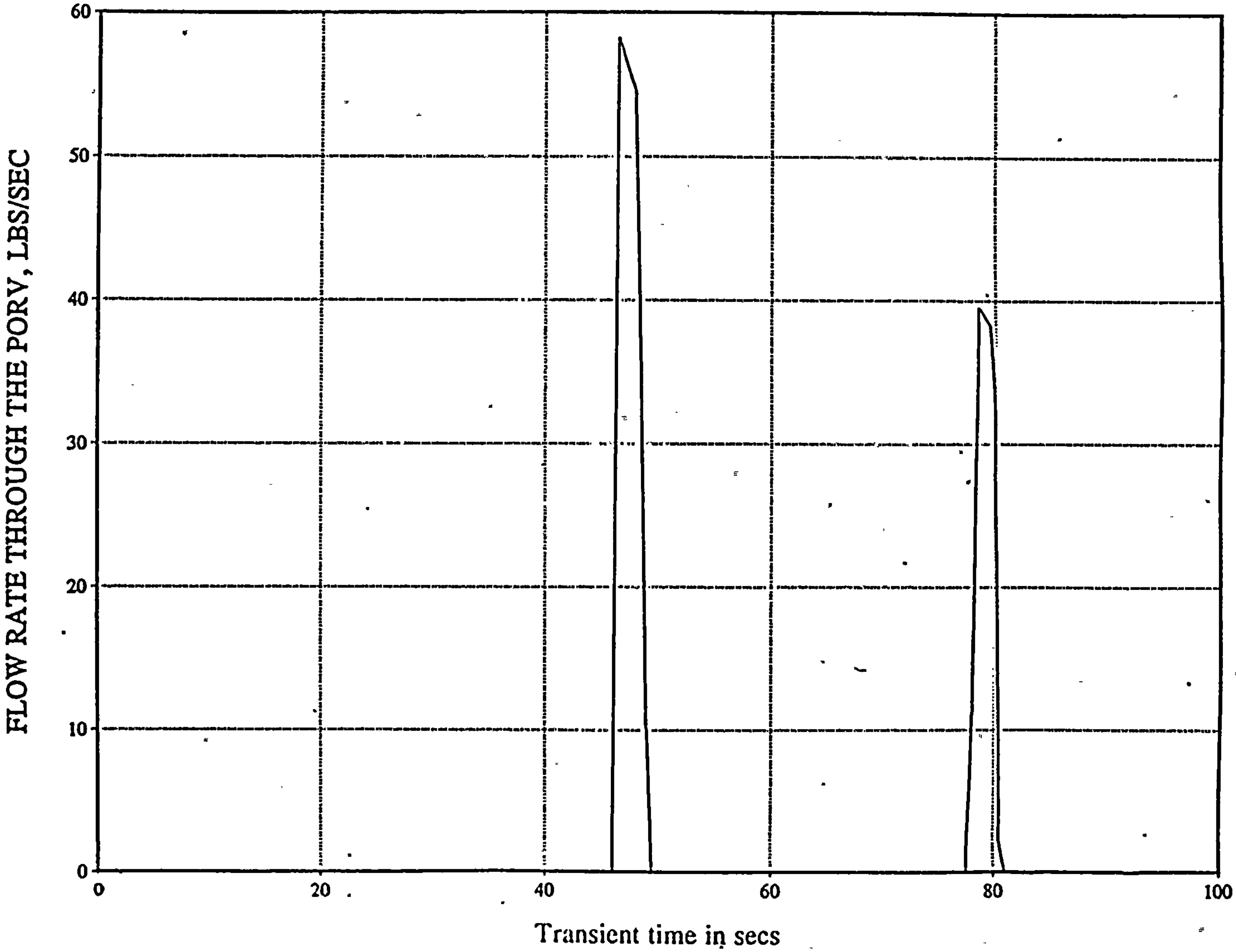


FIGURE 21

CASE 6 HEAT ADDITION CASE PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

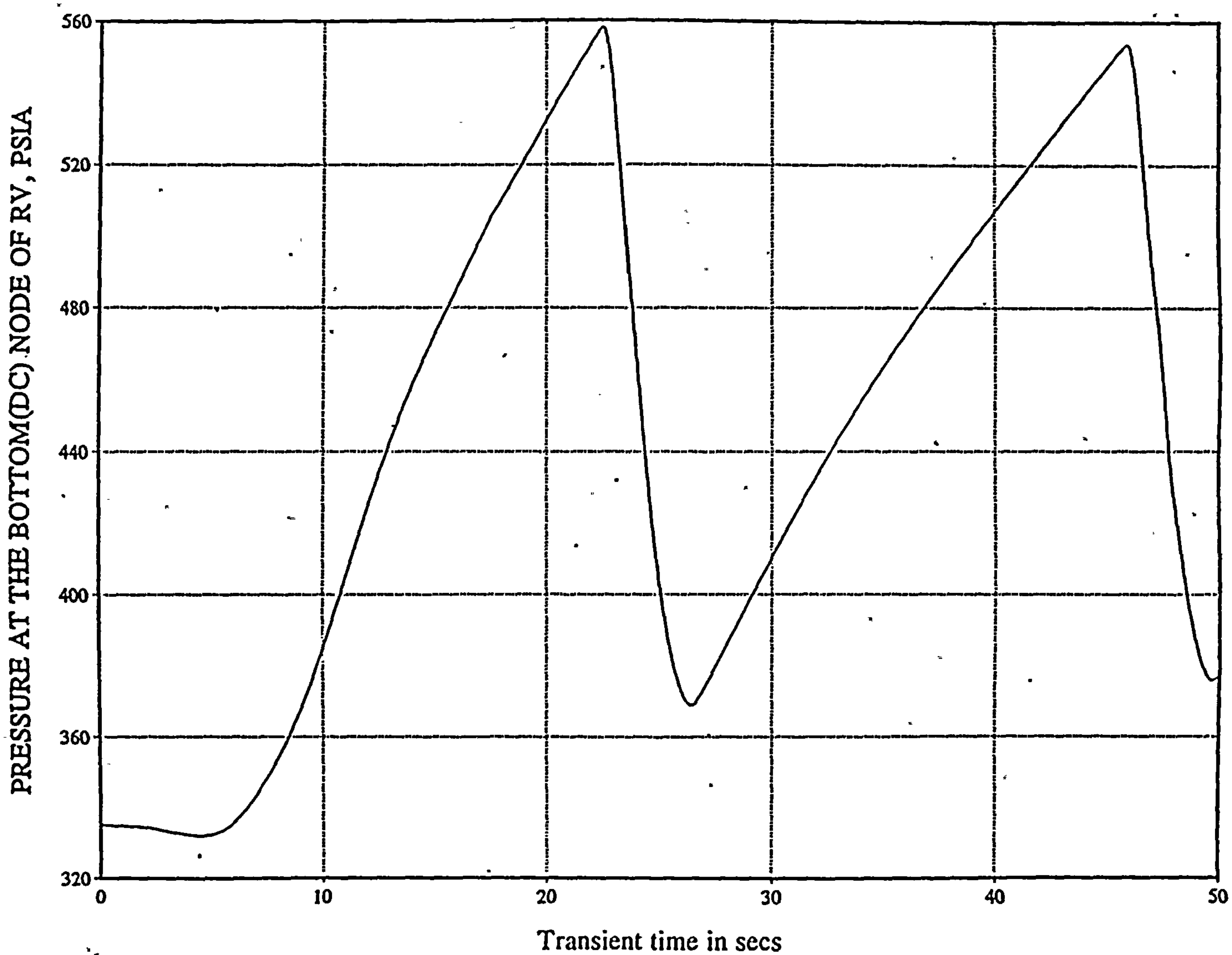
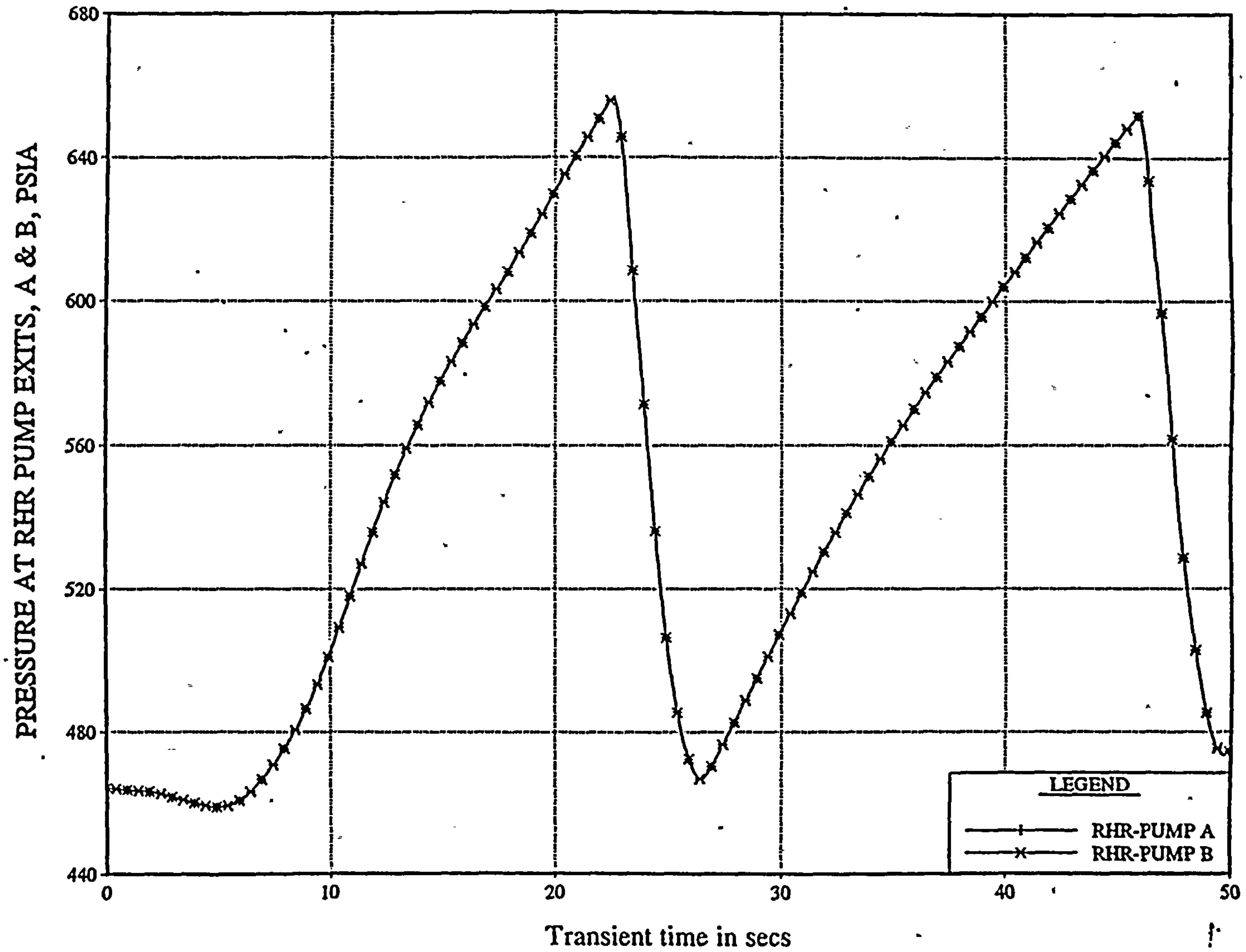


FIGURE 22

CASE 6 HEAT ADDITION CASE

PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR



FTI Non-Proprietary

86-1234820-01

FIGUR

CASE 6 HEAT ADDITION CASE

PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

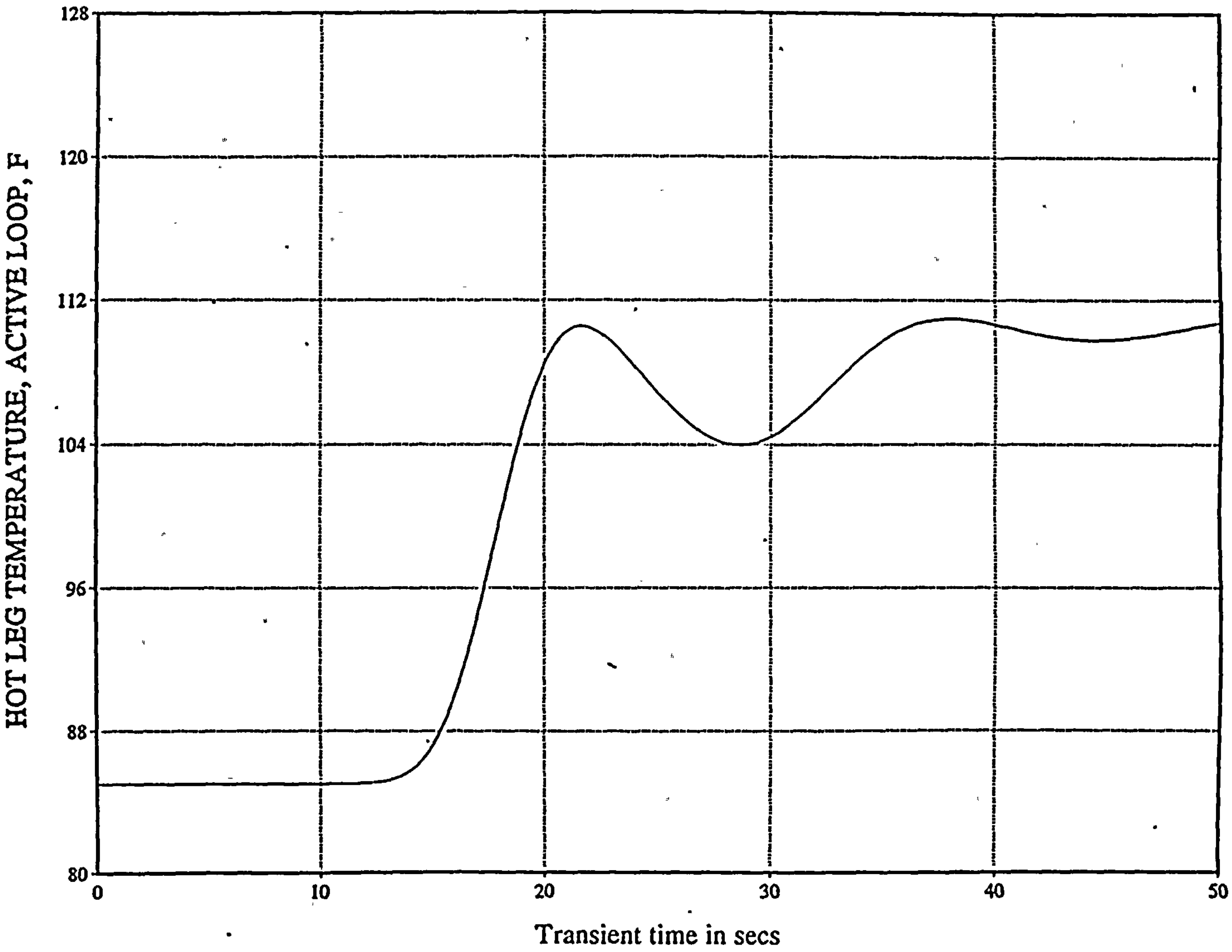
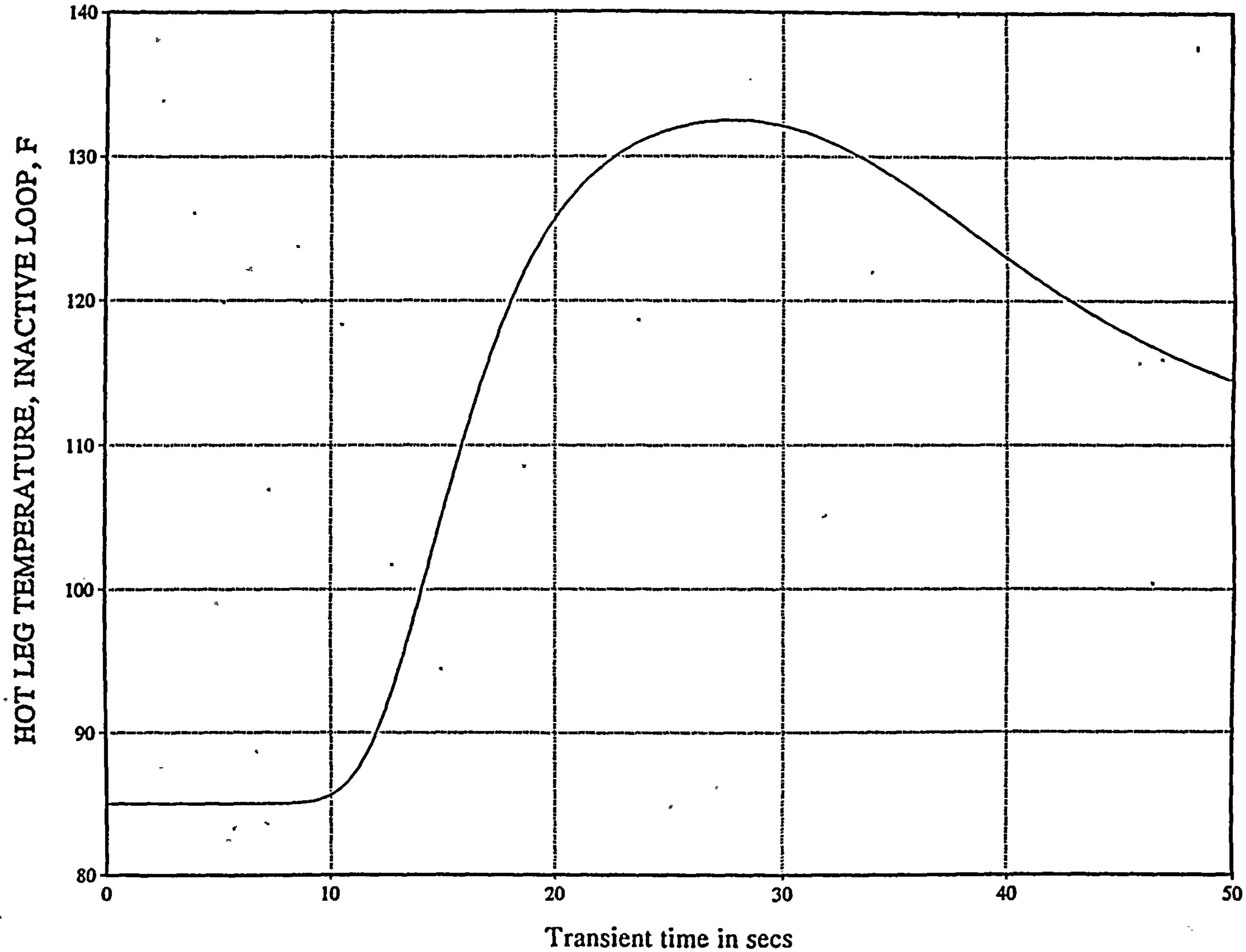


