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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-1 TEST S-02-4 (BLOWDOWN HEAT TRANSFER TEST)

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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-1

TEST S-02-4

(Blowdown Heat Transfer Test)

by

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ABSTRACT

Recorded test data are presented for Test S-02-4 of the Semiscale Mod-1 blowdown heat transfer test series. Test S-02-4 is one of several Semiscale Mod-1 experiments conducted to investigate the thermal and hydraulic phenomena accompanying a hypothesized loss-of-coolant accident (LOCA) in a water-cooled nuclear reactor system and to provide data for the assessment of the Loss-of-Fluid Test (LOFT) design basis.

Test S-02-4 was conducted from an initial cold-leg fluid temperature of 544°F and an initial pressure of 2,263 psia. A simulated double-ended offset shear cold leg break was used to investigate the system response to a depressurization transient with full design core power (1.6 MW). An electrically heated core was used in the pressure vessel to simulate the effects of a nuclear core. System flow was set to achieve the full design core temperature differential of 66°F. The flow resistance of the intact loop was based on core area scaling. During system depressurization, core power was reduced from the initial level of 1.6 MW in such an manner as to simulate the surface heat flux response of the LOFT nuclear fuel rods until such time that departure from nucleate boiling (DNB) occurs. Blowdown to the pressure suppression system was accomplished without simulated emergency core cooling injection or pressure suppression system coolant spray.

The purpose of this report is to make available the uninterpreted data from Test S-02-4 for future data analysis and test results reporting activities. The data, presented in the form of graphs in engineering units, have been analyzed only to the extent necessary to assure that they are reasonable and consistent.

SUMMARY

Test S-02-4 was performed as part of the Semiscale Mod-1 portion of the Semiscale Program conducted by Aerojet Nuclear Company for the United States Government. This test was one of the Semiscale Mod-1 tests in Test Series 2 performed with an electrically heated core in place of the core simulator used in previous isothermal tests (Test Series 1). Hardware configuration and test parameters were selected to yield a system response that simulates the response of a pressurized water reactor (PWR) to hypothesized loss-of-coolant accident (LOCA).

Test S-02-4 utilized a pressure vessel with internals; an intact loop with active pump, steam generator, and pressurizer; a broken loop with simulated pump, simulated steam generator, and rupture assemblies; and a pressure suppression system with header and pressure suppression tank. The electrically heated core consisted of 39 heater rods with a maximum total power capacity of 1.6 MW. For this test, core power was initially 1.6 MW and was subsequently reduced to simulate the surface heat flux response of LOFT nuclear fuel rods until such time as departure from nucleate boiling (DNB) occurs. The test objectives specific to Test S-02-4 were (a) to gain information on the heat transfer characteristics of the Mod-1 core while operating at the design power level with radial power peaking, and (b) to determine the effects of a temperature differential across the heated core on system response before and during blowdown. Test S-02-4 was conducted from initial conditions of 2,263 psia and 544°F (cold inlet) with a simulated full size (200%) double-ended offset shear of the cold leg broken loop piping at an initial core power level of 1.6 MW with an initial core inlet flow rate of 156 gpm. The instantaneous offset shear of the broken loop cold leg piping was simulated by simultaneous actuation (within 10 milliseconds) of the rupture assemblies. The instrumentation used in Test S-02-4 generally functioned as intended except for a temporary instrumentation failure which caused a step offset in much of the data in the period from 10.5 to 13 seconds after blowdown. Of 214 measurements attempted, 212 produced usable data.

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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-1 SYSTEM TEST S-02-4 (Blowdown Heat Transfer Test)

I. INTRODUCTION

The Semiscale Mod-1 experiments represent the current phase of the Semiscale Program conducted by Aerojet Nuclear Company for the United States Government. The program, which is sponsored by the Nuclear Regulatory Commission through the Energy Research and Development Administration, is part of the overall program designed to investigate the response of a water-cooled nuclear reactor system to a hypothesized loss-of-coolant accident (LOCA). The underlying objectives of the Semiscale project are to quantify the physical processes controlling system behavior during an LOCA and to provide an experimental data base for assessing reactor safety evaluation models. The Semiscale Mod-1 program has the further objective of providing support to other experimental programs in the form of instrumentation assessment, optimization of test series, selection of test parameters, and evaluation of test results.

Test S-02-4 was conducted in the Semiscale Mod-1 system as part of a series of tests (Test Series 2) to obtain thermal-hydraulic response data from a blowdown transient in a simulated nuclear reactor with a heated core to provide an experimental basis for analytical model development and verification. The test was also conducted to obtain data to aid in assessing the Loss-of-Fluid Test (LOFT) design basis and in planning LOFT experiments.

For Test S-02-4, a 39-rod electrically heated core was used in the core barrel of the pressure vessel in place of the core simulator used in previous (isothermal) tests. (The heater array can accommodate 40 rods, but one location was used for a liquid level detector.) The initial core power level was set at the maximum design power of 1.6 MW. The radial power profile was peaked, with the four center rods having a 20.4% higher maximum power density than the core average maximum axial power density. During the blowdown, the core heater power was adjusted to simulate the thermal response characteristics of nuclear-heated rods prior to departure from nucleate boiling (DNB). The pipe break configuration simulated a full size (200%) double-ended break in the cold leg broken loop piping.

The purpose of this report is to present the test data in an uninterpreted, but readily usable, form for use by the nuclear community in advance of detailed analysis and interpretation. Section II briefly describes the system configuration, procedures, initial test conditions, and events that are applicable to Test S-02-4; Section III presents the data graphs and provides comments and supporting information necessary for interpretation of the data. A description of the overall Semiscale program and test series, a more detailed description of the Semiscale Mod-1 system, and a description of the measurement and data processing techniques and uncertainties can be found in Reference 1.

II. SYSTEM, PROCEDURES, CONDITIONS, AND EVENTS FOR TEST S-02-4

The following system configuration, procedures, initial test conditions, and events are specific to Test S-02-4.

1. SYSTEM CONFIGURATION AND TEST PROCEDURES

The Semiscale Mod-1 system used for Test S-02-4 consisted of a pressure vessel with internals; an intact loop with steam generator, pump, and pressurizer; a blowdown loop with simulated steam generator, simulated pump, and two rupture assemblies; a 39-rod electrically heated core; and a pressure suppression system with a suppression tank and header. The Semiscale Mod-1 experimental system is described in detail in Reference 1.

For Test S-02-4, the intact loop steam generator was maintained in the active condition, in which the steam generator secondary pressure and water level are automatically adjusted to control the water temperature in the cold leg of the intact loop.

In preparation for Test S-02-4, the system was filled with treated demineralized water and vented at strategic points to assure a liquid full system. Prior to warmup, the system was pressurized to check for leakage. Warmup to initial test conditions was accomplished with the heaters in the vessel core. Heatup of the broken loop piping was accomplished with bypass lines which served to allow circulation through the broken loop. During warmup, the purification and sampling systems were valved into the primary system to maintain water chemistry requirements and to provide a water sample at system conditions for subsequent analysis.

At 100-degree temperature intervals during warmup, detector readings were sampled to allow the integrity of the measurement instrumentation and the operability of the data acquisition system to be checked. After the core power was increased to 1.6 MW, initial test conditions were held for about 30 minutes to establish equilibrium in the system. At the end of this period, all auxiliary systems including the bypass lines were isolated to prevent blowdown through those systems.

The system was successfully subjected to a simulated double-ended cold leg pipe break through two rupture assemblies and two blowdown nozzles, each nozzle having a break area of 0.00262 ft^2. Pressure to operate the rupture assemblies and initiate blowdown was taken from an accumulator system filled with water and pressurized to 2,250 psig with gaseous nitrogen. Immediately following initiation of blowdown (0.02 second after initiation of blowdown), the lines to the accumulator were again isolated. The effluent from the primary system was ejected into the pressure suppression system. At blowdown, power to the primary coolant circulation pump was reduced, and the pump was allowed to coast down to a speed of 1,600 rpm which was maintained for the duration of the test. A flywheel mounted on the pump motor shaft provided a simulation of the predicted coastdown of the LOFT pumps. During the blowdown transient, power to the electrically heated core was automatically controlled to simulate the thermal response of the nuclear-heated LOFT fuel rods until such time as DNB occurred (Reference 1).

2. INITIAL TEST CONDITIONS AND SEQUENCE OF EVENTS

Conditions in the Semiscale Mod-1 system at initiation of blowdown are given in Tables I and II; the primary system water chemistry prior to blowdown is given in Table III; and the sequence of events relative to rupture is given in Table IV.

TABLE I

CONDITIONS AT BLOWDOWN INITIATION

	Measured[a]	Specified
Core Power	1.60 MW	1.60 ± 0.01 MW
Intact Loop Cold Leg Fluid Temperature	544°F	544 ± 2°F
Hot Leg to Cold Leg Temperature Differential	76.0°F	66 ± 1°F
Pressurizer Pressure	2263 psia	2263 ± 5 psia
Pressurizer Water Volume	0.58 ft^3	[b]
Steam Generator Feedwater Temperature	540°F	534 ± 10°F
Steam Generator Liquid Level (from bottom of tube sheet)	116 in.	116 ± 2 in.
Fluid Temperature in Broken Loop (pump side)	589°F	605 ± 5°F[c]
Intact Loop Cold Leg Flow	156 gpm	[d]
Pressure Suppression Tank Water Level	65.4 in.	65.4 in.
Pressure Suppression Tank Pressure	32.0 psia	32.0 psia
Pressure Suppression Tank Water Temperature	76°F	<75°F

[a] Measured initial conditions are taken from process instrumentation read just prior to blowdown. Those measured conditions which did not meet the specified initial conditions were considered acceptable for analysis purposes within the test objectives.

[b] Pressurizer water volume was specified in terms of differential pressure in the level measuring system.

[c] Preferred range; minimum acceptable value is 580°F.

[d] Flow is not specified, since it must be adjusted to achieve the required differential temperature across the core.

TABLE II

PRIMARY COOLANT TEMPERATURE DISTRIBUTION AT RUPTURE[a]

	Detector	Temperature (°F)
Vessel Lower Plenum (lower portion)	TFV-LP-7-1/2	541
Vessel Lower Plenum (upper portion)	TFV-LP-27-1/2	540
Hot Leg, Intact Loop (near vessel)	RBU-2	609
Hot Leg, Intact Loop (104 in. from vessel center)	TFU-5	608
Cold Leg, Intact Loop (near pump inlet)	TFU-10	539
Cold Leg, Intact Loop	RBU-14A	542
Cold Leg, Broken Loop (near nozzle)	TFB-23	536
Hot Leg, Broken Loop (near vessel)	TFB-30	603
Cold Leg, Broken Loop (near nozzle)	TFB-42	589

[a] Data taken from final digital scan, approximately two minutes before blowdown.

TABLE III

WATER CHEMISTRY PRIOR TO BLOWDOWN[a]

ph	10.12
Conductivity (μmhos/cm)	84.2
Lithium (ppm)	2.5
Chlorides (ppm)	<0.1
Fluorides (ppm)	<0.3
Oxygen (ppm)	<0.1
Total Gas (cc/1)	199

[a] Water sample taken at a system pressure of 2,250 psig and a system temperature of 544°F (cold leg).

TABLE IV

SEQUENCE OF EVENTS DURING TEST[a]

Event	Time Relative to Rupture
Established Core Power Level	-34 min
Bypass Lines Valved Out of System, Initiation of Blowdown	-2.5 sec
Reduced Pump Power	0
Steam Generator Feedwater and Discharge Valves Closed	1 sec
Core Power Tripped Off	30.0 sec

[a] A time-controlled sequencer was used to control critical events during the test.

III. DATA PRESENTATION

The data from Semiscale Mod-1 Test S-02-4 are presented with brief comment. Processing analysis has been performed only to the extent necessary to obtain appropriate engineering units and to assure that the data are reasonable and consistent. In all cases, in converting transducer output to engineering units, a homogeneous fluid was assumed. Further interpretation and analysis should consider that sudden decompression processes such as those occurring during blowdown may have subjected the measurement devices to nonhomogeneous fluid conditions. It should also be noted that much of the data contains a noticeable step in the period from 10.5 to 13 seconds after the initiation of blowdown. The step was caused by a detector which temporarily failed in such a manner as to cause the output of its amplifier to saturate at a value greater than its normal maximum of 10 volts. The excess voltage changed the ground potential of the multiplex unit causing a small shift in the readings. On channels with outputs near the maximum voltage, the effect of the transient was negligible; however, where the amplifier output was in the low end of the range, the effect of the offset was significant.

The performance of the system during Test S-02-4 was monitored by about 200 detectors. The data obtained were recorded on both digital and analog data acquisition systems. The digital system was used to process the data presented in this report. The analog system was used primarily to provide redundancy.

The data are presented, in many instances, in the form of composite graphs to facilitate comparison of a given variable at several locations. The scales selected for the graphs do not reflect the obtainable resolution of the data. (The data processing techniques are described in greater detail in Reference 1.)

Figures 1 through 6 and Table V provide supporting information for interpretation of the data graphs shown in Figures 7 through 146. Figures 1 through 6 show the relative locations of all detectors used during the Mod-1 blowdown heat transfer test series. Table V groups the measurements taken during Test S-02-4 according to measurement type; identifies the specific measurement location, and the range of the detector and actual recording range of the data acquisition system; provides brief comments regarding the data; and references the measurements and comments to the corresponding figure. Figures 7 through 146 present all the blowdown data obtained. Time zero on the graphs is the time of rupture initiation.

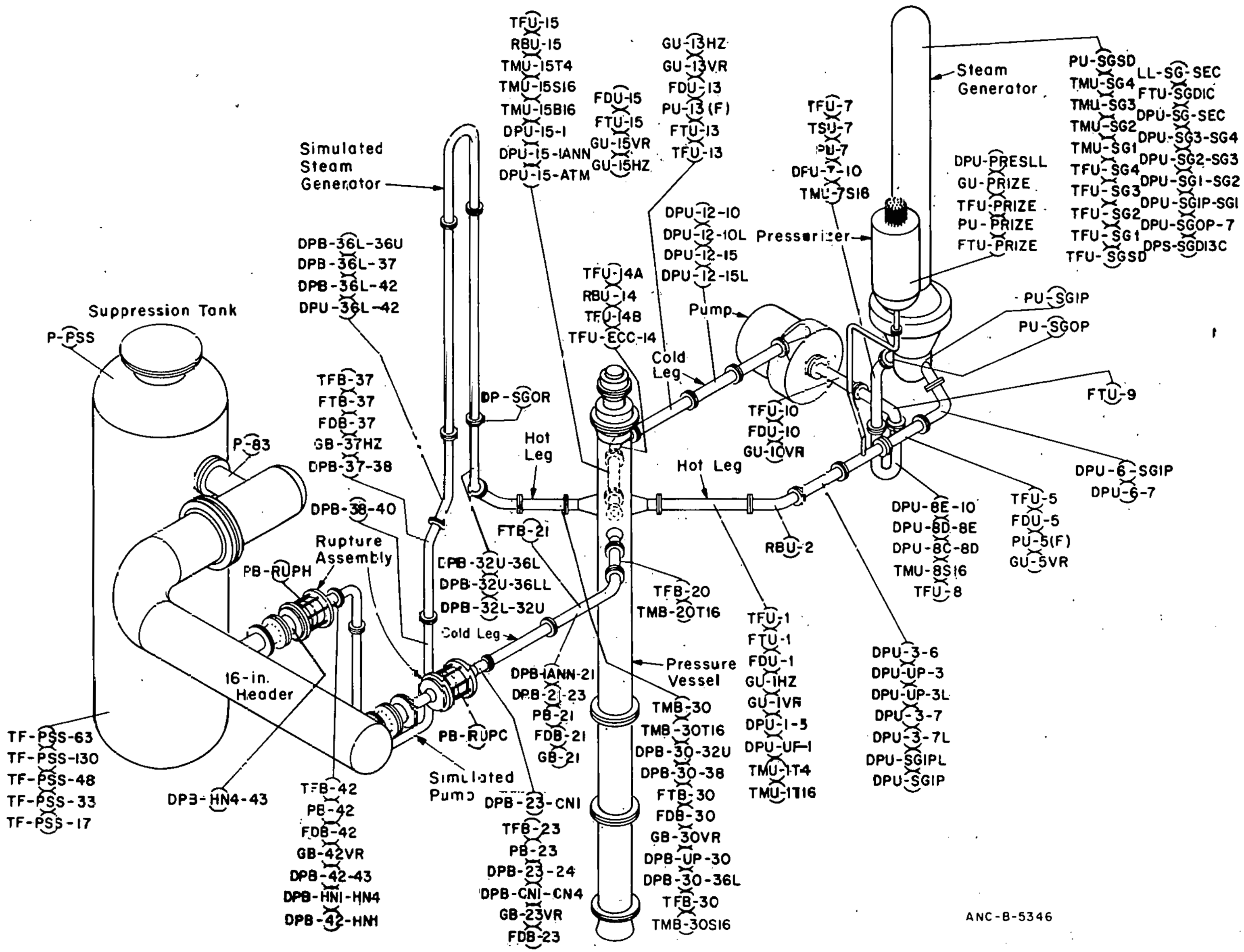

Fig. 1 Semiscale Mod-1 system and instrumentation cold leg break configuration -- isometric.

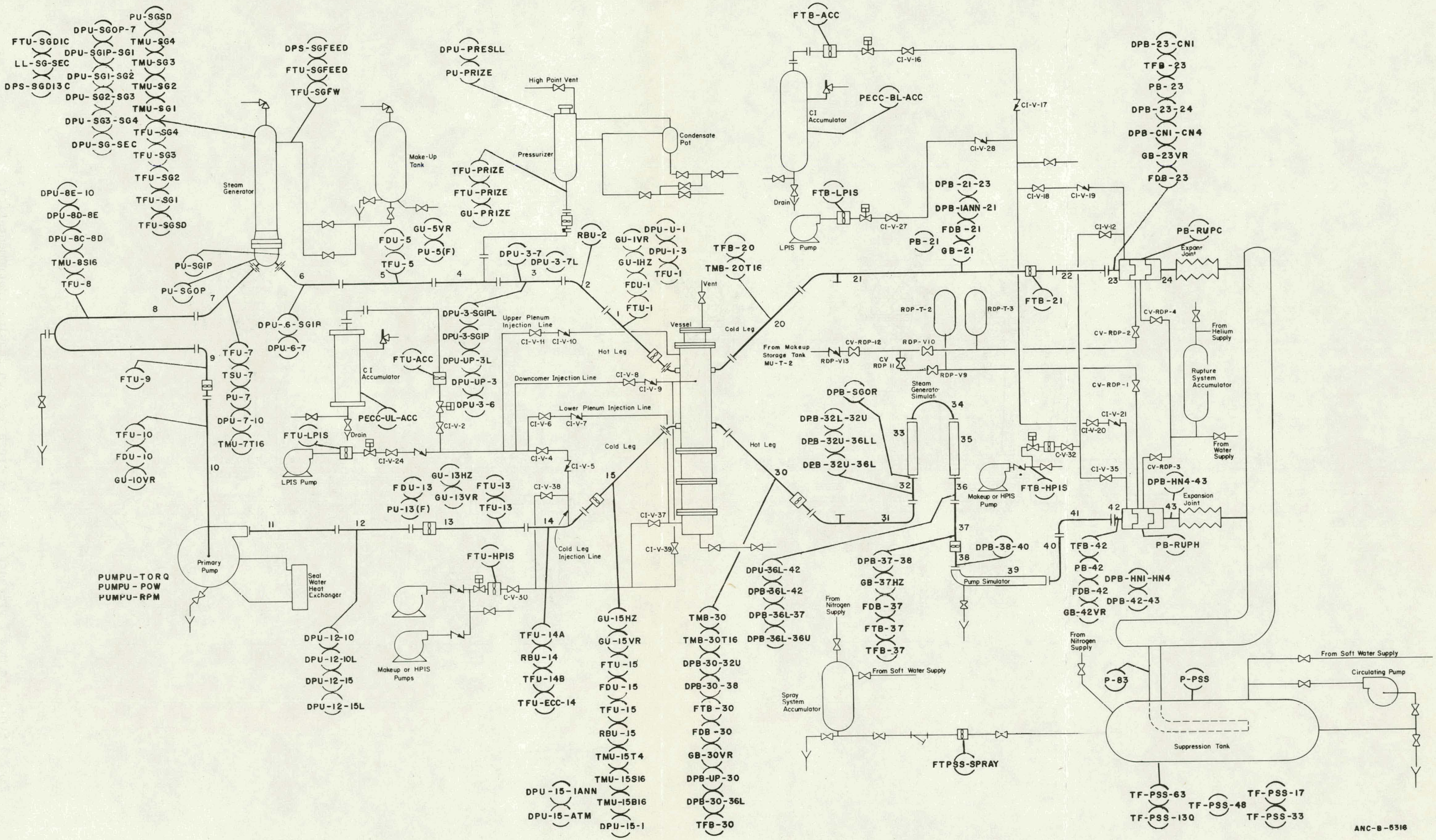

Fig. 2 Semiscale Mod-1 system and instrumentation for cold leg break configuration -- schematic.

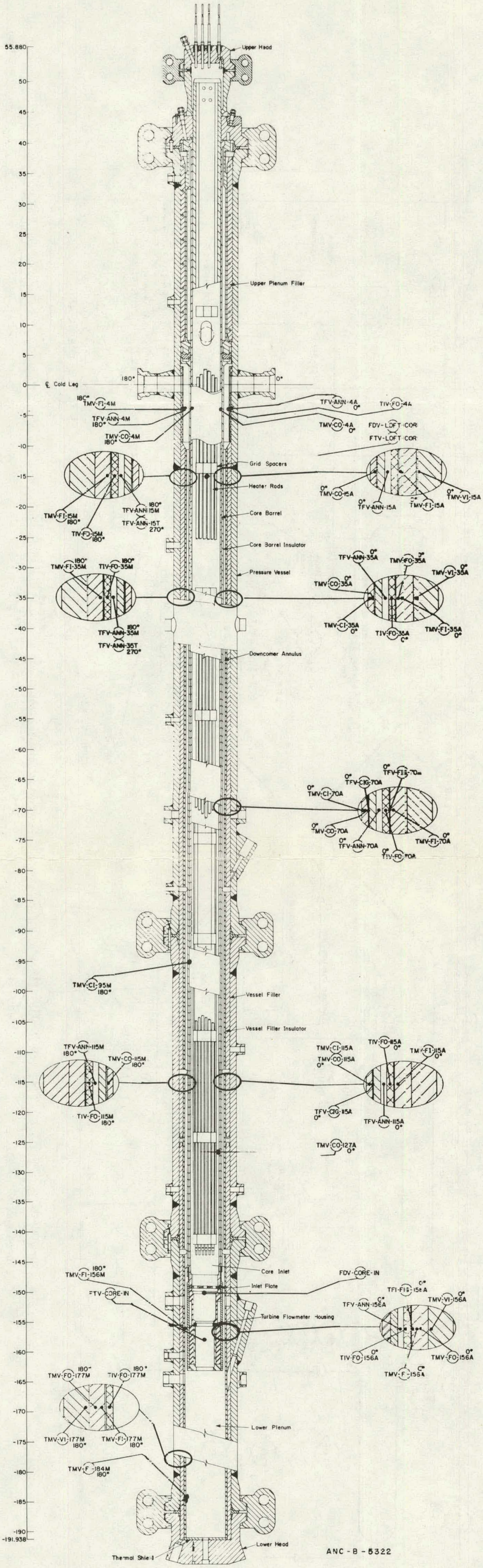

Fig. 3 Semiscale Mod-1 pressure vessel -- cross section showing instrumentation.

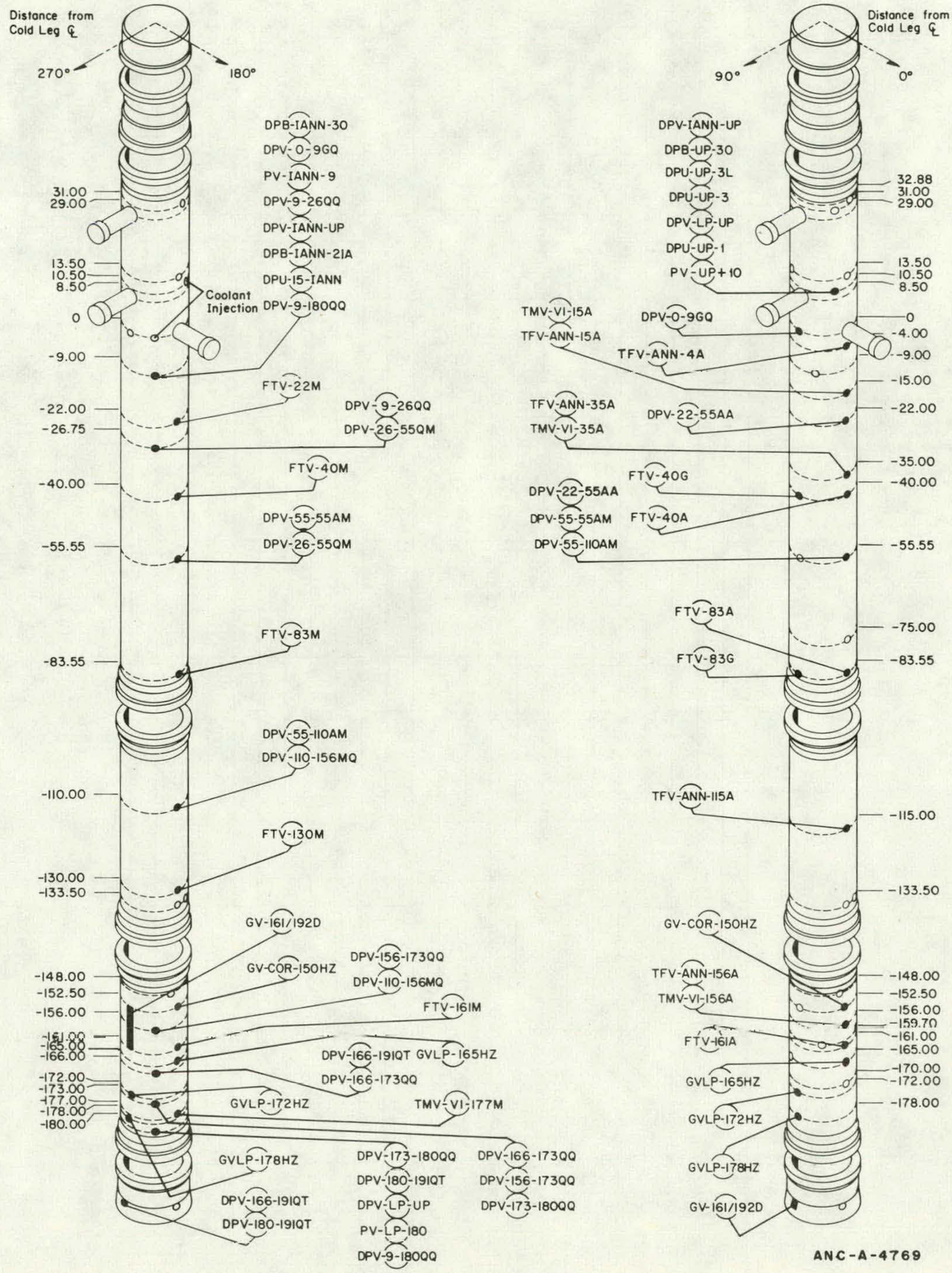

Fig. 4 Semiscale Mod-1 pressure vessel -- isometric showing instrumentation.

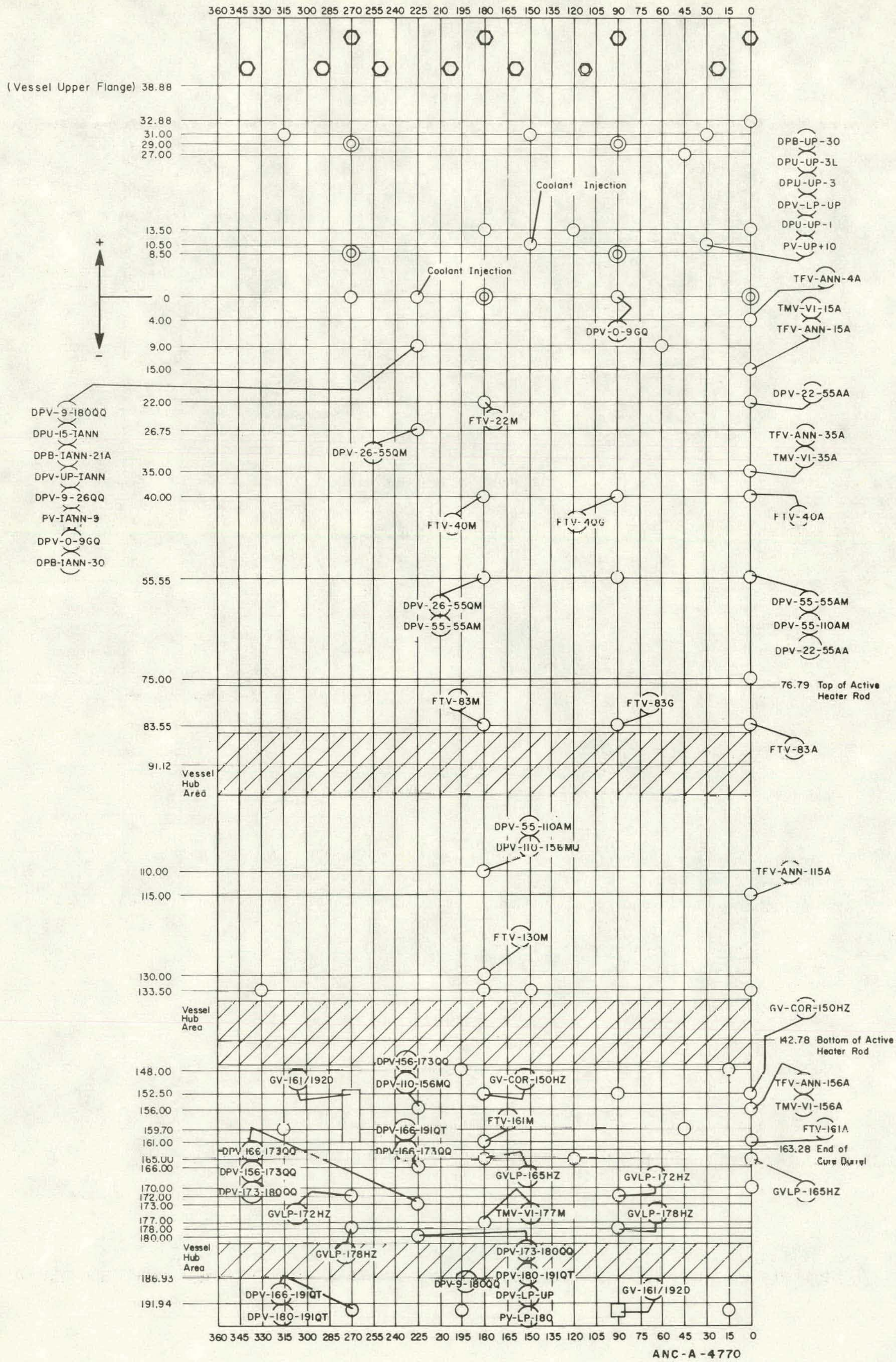

Fig. 5 Semiscale Mod-1 pressure vessel -- penetrations and instrumentation.