FIGURE 24

CASE 6 HEAT ADDITION CASE

PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR



FTI Non-Proprietary

86-1234820-01

FIGURE 25

CASE 6 HEAT ADDITION CASE PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

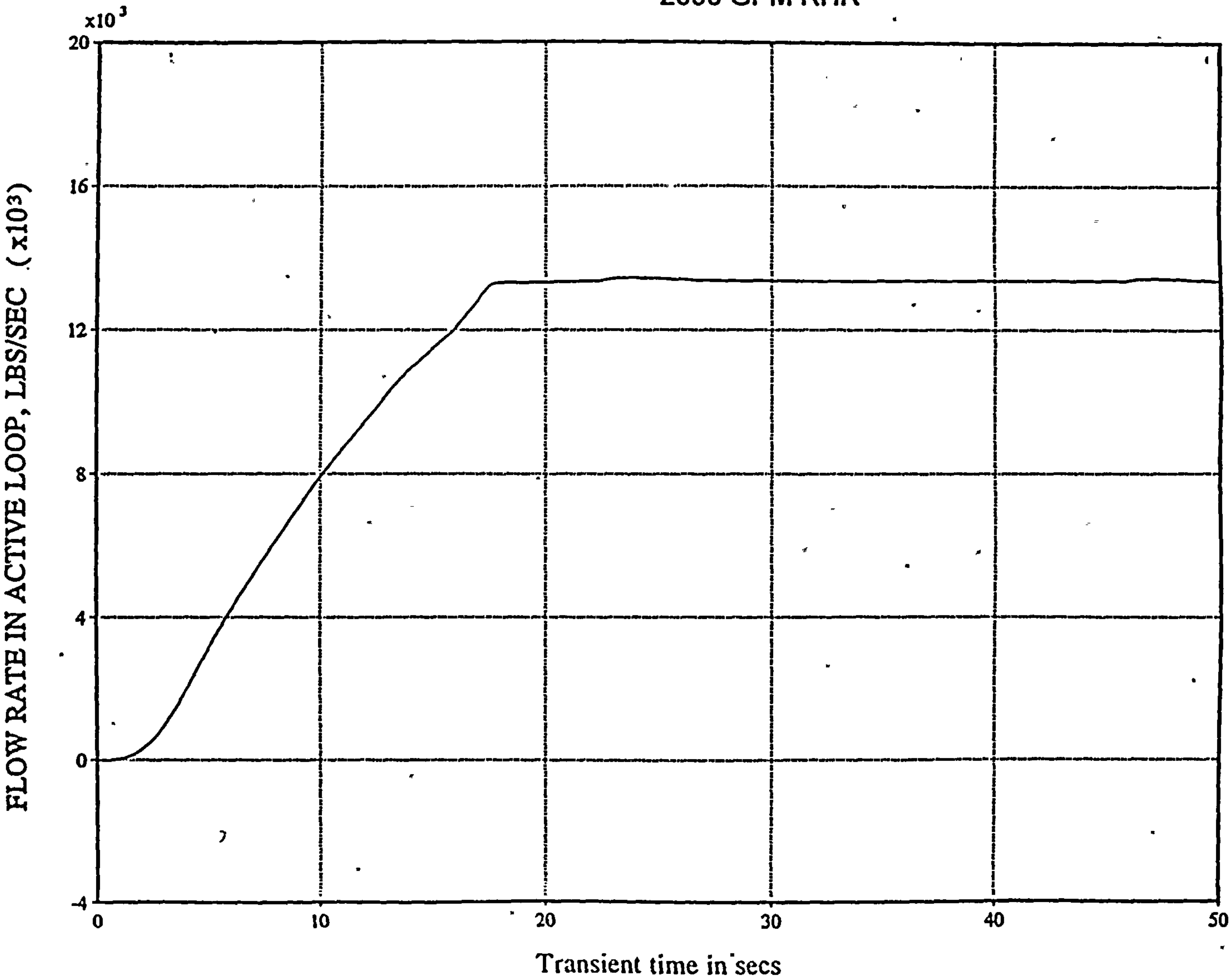


FIGURE 26

CASE 6 HEAT ADDITION CASE PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

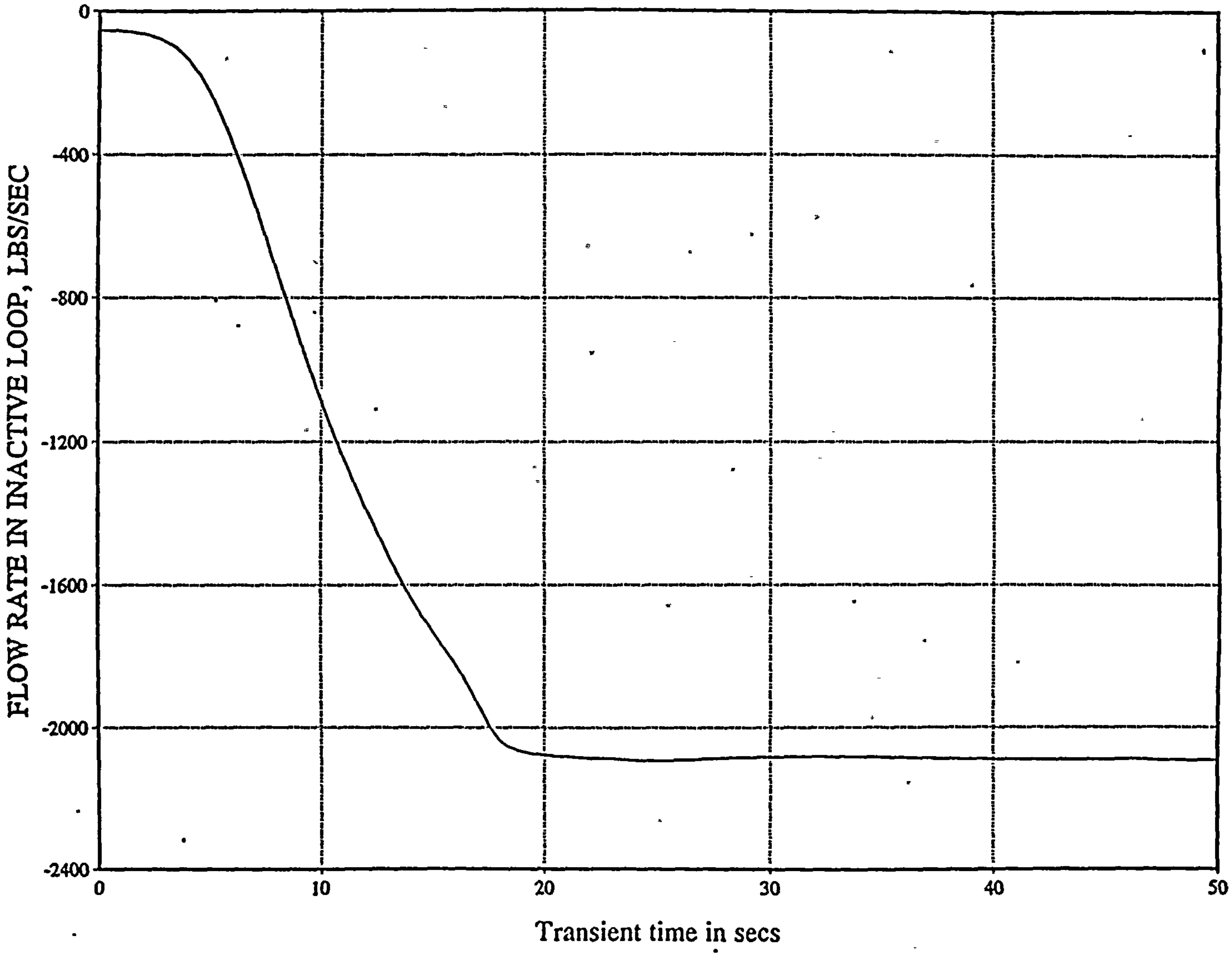
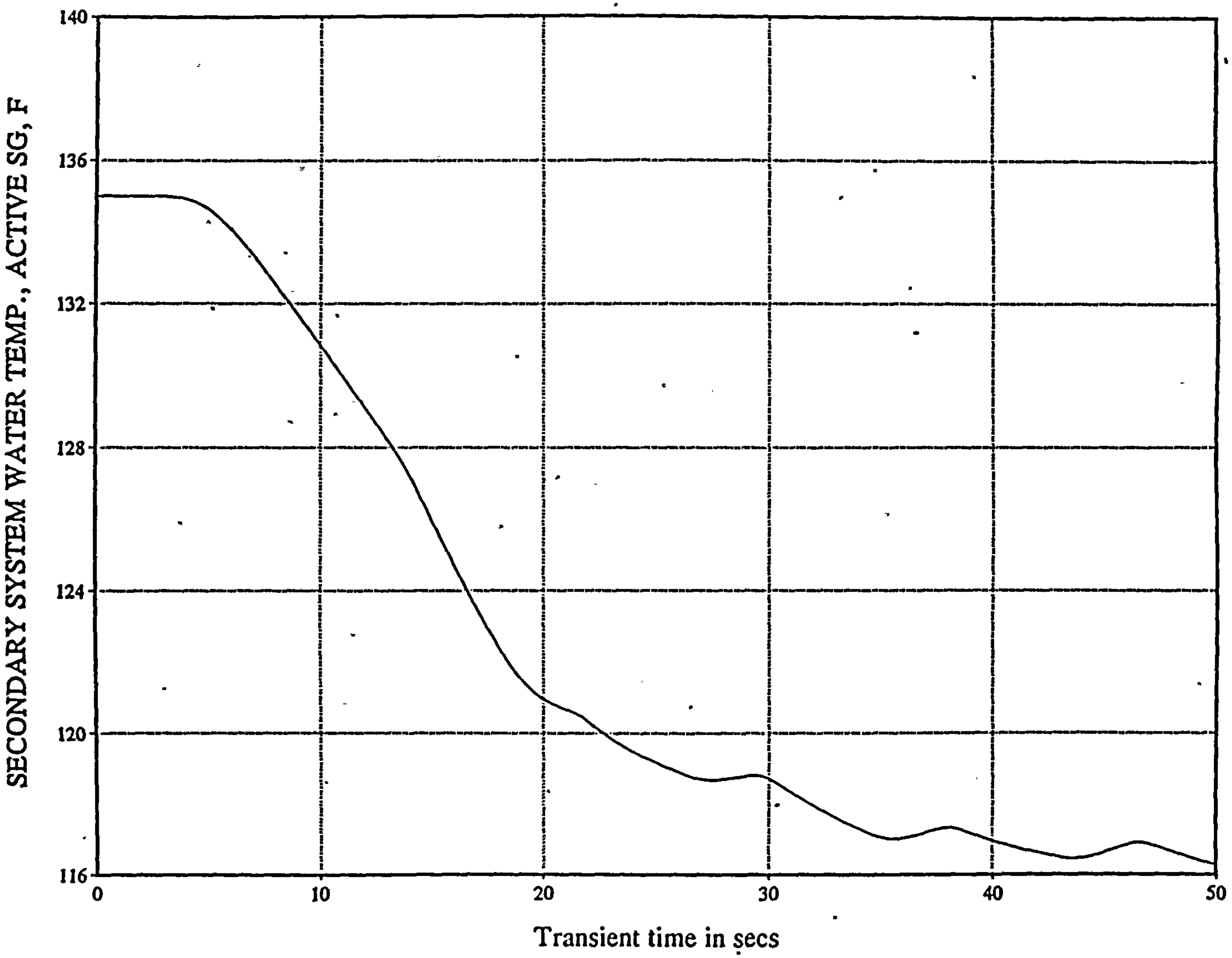


FIGURE 27

CASE 6 HEAT ADDITION CASE PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR



FIGU[illegible]8

CASE 6 HEAT ADDITION CASE PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

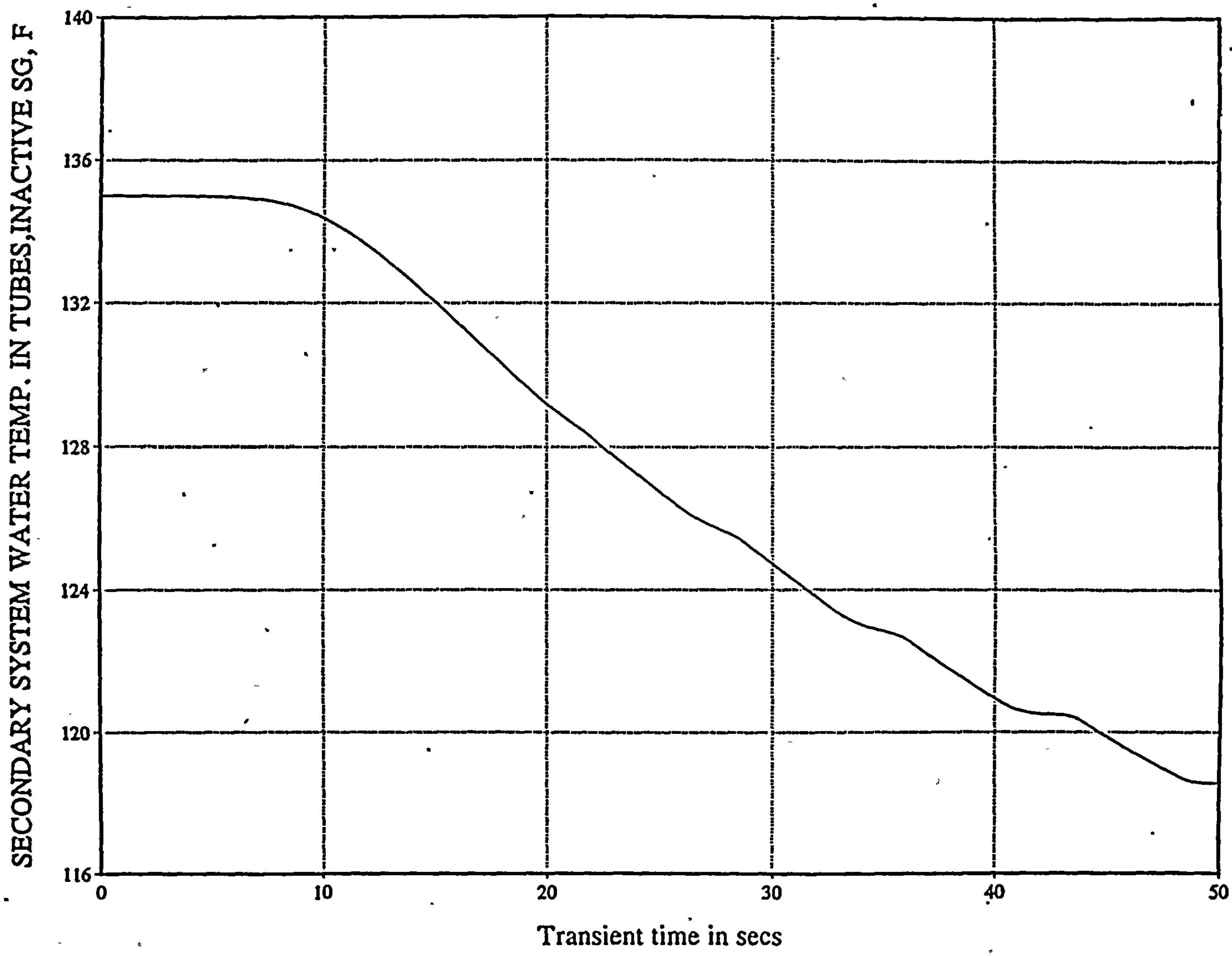


FIGURE 29

CASE 6 HEAT ADDITION CASE PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

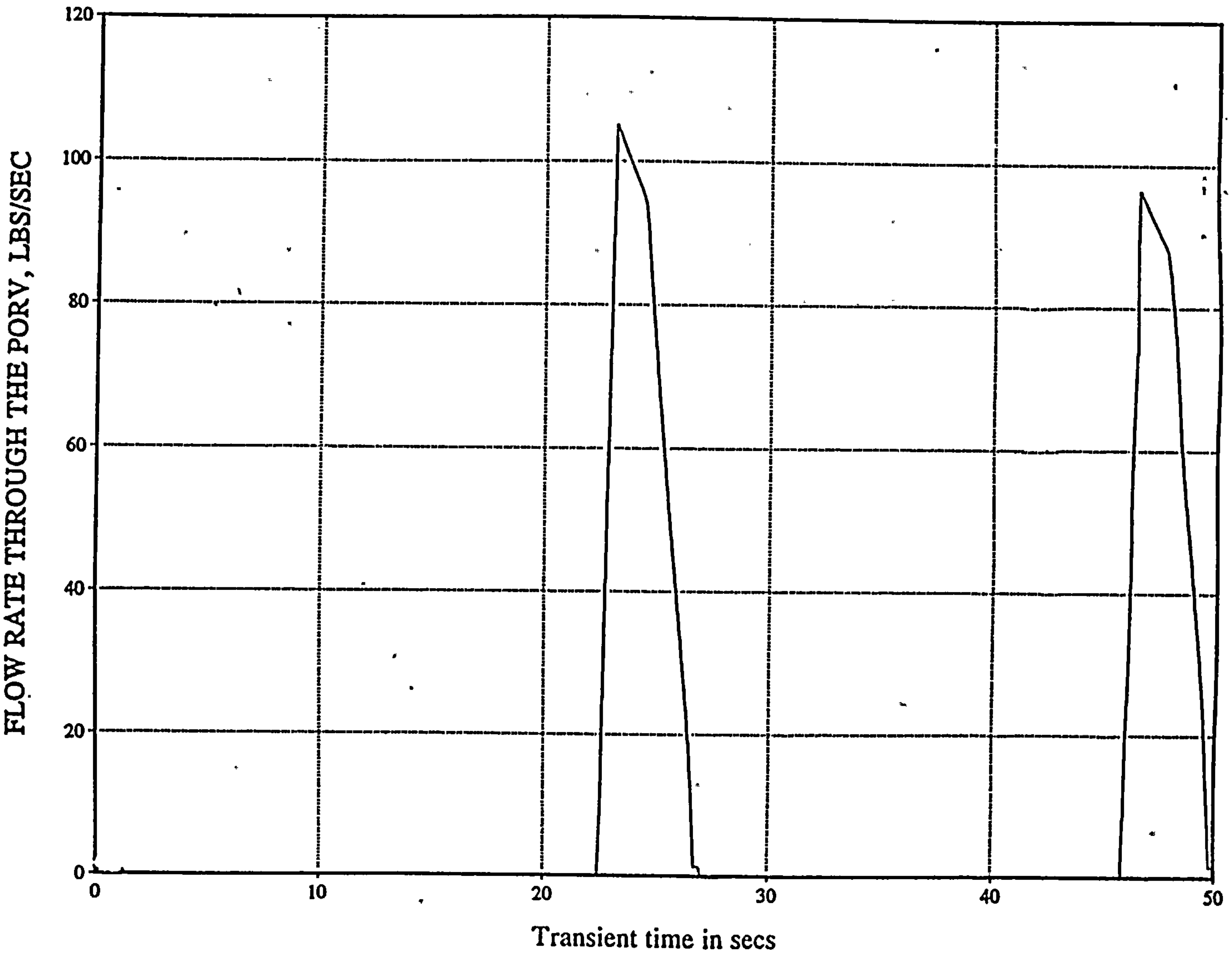
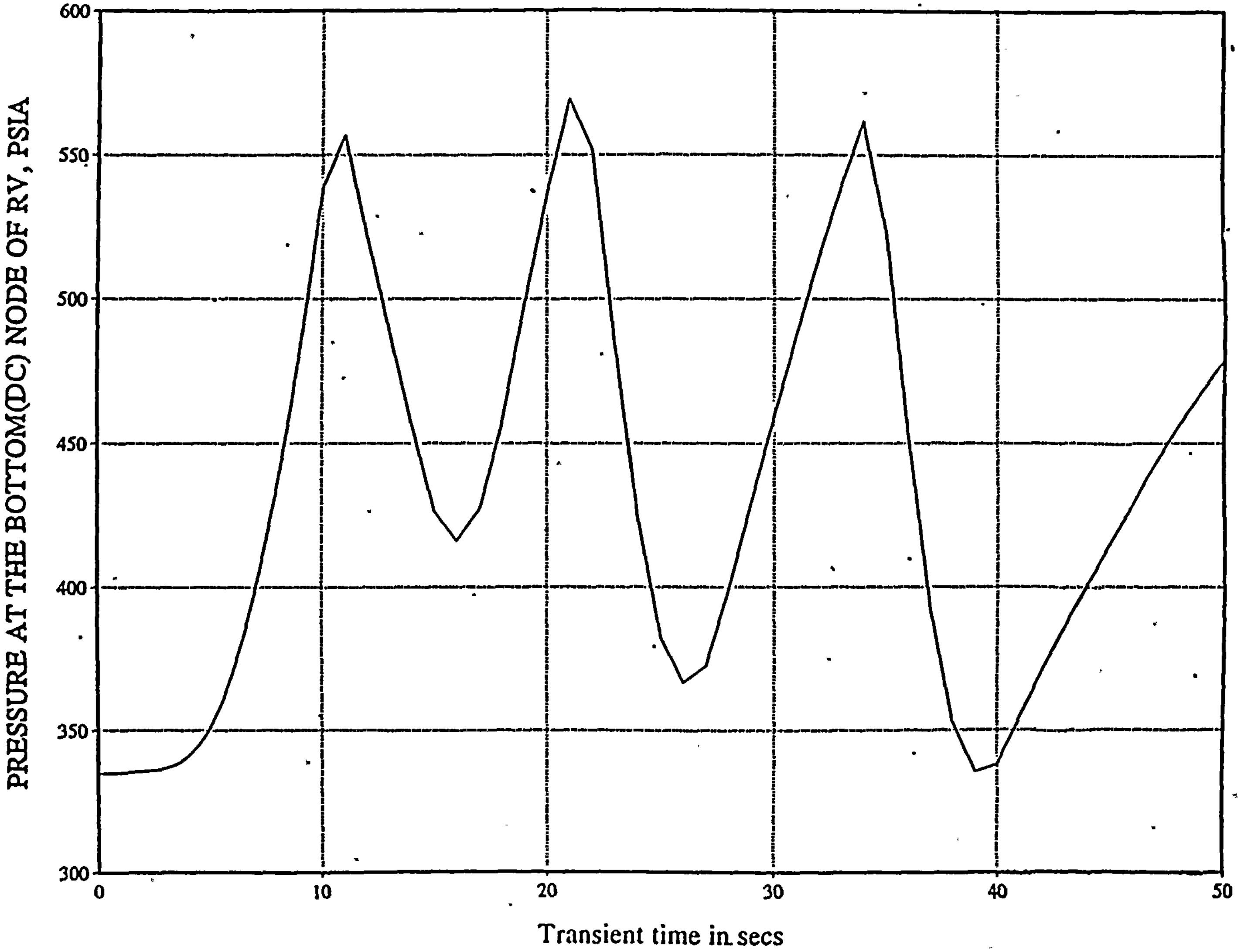