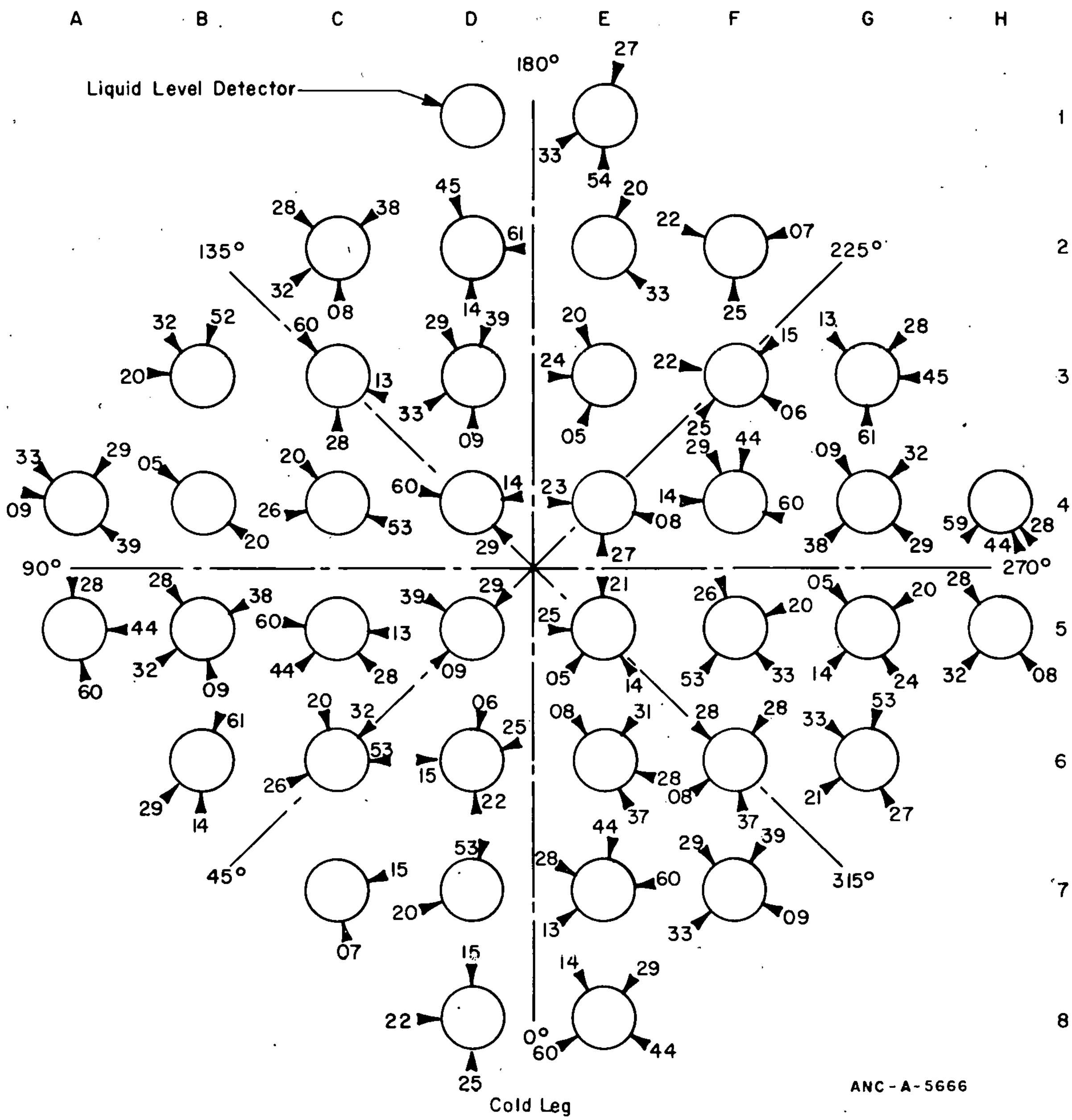

Fig. 6 Semiscale Mod-1 heated core, plan view.

TABLE V

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-4

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement Comments[b]
FLUID TEMPERATURE	Chromel-Alumel thermocouples unless specified otherwise	0-2300°F	0-1017°F		
Intact Loop				7	
RBU-2	Hot leg, Spool 2, 46 in. from vessel center (platinum resistance bulb)	0-1000°F	0-1000°F		
TFU-5	Hot leg, Spool 5, 104 in. from vessel center				
TFU 10	Cold leg, Spool 10, 144 in. from vessel center				
RBU-14A	Cold leg, Spool 14, 43 in. from vessel center, upstream of cold leg injection port (platinum resistance bulb)	0-1000°F	0-1000°F		
Broken Loop		0-2300°F	0-591°F		
TFB-20	Cold leg, Spool 20, 21 in. from vessel center			8	
TFB-23	Cold leg, Spool 23, 91 in. from vessel center, upstream of vessel-side nozzle			8	
TFB-30	Hot leg, Spool 30, 16 in. from vessel center		0-1017°F	9	
TFB-42	Hot leg, Spool 42, 414 in. from vessel center along cold leg, upstream of pump-side nozzle		0-1017°F	9	
Downcomer Annulus	Centered in annulus, Type J iron-constantan thermocouples	0-1400°F	0-803°F		
TFV-ANN-15M	15 in. below cold leg centerline, 180°			10	
TFV-ANN-35A	35 in. below cold leg centerline, 0°			10	
TFV-ANN-35T	35 in. below cold leg centerline, 270°			10	
TFV-ANN-115A	115 in. below cold leg centerline, 0°			11	
TFV-ANN-115M	115 in. below cold leg centerline, 180°			11	
Upper Plenum		0-2300°F	0-1017°F	12	
TFV-UP+13	In upper plenum 13.5 in. above cold leg centerline at 180°				
Lower Plenum	On fluid thermocouple rack, 1 in. from vessel center, 45°	0-2300°F	0-1017°F	13	
TFV-LP-7-1/2	7.5 in. from bottom				
TFV-LP-14-1/2	14.5 in. from bottom				
TFV-LP-27-1/2	27.5 in. from bottom				
Core Grid Spacers		0-2300°F	0-2382°F		
Grid Spacer 5	55 in. below cold leg centerline, 21.5 in. above top of heated length			14	
TFG-5CD-45	Thermocouple in space defined by Columns C and D, Rows 4 and 5				
Grid Spacer 6	76 in. below cold leg centerline, 1.2 in. above top of heated length			15	
TFG-6AB-45	Thermocouple in space defined by Columns A and B, Rows 4 and 5				
TFG-6CD-45	Thermocouple in space defined by Columns C and D, Rows 4 and 5				
TFG-6DE-45 -67	Thermocouples in space defined by Columns D and E, Rows 4 and 5, and 6 and 7				
TFG-6GH-45	Thermocouple in space defined by Columns G and H, Rows 4 and 5				
Grid Spacer 8	109 in. below cold leg centerline at center of heated length			16	
TFG-8CD-45	Thermocouple in space defined by Columns C and D, Rows 4 and 5				

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-4

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement Comments[b]
FLUID TEMPERATURE (contd.)					
Core Grid Spacers (contd.)					
TFG-8DE-23 -45 -67	Thermocouples in space defined by Columns D and E, Rows 2 and 3, 4 and 5, 6 and 7			16	
TFG-8EF-45	Thermocouple in space defined by Columns E and F, Rows 4 and 5			16	
Grid Spacer 10	143 in. below cold leg centerline at bottom of heated length			17	
TFG-10CD-45	Thermocouple in space defined by Columns C and D, Rows 4 and 5				
TFG-10DE-23 -67	Thermocouples in space defined by Columns D and E, Rows 2 and 3, 6 and 7				TFG-10DE-23 failed
TFG-10EF-45	Thermocouple in space defined by Columns E and F, Rows 4 and 5				
TFG-10GH-45	Thermocouple in space defined by Columns G and H, rows 4 and 5				
ECC System					
TFU-ECC	On centerline of ECC line just upstream of junction with Spool 14				Not reported; ECC not used in test.
Steam Generator		0-2300°F	0-591°F		
TFU-SGFW	In feedwater line leading to steam generator			18	
TFU-SGSD	In steam dome, 129.5 in. from bottom of tube sheet			18	
TFU-SG1	Secondary side, 12 in. above bottom of tube sheet			19	
TFU-SG2	Secondary side, 24 in. above bottom of tube sheet			19	
TFU-SG3	Secondary side, 48 in. above bottom of tube sheet			19	
TFU-SG4	Secondary side, 96 in. above bottom of tube sheet			19	
Pressurizer		0-2300°F	0-1017°F	20	
TFU-PRIZE	In surge line, near pressurizer exit, between turbine flowmeter and pressurizer				
Pressure Suppression System		0-2300°F	0-591°F	21	
TF-PSS-33	33 in. from bottom of tank				
TF-PSS-130	130 in. from bottom of tank				
MATERIAL TEMPERATURE	Chromel-Alumel thermocouples unless specified otherwise	0-2300°F	0-591°F		
Intact Loop				22	
TMU-7S16	Cold leg, Spool 7, side, 1/16 in. from pipe ID, 242 in. from vessel center (vertical pipe)				
TMU-8S16	Cold leg, Spool 8, side, in pump trap. 1/16 in. from pipe ID, 195 in. from vessel center				
Broken Loop		0-2300°F		23	
TMB-20T16	Cold leg, Spool 20, top, 1/16 in. from pipe ID, 21 in. from vessel center		0-591°F		
TMB-30T4	Hot leg, Spool 30, top, 1/4 in. from pipe ID, 16 in. from vessel center		0-1017°F		
TMB-30T16	Hot leg, Spool 30, top, 1/16 in. from pipe ID, 16 in. from vessel center		0-1017°F		
Vessel Wall	1/8 in. from vessel ID	0-2300°F	0-591°F	24	
TMV-VI-15A	15 in. below cold leg centerline, 0°				

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-4

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement Comments[b]
MATERIAL TEMPERATURE (contd.)					
Vessel Filler	Type J iron-constantan thermocouples	0-1400°F	0-803°F	25	
TMV-FO-35A	35 in. below cold leg centerline, 0.65 in. from filler ID, 0°				Questionable measurement
TMV-FI-35M	35 in. below cold leg centerline, 1/16 in. from filler ID, 180°				
Vessel Filler Insulator	Outer surface of insulator, Type J iron-constantan thermocouples	0-1400°F	0-803°F	26	
TIV-FO-35A	35 in. below cold leg centerline, 0°				
Core Barrel	Type J iron-constantan thermocouples	0-1400°F	0-803°F	27	
TMV-CO-35A	35 in. below cold leg centerline, 1/16 in. from core barrel OD, 0°				
TMV-CI-35A	35 in. below cold leg centerline, 1/16 in. from core barrel ID, 0°				
Core Heater Cladding Temperatures		0-2300°F	0-2382°F		
High Power Heaters	Chromel-Alumel thermocouples unless specified otherwise				
TH-D4-14 -29 -60	Heater at Column D Row 4. Thermocouples 14 in. (270°), 29 in. (315°), and 60 in. (105°) above bottom of core			28	
TH-D5-09 -29 -39	Heater at Column D Row 5. Thermocouples 9 in. (45°), 29 in. (225°), and 39 in. (135°) above bottom of core			29	
TH-E4-23 -27	Heater at Column E Row 4. Thermocouples 23 in. (90°) and 27 in. (0°) above bottom of core			30	
TH-E5-14 -21 -25	Heater at Column E Row 5. Thermocouples 14 in. (330°), 21 in. (180°), and 25 in. (90°) above bottom of core			31	
Low Power Heaters					
TH-A4-09 -29 -33	Heater at Column A Row 4. Thermocouples 9 in. (105°), 29 in. (240°), 33 in. (135°), and 39 in. (300°) above bottom of core			32	
[illegible]	Heater at Column A Row 5. Thermocouple 29 in. (180°) above bottom of core			33	
TH-B3-32	Heater at Column B Row 3. Thermocouple 32 in. (135°) above bottom of core			34	
TH-B5-29	Heater at Column B Row 5. Thermocouple 29 in. (150°) above bottom of core			35	
TH-B6-29	Heater at Column B Row 6. Thermocouple 29 in. (45°) above bottom of core			36	
TH-C2-28	Heater at Column C Row 2. Thermocouple 28 in. (135°) above bottom of core			37	
TH-C3-13 28 -60	Heater at Column C Row 3. Thermocouples 13 in. ([illegible]), 28 in. (0°), and 60 in. (150°) above bottom of core			38	
TH-C4-26	Heater at Column C Row 4. Thermocouple 26 in. (75°) above bottom of core			39	
TH-C5-28	Heater at Column C Row 5. Thermocouple 28 in. (315°) above bottom of core			40	
TH-C6-20 -32	Heater at Column C Row 6. Thermocouples 20 in. (165°) and 32 in. (225°) above bottom of core			41	Spurious transient near t=5 sec was attentuated for presentation; original transient went to -1300°F
TH-C7-15	Heater at Column C Row 7. Thermocouple 15 in. (255°) above bottom of core			42	
TH-D2-14	Heater at Column D Row 2. Thermocouple 14 in. (0°) above bottom of core			43	

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-4

Measurement	Location and Comments[a]	Range[a]		Figure[a]	Measurement Comments[b]
		Detector	Data Acquisition System		
MATERIAL TEMPERATURE (contd.)					
Low Power Heaters (contd.)					
TH-D3-29	Heater at Column D Row 3. Thermocouple 29 in. (150°) above bottom of core			44	
TH-D6-15 -22 -25	Heater at Column D Row 6. Thermocouples 15 in. (90°), 22 in. (345°), and 25 in. (255) above bottom of core			45	Spurious transient near t=12 sec was attenuated for presentation; original transient went to 2440°F
TH-D7-20	Heater at Column D Row 7. Thermocouple 20 in. (60°) above bottom of core			46	
TH-D8-25	Heater at Column D Row 8. Thermocouple 25 in. (0°) above bottom of core			47	
TH-E1-27 -33	Heater at Column E Row 1. Thermocouples 27 in. (195°) and 33 in. (60°) above bottom of core			48	
TH-E2-33	Heater at Column E Row 2. Thermocouple 33 in. (315°) above bottom of core			49	
TH-E3-05 -20	Heater at Column E Row 3. Thermocouples 5 in. (15°) and 20 in. (165°) above bottom of core			50	
TH-E6-08 -28 -31 -37	Heater at Column E Row 6. Thermocouples 8 in. (150°), 28 in. (285°), 31 in. (225°), and 37 in. (330°) above bottom of core			51	
TH-E7-13 -29 -44 -60	Heater at Column E Row 7. Thermocouples 13 in. (45°), 29 in. (120°), 44 in. (195°) and 60 in. (270°) above bottom of core			52	
TH-E8-14 -29 -45	Heater at Column E Row 8. Thermocouples 14 in. (150°), 29 in. (225°), and 45 in. (300°) above bottom of core			53	
TH-F2-22 -25	Heater at Column F Row 2. Thermocouples 22 in. (105°) and 25 in. (0°) above bottom of core			54	
TH-F3-22 -25	Heater at Column F Row 3. Thermocouples 22 in. (105°) and 25 in. (30°) above bottom of core			55	
TH-F4-14 -28	Heater at Column F Row 4. Thermocouples 14 in. (90°) and 28 in. (165°) above bottom of core			56	
TH-F5-20 -26 -33 -53	Heater at Column F Row 5. Thermocouples 20 in. (255°), 26 in. (165°), 33 in. (315°), and 53 in. (30°) above bottom of core			57	
TH-F6-08 -28 -28	Heater at Column F Row 6. Thermocouples 8 in. (60°), 28 in. (135°), and 28 in. (210°) above bottom of core			58	Spurious transient at t=35 sec was attenuated for presentation; original transient was to 450°F
TH-F7-29 -33 -39	Heater at Column F Row 9. Thermocouples 29 in. (150°), 33 in. (45°), and 39 in. (210°) above bottom of core			59	
TH-G4-33	Heater at Column G Row 4. Thermocouple 33 in. (225°) above bottom of core			60	
TH-G5-14 -24	Heater at Column G Row 5. Thermocouples 14 in. (45°) and 24 in. (330°) above bottom of core			61	
TH-G6-21 -33 -53	Heater at Column G Row 6. Thermocouples 21 in. (60°), 33 in. (135°), and 53 in. (195°) above bottom of core			62	Spurious transient at t=36 sec was attenuated for presentation; original transient was to 2440°F
TH-H4-28	Heater at Column H Row 4. Thermocouple 28 in. (315°) above bottom of core			63	

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-4

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement Comments[b]
PRESSURE		0-3000 psi			
Intact Loop				64	
PU-5(F)	Hot leg, Spool 5, 100 in. from vessel center		0-4676 psia		
PU-7	Cold leg, Spool 7, 240 in. from vessel center		0-4955 psia		
PU-13(F)	Cold leg, Spool 13, 54 in. from vessel center (flush mount)		0-4384 psia		
Broken Loop		0-3000 psi			
PB-23	Cold leg, Spool 23, 92 in. from vessel center, upstream of vessel-side nozzle (tee off DP tap)		0-2300 psia	65	
PB-CN1	Vessel-side nozzle, nozzle throat, 96 in. from vessel center, (tee off DP tap)		0-4606 psia	65	
PB-42	Cold leg, Spool 42, 415 in. from vessel center along hot leg, upstream of pump-side nozzle (tee off DP tap)		0-3276 psia	66	
PB-HN1	Pump-side nozzle, nozzle throat, 419 in. from vessel center along hot leg (tee off DP tap)		0-4624 psia	66	
Vessel		0-3000 psi		67	
PV-UP+10	In upper plenum, 10 in. above cold leg centerline, mounted on standoff, 30°		0-3397 psia		
PV-LP-180	In upper part of lower plenum, 180 in. below cold leg centerline, mounted on standoff, 225°		0-2563 psia		
ECC System					
PECC-UL-ACC	In intact loop accumulator				Not reported; ECC not used in test
Steam Generator		0-3000 psi			
PU-SGSD	Secondary side, steam dome		0-1521 psia	68	
PU-SGIP	Inlet plenum, 13 in. below bottom of tube sheet (flush mount)		0-4603 psia	69	
Pressurizer		0-3000 psi		70	
PU-PRIZE	Steam dome				
Pressure Suppression System		0-750 psi		71	
P-PSS	Suppression tank top		0-321 psia		
P-83	Suppression tank header just before entrance to suppression tank		0-380 psia		
DIFFERENTIAL PRESSURE	Elevation difference between transducer taps is zero unless otherwise specified				
Intact Loop					
DPU-UP-1	Upper plenum 10.5 in. above cold leg centerline at 30° to hot leg, Spool 1, 31 in. from vessel center, upper plenum tap approximately 2 in. above Spool 1 tap	±100 in. water	±5.0 psid	72	
DPU-1-3	Hot leg Spool 1, 62 in. from vessel center to hot leg Spool 3, 62 in. from vessel center	±20 in. water	±1.0 psid	73	
DPU-3-6	Hot leg Spool 3, 62 in. from vessel center to hot leg Spool 6, 114 in. from vessel center	±20 in. water	±1.0 psid	74	Data acquisition system saturated from t=0 to t=3.5 sec. Detector reading may be affected by blowdown of the sense line
DPU-6-7	Hot leg Spool 6, 114 in. from vessel center, across steam generator, to cold leg Spool 7, 231 in. from vessel center. Spool 6 tap is 17 in. above Spool 7 tap	±500 in. water	±25 psid	75	
DPU-SGOP-7	From steam generator outlet plenum, 269 in. from vessel center along cold leg to cold leg Spool 7, 231 in. from vessel center, including orifice, Spool 7 tap is 35 in. below SGOP tap	±500 in. water	±25 psid	76	

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-4

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement Comments[b]
DIFFERENTIAL PRESSURE (contd.)					
Intact Loop (contd.)					
DPU-7-10	Steam generator outlet to pump inlet, cold leg Spool 7, 231 in. from vessel center to cold leg Spool 10, 141 in. from vessel center	±50 in. water	±2.5 psid	77	
DPU-12-10	Pump outlet to pump inlet, cold leg Spool 12, 75 in. from vessel center to cold leg Spool 10, 141 in. from vessel center, Spool 10 tap is 10 in. below Spool 12 tap	±50 psid	±50 psid	78	
DPU-12-10L	Pump outlet to pump inlet, cold leg Spool 12, 75 in. from vessel center to cold leg Spool 10, 141 in. from vessel center, Spool 10 tap is 10 in. below Spool 12 tap (low range)	±100 in. water	±5.0 psid	79	Data acquisition system saturated to t=6.4 sec
DPU-12-15	Across cold leg injection point, cold leg Spool 12, 75 in. from vessel center to cold leg Spool 15, 16 in. from vessel center	±100 in. water	±10 psid	80	
DPU-15-1	Cold leg to hot leg, cold leg Spool 15, 16 in. from vessel center to hot leg Spool 1, 31 in. from vessel center, Spool 15 tap is 8.5 in. below Spool 1 tap	±500 in. water	±25 psid	81	
DPU-15-IANN	Cold leg Spool 15, 16 in. from vessel center to inlet annulus 9 in. below cold leg centerline at 225°, Spool 15 tap is 9 in. above inlet annulus tap	±100 in. water	±5.0 psid	82	
DPU-15-ATM	Cold leg Spool 15, 16 in. from vessel center to atmosphere	±500 psid	±500 psid	83	Data acquisition system saturated to t=17.4 sec
DPU-PRESLL	Pressurizer water level, elevation difference between taps is 34 in., lower tap is approximately 3.5 in. above pressurizer exit	±50 in. water	±2.5 psid	84	Data invalid after t=11 sec due to blowdown of sense lines
Broken Loop					
DPB-CN1-CN4	Vessel-side nozzle, nozzle throat, 96 in. from vessel center to nozzle divergent section, 101 in. from vessel center	±1000 psid	±1000 psid	85	
DPB-30-36L	Across entire simulated steam generator assembly, hot leg Spool 30, 18 in. from vessel center to cold leg Spool 36 lower tap, 242 in. from vessel center. Spool 30 tap is 19 in. below Spool 36 tap	±500 psid	±500 psid	86	
DPB-32U-36L	Across simulated steam generator orifice assembly, hot leg Spool 32 upper tap, 73 in. from vessel center to Spool 36 lower tap, 242 in. from vessel center, Spool 32 upper tap is 16 in. above Spool 36 lower tap	±500 psid	±500 psid	87	
DPB-38-40	Across simulated pump, cold leg Spool 38, 305 in. from vessel center along hot leg to cold leg Spool 40, 365 in. from vessel center along hot leg	±1000 psid	±1000 psid	88	
Vessel					
DPV-IANN-UP	Inlet annulus, 9 in. below cold leg centerline at 225° to upper plenum, 10.5 in. above cold leg centerline at 30°, elevation difference between taps is 19 in.	±500 in. water	±25 psid	89	
DPV-9-180QQ	Inlet annulus, 9 in. below cold leg centerline at 225° to lower plenum, 180 in. below cold leg centerline at 225°, elevation difference between taps is 171 in.	±300 in. water	±15 psid	90	
DPV-22MI	Across filler insulator gap 22 in. below cold leg centerline from 180° to 120°	±1000 psid	±1000 psid	91	Long-term data not valid due to blowdown of sense lines. Measurement taken for subcooled pressure spike only
DPV-26-55QM	Across part of downcomer, 26 in. (225°) to 55 in. (180°) below centerline of cold leg, elevation difference between taps is 29 in.	±50 in. water	±2.5 psid	92	

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-4

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement Comments[b]
DIFFERENTIAL PRESSURE (contd.)					
Vessel (contd.)					
DPV-156-173QQ	Across downcomer exit, 7 in. above exit to 10 in. below exit, taps at 156 in. (225°) and 173 in. (225°) below cold leg centerline, elevation difference between taps is 17 in.	±20 in. water	±1.0 psid	93	
DPV-166-191QT	Across lower plenum, 166 in. (225°) to 191 in. (270°) below cold leg centerline, elevation difference between taps is 25 in.	±50 in. water	±2.5 psid	94	
DPV-LP-UP	Lower plenum, 180 in. below cold leg centerline at 225° to upper plenum 10.5 in. above cold leg centerline at 30°, elevation difference between taps is 191 in.	±300 in. water	±15 psid	95	
DPU-UP-1	Upper plenum, 10.5 in. above cold leg centerline at 30° to intact loop hot leg Spool 1, 31 in. from vessel center, upper plenum tap is approximately 2 in. above Spool 1 tap	+100 in. water	±5.0 psid	77	
DPU-15-IANN	Cold leg Spool 15, 16 in. from vessel center to inlet annulus 9 in. below cold leg centerline at 225°, Spool 15 tap is 9 in. above inlet annulus tap	±100 in. water	±5.0 psid	82	
Steam Generator					
DPS-SGFEED	In steam generator feed line	±100 in. water	±5.0 psid	96	
DPS-SGDISC	In steam generator discharge line	±100 in. water	±5.0 psid	97	
DPU-SGOP-7	From steam generator outlet plenum, 269 in. from vessel center along cold leg to cold leg Spool 7, 231 in. from vessel center, including orifice, Spool 7 tap is 35 in. below SGOP tap	±500 in. water	±25 psid	76	
DPU-SG-SEC	Secondary side, differential pressure taps at 45 and 126 in. above bottom of tube sheet, elevation difference between taps is 81 in.	±100 in. water	+5.0 psid	98	Offset changed from that of previous tests to maintain positive reading under normal conditions
Pressurizer					
DPU-PRESLL	Pressurizer water level, elevation difference between taps is 34 in., lower tap is approximately 3.5 in. above pressurizer exit	±50 in. water	±2.5 psid	84	Data after t=11 sec is invalid due to blowdown of the condensation chamber and sense lines
VOLUMETRIC FLOW RATE	Turbine flowmeter, bidirectional				
Intact Loop	3-in. Schedule 160 pipe				
FTU-1	Hot leg, Spool 1, 18 in. from vessel center	±20-±400 gpm	±800 gpm	99	
FTU-9	Cold leg, Spool 9, 154 in. from vessel center	±20-±400 gpm	±800 gpm	99	
FTU-13	Cold leg, Spool 13, 64 in. from vessel center	±20-±400 gpm	±800 gpm	100	
FTU-15	Cold leg, Spool 15, 29 in. from vessel center	±10-±200 gpm	±300 gpm	100	
Broken Loop	All measurements bidirectional, Schedule 160 pipe				
FTB-21	Cold leg, Spool 21, 58 in. from vessel center, 3-in. pipe	±20-±400 gpm	±1500 gpm	101	
FTB-30	Hot leg, Spool 30, 25 in. from vessel center, 3-in. pipe	+20-+400 gpm	±700 gpm	101	Part of initial spike at t=0 may be due to AC interference
Core					
FTV-CORE-IN	Entrance to core, approximately 158 in. below cold leg centerline	±20-±400 gpm	±400 gpm	102	
ECC System					
FTU-ACC	In line immediately after intact loop accumulator, 1-in. line				Not reported; ECC not used in test

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-4

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement Comments[b]
VOLUMETRIC FLOW RATE (contd.)					
Pressurizer	1-1/2-in. turbine				
FTU-PRIZE	Surge line	±5–±100 gpm	±100 gpm		Turbine failed
FLUID VELOCITY	Turbine flowmeter, bidirectional				
Downcomer Gap				103	
FTV-40A	40 in. below cold leg centerline, 0°	±2.5–±50 ft/sec	±70 ft/sec		
FTV-40M	40 in. below cold leg centerline, 180°	±2.5–±50 ft/sec	±50 ft/sec		
FTV-83M	83 in. below cold leg centerline, 180°	±2.5–±50 ft/sec	±40 ft/sec		Measurement is unidirectional due to the failure of one pickup probe
MOMENTUM FLUX	Drag-disc bidirectional. Computer conversion of voltage output to momentum flux is unidirectional and therefore shows magnitude only				
Intact Loop	3-in. pipe				
FDU-1	Hot leg, Spool 1, 29 in. from vessel center, target size 1.0 in.	±1–±2000 lbm/ft-sec^2	±3250 lbm/ft-sec^2	104	
FDU-5	Hot leg, Spool 5, 100 in. from vessel center, target size 1.0 in.	±1–±2000 lbm/ft-sec^2	±4250 lbm/ft-sec^2	105	
FDU-10	Cold leg, Spool 10, 137 in. from vessel center, target size 0.875 in.	±200–±104,000 lbm/ft-sec^2	±21,000 lbm/ft-sec^2	106	
FDU-13	Cold leg, Spool 13, 54 in. from vessel center, target size 0.875 in.	±200–±14,800 lbm/ft-sec^2	±18,750 lbm/ft-sec^2	107	
FDU-15	Cold leg, Spool 15, 19 in. from vessel center, target size 0.875 in.	±200–±14,500 lbm/ft-sec^2	±18,770 lbm/ft-sec^2	108	
Broken Loop					
FDB-21	Cold leg, Spool 21, 53 in. from vessel center, 3-in. pipe, target size 0.406 in.	±200–±70,500 lbm/ft-sec^2	±87,940 lbm/ft-sec^2	109	
FDB-23	Cold leg, Spool 23, 93 in. from vessel center, upstream of vessel-side nozzle, downstream of injection point, 2-in. pipe, target size 0.406 in.	±200–±125,000 lbm/ft-sec^2	±125,320 lbm/ft-sec^2	110	
FDB-30	Hot leg, Spool 30, 21 in. from vessel center, 3-in. pipe, target size 0.656 in.	±200–±60,000 lbm/ft-sec^2	±44,250 lbm/ft-sec^2	111	
FDB-42	Hot leg, Spool 42, 416 in. from vessel center along cold leg, upstream of pump-side nozzle, downstream of injection point, 2-in. pipe, target size 0.406 in.	±200–±116,000 lbm/ft-sec^2	±131,340 lbm/ft-sec^2	112	
Vessel					
FDV-CORE-IN	In core flow mixer box, 150 in. below cold leg centerline, target size 1.0 x 2.0 in.	±200–±5000 lbm/ft-sec^2	±4750 lbm/ft-sec^2	113	Data processing introduced large spikes which greatly exceeded scale shown
DENSITY					
Intact Loop		0.1-100 lbm/ft^3	0-100 lbm/ft^3		
GU-1VR	Hot leg, Spool 1, 24 in. from vessel center, vertical			114	
GU-1HZ	Hot leg, Spool 1, 26 in. from vessel center, horizontal			114	
GU-5VR	Hot leg, Spool 5, 96 in. from vessel center, vertical			115	
GU-10VR	Cold leg, Spool 10, 141 in. from vessel center, vertical			115	
GU-13VR	Cold leg, Spool 13, 59 in. from vessel center, vertical			116	
GU-15HZ	Cold leg, Spool 15, 20 in. from vessel center, horizontal			117	
GU-15VR	Cold leg, Spool 15, 23 in. from vessel center, vertical			117	

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-4

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement Comments[b]
DENSITY (contd.)					
Broken Loop		0.1-100 lbm/ft^3	0-100 lbm/ft^3		
GB-21VR	Cold leg, Spool 21, 49 in. from vessel center, vertical			118	
GB-23VR	Cold leg, Spool 23, 92 in. from vessel center, vertical			118	
GB-30VR	Hot leg, Spool 30, 18 in. from vessel center, vertical			119	
GB-42VR	Cold leg, Spool 42, 415 in. from vessel center along hot leg, vertical			119	
Vessel		0.1-100 lbm/ft^3	0-100 lbm/ft^3		
GV-COR-150HZ	Core flow mixer box, 152 in. below cold leg centerline, horizontal, 0-180°			120	
GV-161/192D	Lower plenum 161 in. below cold leg centerline (270°) to 192 in. below cold leg centerline (90°), 31 in. vertical 32.2 in. diagonal			120	
GVLP-165HZ	Upper part of lower plenum, 165 in. below cold leg centerline, 1.724 in. below downcomer exit, horizontal, 0-180°			121	
GVLP-172HZ	Lower plenum, 172 in. below cold leg centerline, 8.729 in. below downcomer exit, horizontal, 90-270°			121	
Pressurizer		0.1-100 lbm/ft^3	0-100 lbm/ft^3	122	
GU-PRIZE	Surge line				
LIQUID LEVEL					
Steam Generator					
DPU-SG-SEC	Secondary side, differential pressure taps at 45 and 126 in. above tube sheet, elevation difference between taps is 81 in.	±100 in. water	±5.0 psid	98	
Pressurizer					
DPU-PRESLL	Pressurizer water level, elevation difference between taps is 34 in., lower tap is approximately 3.5 in. above pressurizer exit	±50 in. water	±2.5 psid	84	
MASS FLOW RATE	Mass flow rate obtained by combining density (gamma attenuation technique) with volumetric flow rate (turbine flowmeter) or momentum flux (drag disc)	Range for mass flow is determined from range of individual detectors used in calculation			
Intact Loop					
FDU-1 GU-1VR FTU-1 GU-1VR	Hot leg, Spool 1			123 124	
FDU-5 GU-5VR	Hot leg, Spool 5			125	
FTU-9 GU-10VR	Cold leg, Spool 9			126	
FDU-10 GU-10VR	Cold leg, Spool 10			127	
FDU-13 GU-13VR FTU-13 GU-13VR	Cold leg, Spool 13			128 129	
FDU-15 GU-15VR FTU-15 GU-15VR	Cold leg, Spool 15			130 131	
FTU-PRIZE GU-PRIZE	Pressurizer surge line				FTU-PRIZE failed
Broken Loop					
FDB-21 GB-21VR FTB-21 GB-21VR	Cold leg, Spool 21			132 133	Discrepancies in mass flow measurements from FDB-21 and FTB-21 may be due to changes in the calibration factors due to the combined effects of two phase flow and complex geometries not accounted for in present calibration techniques
FDB-23 GB-23VR	Cold leg, Spool 23			134	
FDB-30 GB-30VR FTB-30 GB-30VR	Hot leg, Spool 30			135 136	
FDB-42 GB-42VR	Cold leg, Spool 42			137	

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-4

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement Comments[b]
MASS FLOW RATE (contd.)					
Vessel					
FTV-CORE-IN GV-COR-150HZ	Entrance to core			138	
FDV-CORE-IN GV-COR-150HZ	Entrance to core			139	
CORE CHARACTERISTICS					
PWRCOR T-1	Core power		1600 kW	140	
PWRCOR T-2	Core power		1600 kW	140	
VOLTCORE-T	Core voltage		200 V	141	
AMPCORE-T	Core current		10,000 A	142	
F5 AMPS	Total current heater pin F5			143	
PUMP CHARACTERISTICS					
PUMPU-TORQ	Pump torque	0-500 in.-lb	0-500 in.-lb	144	
PUMPU-POW	Pump motor power		25 kW	145	
PUMPU-RPM	Pump speed	0-3600 rpm	0-3600 rpm	146	

[a] Statements at the beginning of a measurement category regarding location and comments, range, and figure apply to all subsequent measurements within the given category unless specified otherwise.

[b] Detectors which were subjected to overrange conditions during portions of the test were capable of withstanding these conditions without change in operating or measuring characteristics when the physical conditions were again within the detector range.

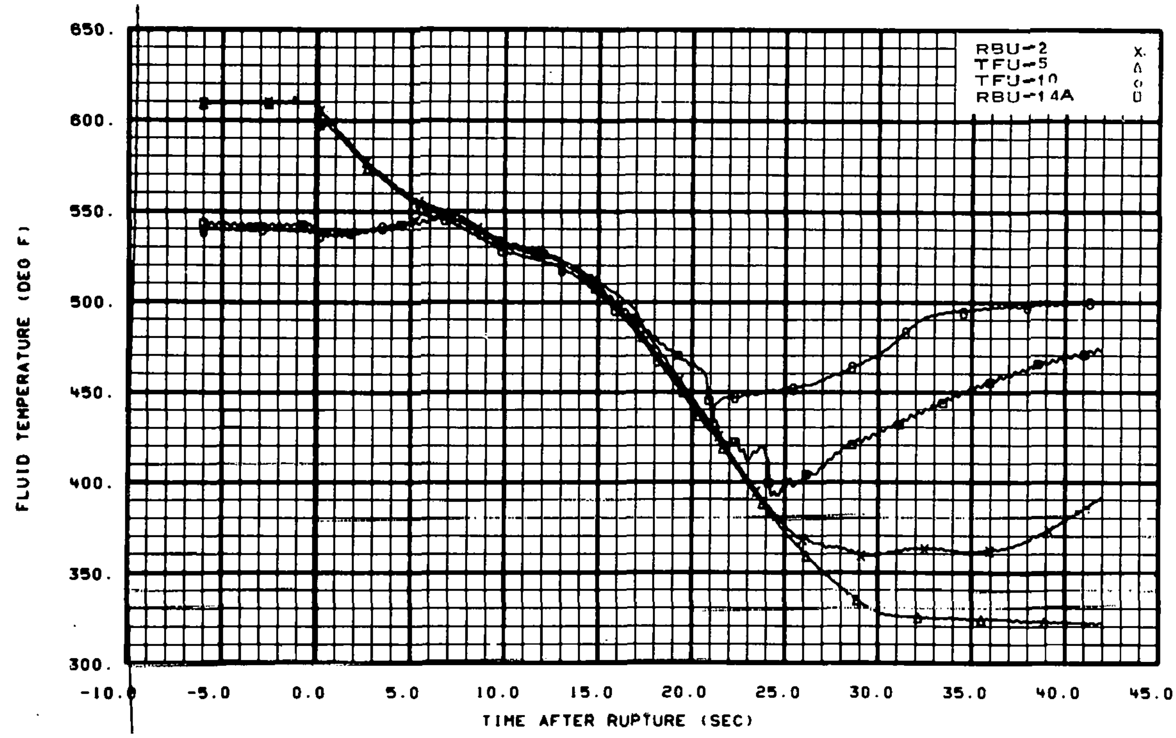

Fig. 7 Fluid temperature in intact loop.

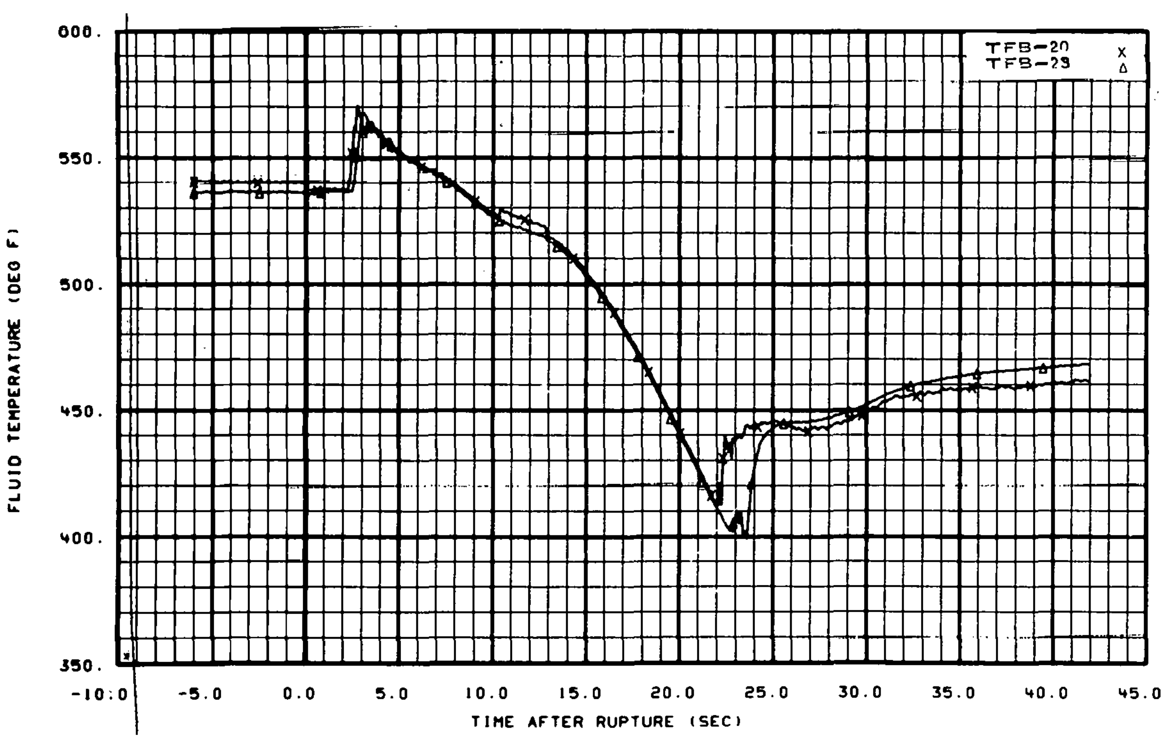

Fig. 8 Fluid temperature in broken loop (vessel side).

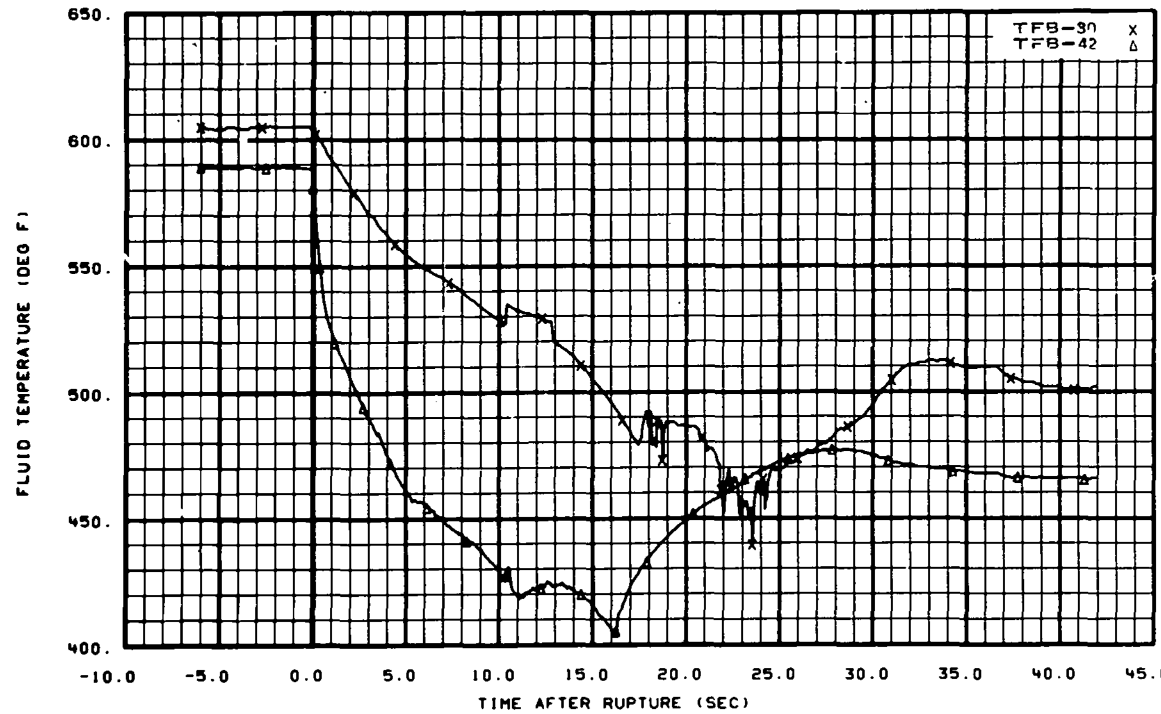

Fig. 9 Fluid temperature in broken loop (pump side).

Fig. 10 Fluid temperature in downcomer annulus (upper).

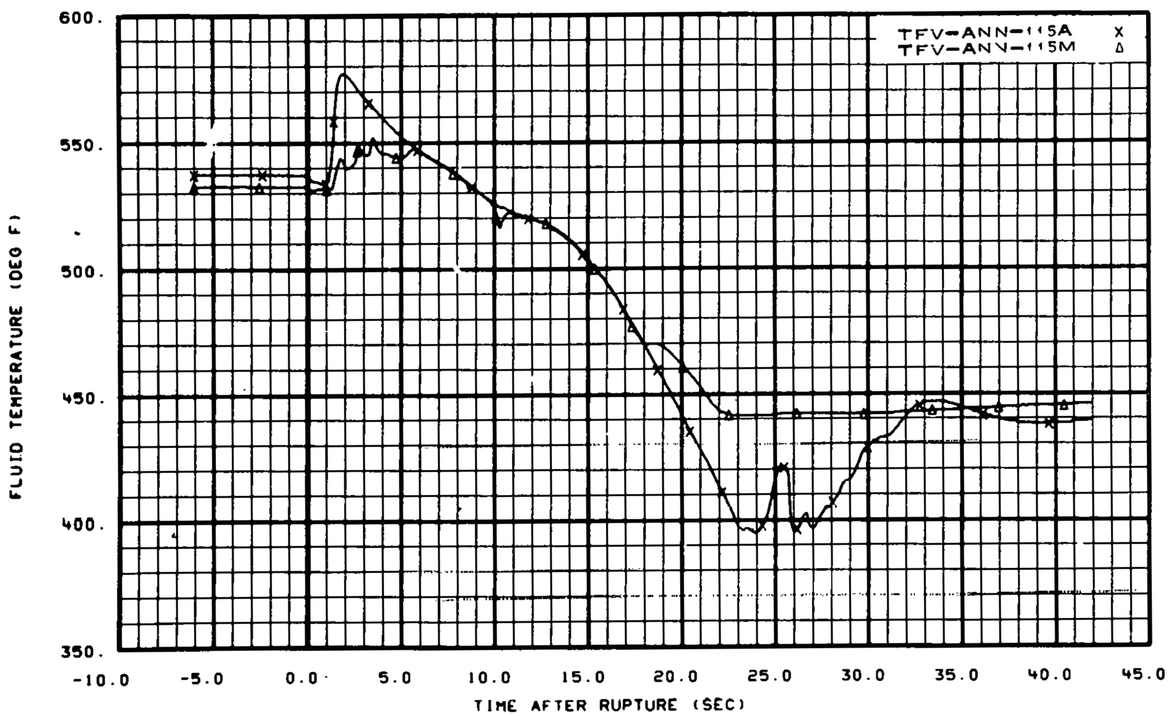

Fig. 11 Fluid temperature in downcomer annulus (lower).

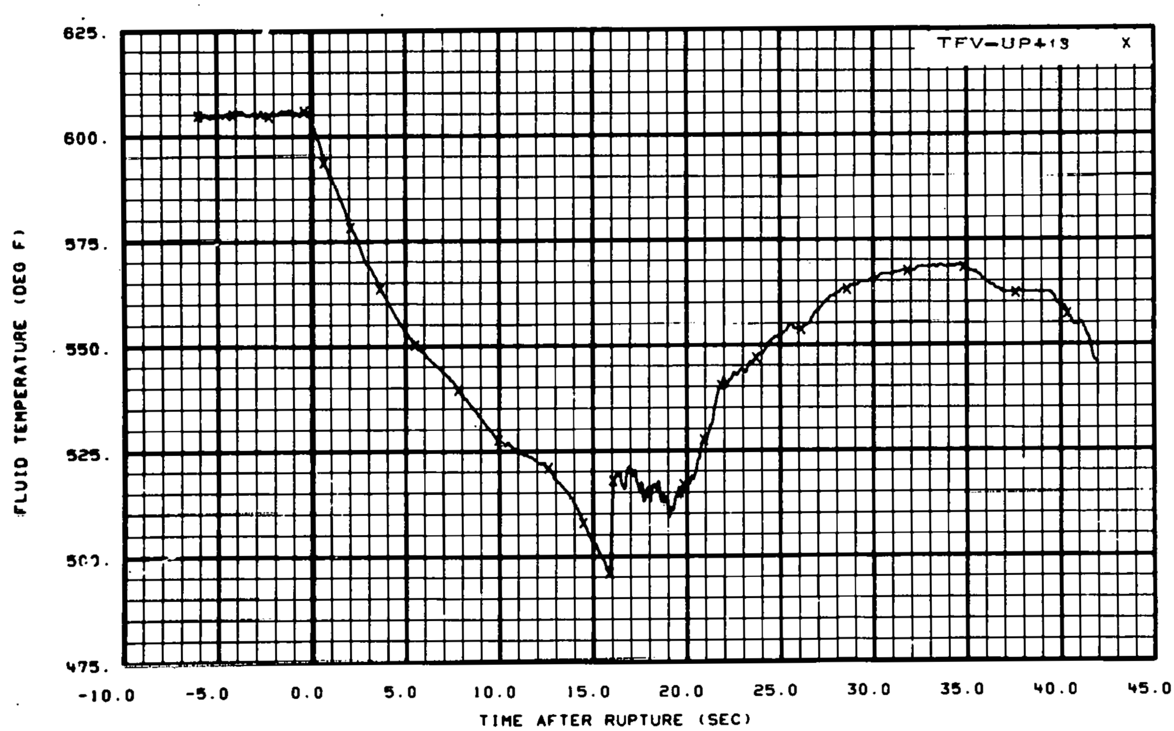

Fig. 12 Fluid temperature in upper plenum.

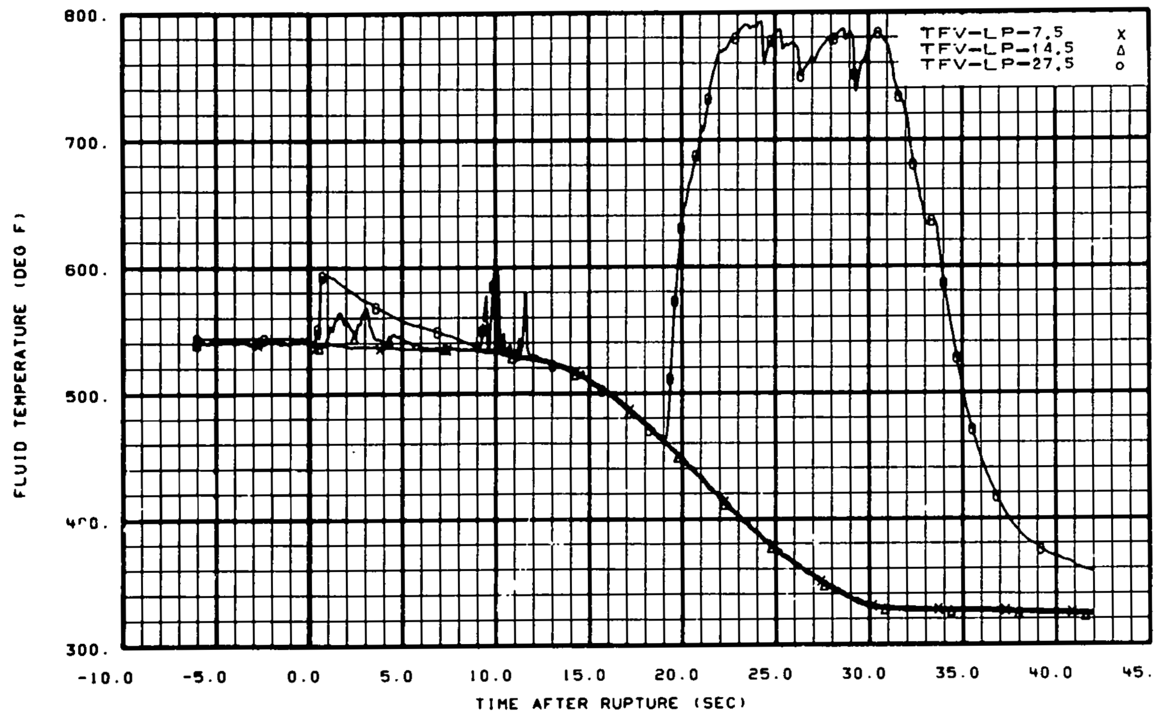

Fig. 13 Fluid temperature in lower plenum.

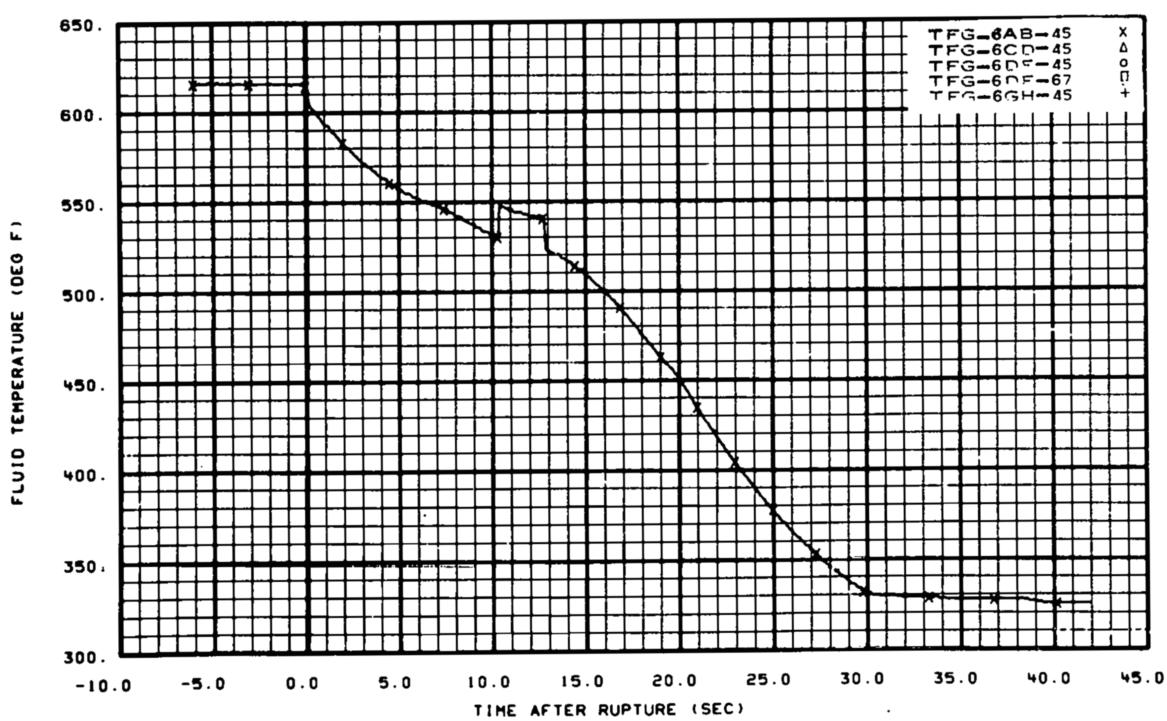

Fig. 14 Fluid temperature in core (Grid Spacer 5).

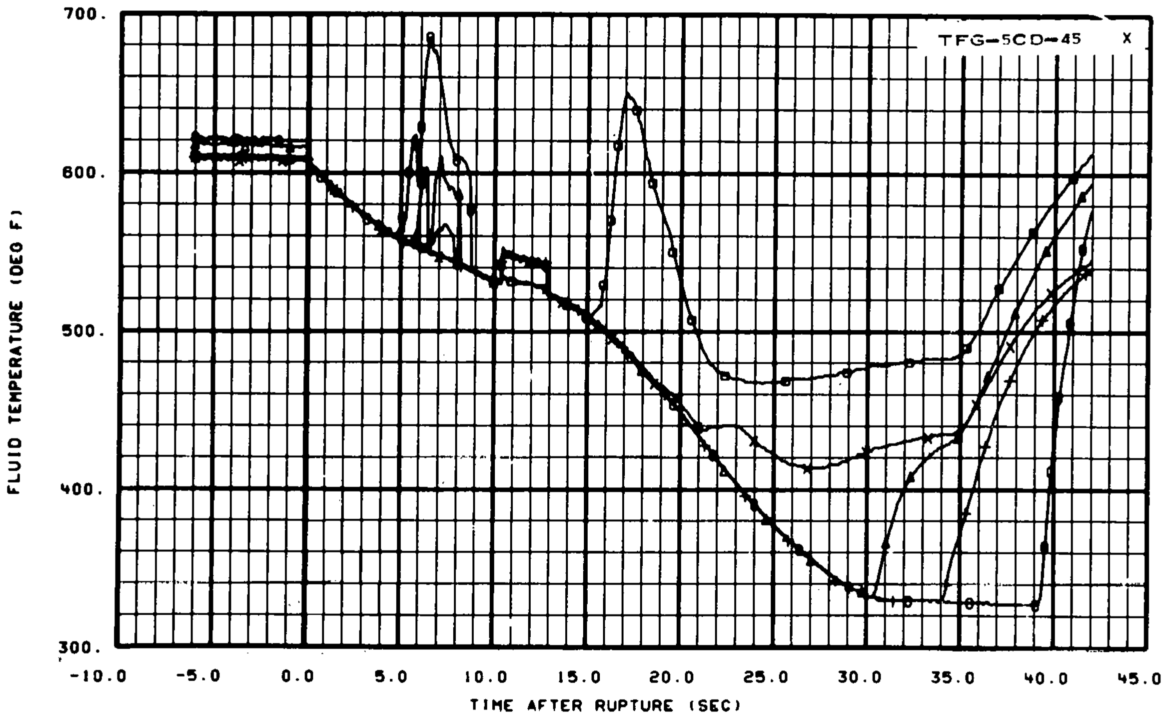

Fig. 15 Fluid temperature in core (Grid Spacer 6).

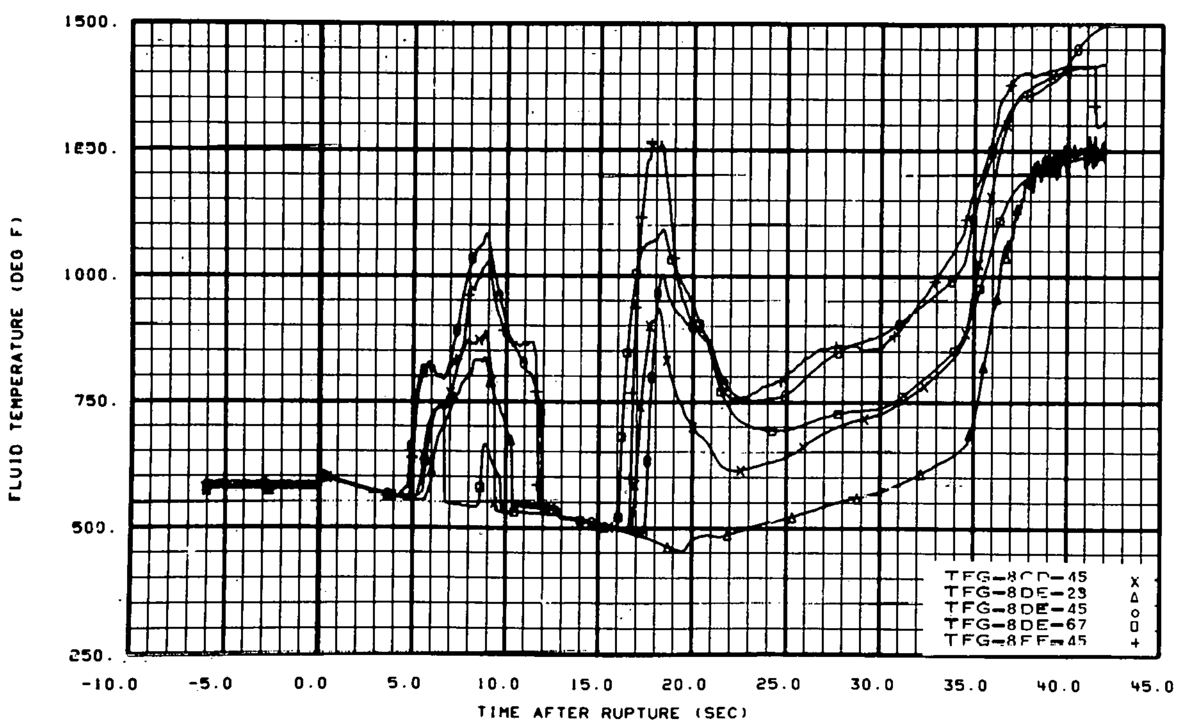

Fig. 16 Fluid temperature in core (Grid Spacer 8).

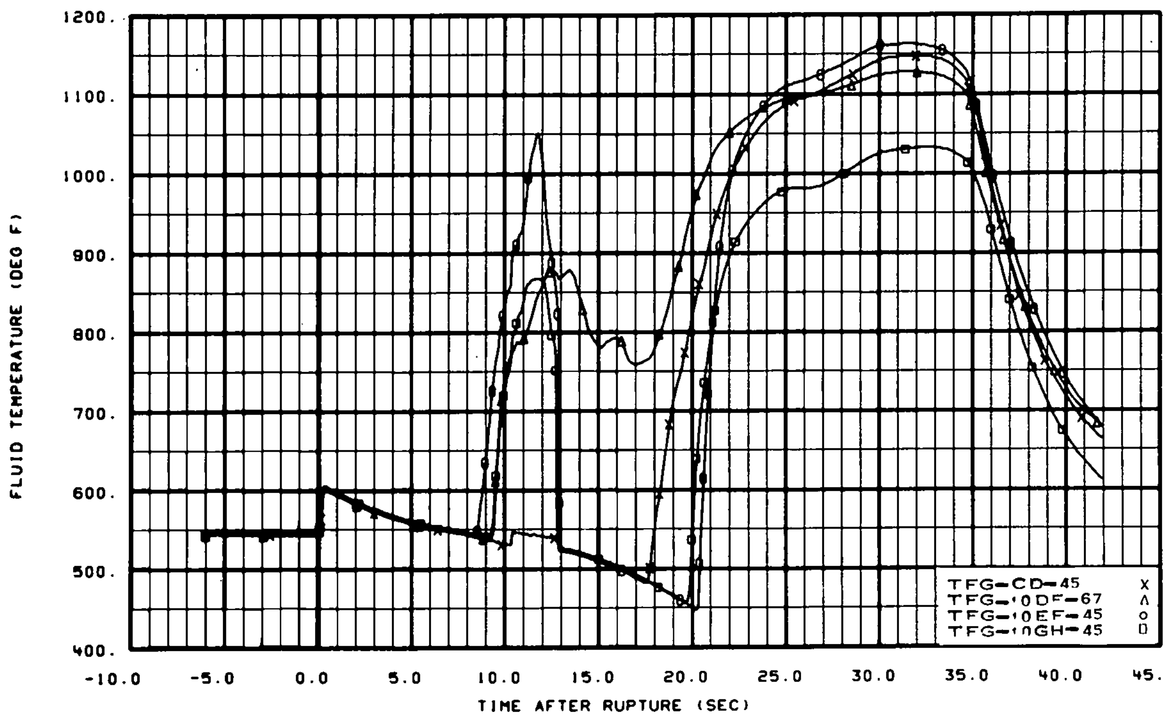

Fig. 17 Fluid temperature in core (Grid Spacer 10).

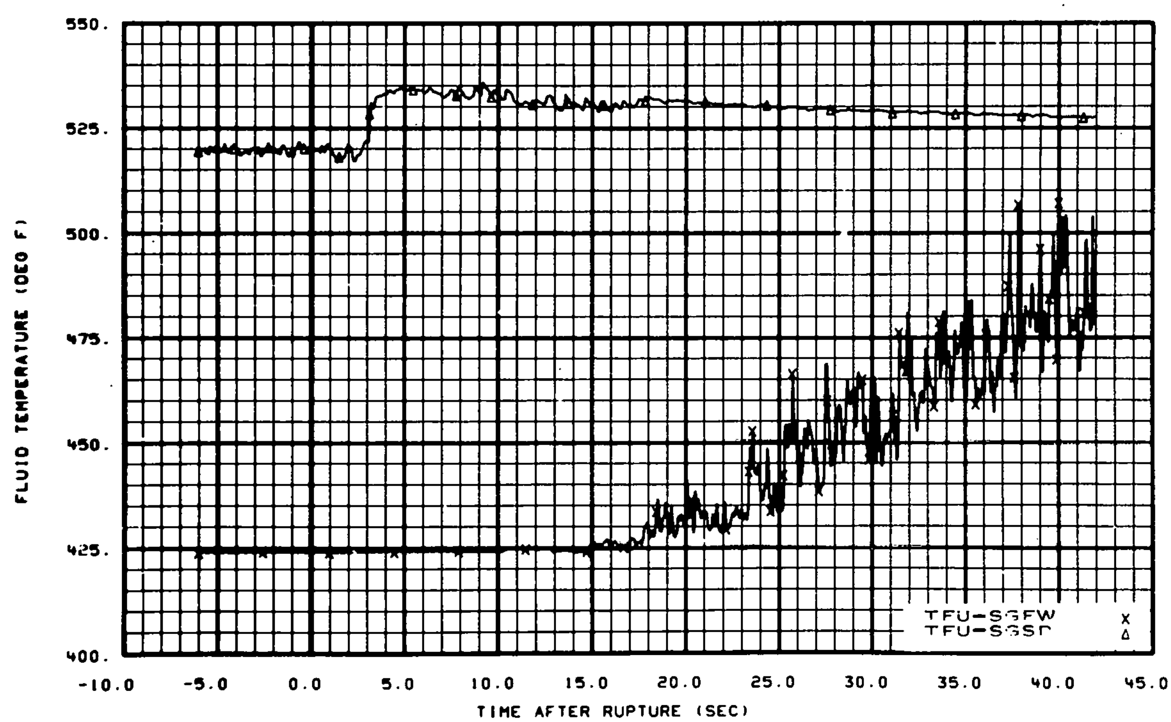

Fig. 18 Fluid temperature in steam generator inlet and outlet.

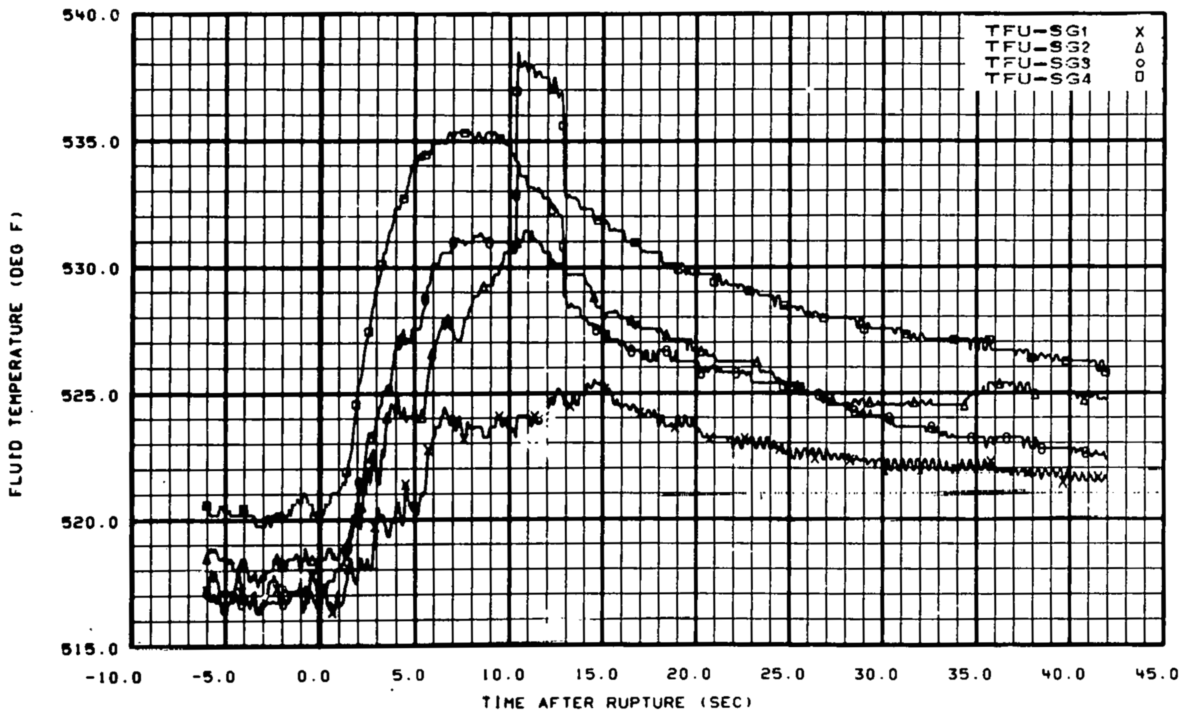

Fig. 19 Fluid temperature in steam generator.