FIGURE 30

CASE 7 HEAT ADDITION CASE PRIMARY TEMPERATURE 280°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR



FTI Non-Proprietary

86-1234820-01

FIGURE 31

CASE 7 HEAT ADDITION CASE

PRIMARY TEMPERATURE 280°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

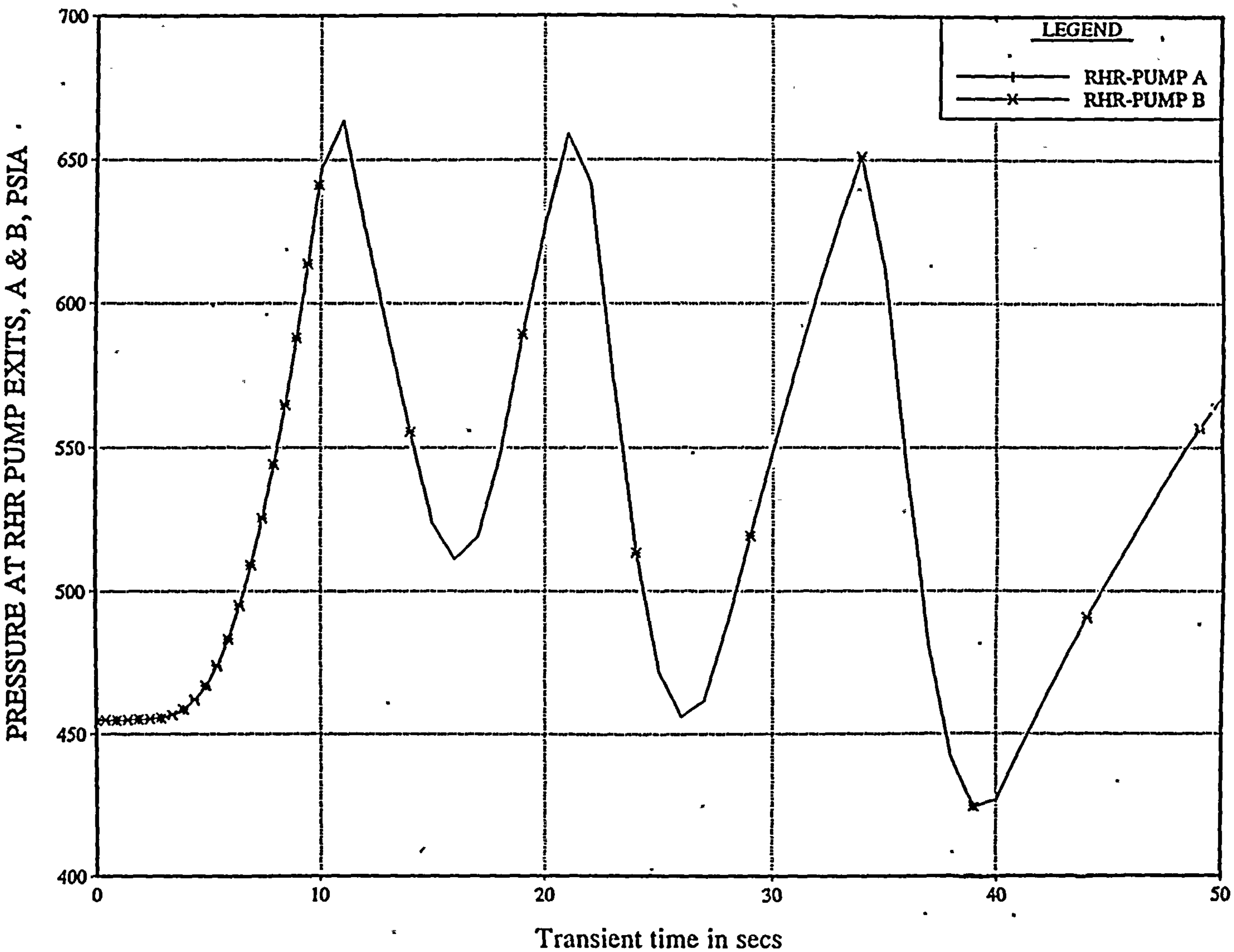


FIGURE 32

CASE 7 HEAT ADDITION CASE PRIMARY TEMPERATURE 280°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

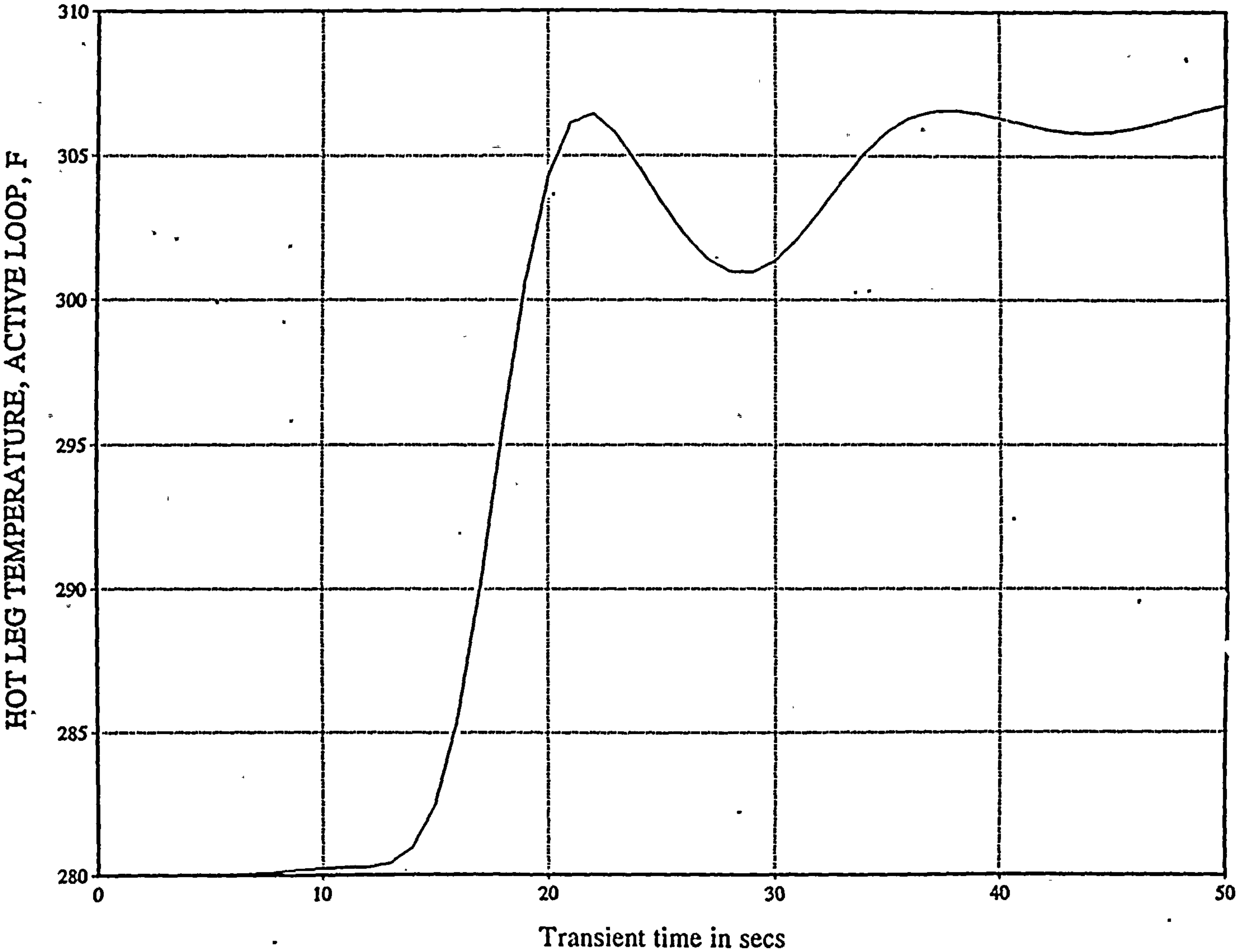


FIGURE 33

CASE 7 HEAT ADDITION CASE

PRIMARY TEMPERATURE 280°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

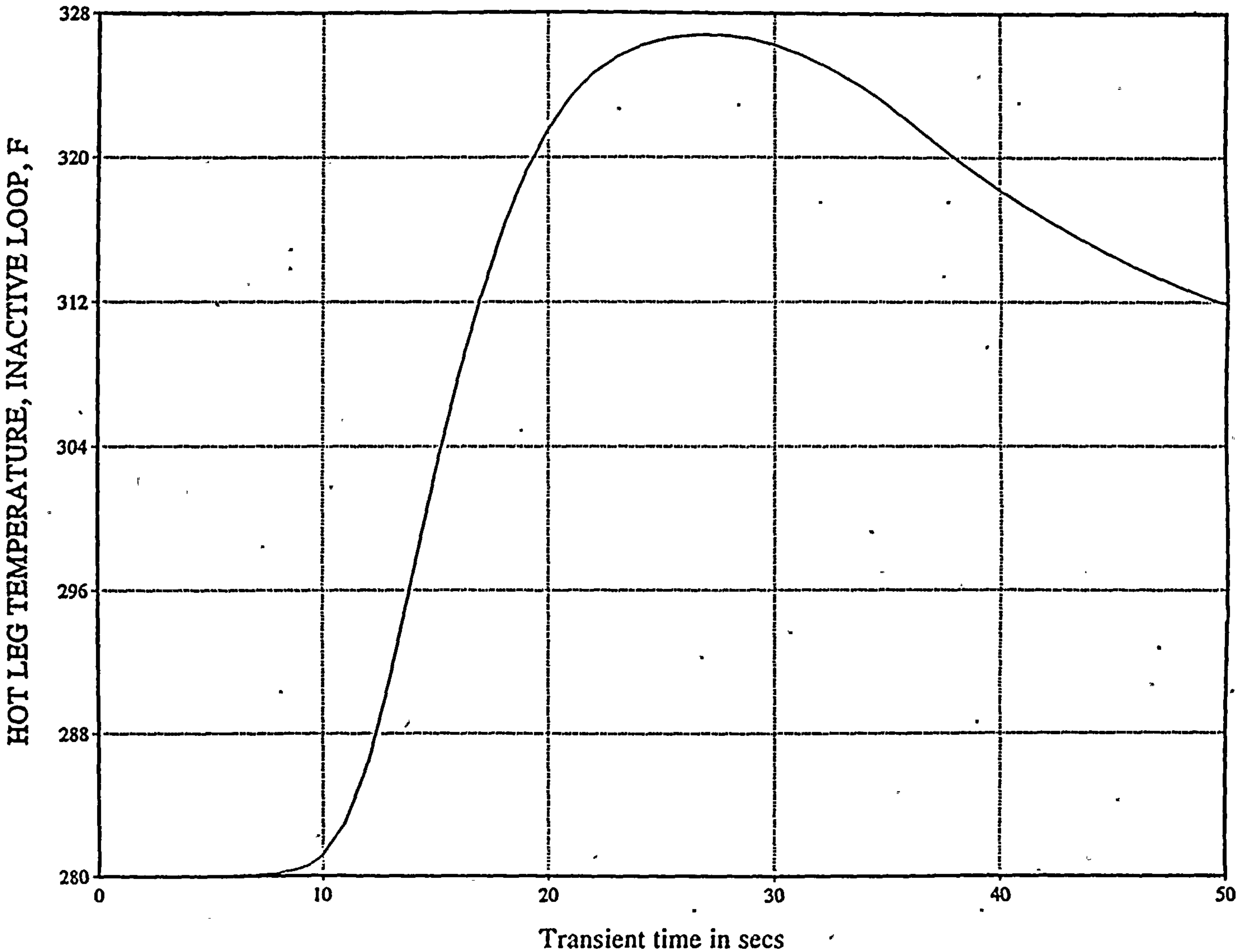


FIGURE 34

CASE 7 HEAT ADDITION CASE

PRIMARY TEMPERATURE 280°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

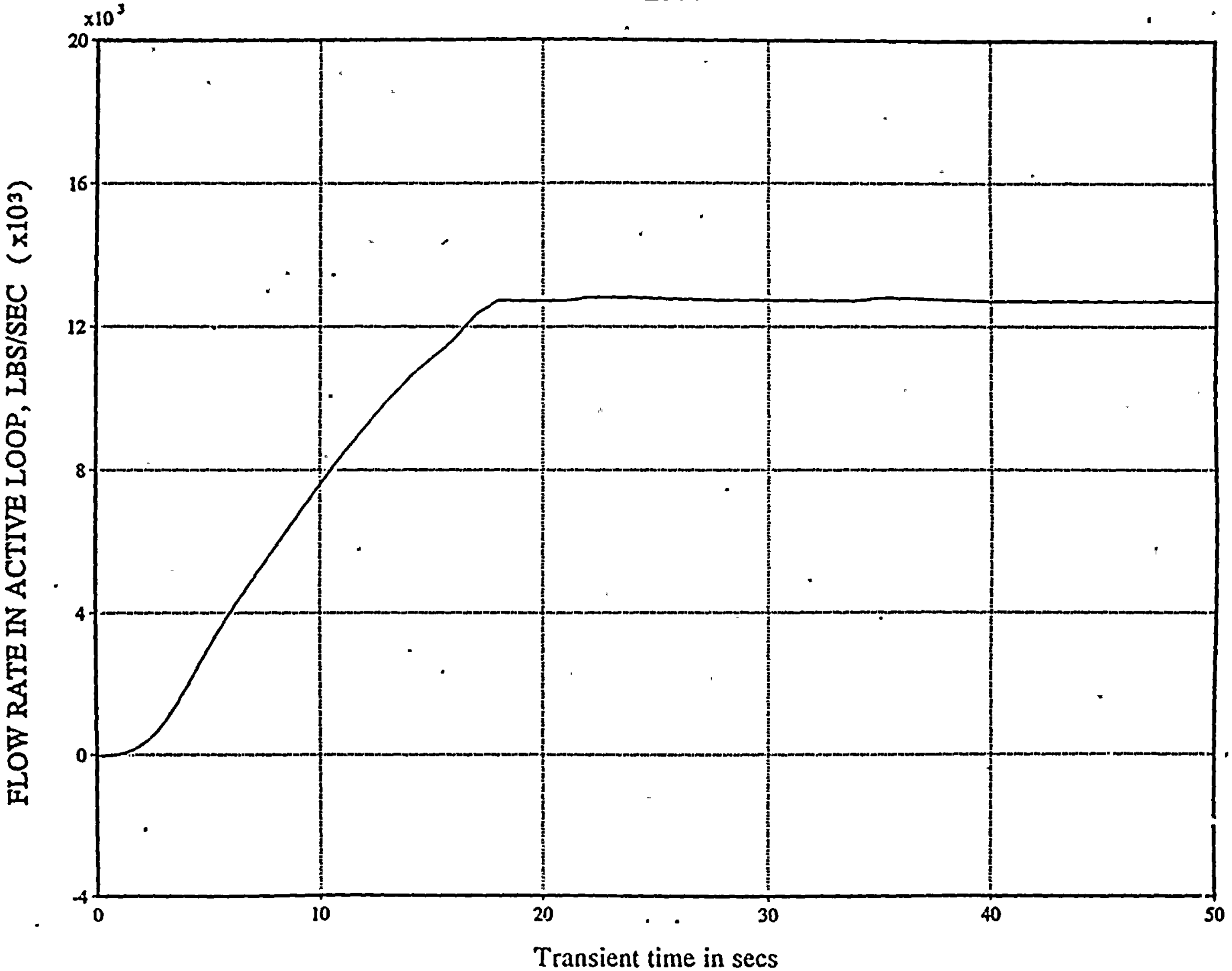


FIGURE 35

CASE 7 HEAT ADDITION CASE PRIMARY TEMPERATURE 280°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

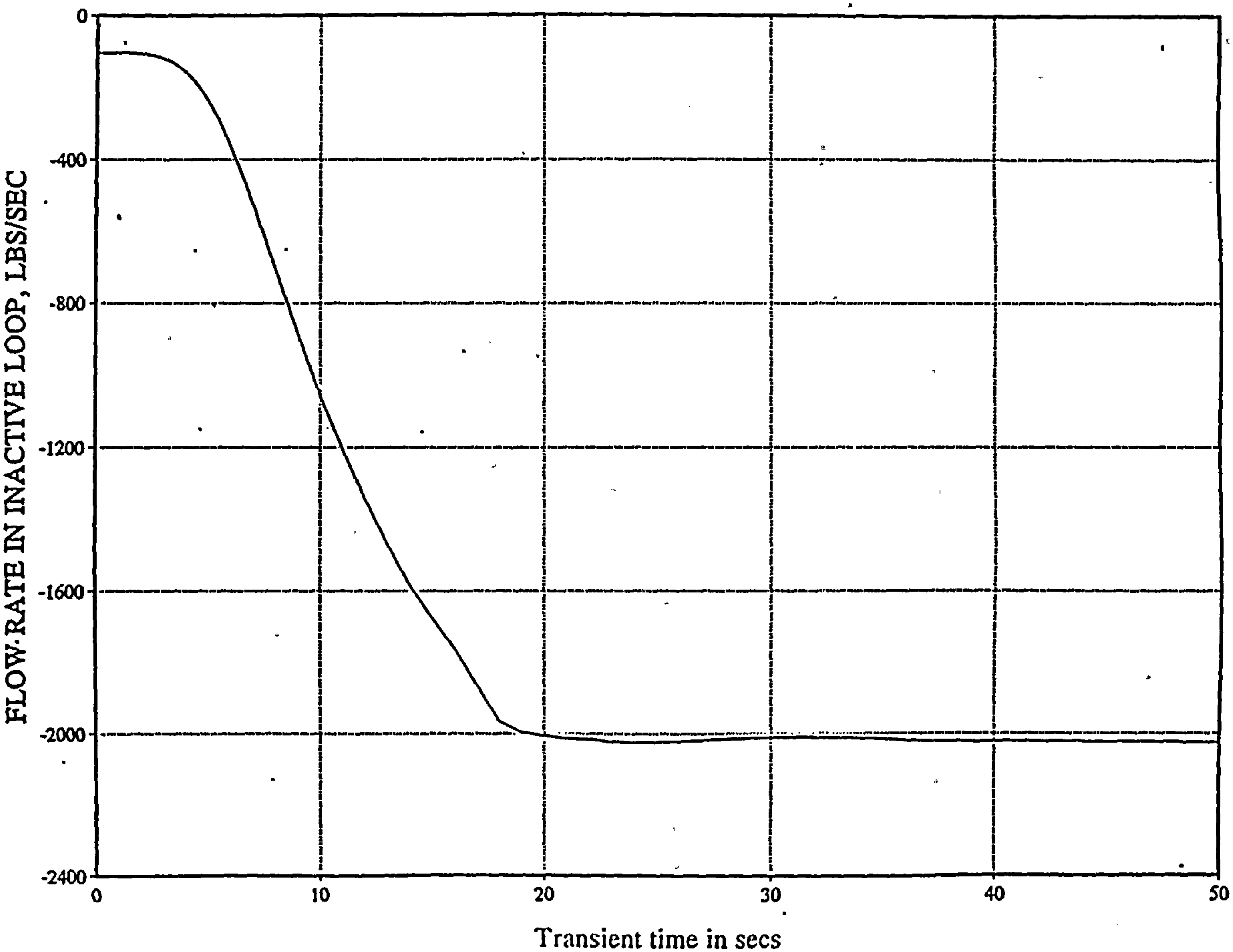


FIGURE 36

CASE 7 HEAT ADDITION CASE PRIMARY TEMPERATURE 280°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

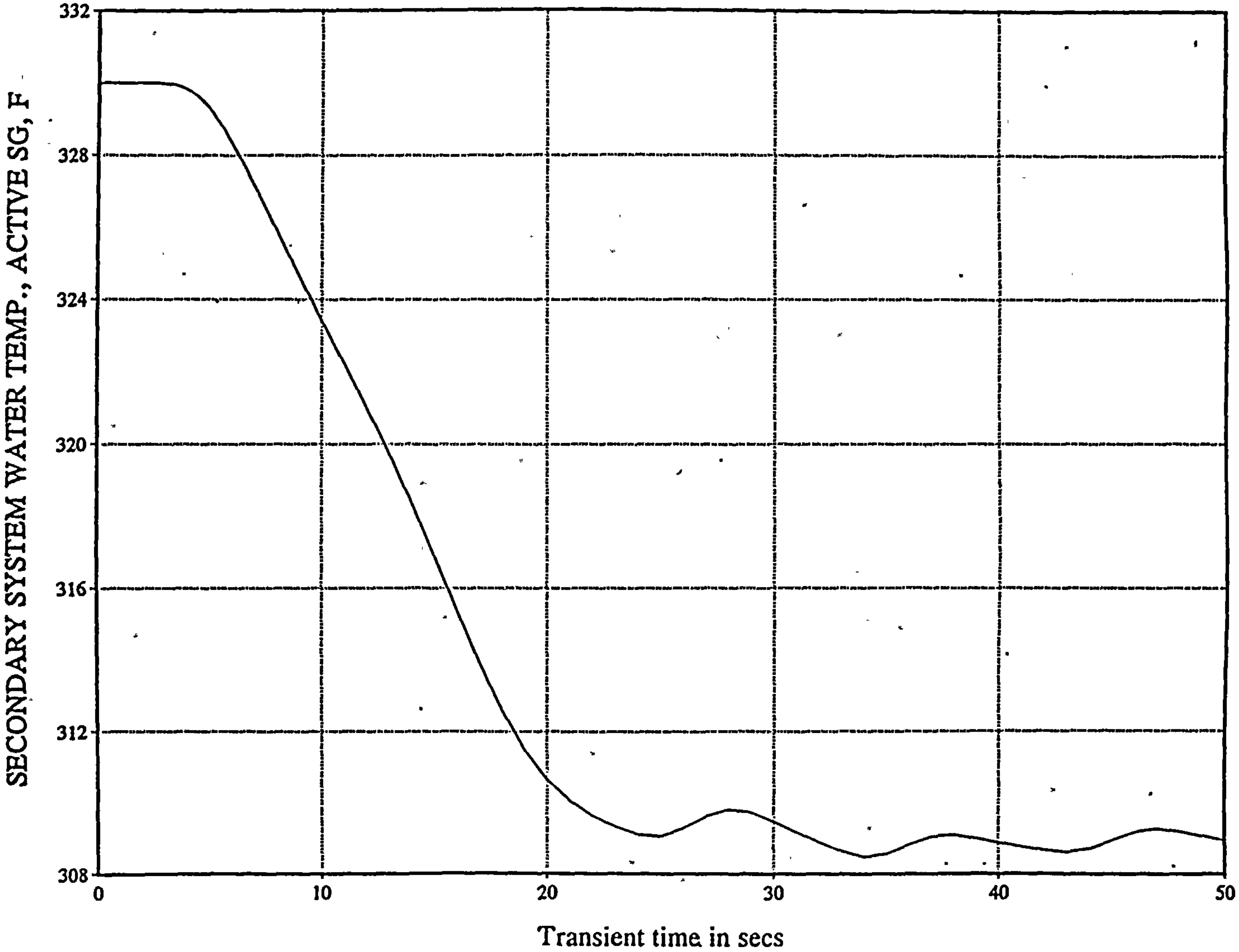
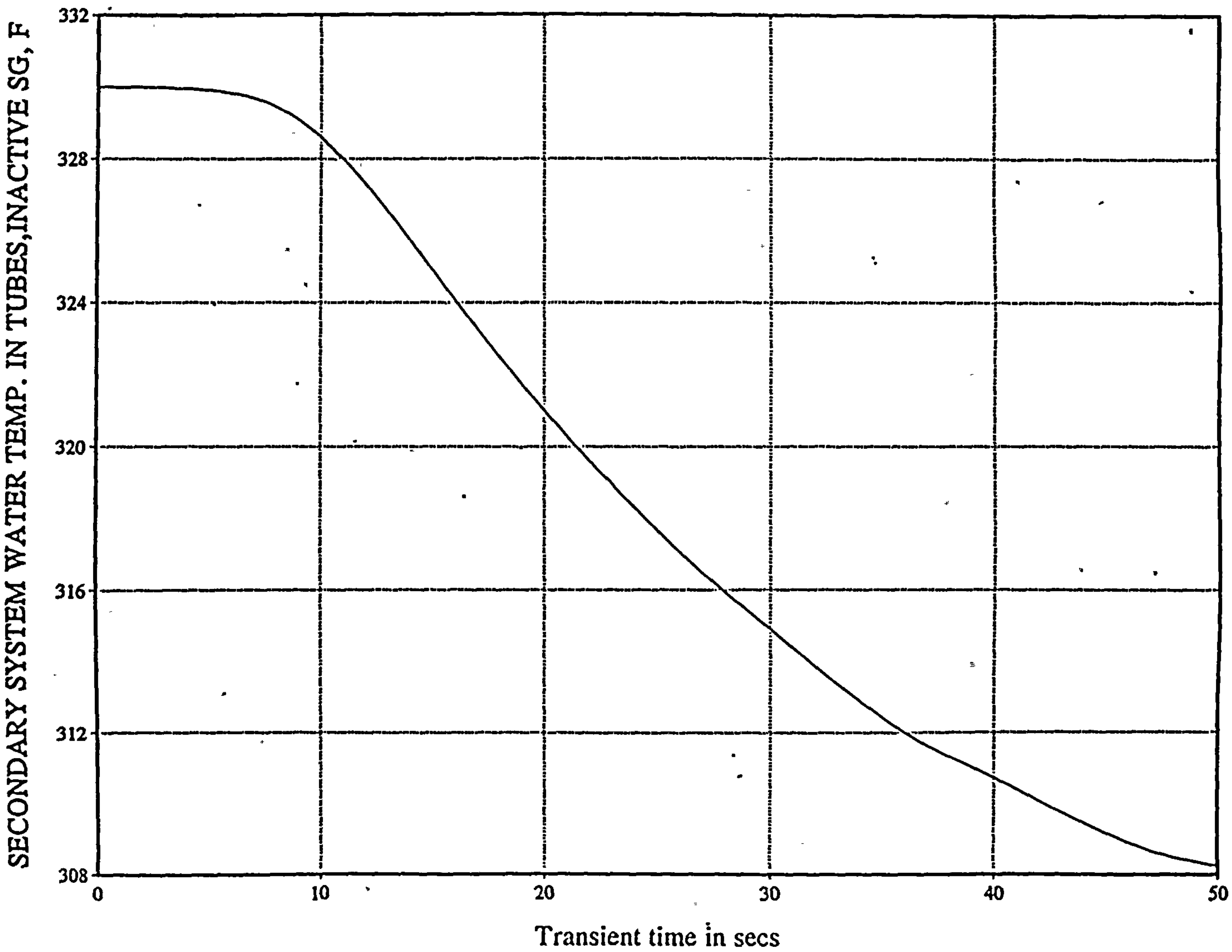