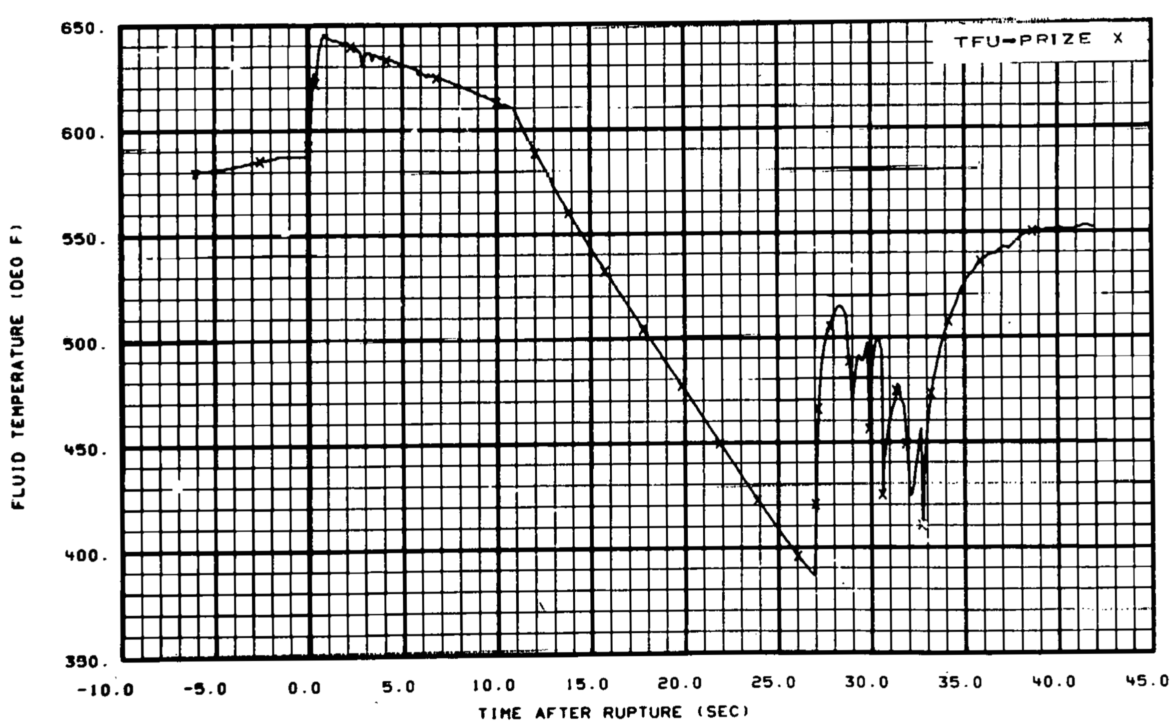

Fig. 20 Fluid temperature in prcssurizer surge line.

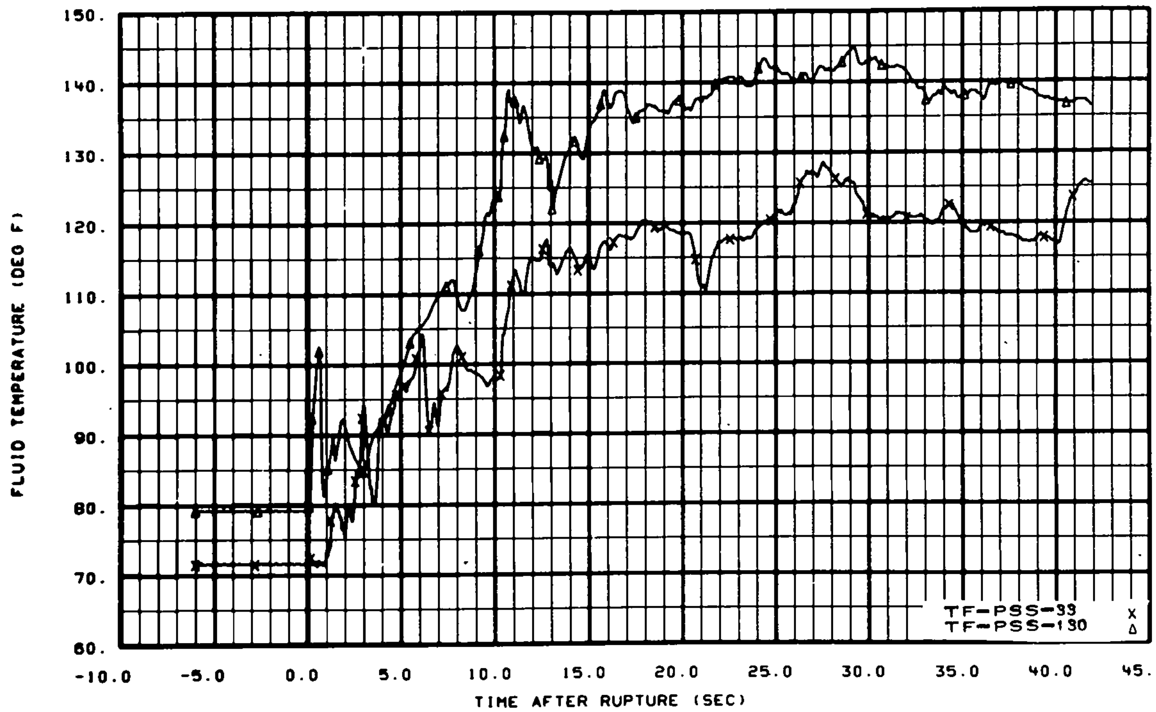

Fig. 21 Fluid temperature in pressure suppression system.

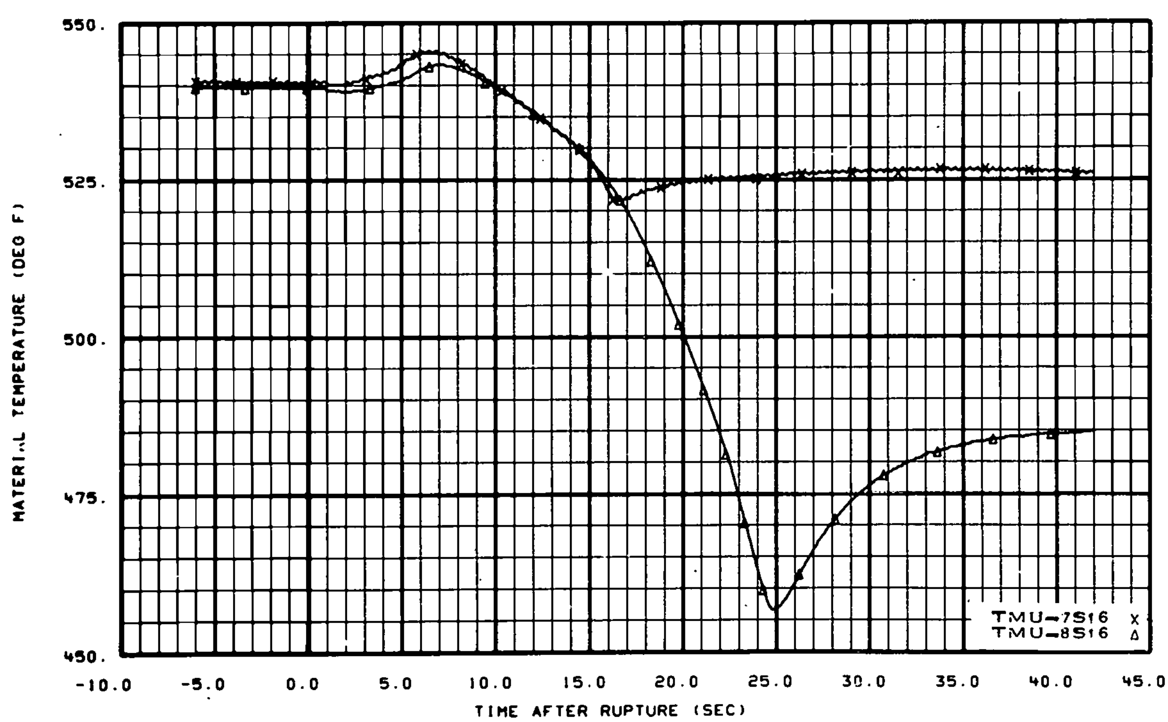

Fig. 22 Material temperature in intact loop.

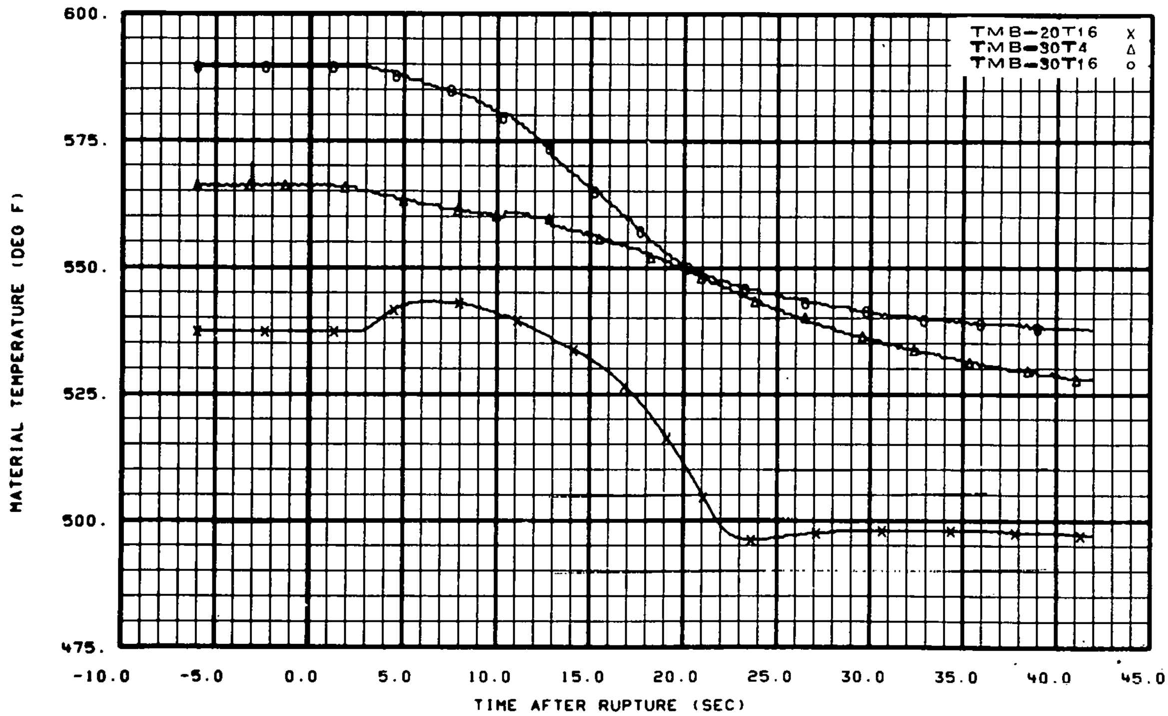

Fig. 23 Material temperature in broken loop.

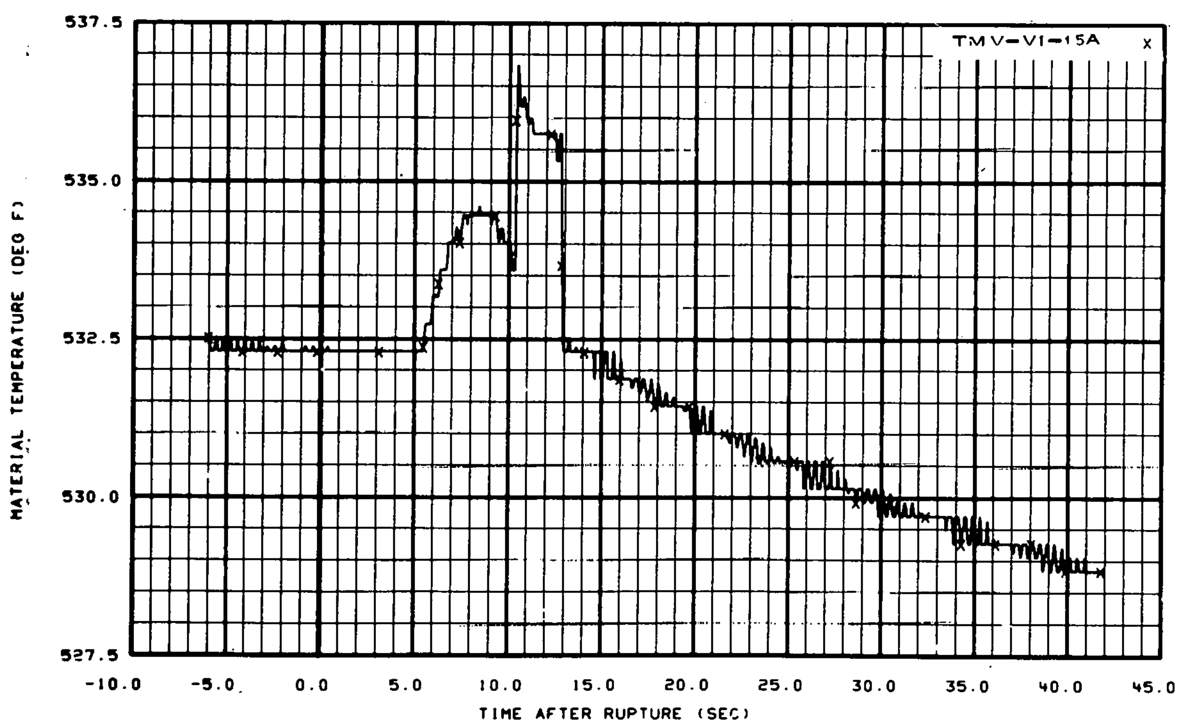

Fig. 24 Material temperature in vessel wall.

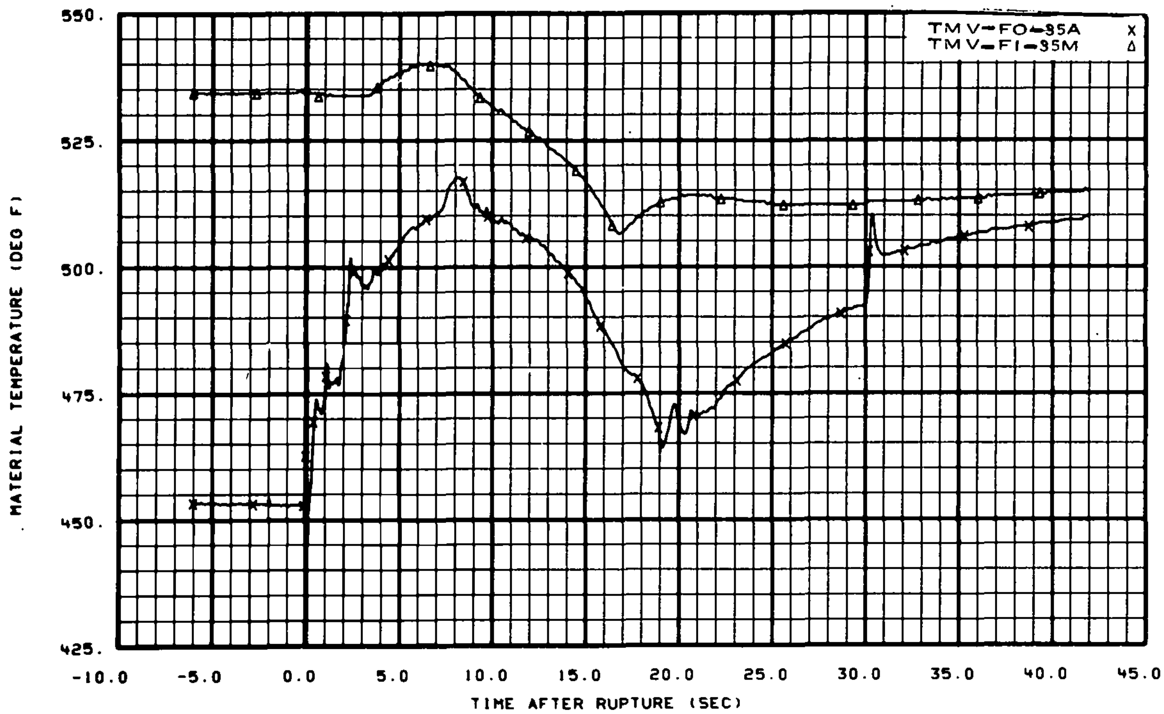

Fig. 25 Material temperature in vessel filler.

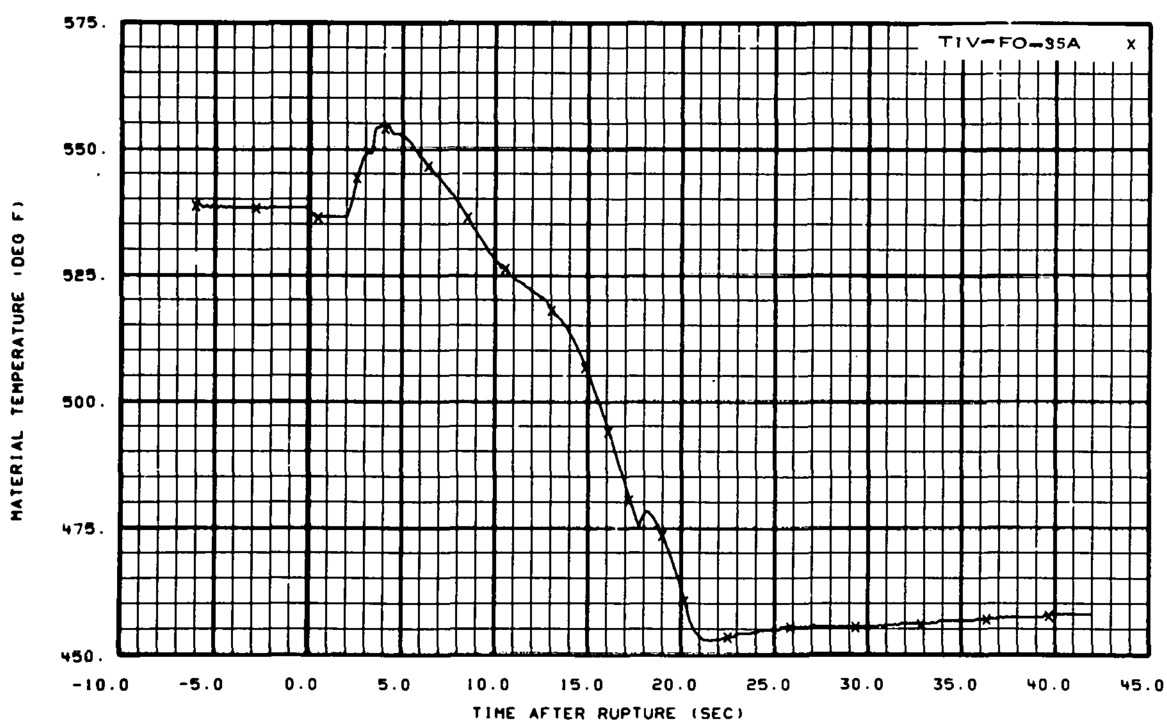

Fig. 26 Material temperature in vessel filler insulator.

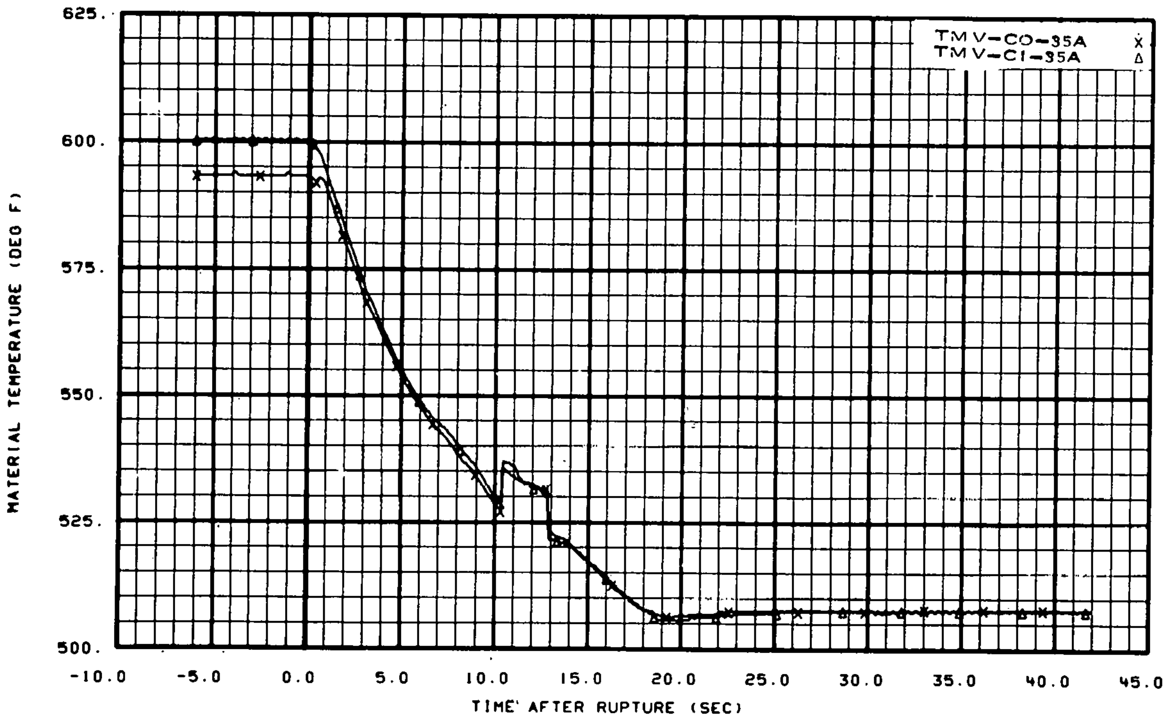

Fig. 27 Material temperature in core barrel.

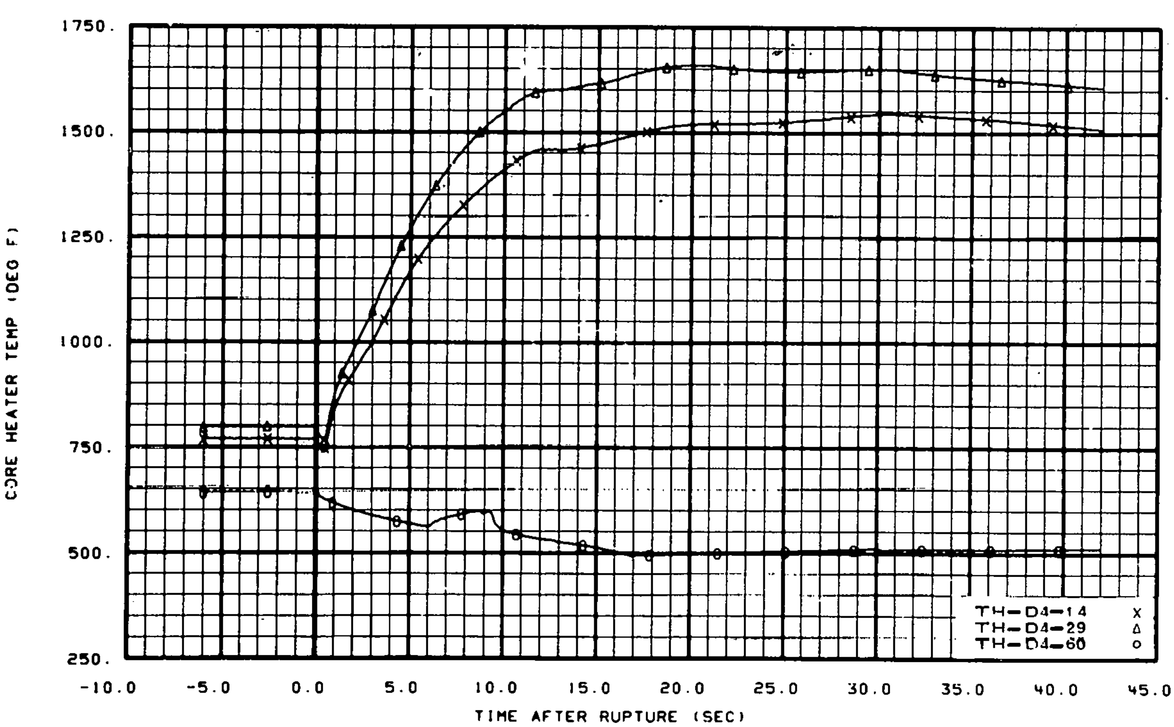

Fig. 28 Core heater temperature, Rod D-4.

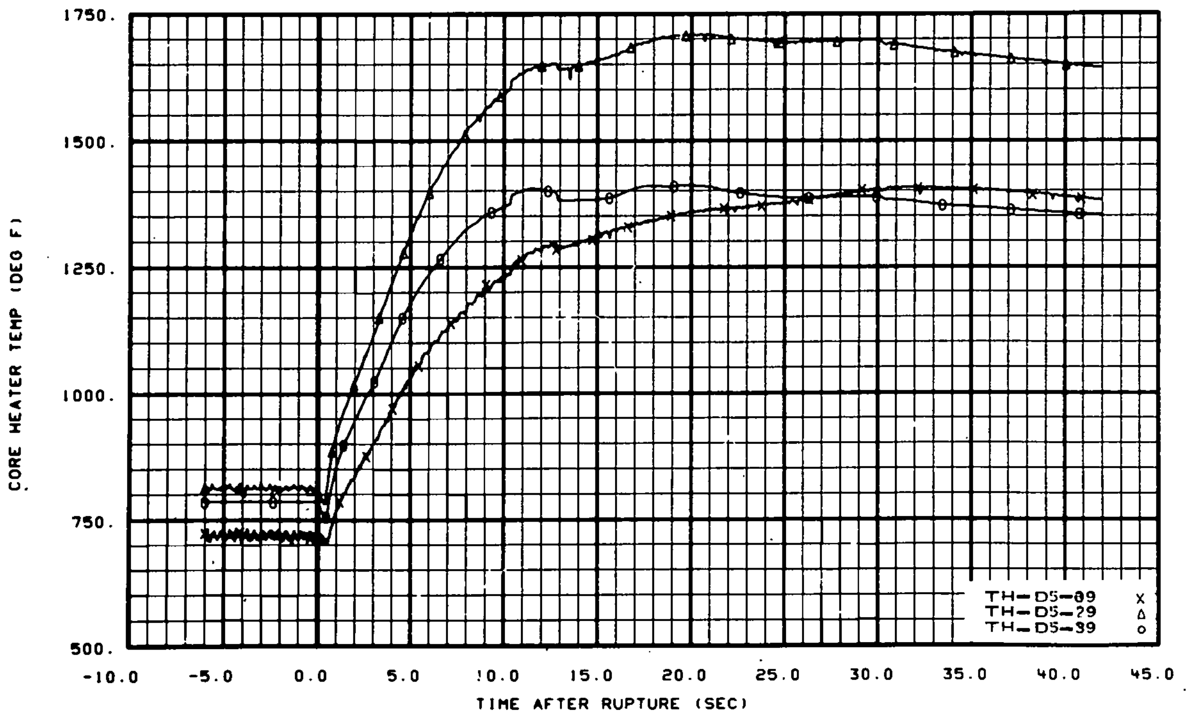

Fig. 29 Core heater temperature, Rod D-5.

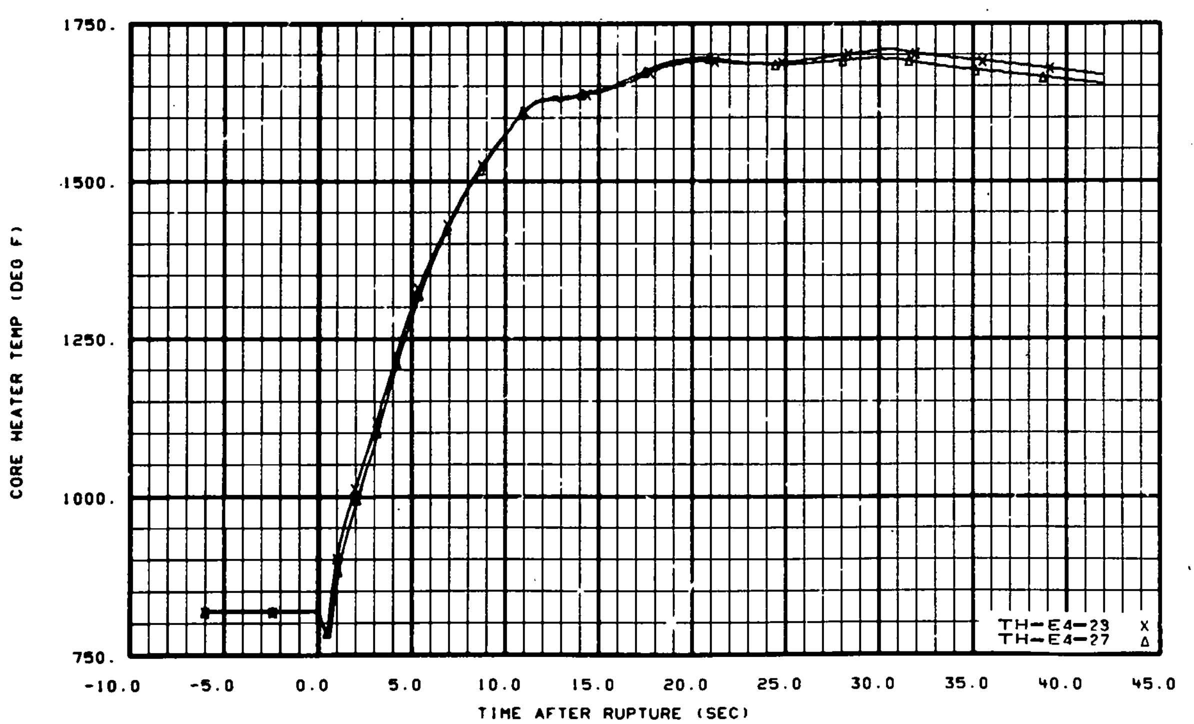

Fig. 30 Core heater temperature, Rod E-4.

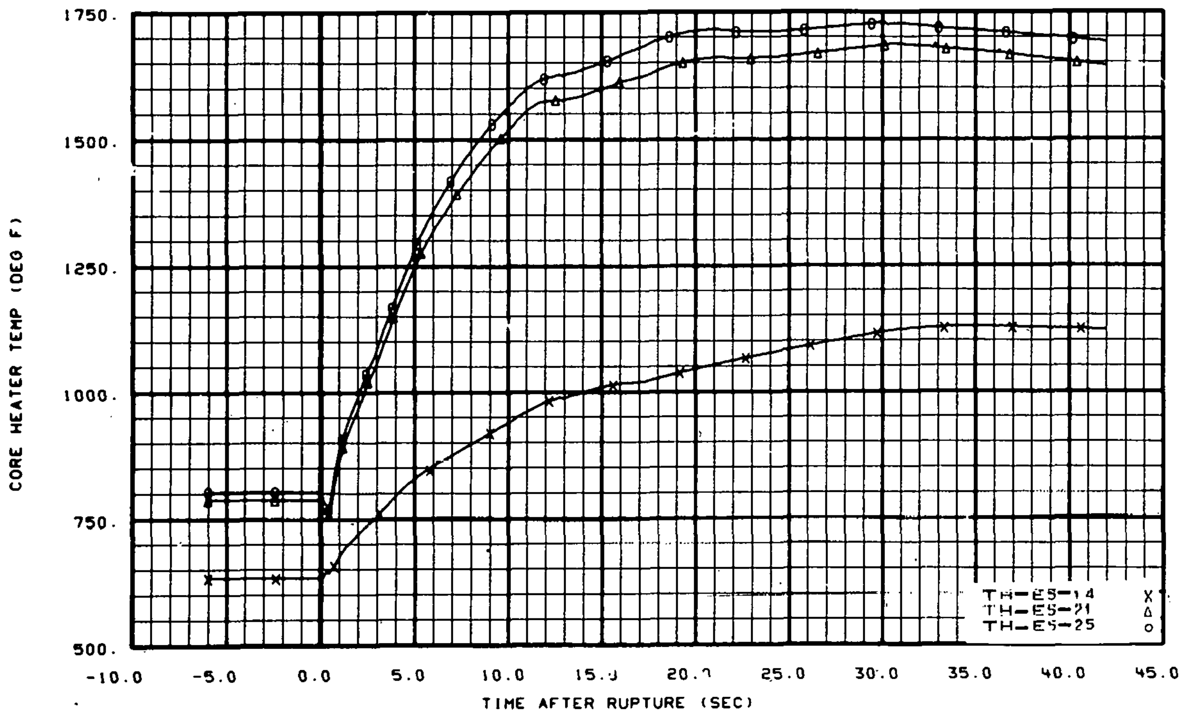

Fig. 31 Core heater temperature, Rod E-5.

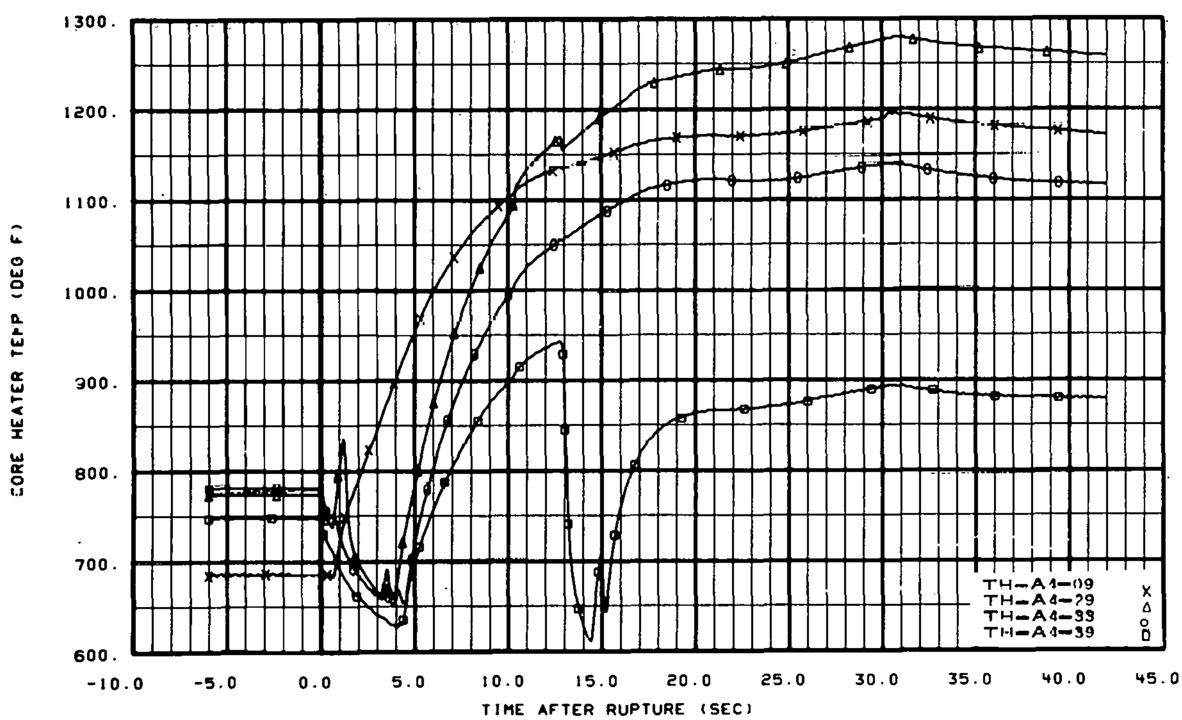

Fig. 32 Core heater temperature, Rod A-4.

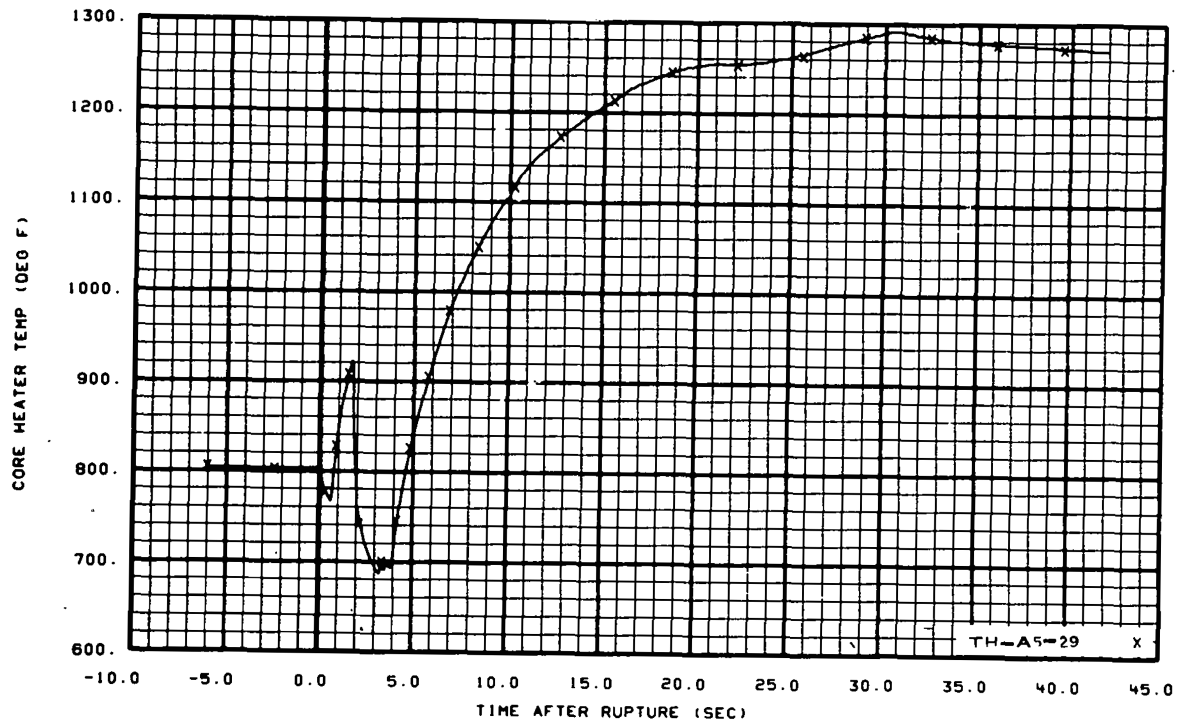

Fig. 33 Core heater temperature, Rod A-5.

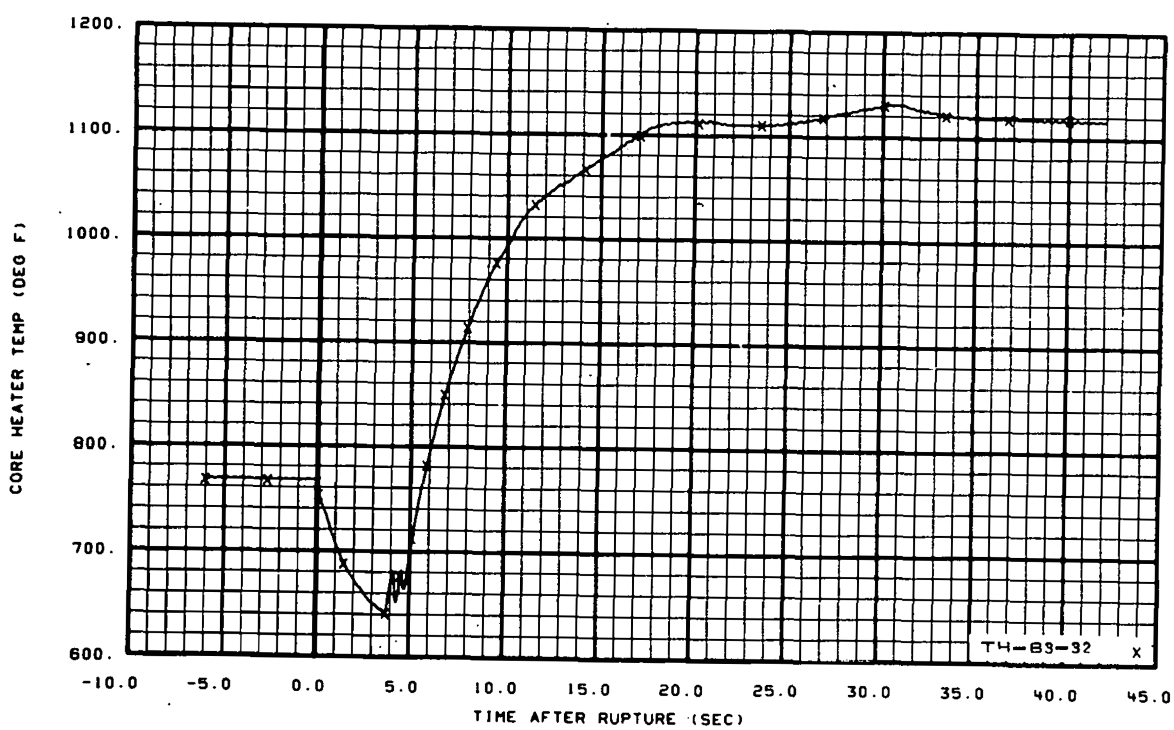

Fig. 34 Core heater temperature, Rod B-3.

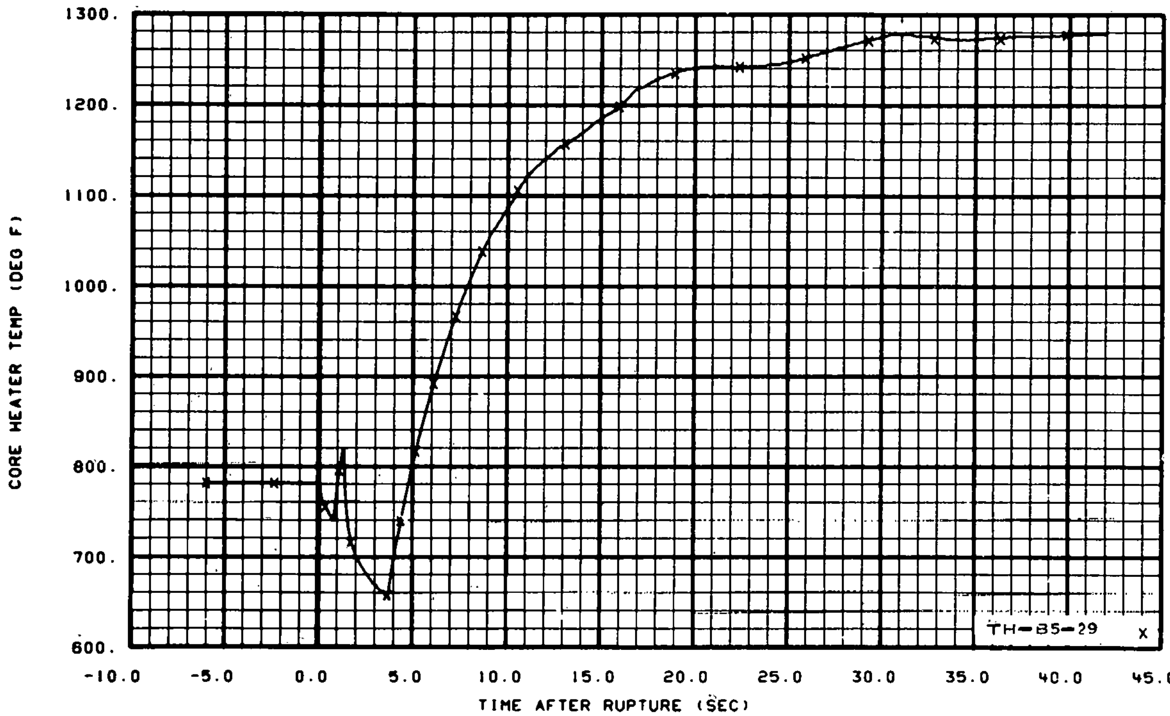

Fig. 35 Core heater temperature, Rod B-5.

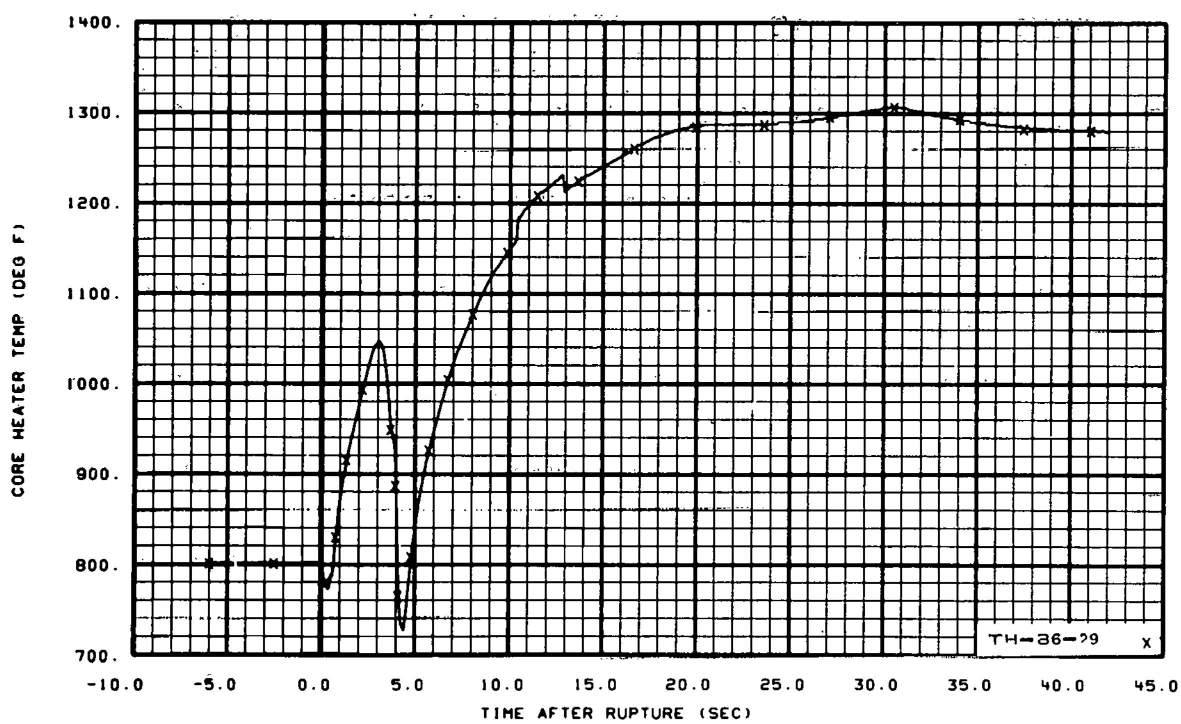

Fig. 36 Core heater temperature, Rod B-6.

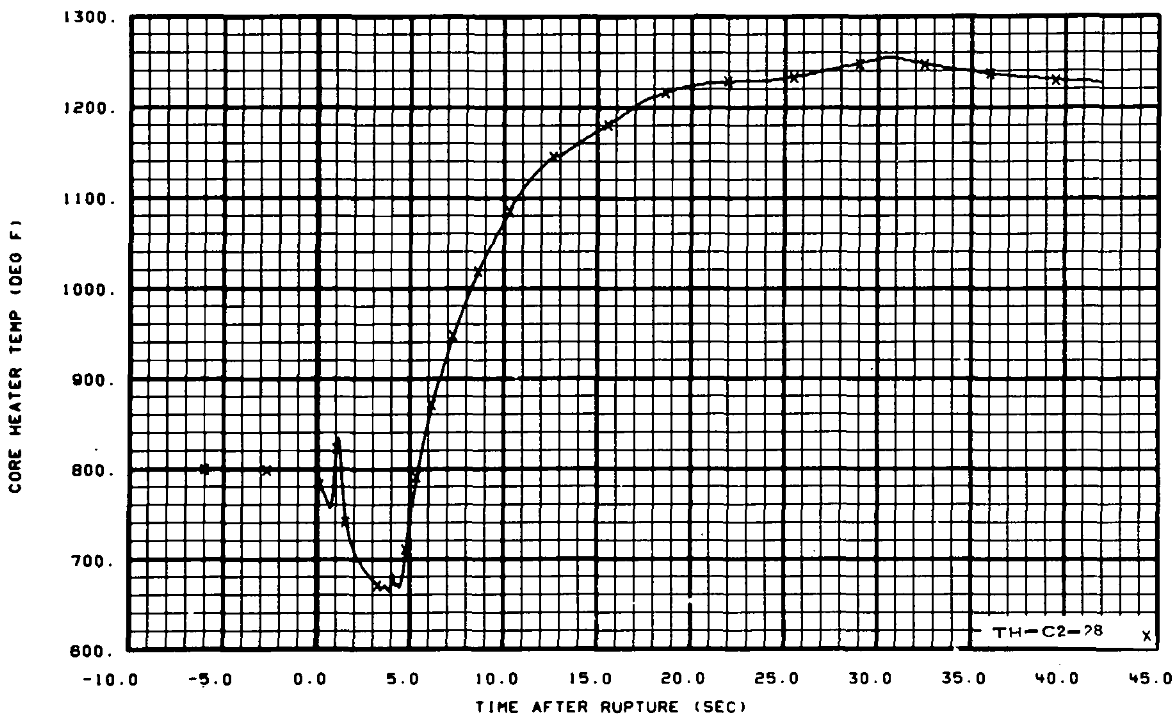

Fig. 37 Core heater temperature, Rod C-2.

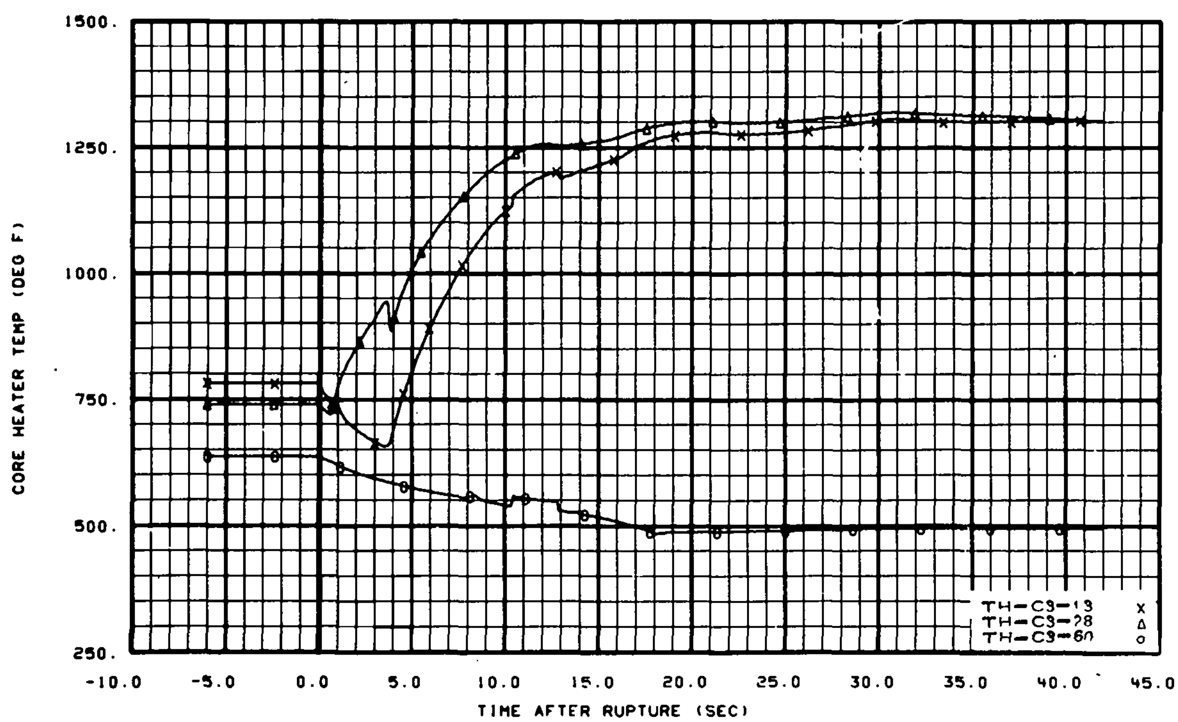

Fig. 38 Core heater temperature, Rod C-3.

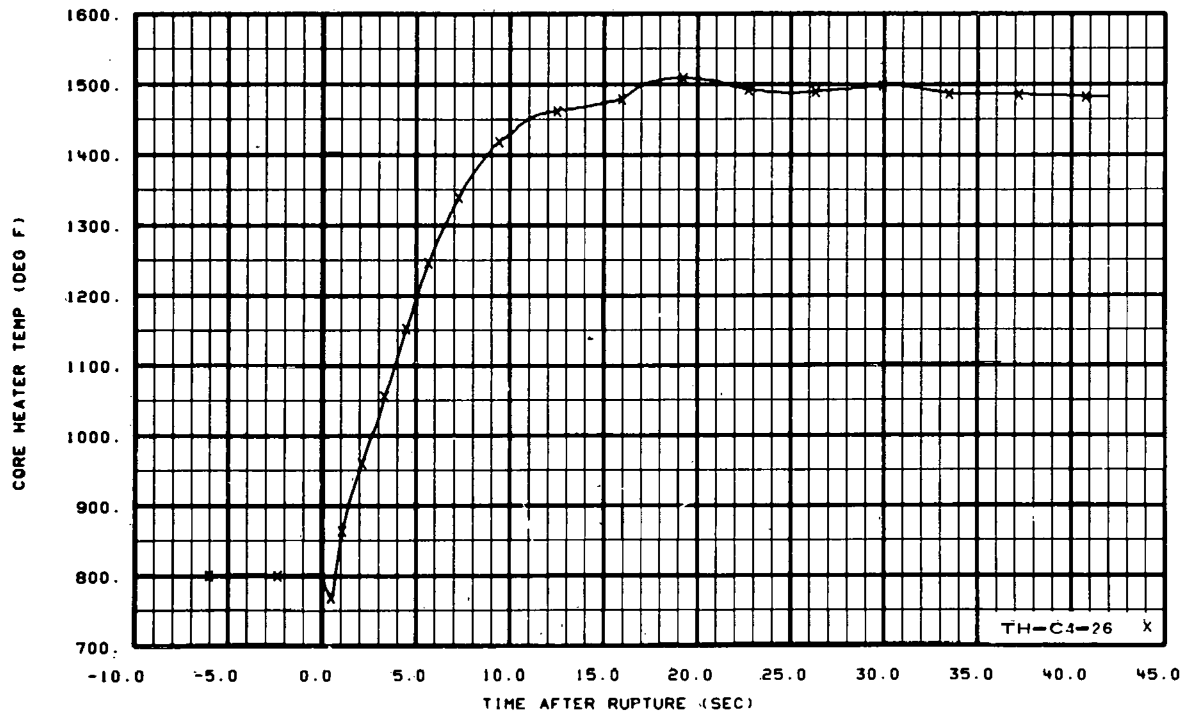

Fig. 39 Core heater temperature, Rod C-4.

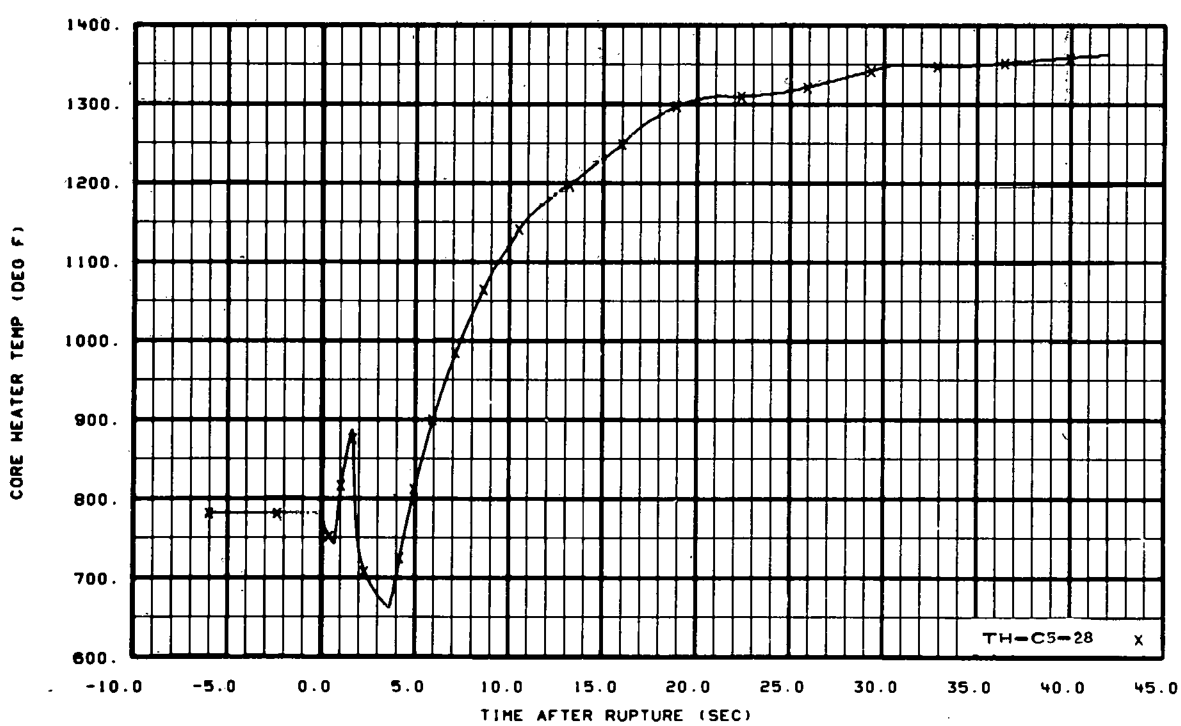

Fig. 40 Core heater temperature, Rod C-5.

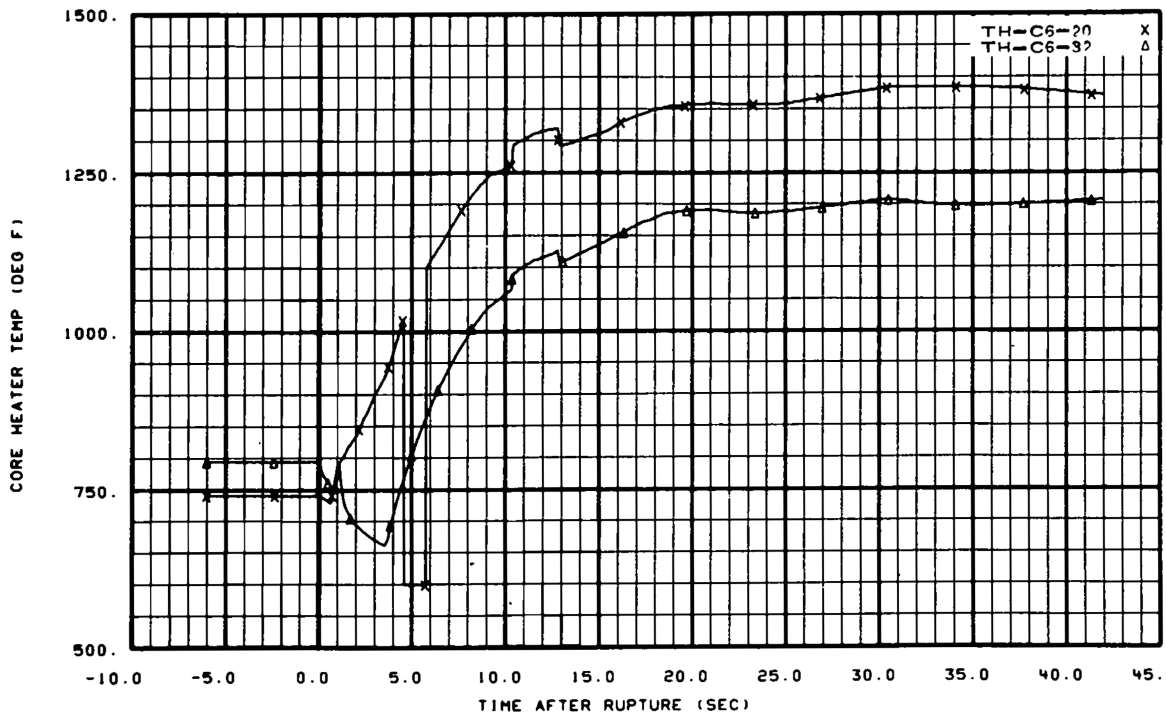

Fig. 41 Core heater temperature, Rod C-6.

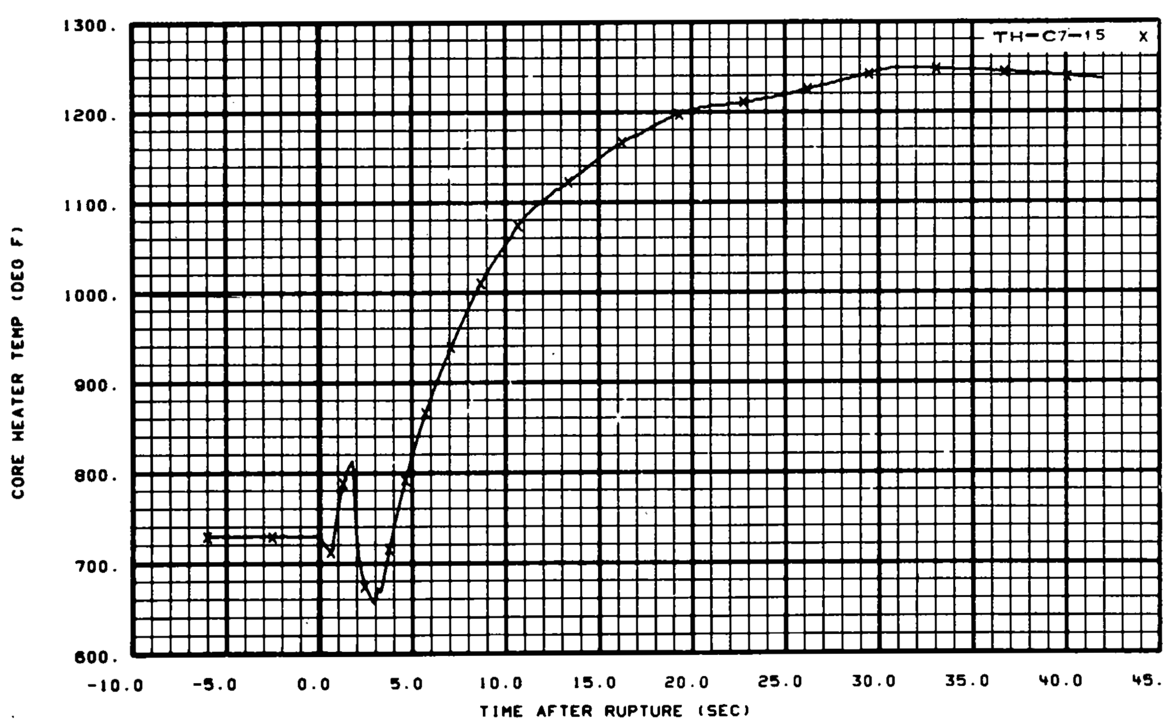

Fig. 42 Core heater temperature, Rod C-7.

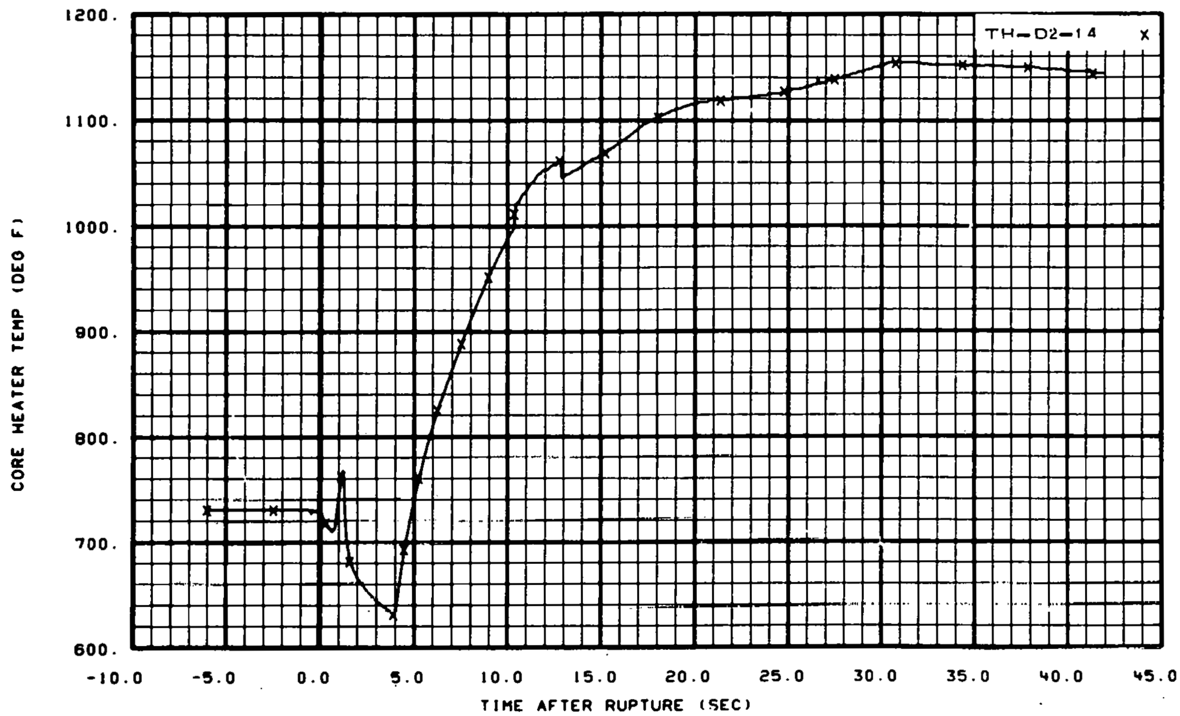

Fig. 43 Core heater temperature, Rod D-2.