FIGURE 37

CASE 7 HEAT ADDITION CASE PRIMARY TEMPERATURE 280°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR

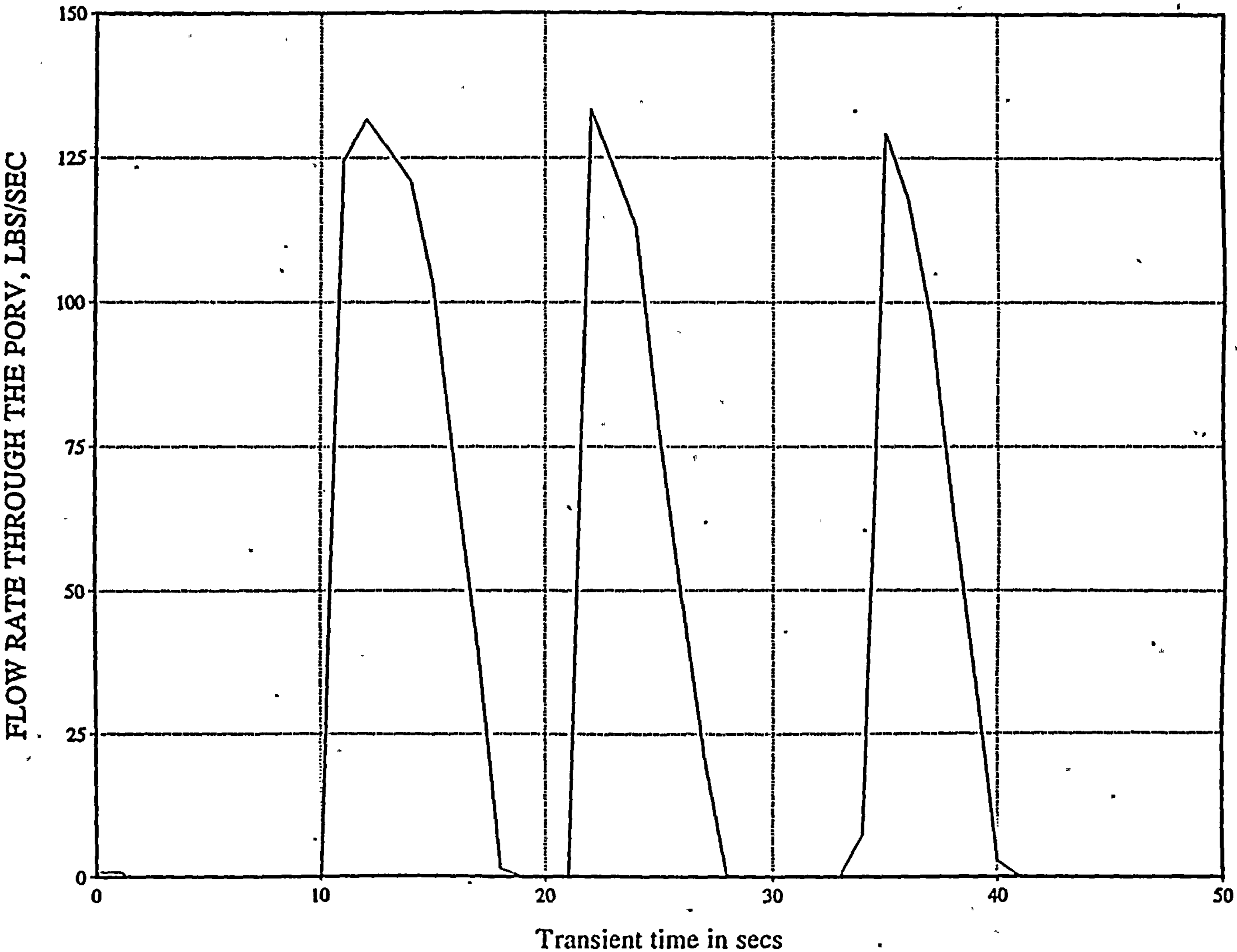


FTI Non-Proprietary

86-1234820-01

FIGURE 38

CASE 7 HEAT ADDITION CASE PRIMARY TEMPERATURE 280°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
2000 GPM RHR



FTI Non-Proprietary

86-123820-01

FIGURE 39

CASE 8 HEAT ADDITION CASE

PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR

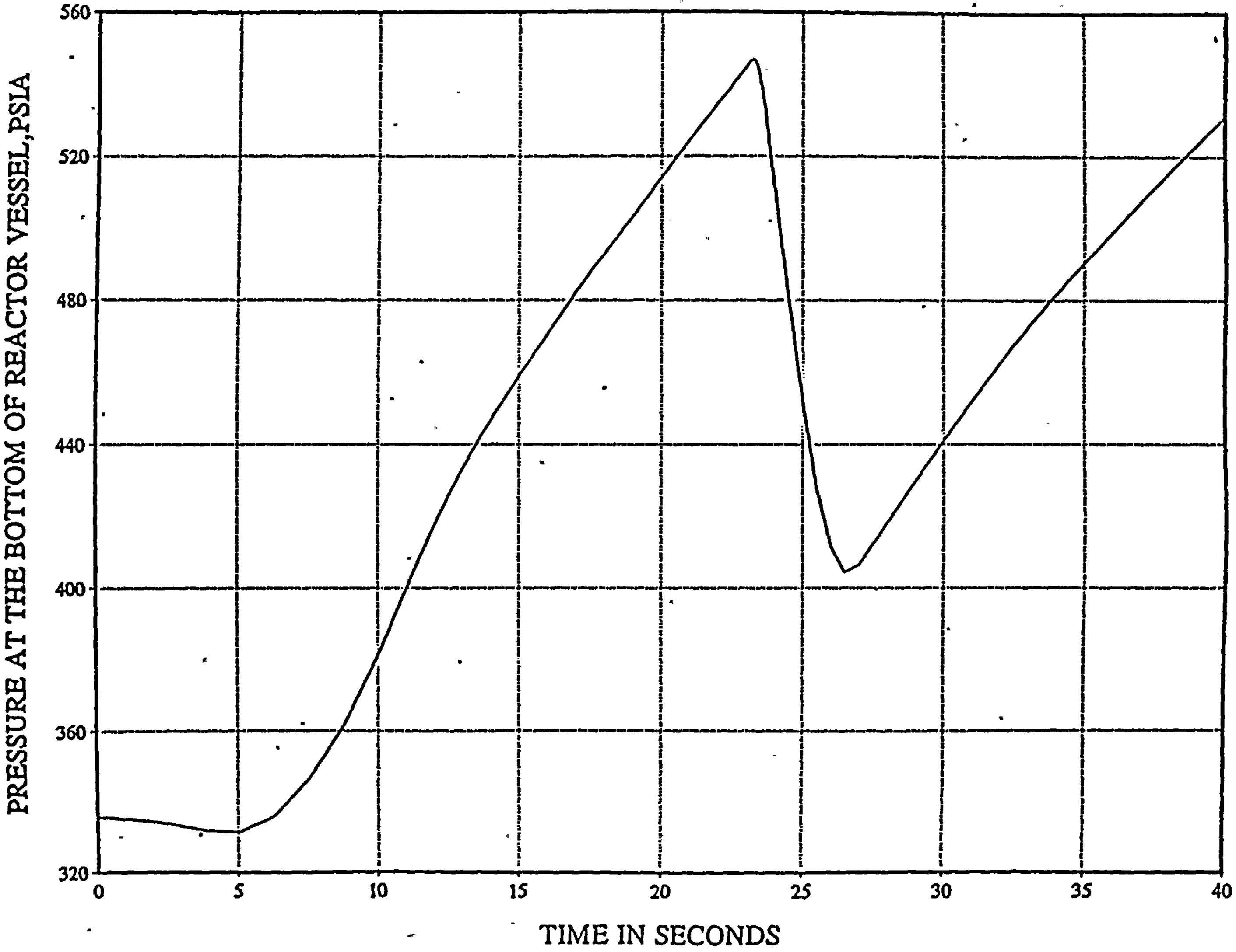
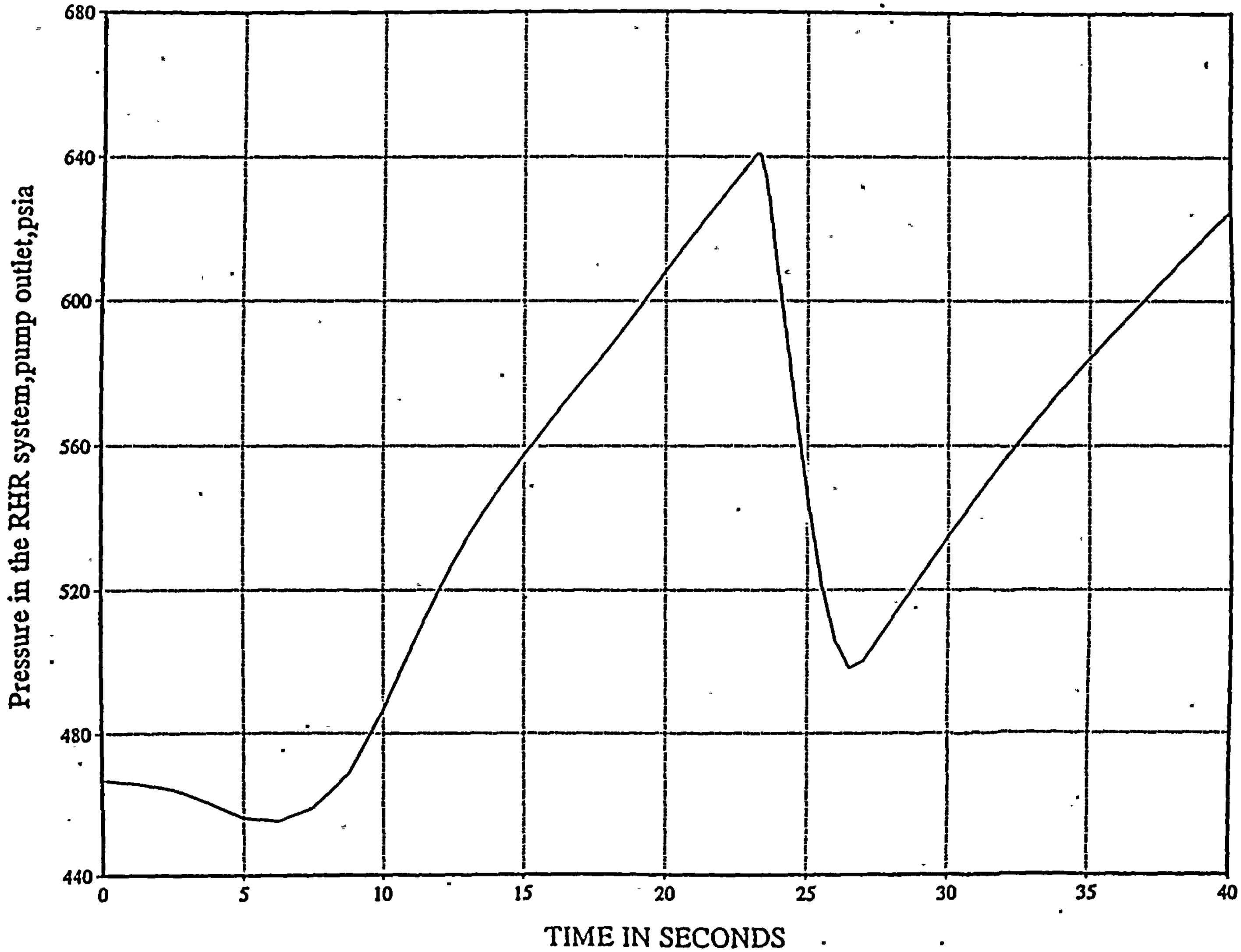


FIGURE 40

CASE 8 HEAT ADDITION CASE PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR



FTI Non-Proprietary

86-1234820-01

FIGURE 41

CASE 8 HEAT ADDITION CASE PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR

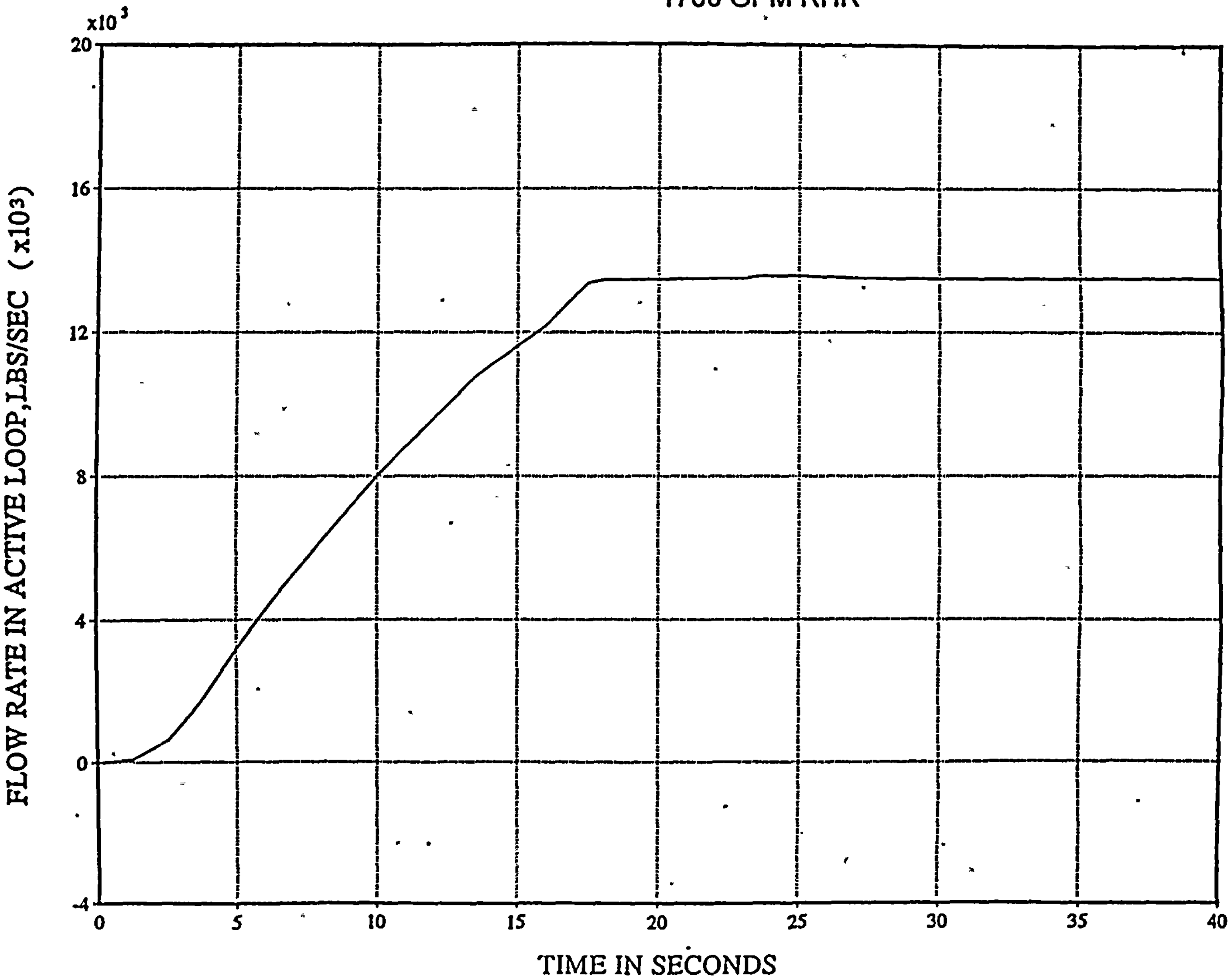
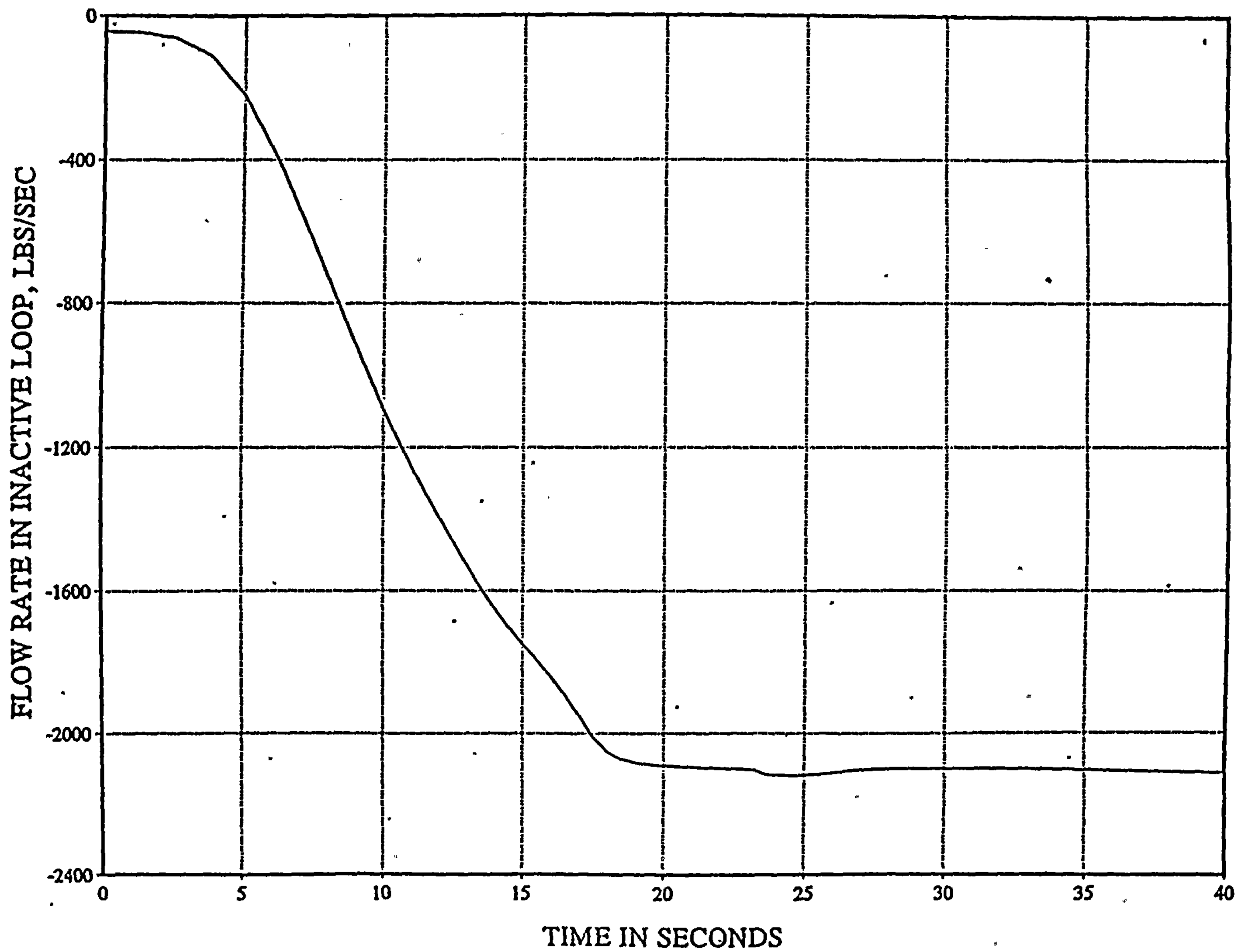


FIGURE 42

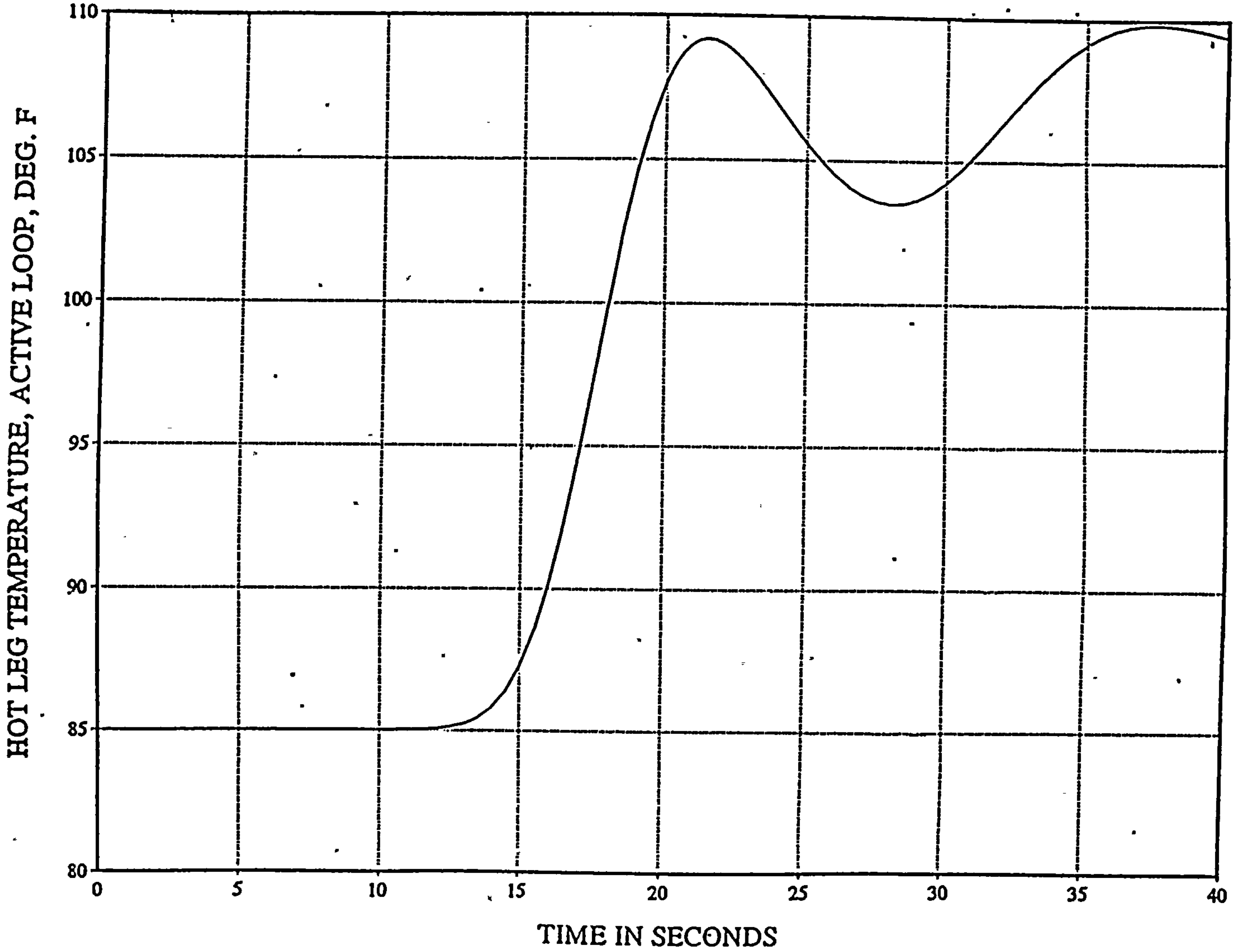
CASE 8 HEAT ADDITION CASE

PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR



86-1234820-01

FIGURE 43
CASE 8 HEAT ADDITION CASE PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR