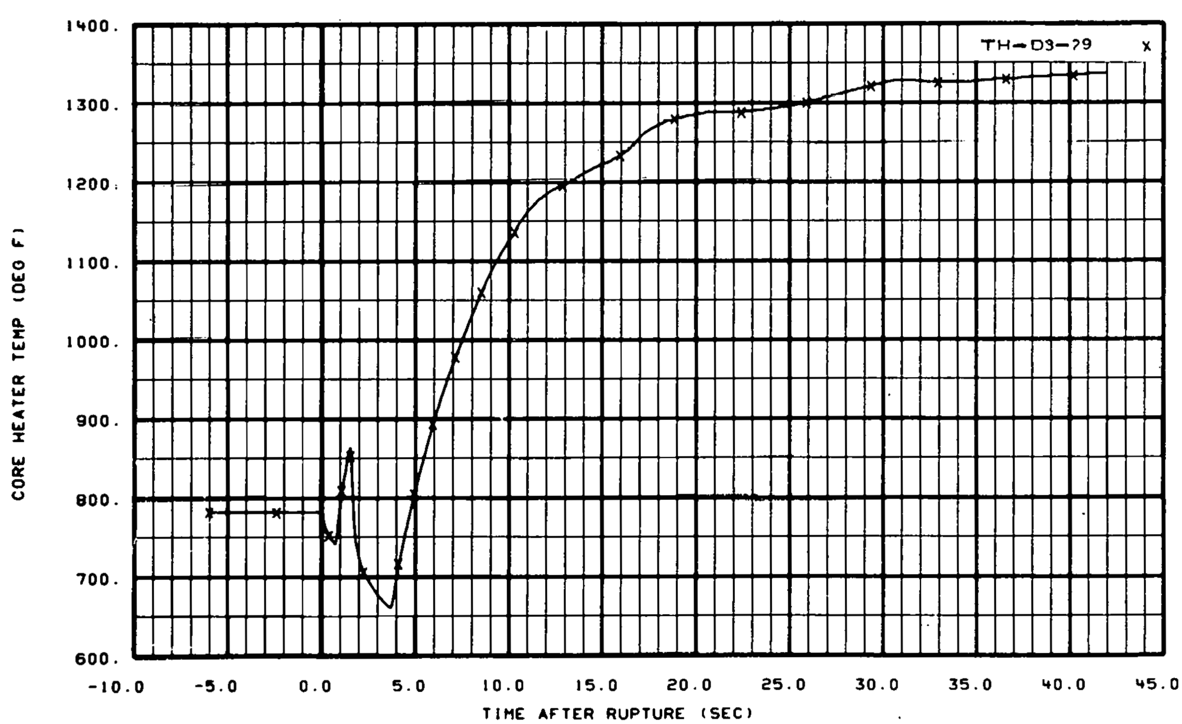

Fig. 44 Core heater temperature, Rod D-3.

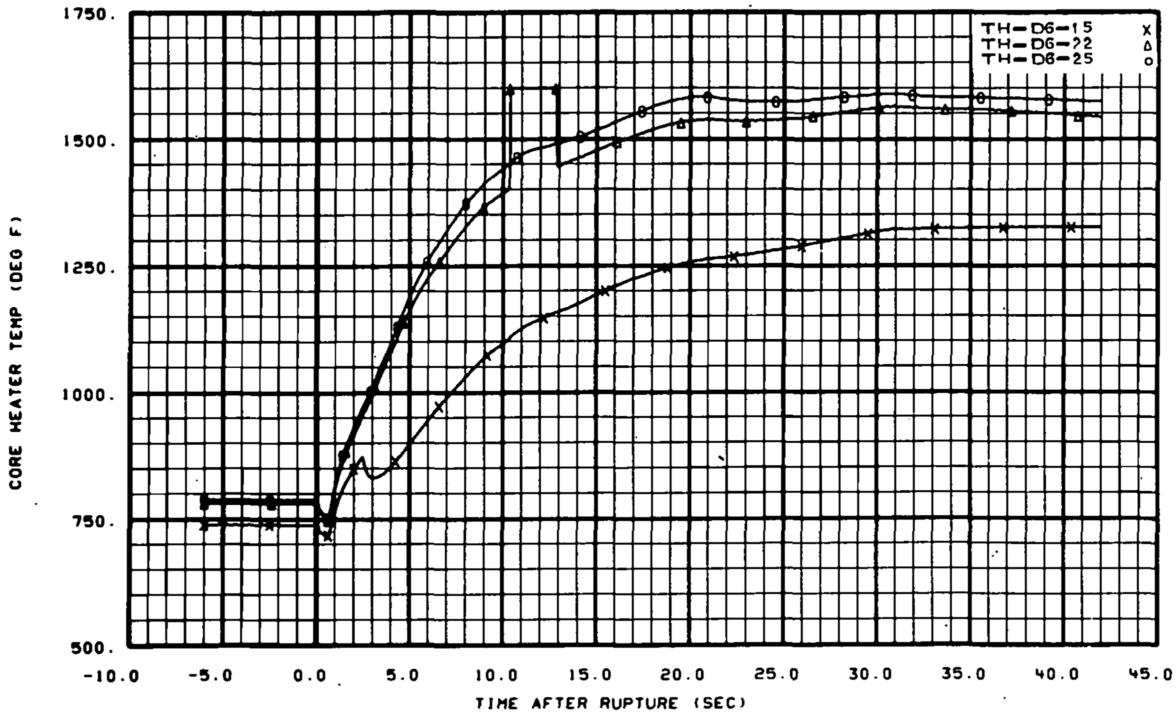

Fig. 45 Core heater temperature, Rod D-6.

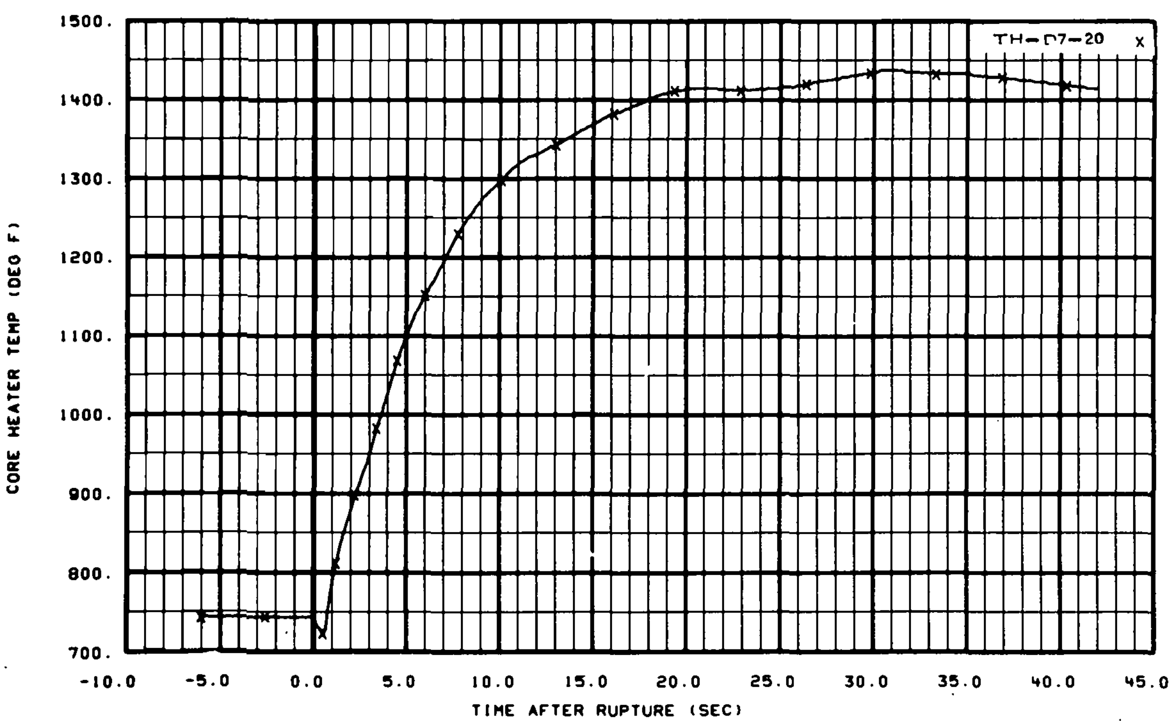

Fig. 46 Core heater temperature, Rod D-8.

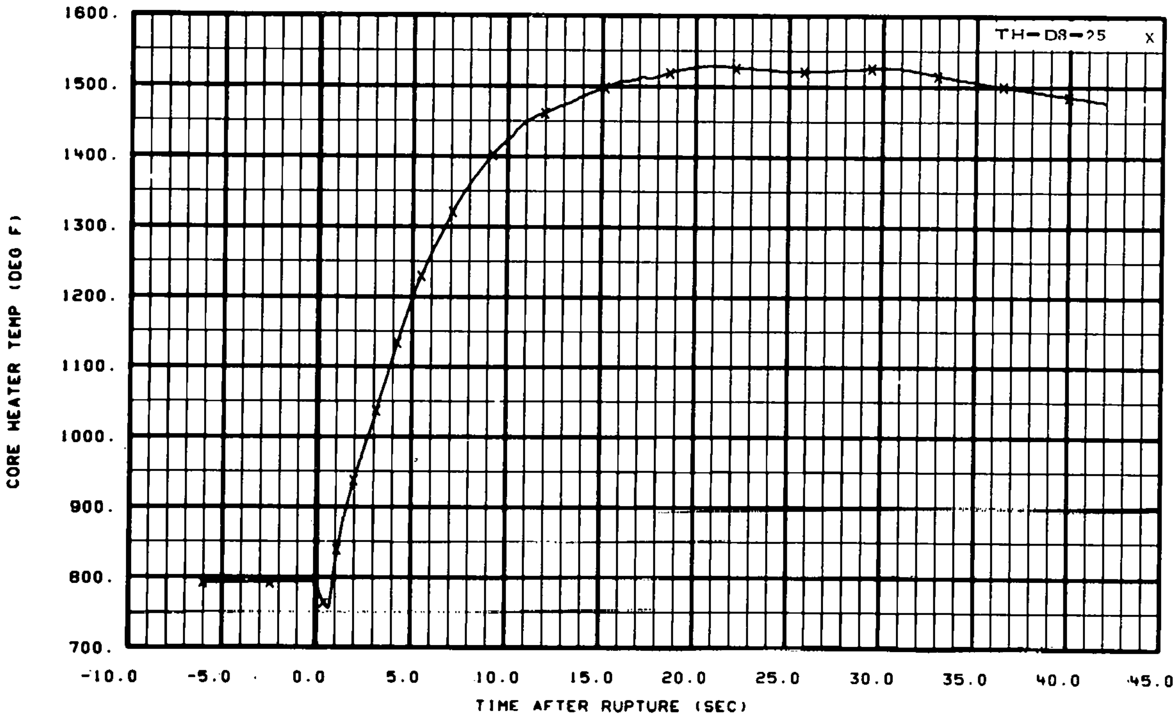

Fig. 47 Core heater temperature, Rod D-8.

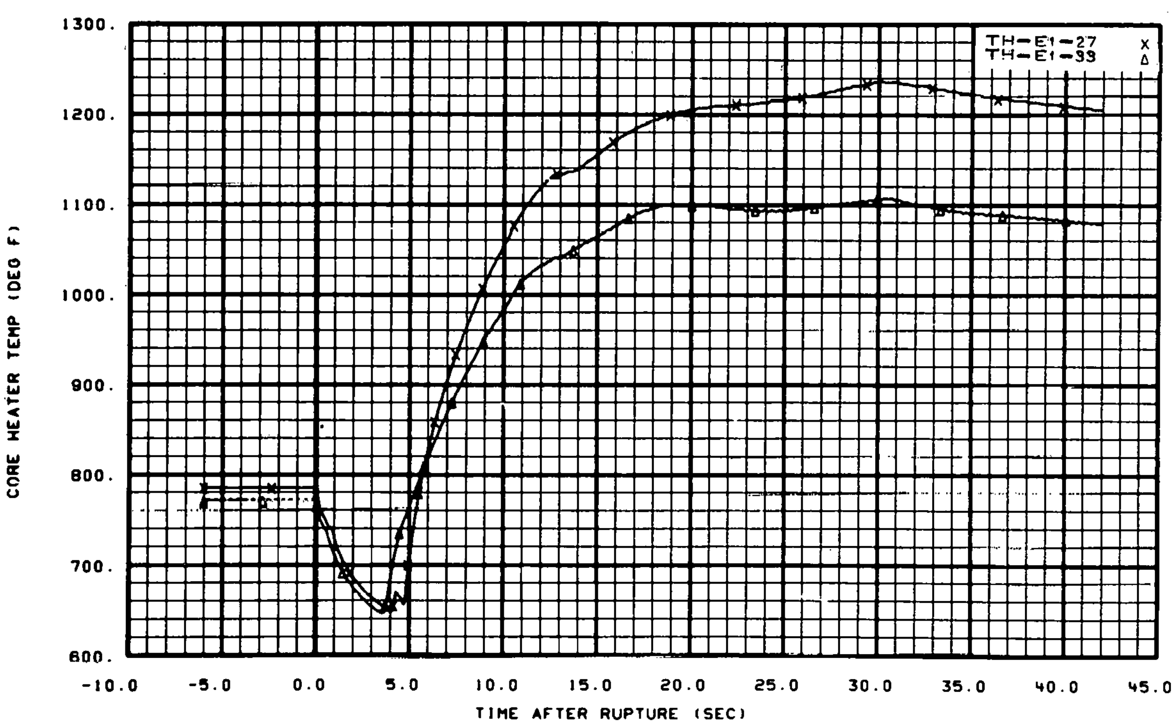

Fig. 48 Core heater temperature, Rod E-1.

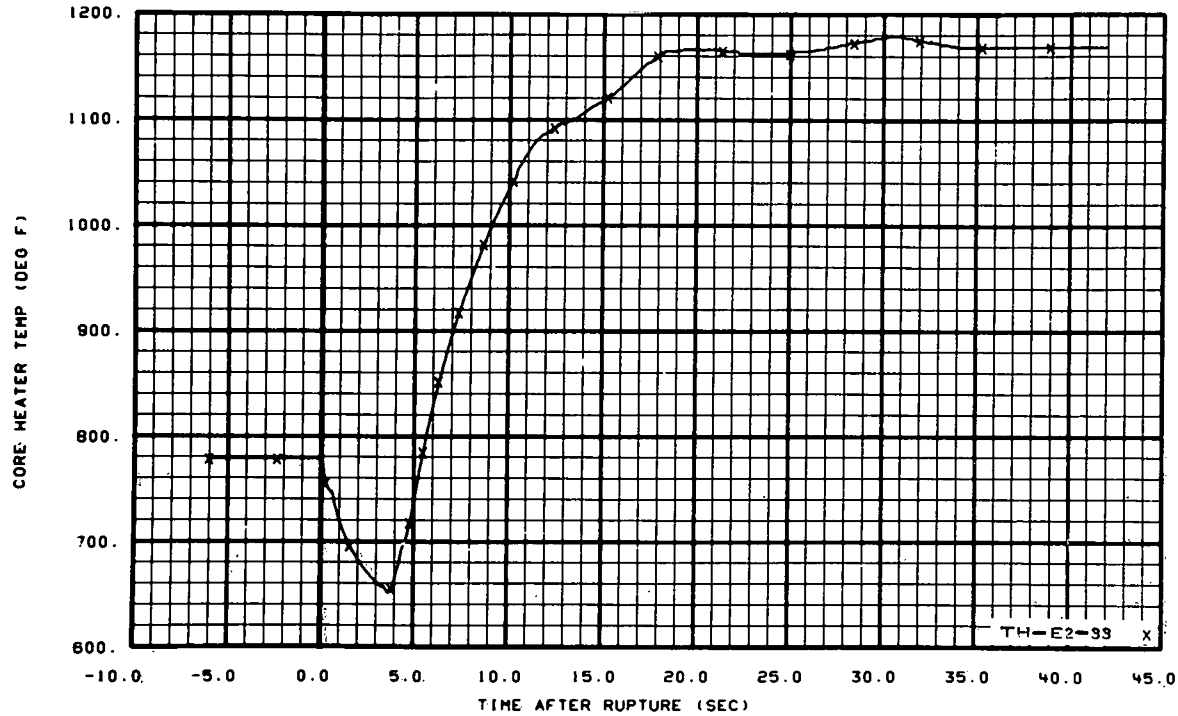

Fig. 49 Core heater temperature, Rod E-2.

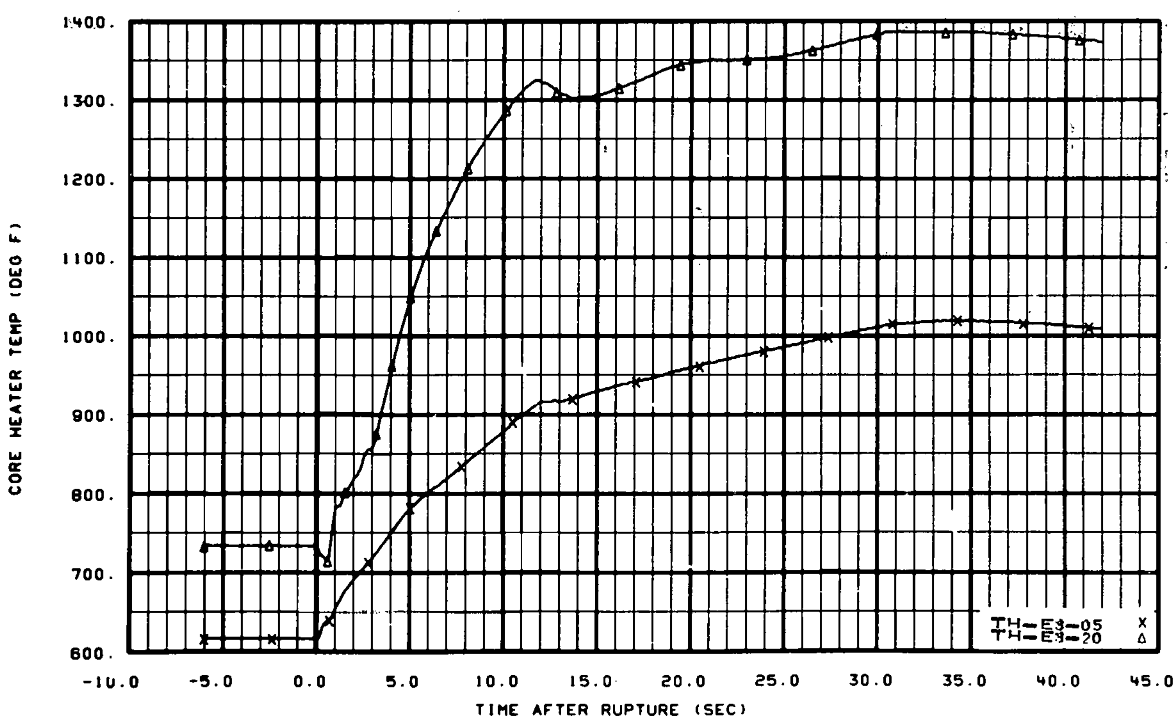

Fig. 50 Core heater temperature, Rod E-3.

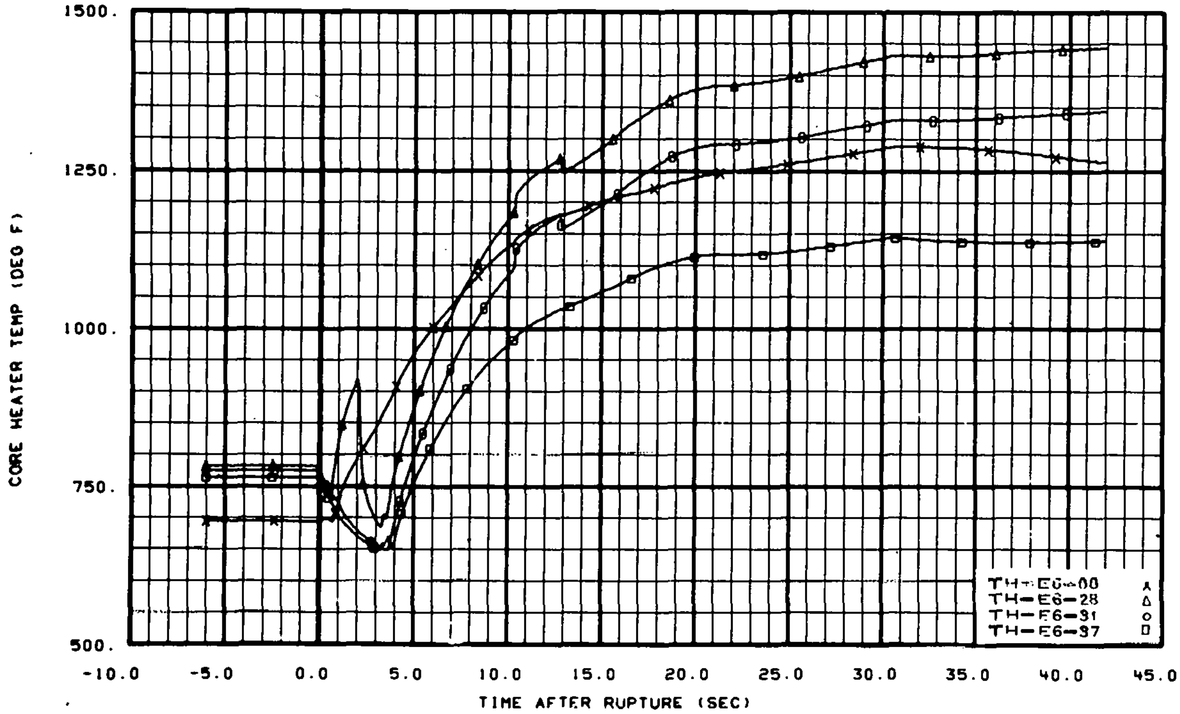

Fig. 51 Core heater temperature, Rod E-6.

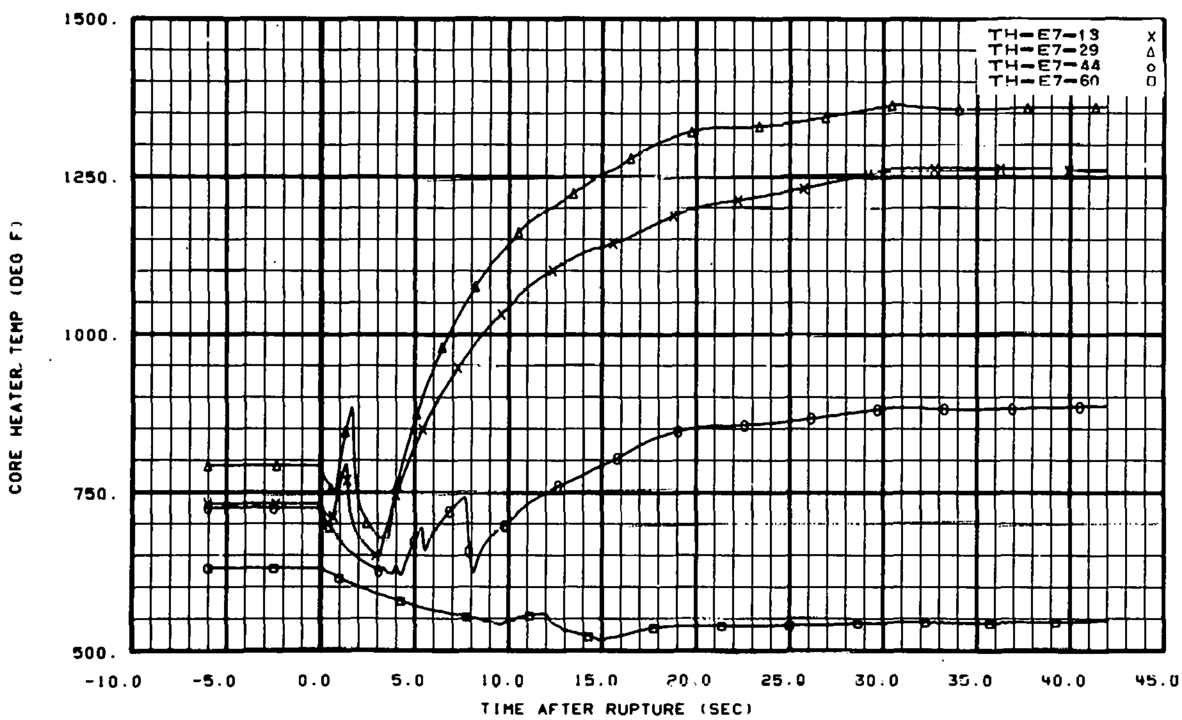

Fig. 52 Core heater temperature, Rod E-7.

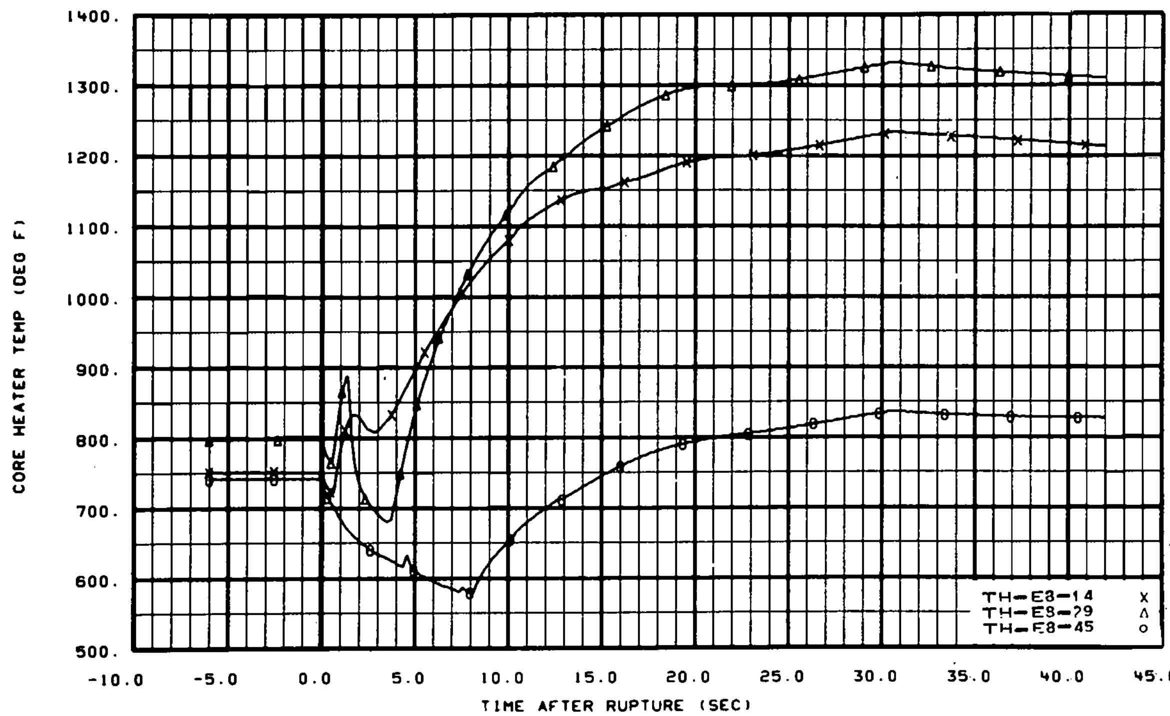

Fig. 53 Core heater temperature, Rod E-8.

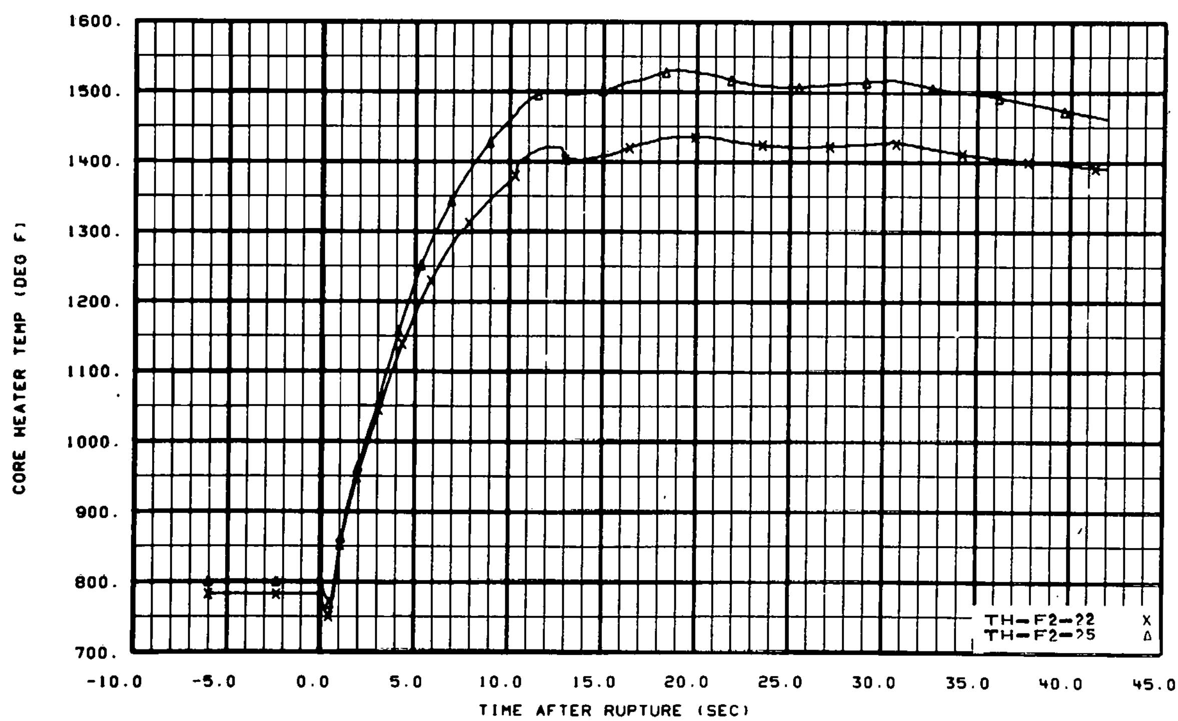

Fig. 54 Core heater temperature, Rod F-2.

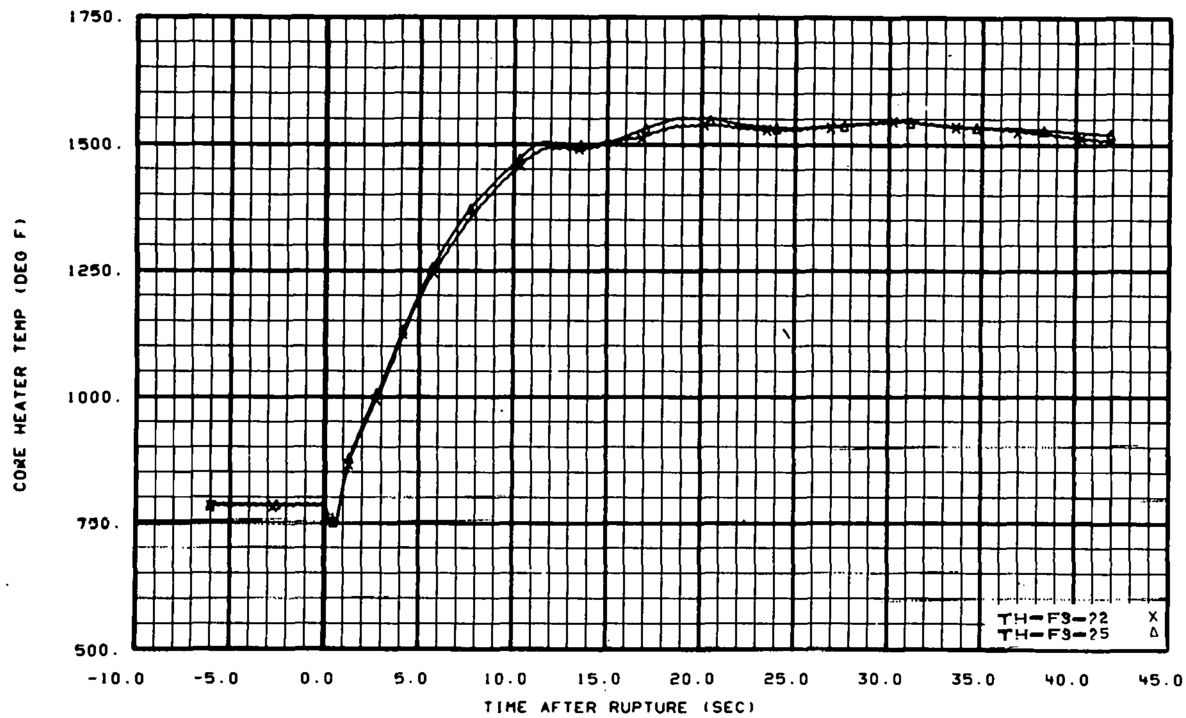

Fig. 55 Core heater temperature, Rod F-3.