FTI Non-Proprietary

86-1234820-01

FIGURE 44

CASE 8 HEAT ADDITION CASE

PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR

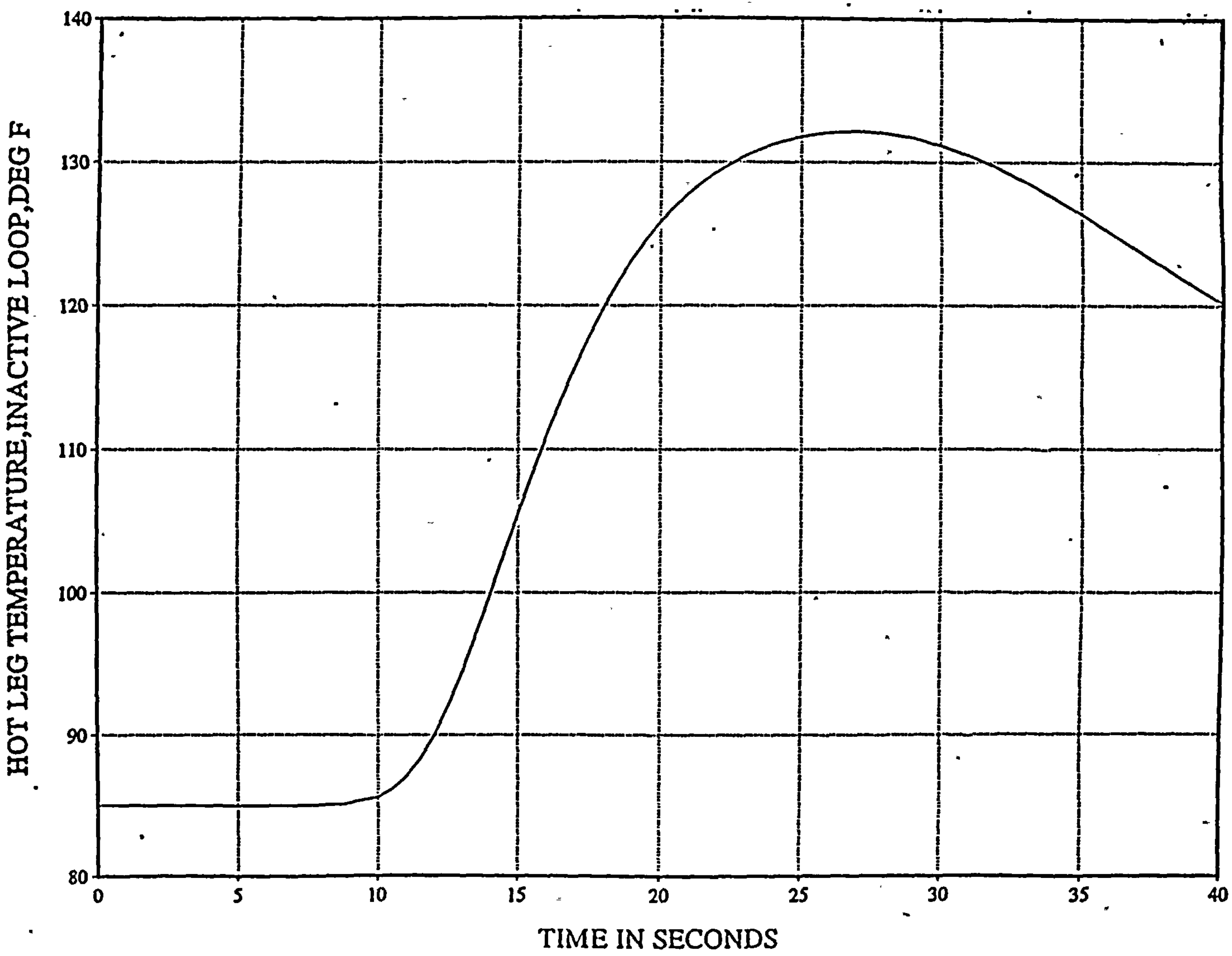
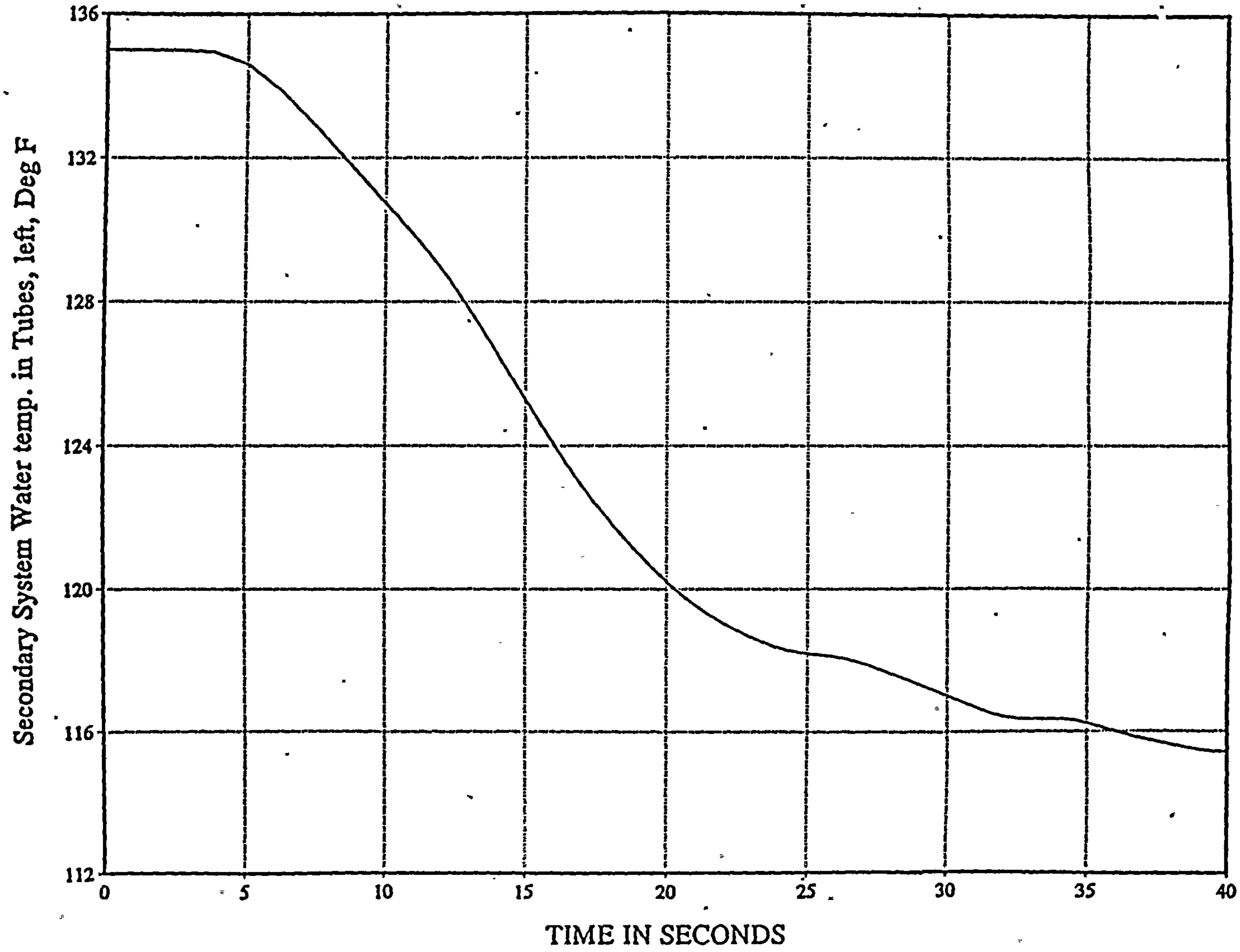


FIGURE 45

CASE 8 HEAT ADDITION CASE PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR

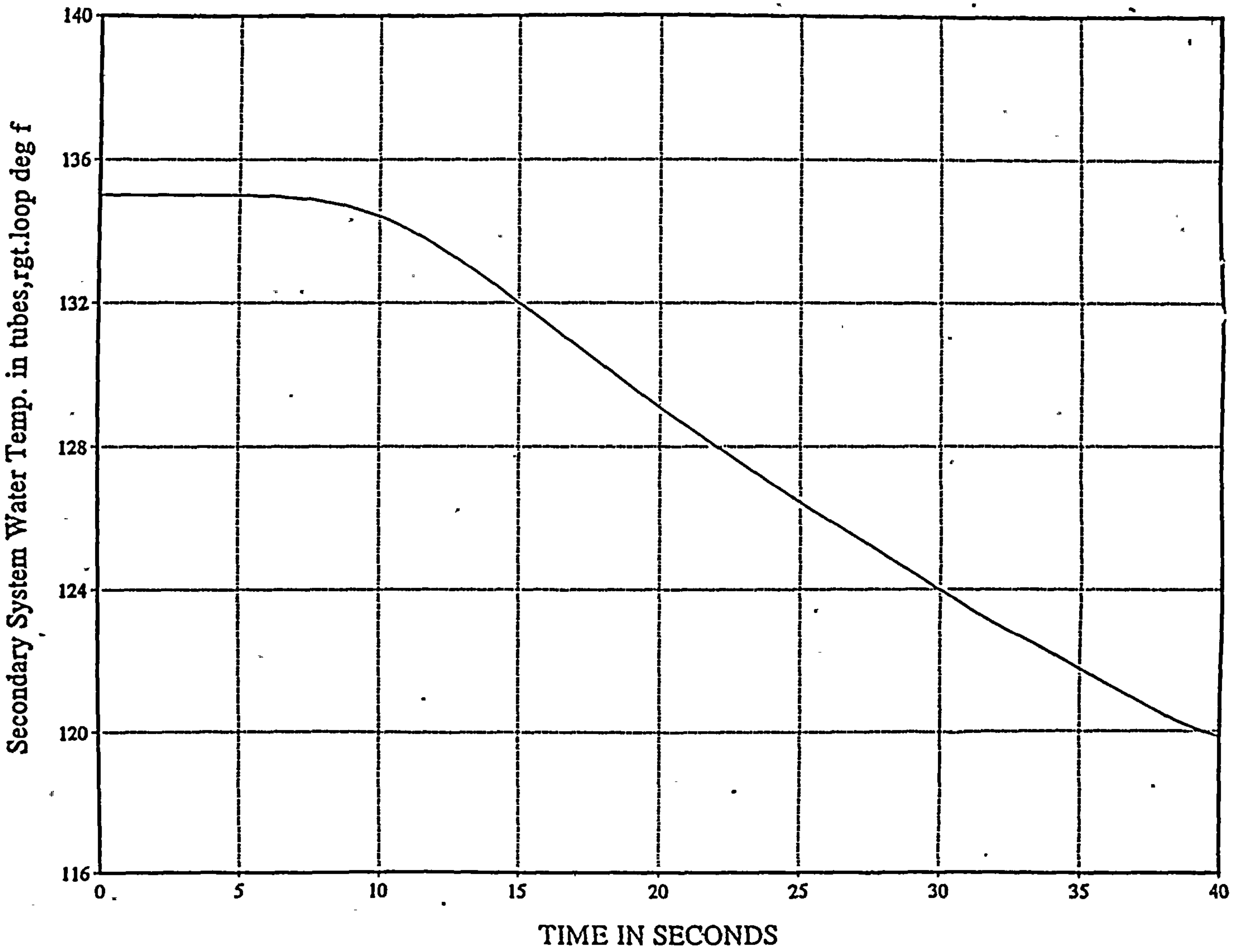


86-1234820-01

FIGURE 46

CASE 8 HEAT ADDITION CASE

PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR

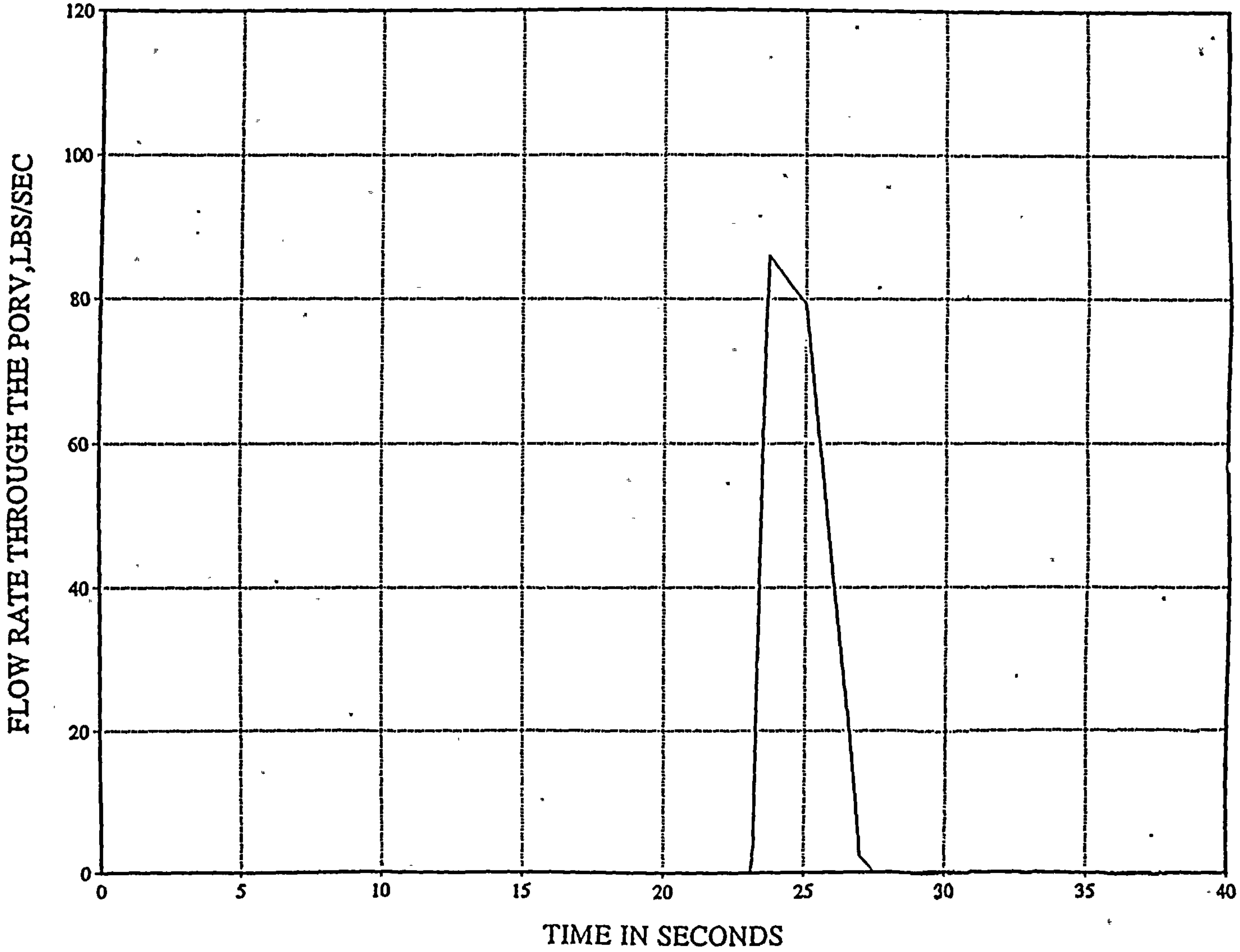


FTI Non-Proprietary

86-1234820-01

FIGURE 47

CASE 8 HEAT ADDITION CASE PRIMARY TEMPERATURE 85°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR

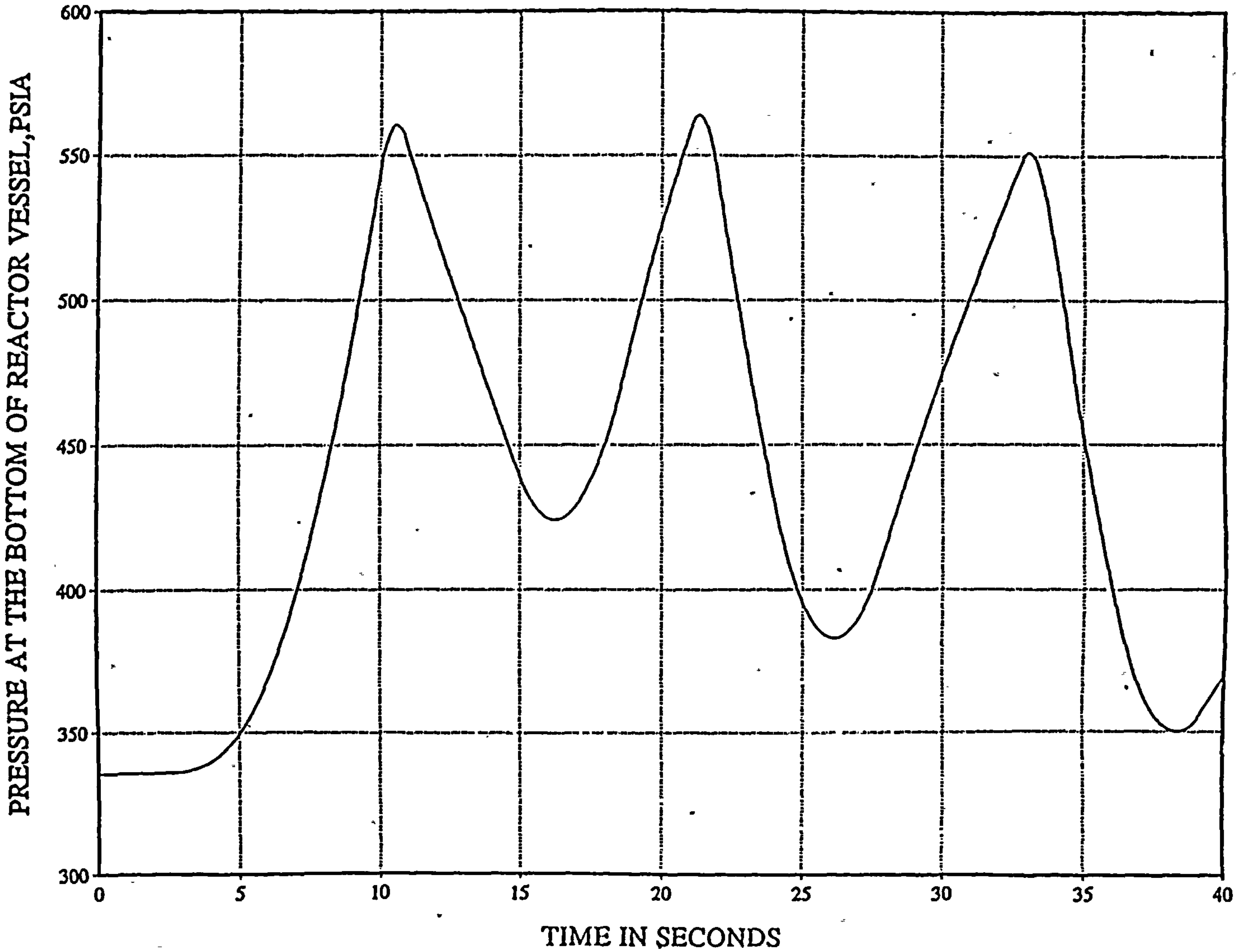


FTI Non-Proprietary

86-1234820-01

FIGURE 48

CASE 9 HEAT ADDITION CASE PRIMARY TEMPERATURE 320°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR



FTI Non-Proprietary

86-1234820-01

FIGURE 49

CASE 9 HEAT ADDITION CASE PRIMARY TEMPERATURE 320°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR

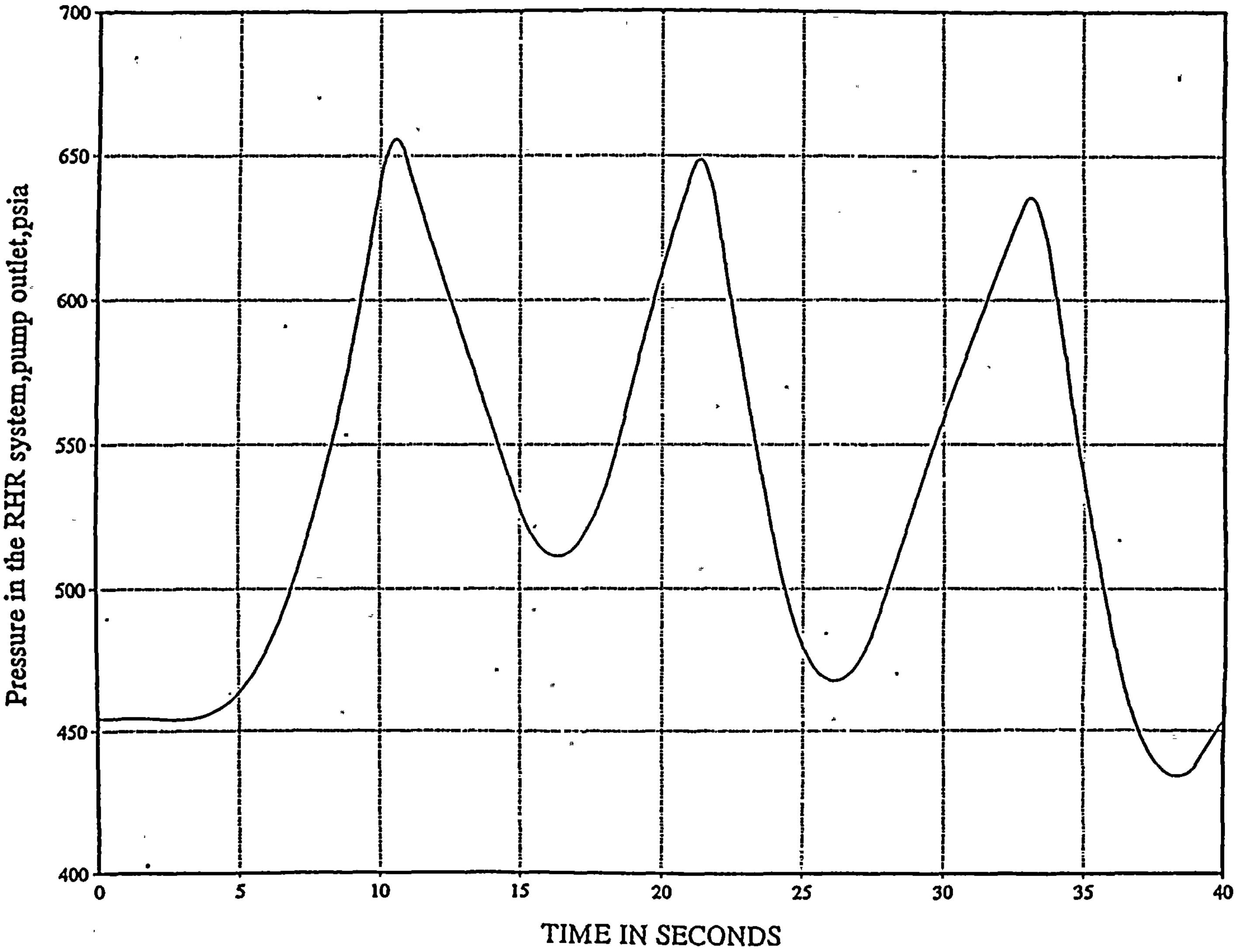
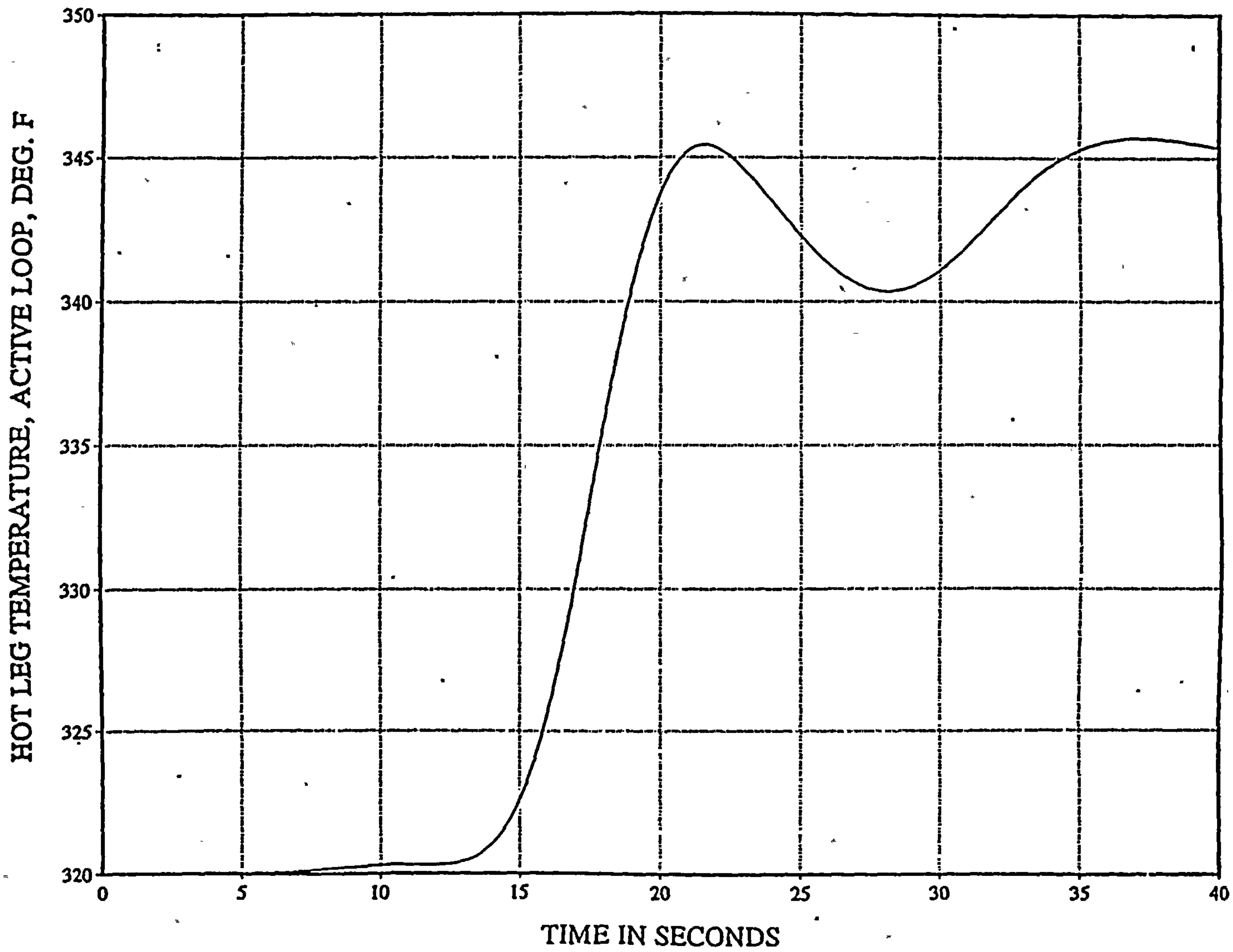


FIGURE 50

CASE 9 HEAT ADDITION CASE PRIMARY TEMPERATURE 320°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR



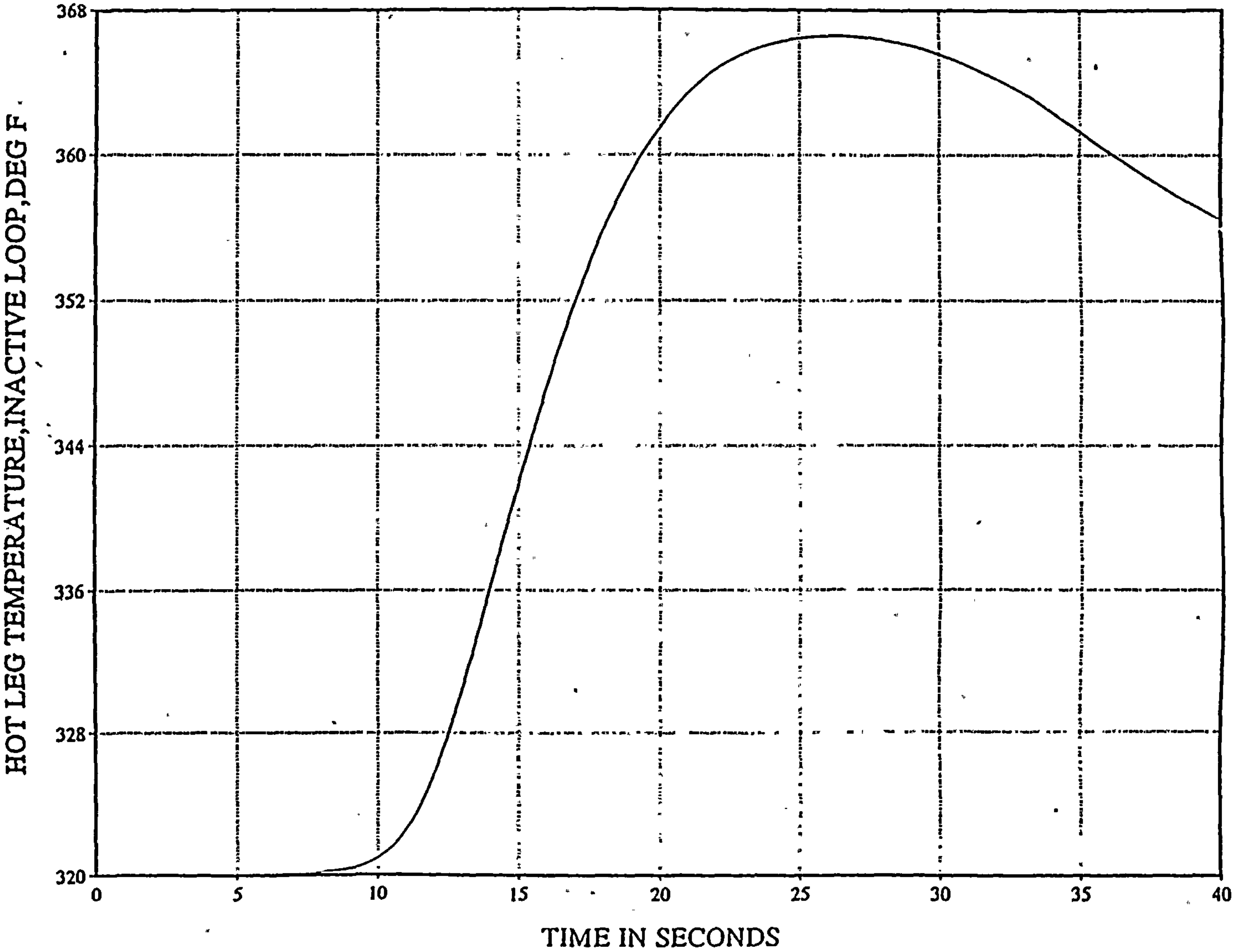
FTI Non-Proprietary

86-1234820-01

FIGURE 51

CASE 9 HEAT ADDITION CASE

PRIMARY TEMPERATURE 320°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR

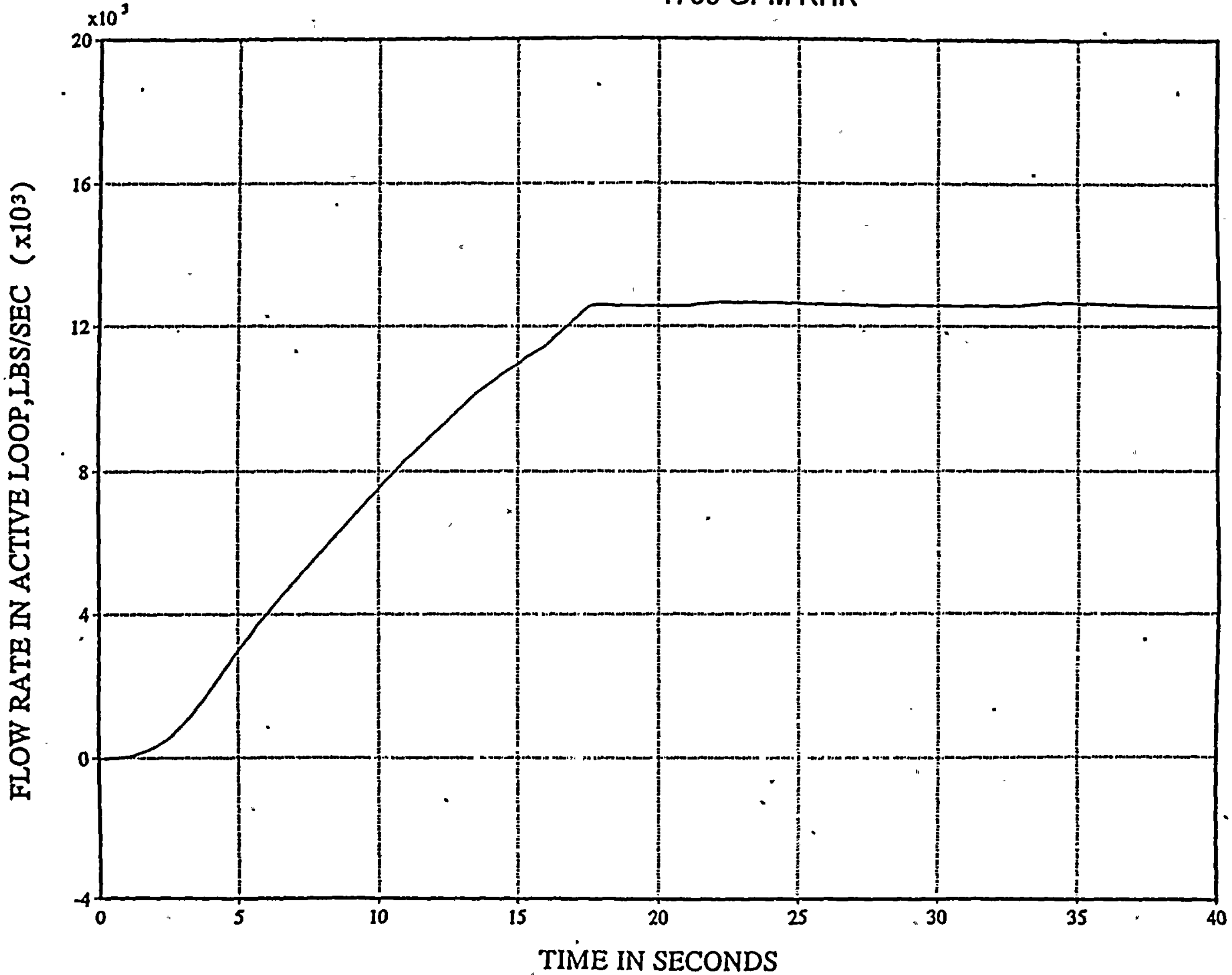


FTI Non-Proprietary

86-1234820-01

FIGURE 52

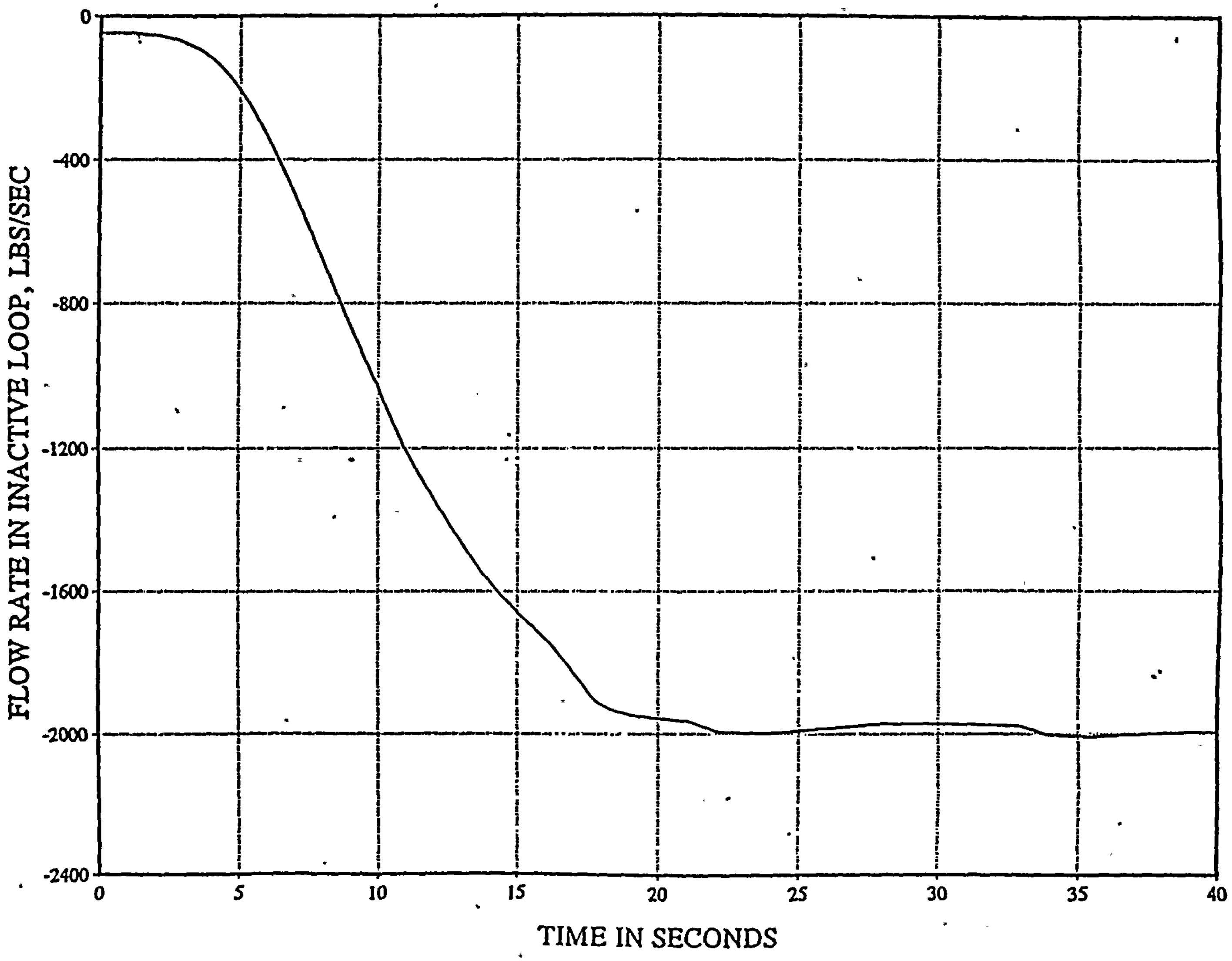
CASE 9 HEAT ADDITION CASE PRIMARY TEMPERATURE 320°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR