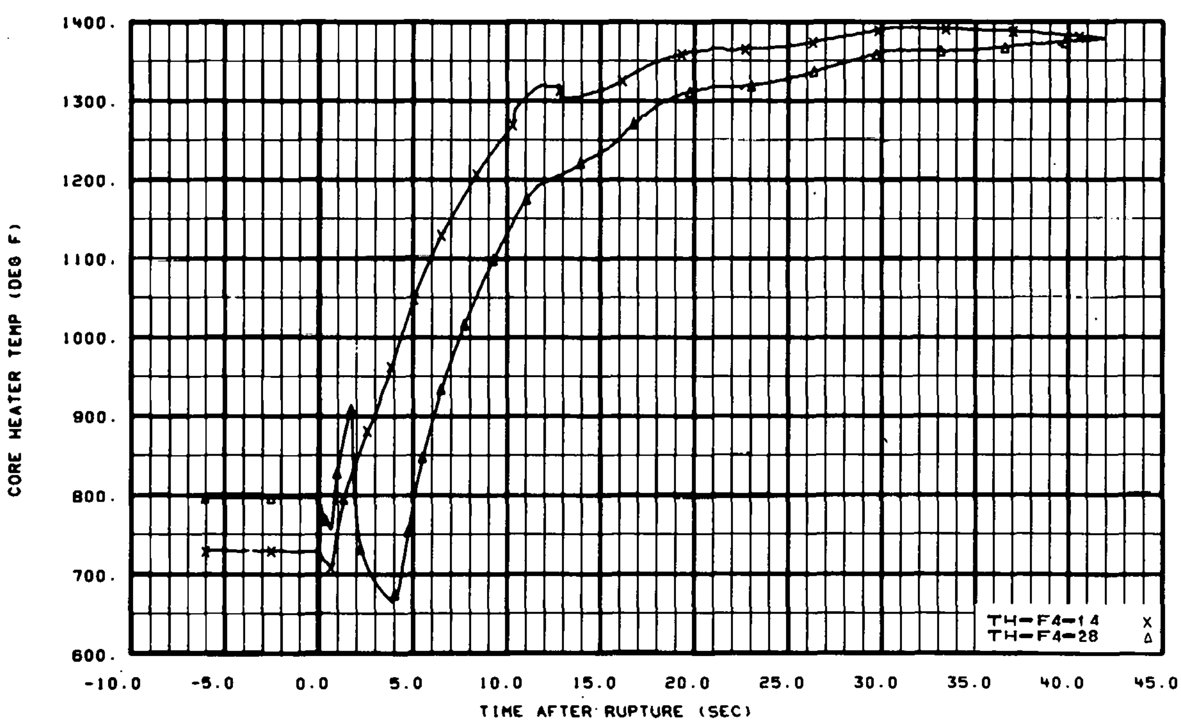

Fig. 56 Core heater temperature, Rod F-4.

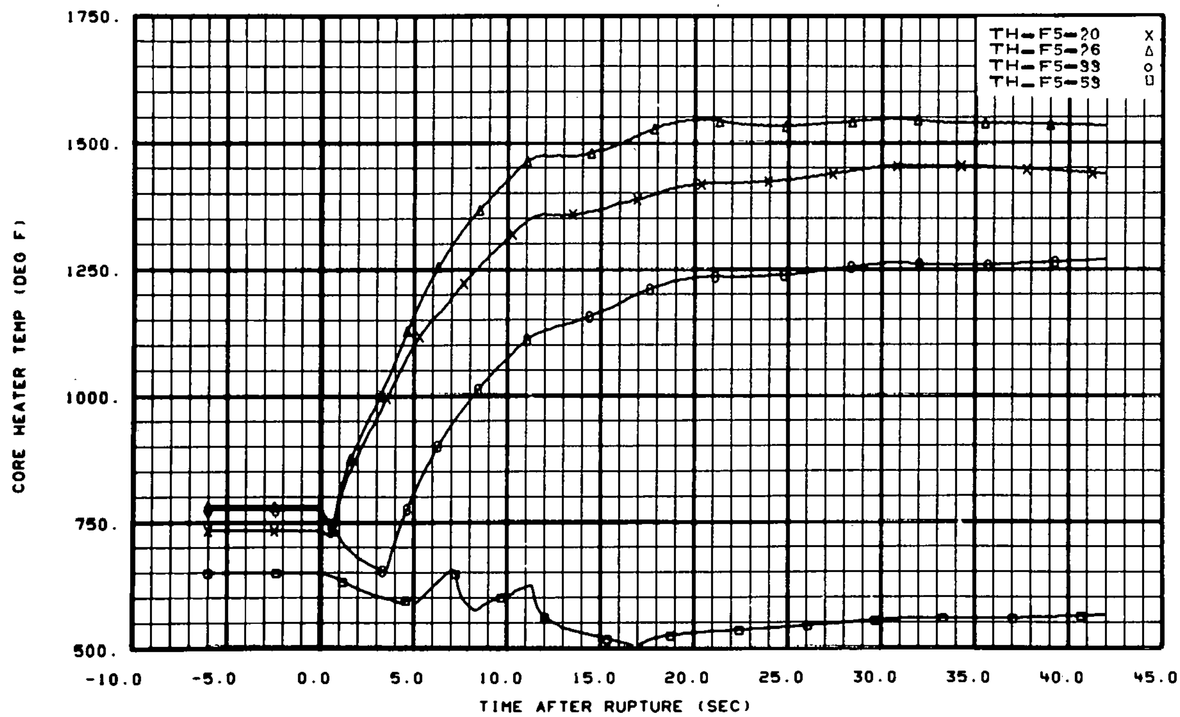

Fig. 57 Core heater temperature, Rod F-5.

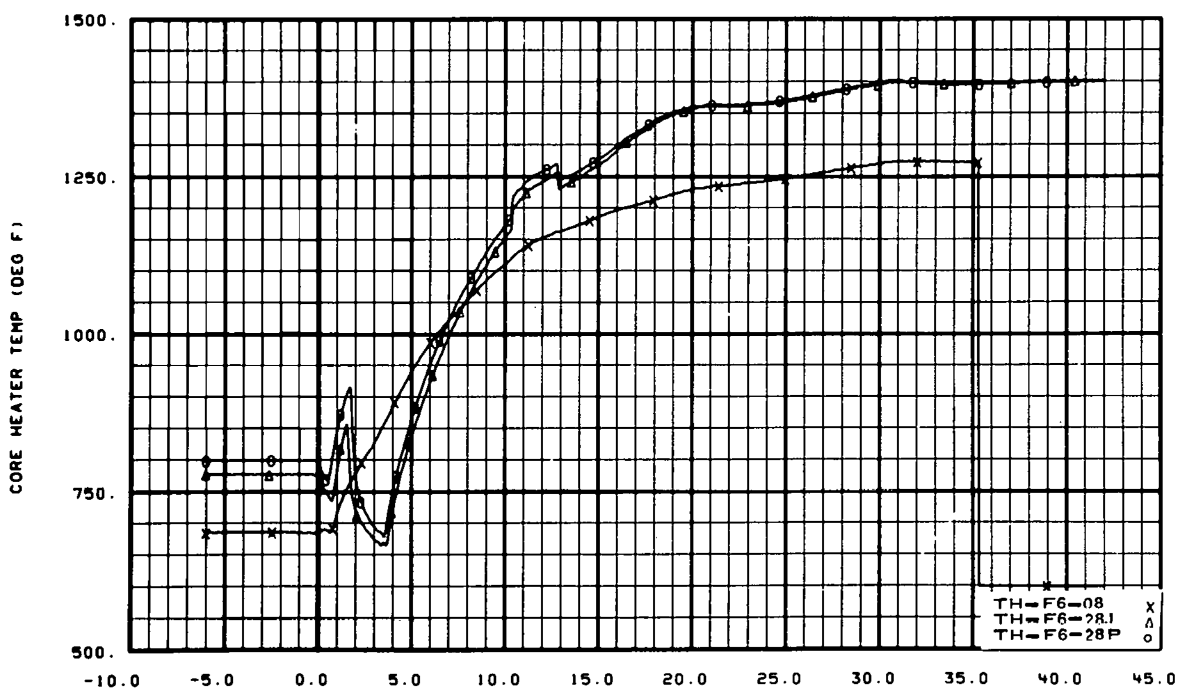

Fig. 58 Core heater temperature, Rod F-6.

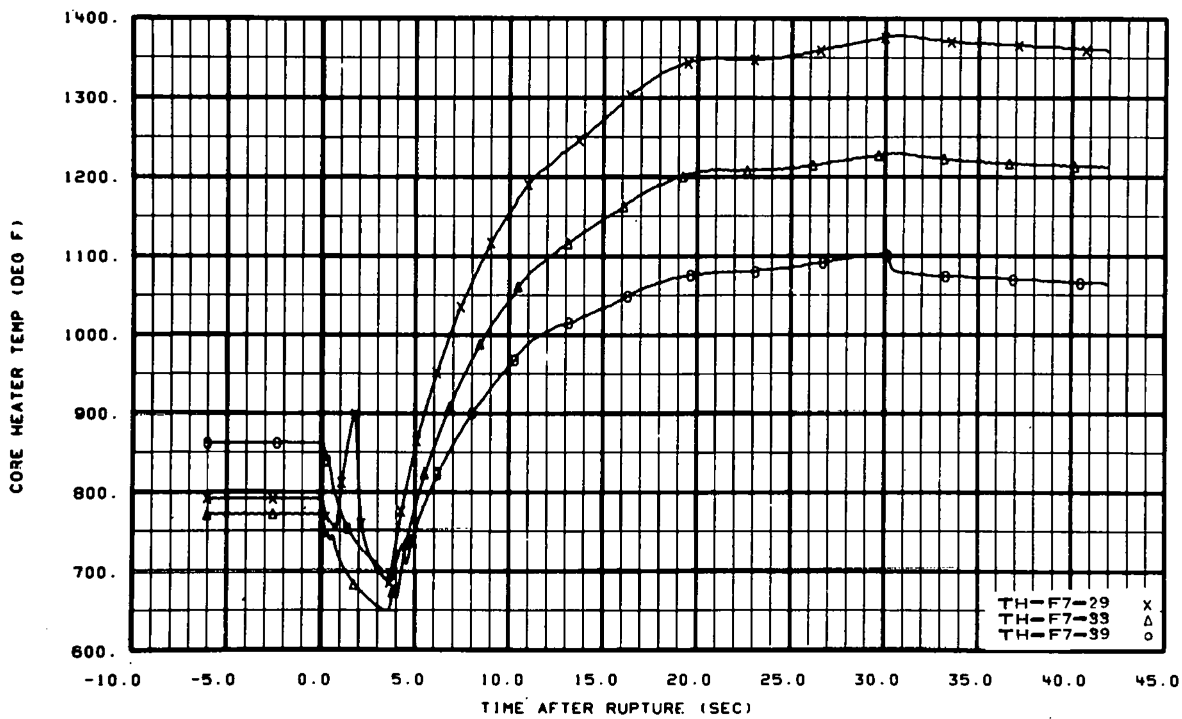

Fig. 59 Core heater temperature, Rod F-7.

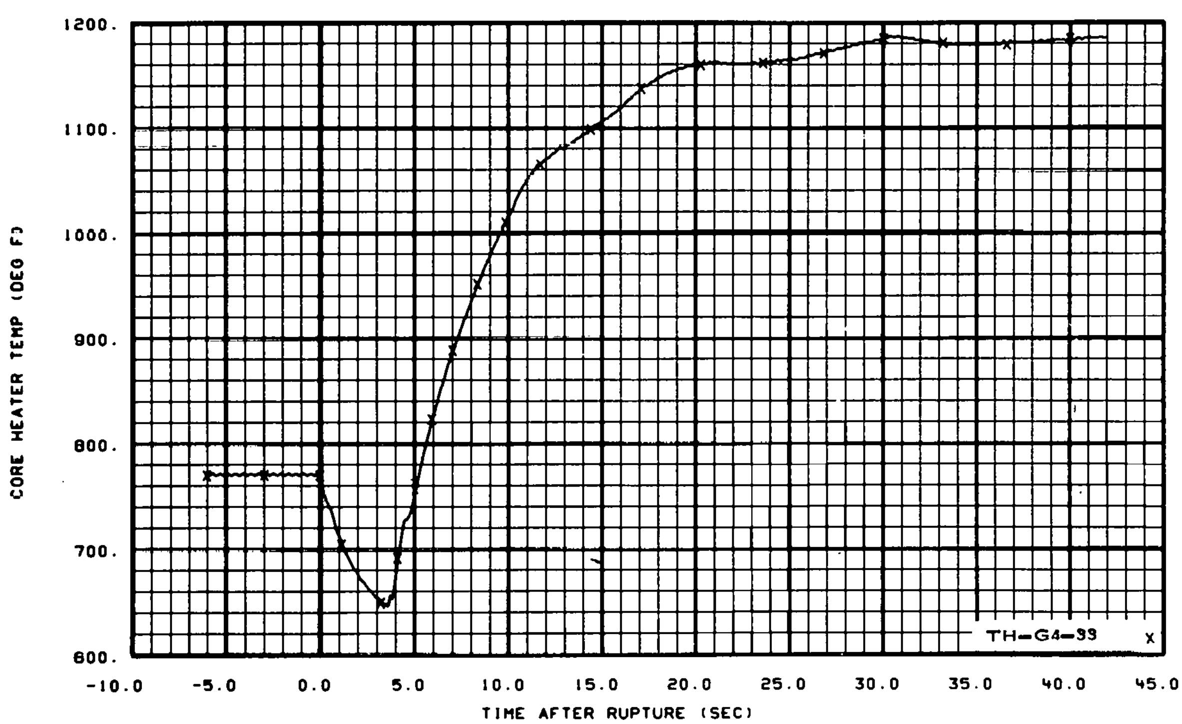

Fig. 60 Core heater temperature, Rod G-4.

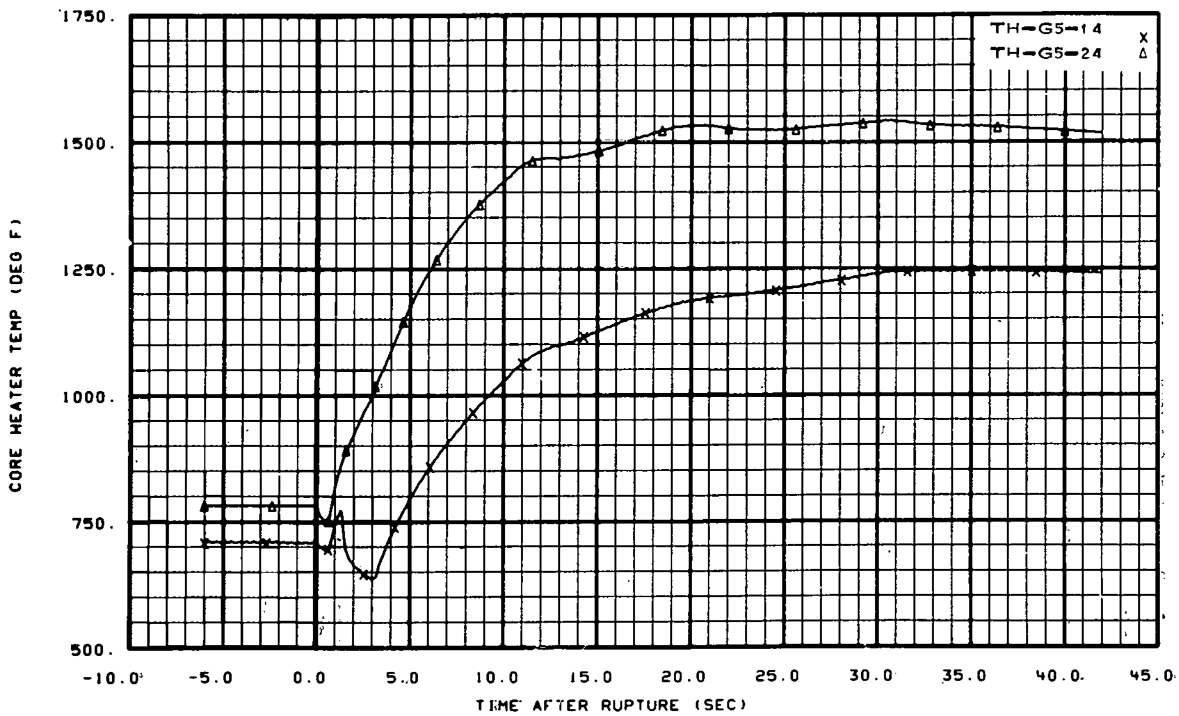

Fig. 61 Core heater temperature, Rod G-5.

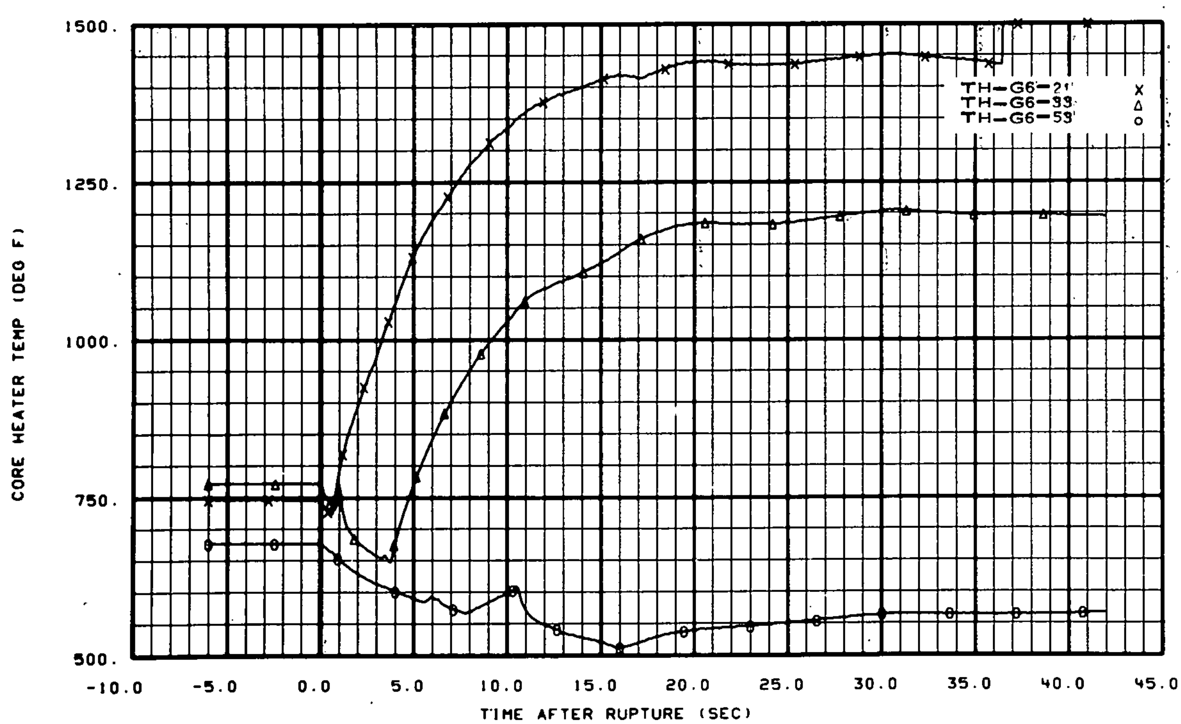

Fig. 62 Core heater temperature, Rod G-6.

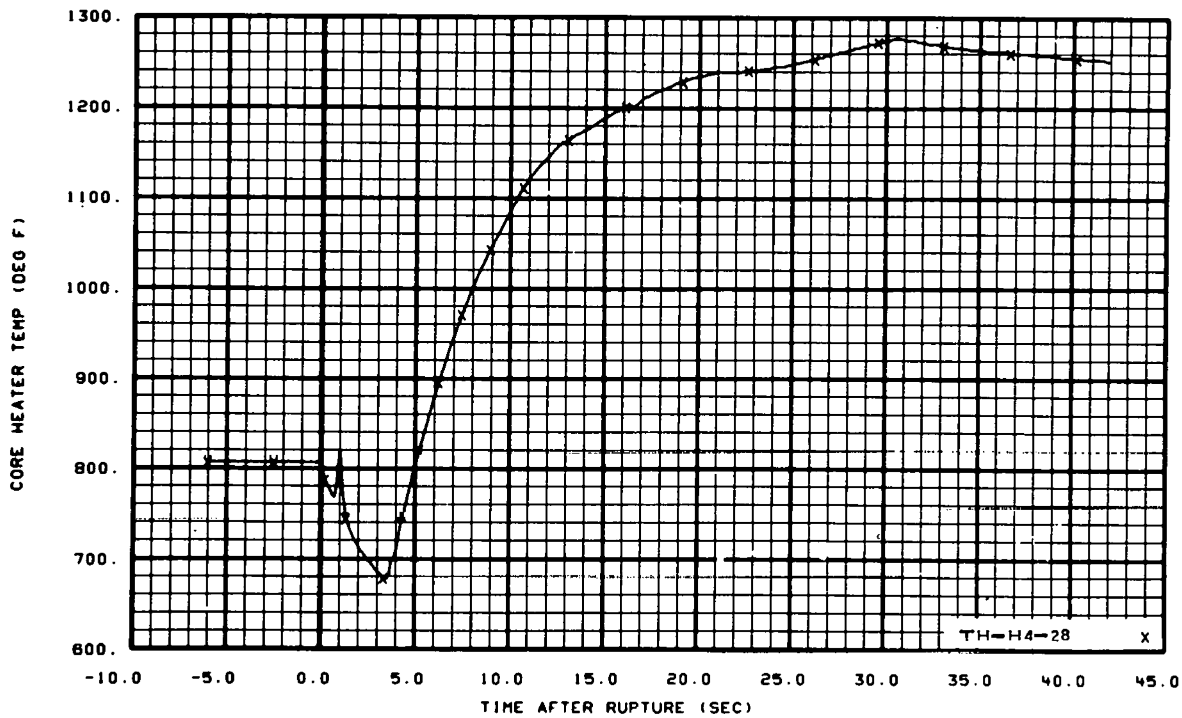

Fig. 63 Core heater temperature, Rod H-4.

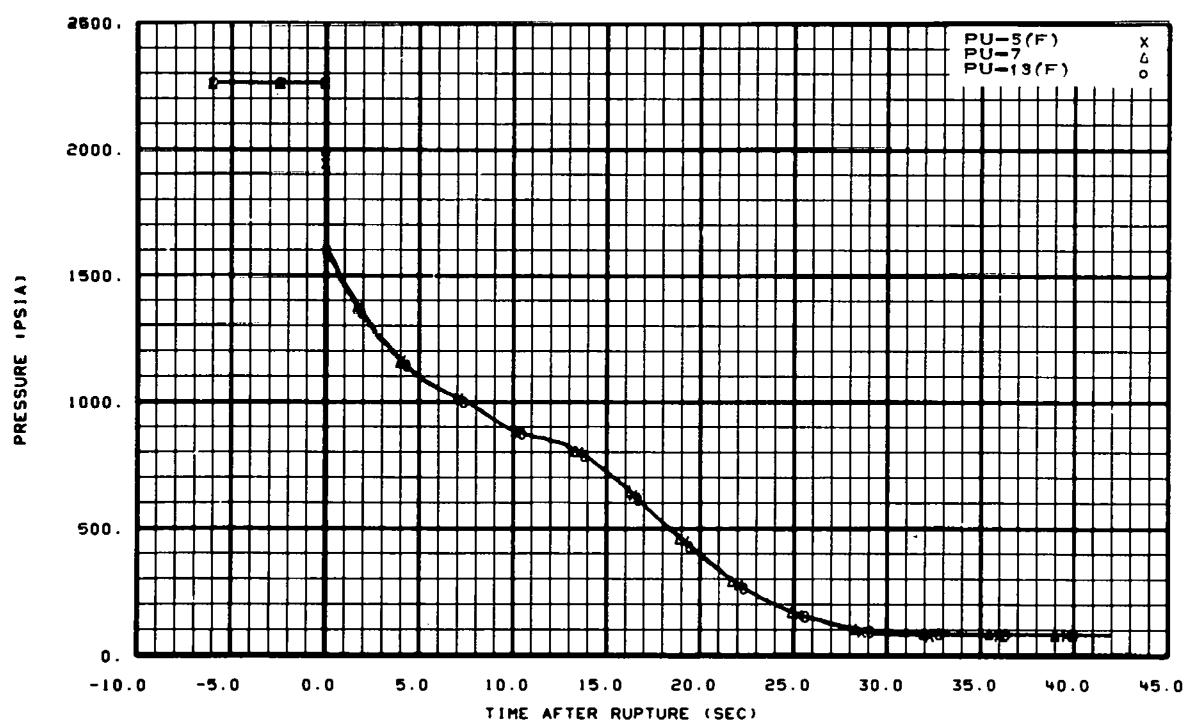

Fig. 64 Pressure in intact loop.

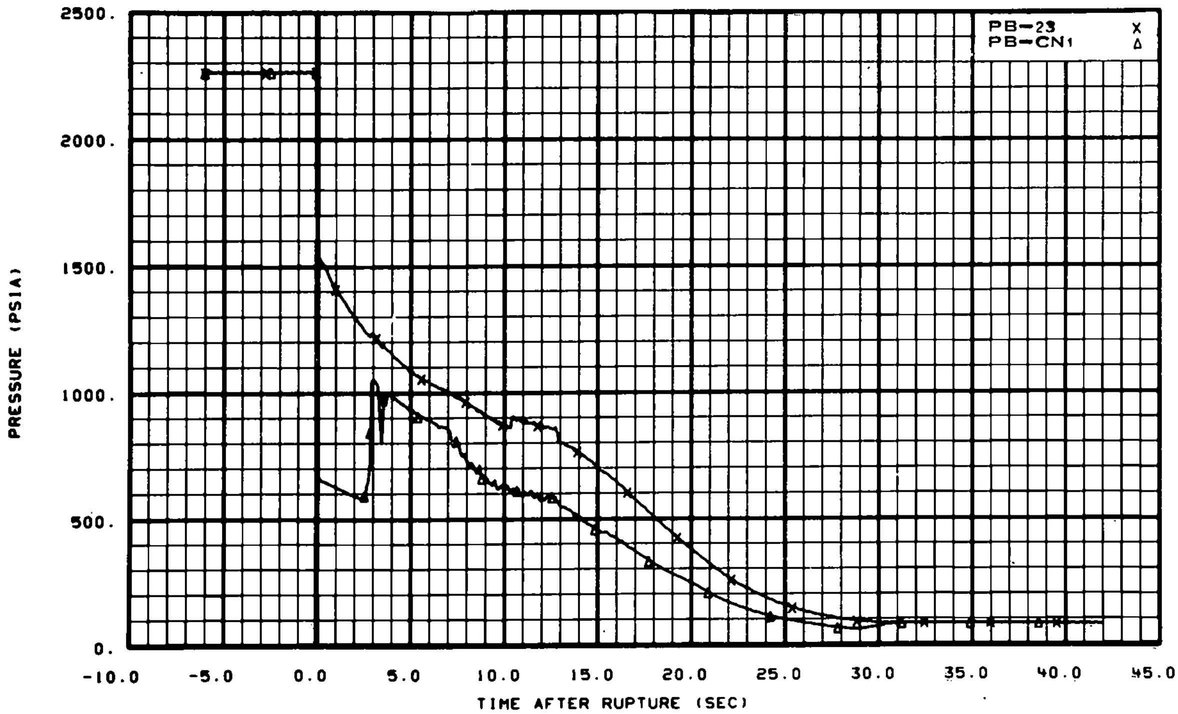

Fig. 65 Pressure in broken loop (vessel side).

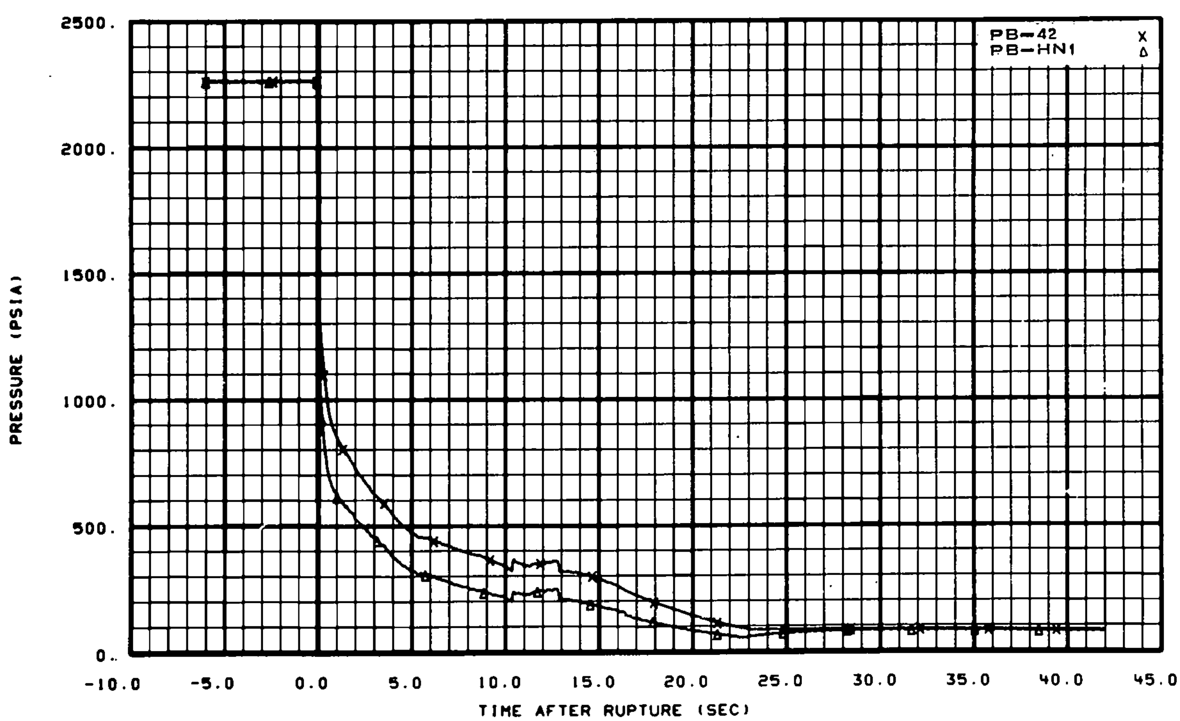

Fig. 66 Pressure in broken loop (pump side).

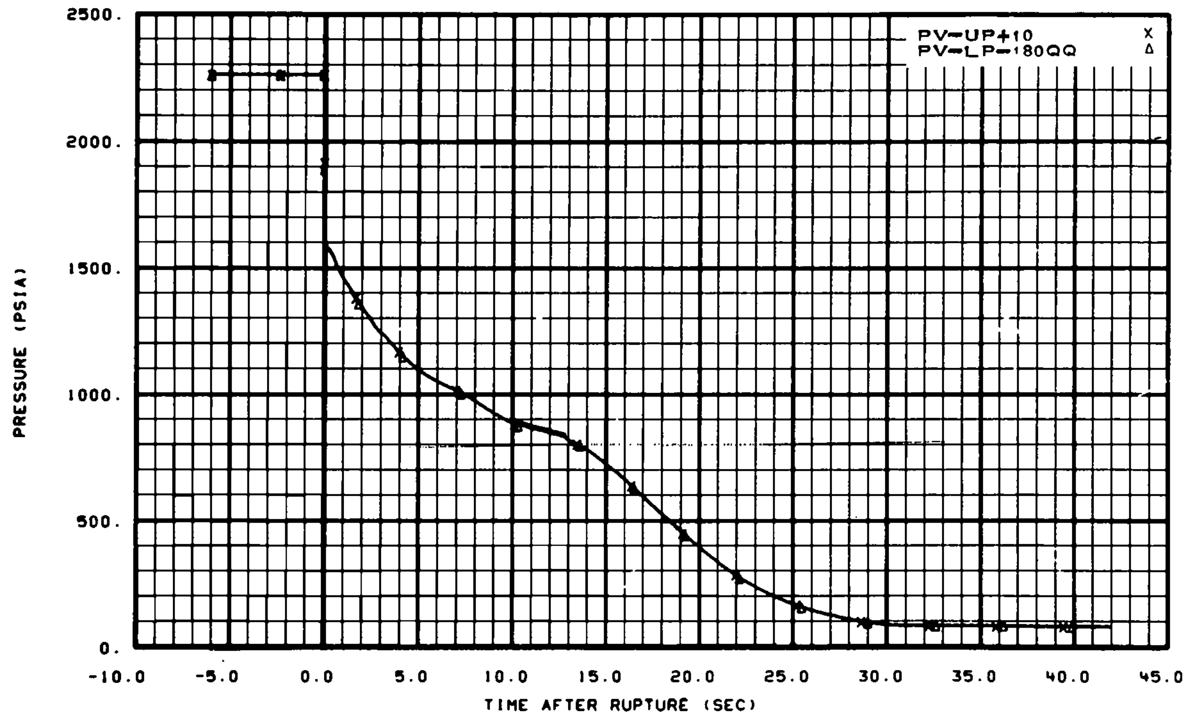

Fig. 67 Pressure in vessel.