FTI Non-Proprietary

86-1234820-01

FIGURE 53
CASE 9 HEAT ADDITION CASE PRIMARY TEMPERATURE 320°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR

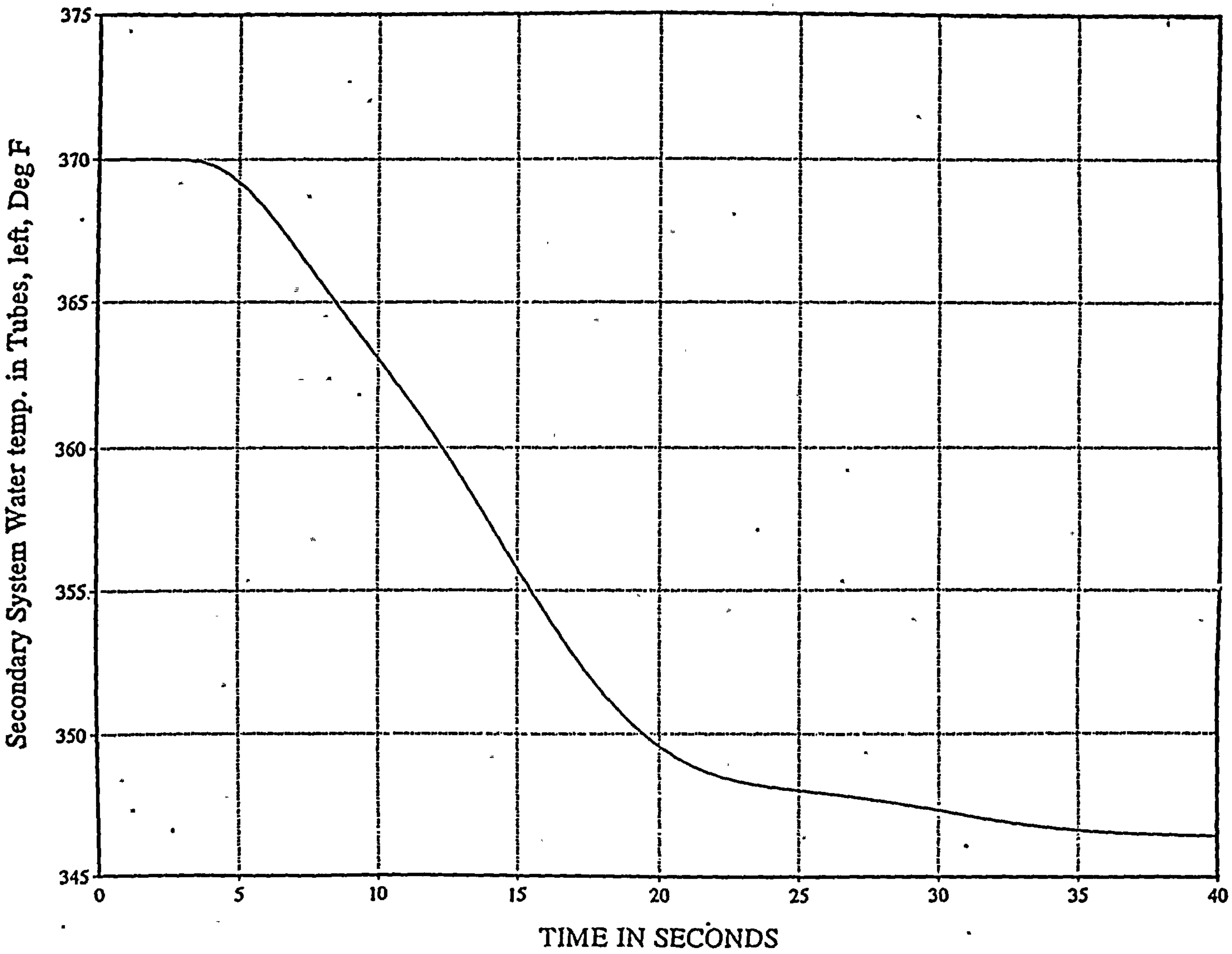


FTI Non-Proprietary

86-1234820-01

FIGURE 54

CASE 9 HEAT ADDITION CASE PRIMARY TEMPERATURE 320°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR

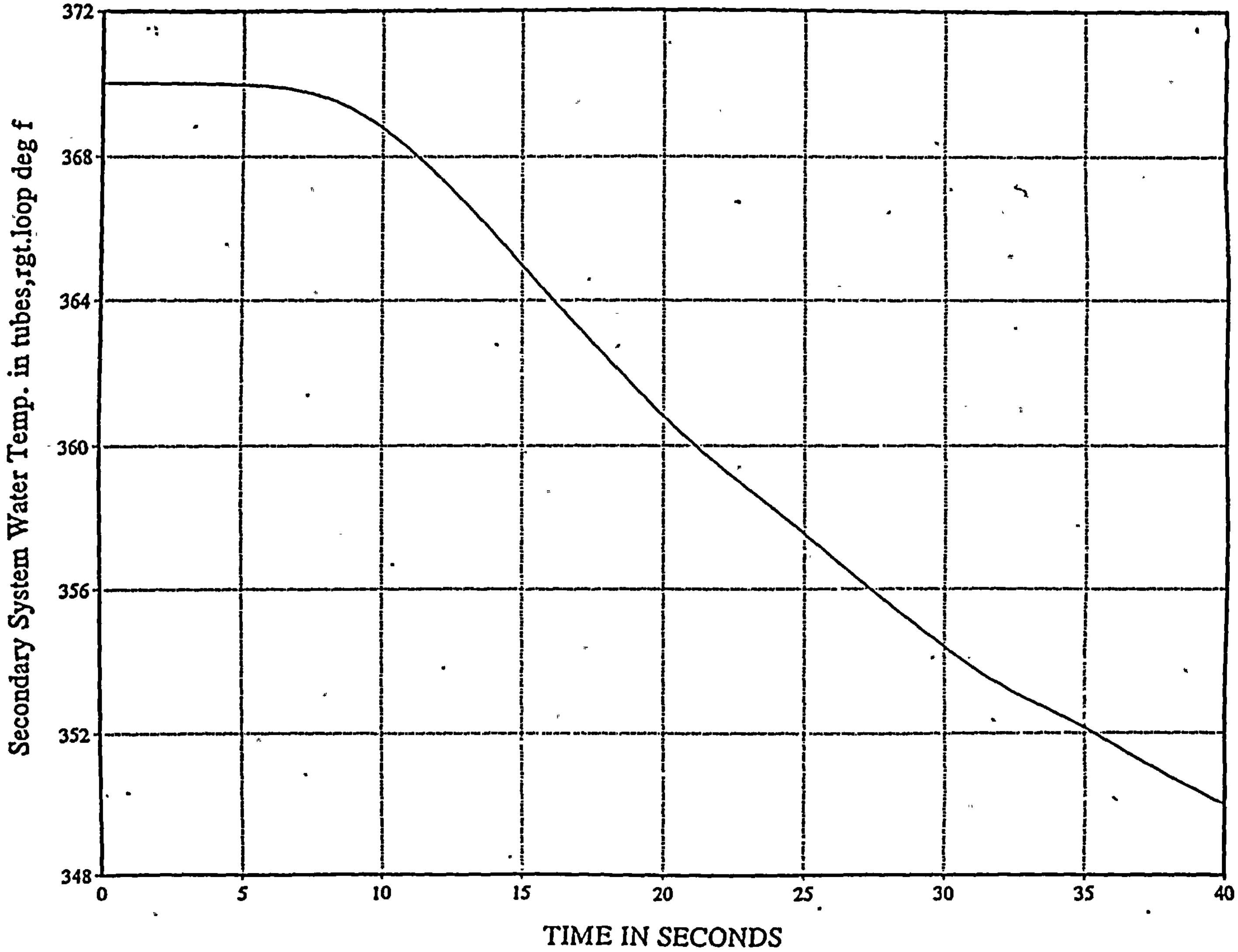


FTI Non-Proprietary

86-1234820-01

FIGURE 55

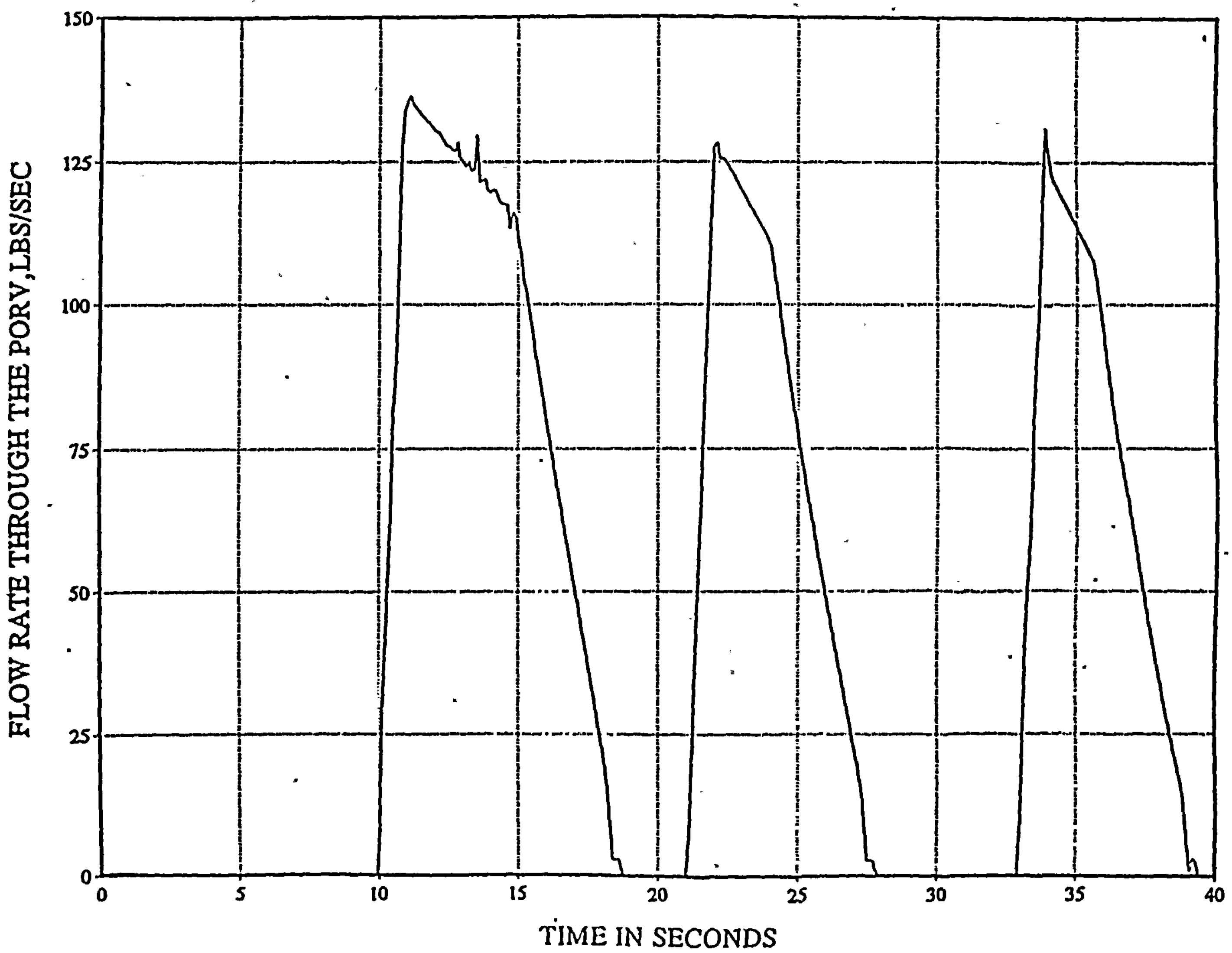
CASE 9 HEAT ADDITION CASE PRIMARY TEMPERATURE 320°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR



86-1234820-01

FIGURE 56

CASE 9 HEAT ADDITION CASE PRIMARY TEMPERATURE 320°F
PRIMARY PRESSURE 329.7 PSIA
NO VENT, NO SI, NO CHARGING PUMP
ONE RC PUMP STARTED
1700 GPM RHR



Page 86

FTI Non-Proprietary

86-1234820-01

FIGURE 57

CASE 2a MASS ADDITION CASE PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 329.7 PSIA

3CHARGING PUMPS TWO RC PUMP RUNNING

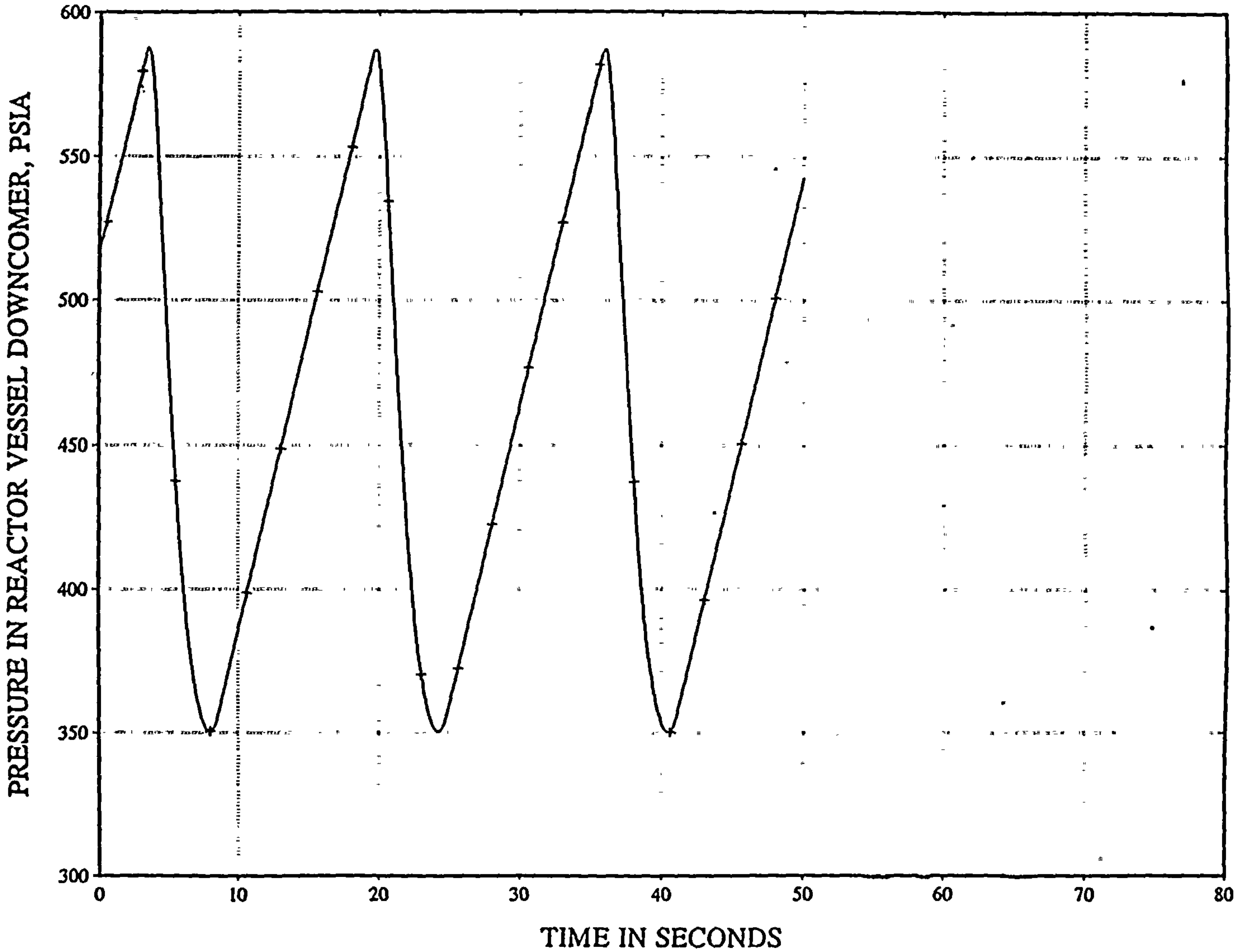
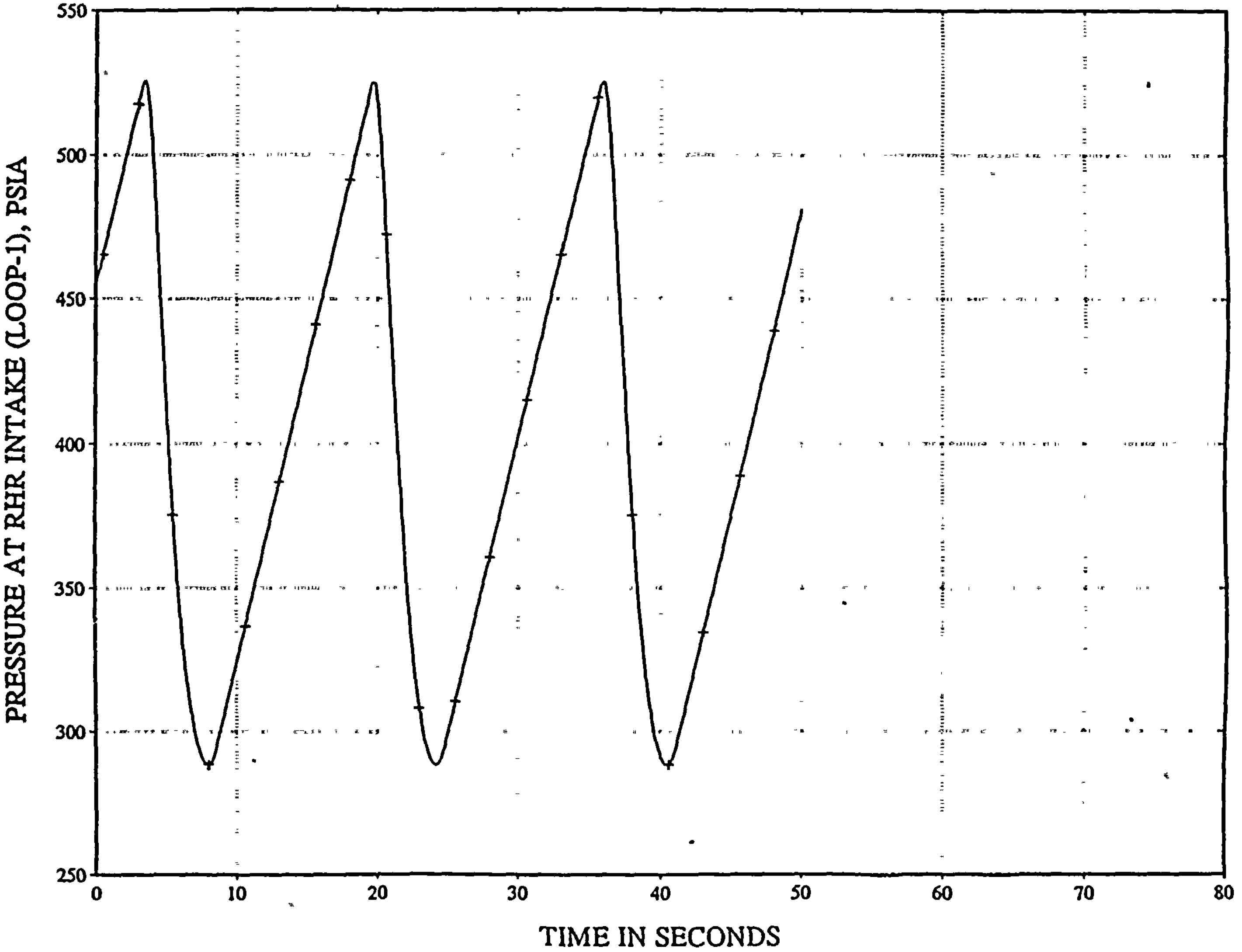


FIGURE 58

CASE 2a MASS ADDITION CASE PRIMARY TEMPERATURE 60°F
PRIMARY PRESSURE 329.7 PSIA
3CHARGING PUMPS TWO RC PUMP RUNNING



FTI Non-Proprietary

86-1234820-01

[illegible]