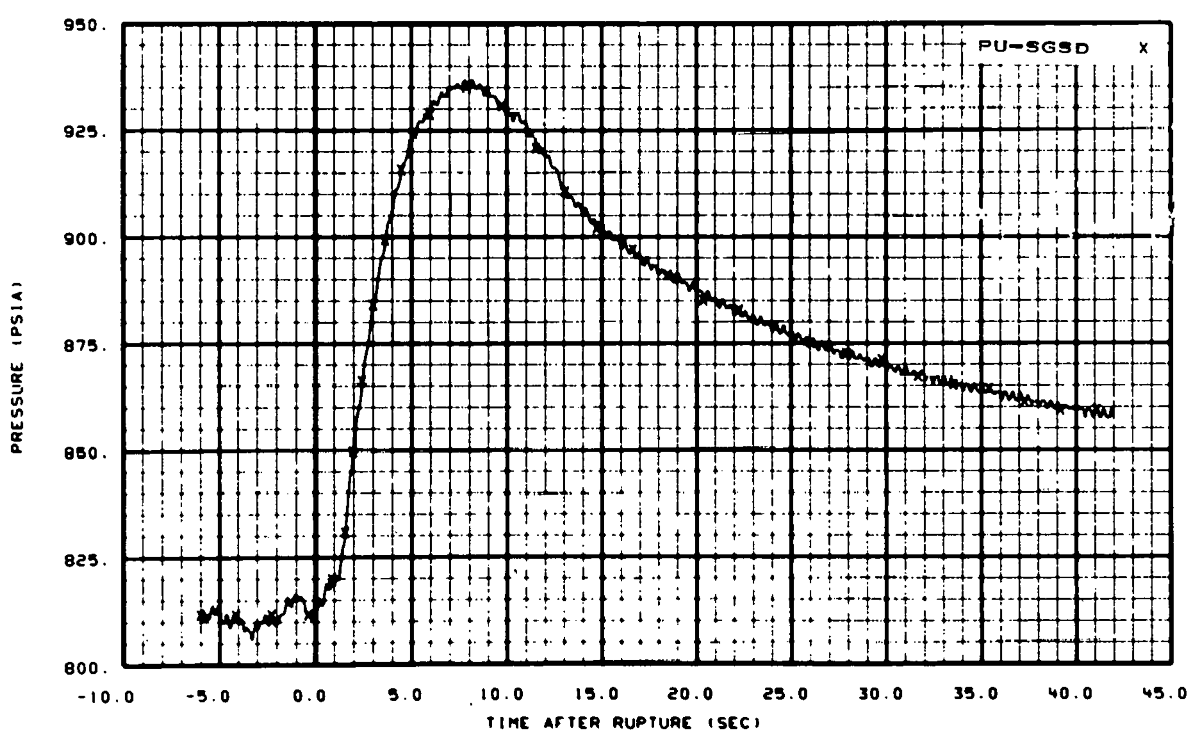

Fig. 68 Pressure in steam generator, secondary side.

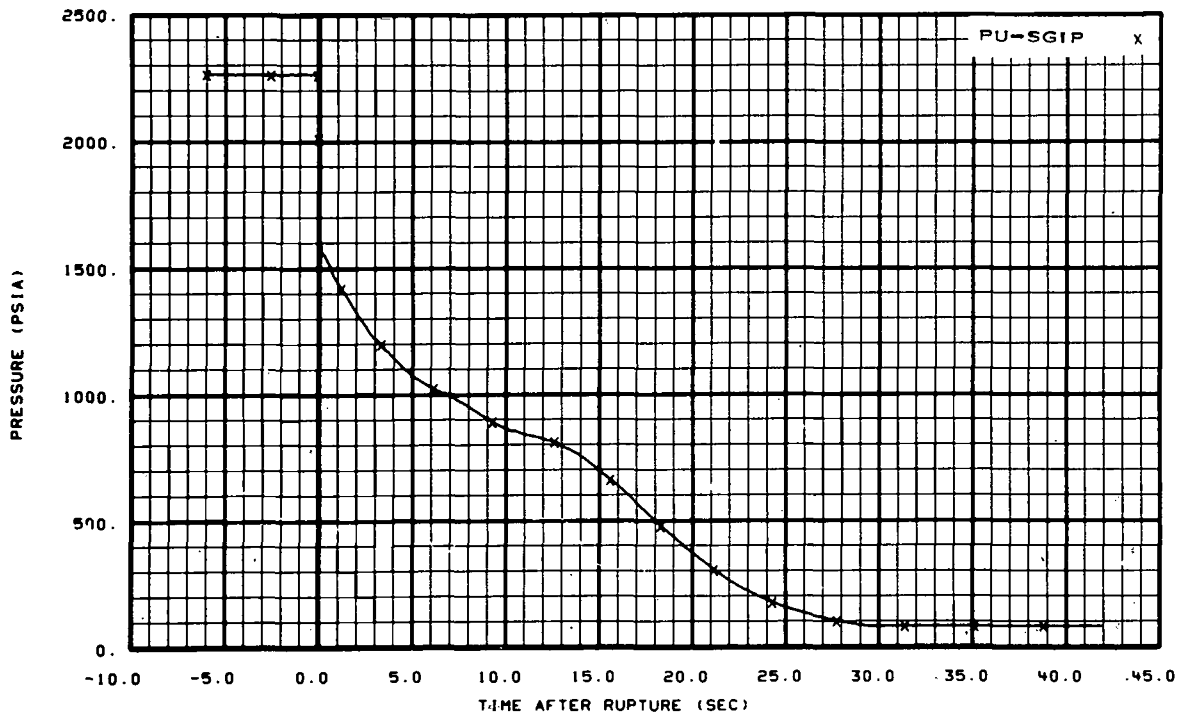

Fig. 69 Pressure in steam generator, primary side.

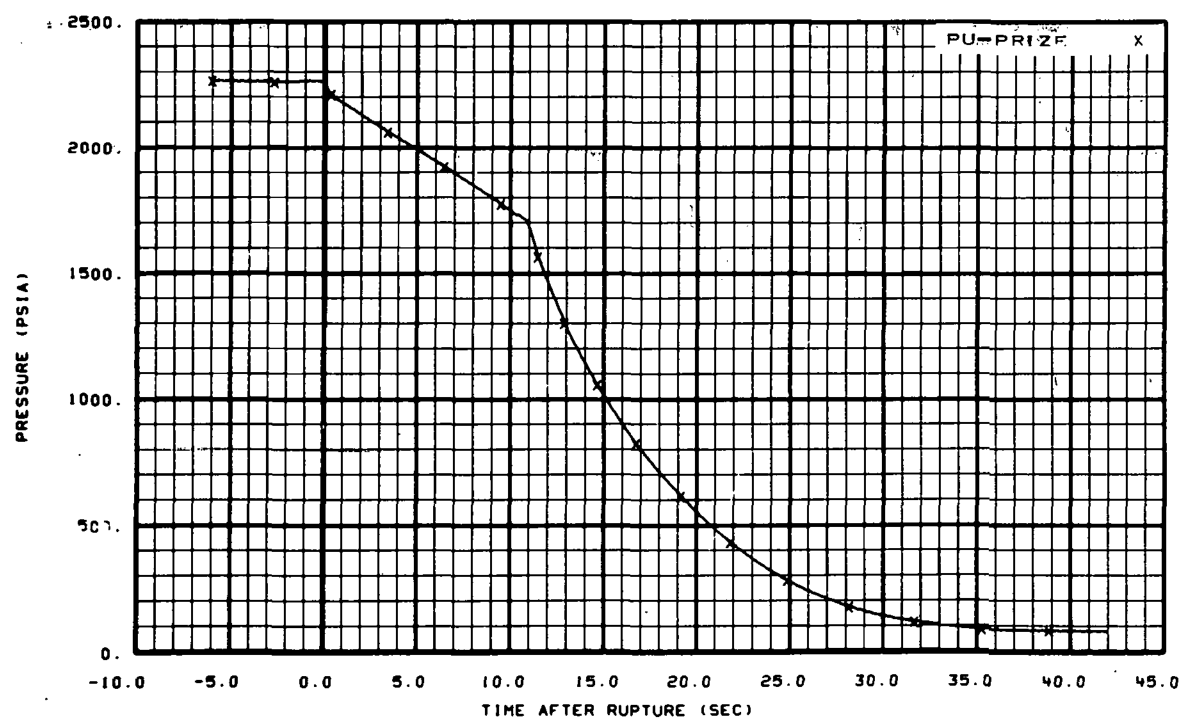

Fig. 70 Pressure in pressurizer.

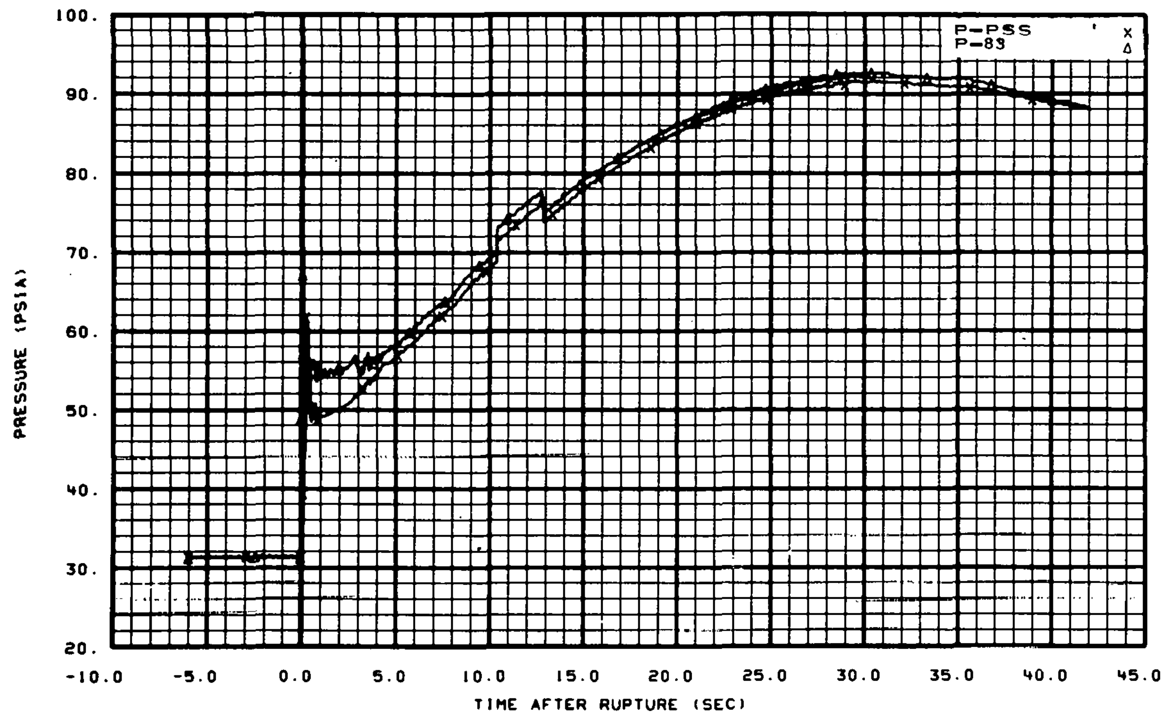

Fig. 71 Pressure in pressure suppression system.

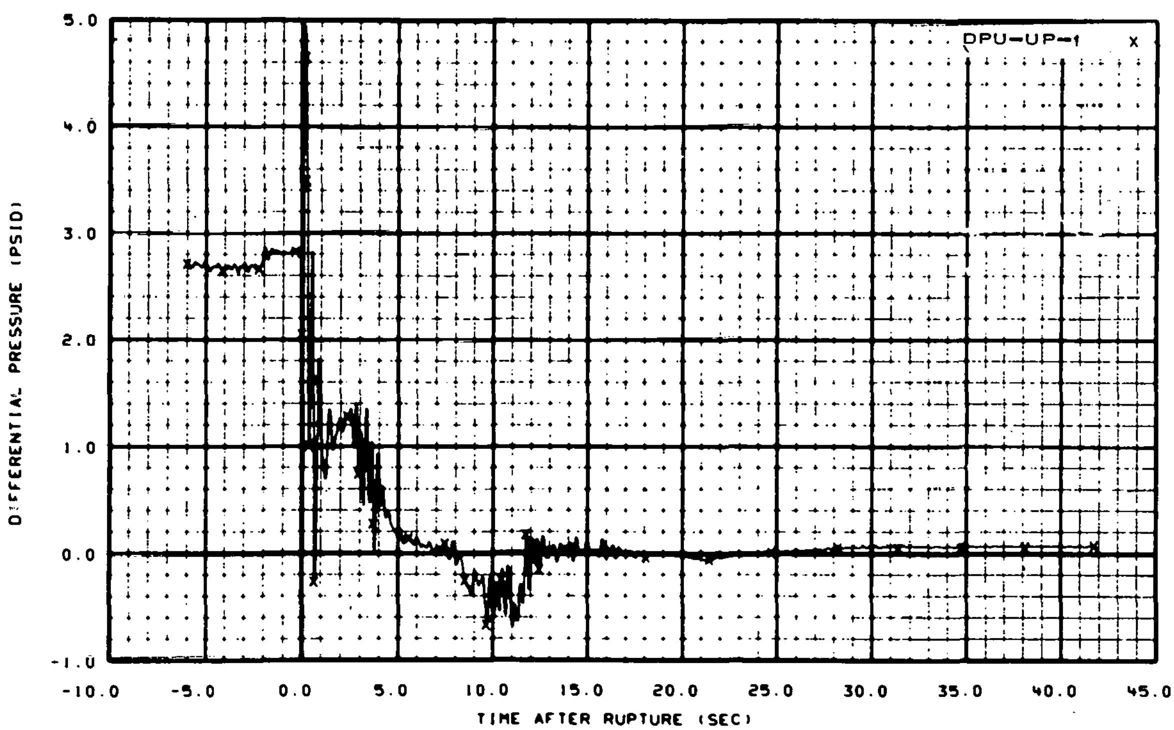

Fig. 72 Differential pressure in intact loop (upper plenum to Spool 1).

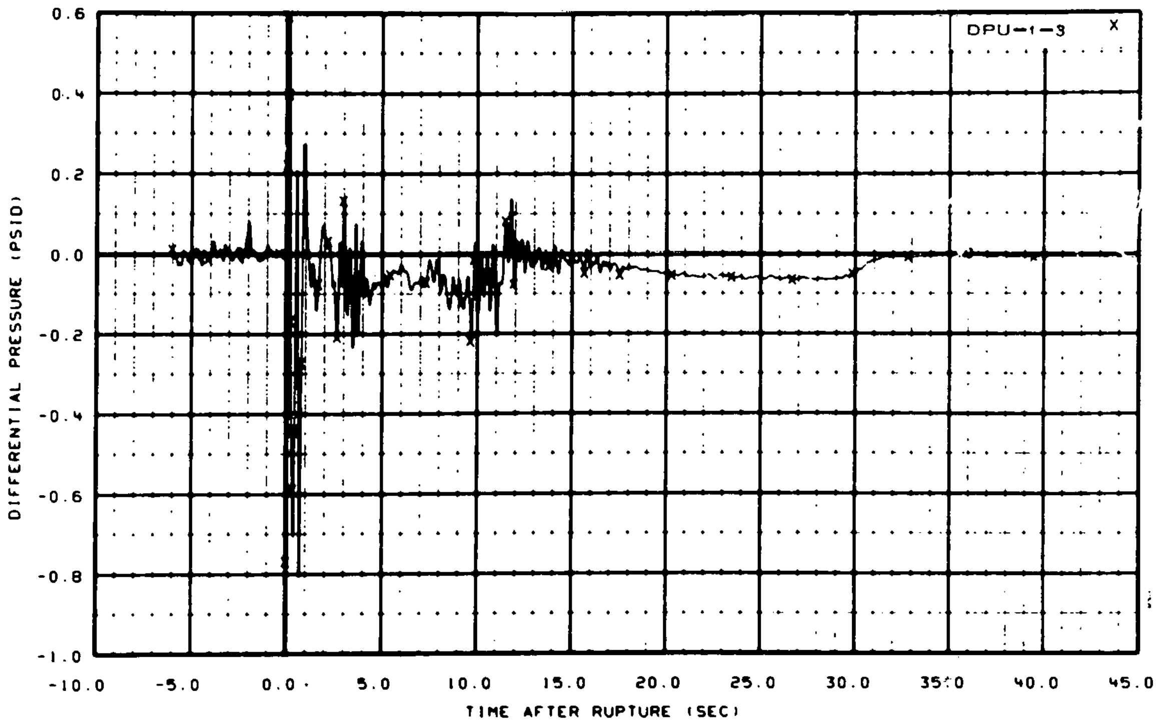

Fig. 73 Differential pressure in intact loop (Spool 1 to Spool 3).

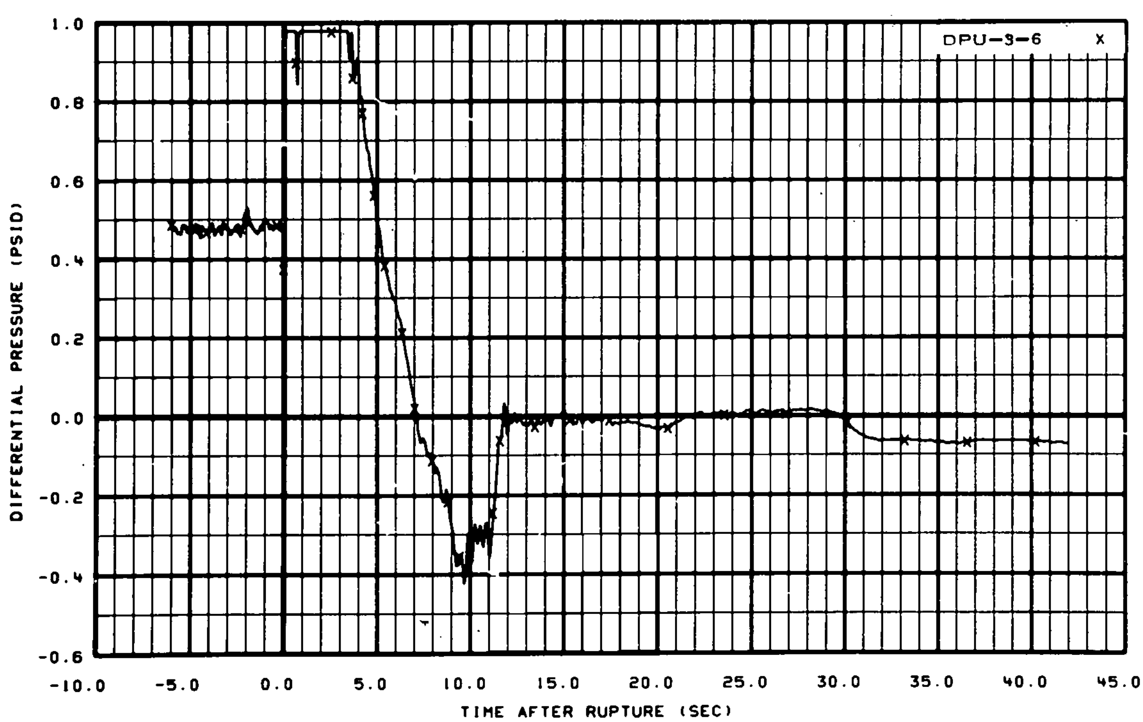

Fig. 74 Differential pressure in intact loop (Spool 3 to Spool 6).

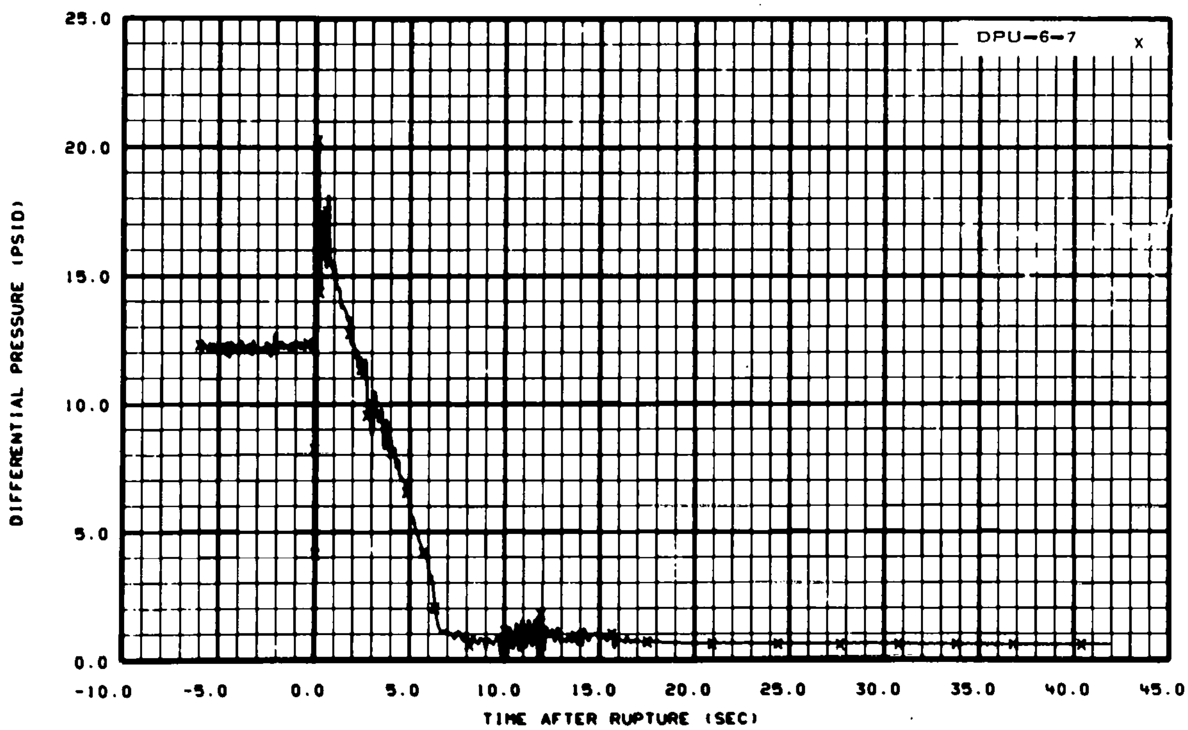

Fig. 75 Differential pressure in intact loop (Spool 6 to Spool 7).

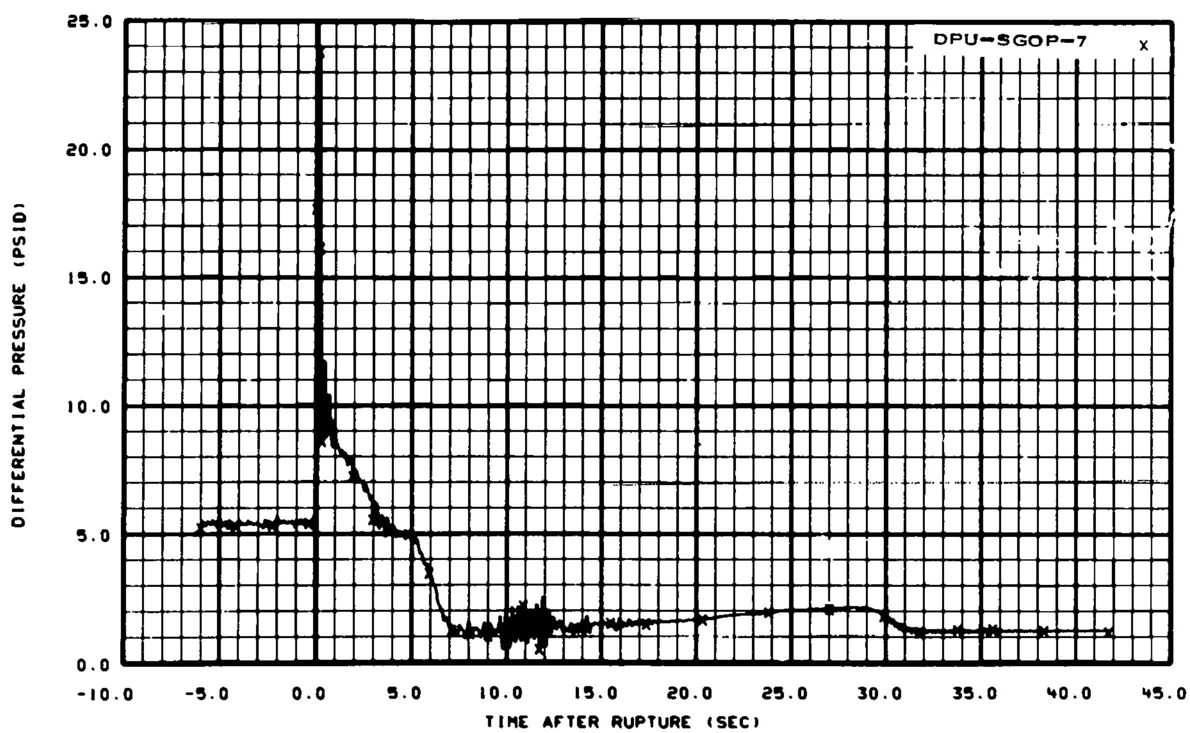

Fig. 76 Differential pressure in intact loop (steam generator outlet plenum to Spool 7).

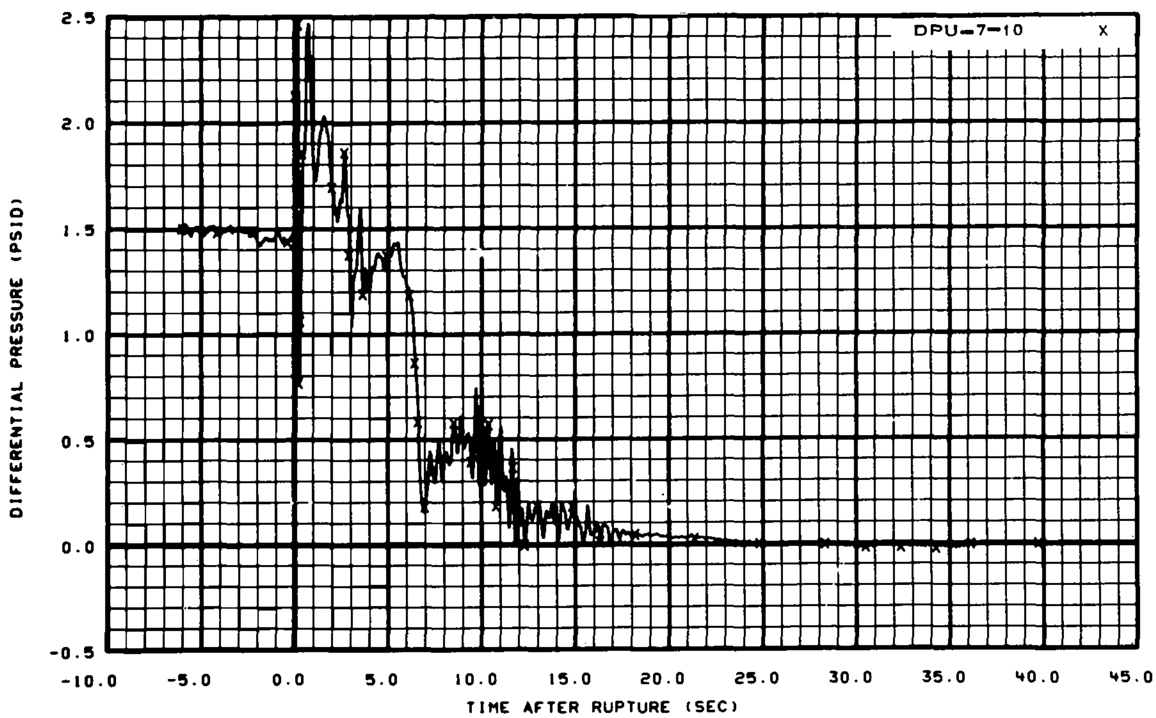

Fig. 77 Differential pressure in intact loop (Spool 7 to Spool 10).

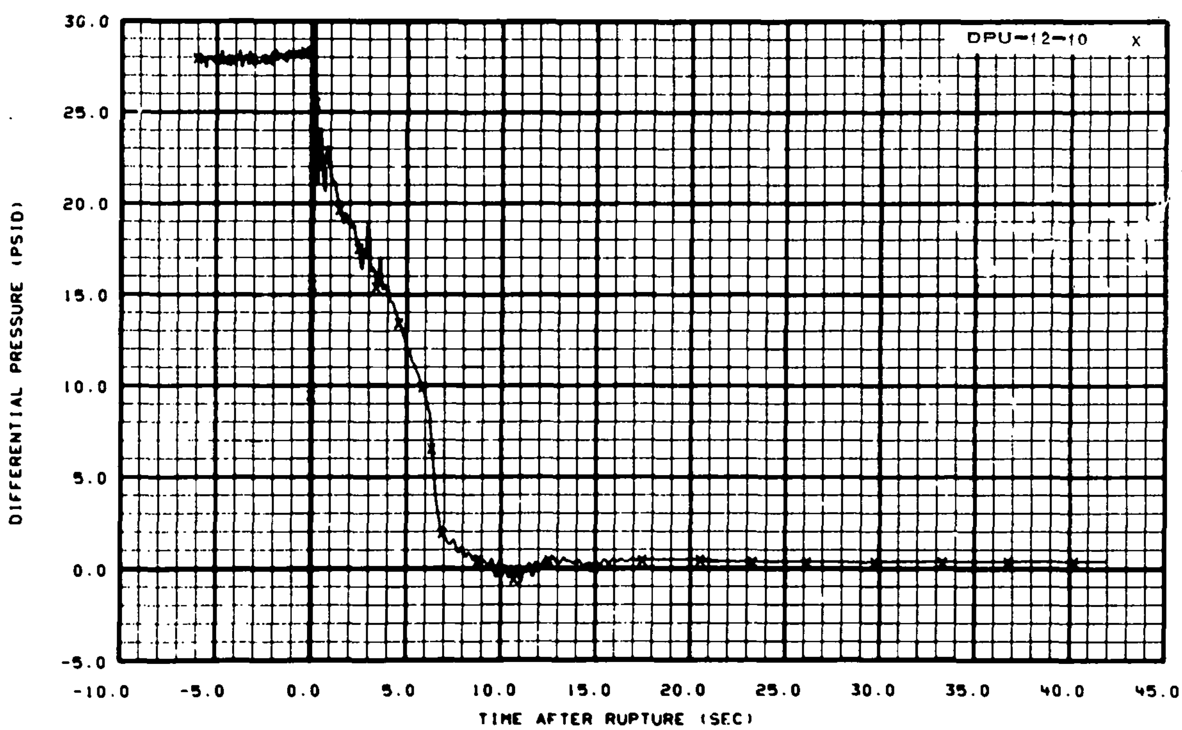

Fig. 78 Differential pressure in intact loop (Spool 12 to Spool 10).

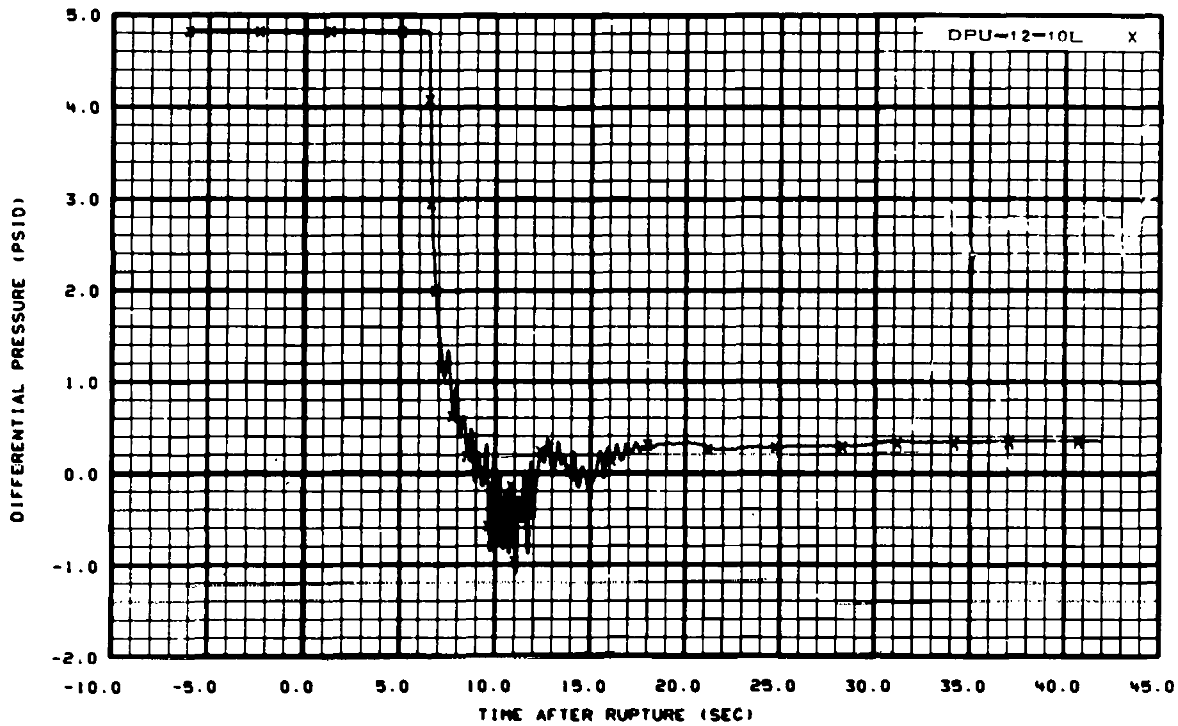

Fig. 79 Differential pressure in intact loop, low range (Spool 12 to Spool 10).

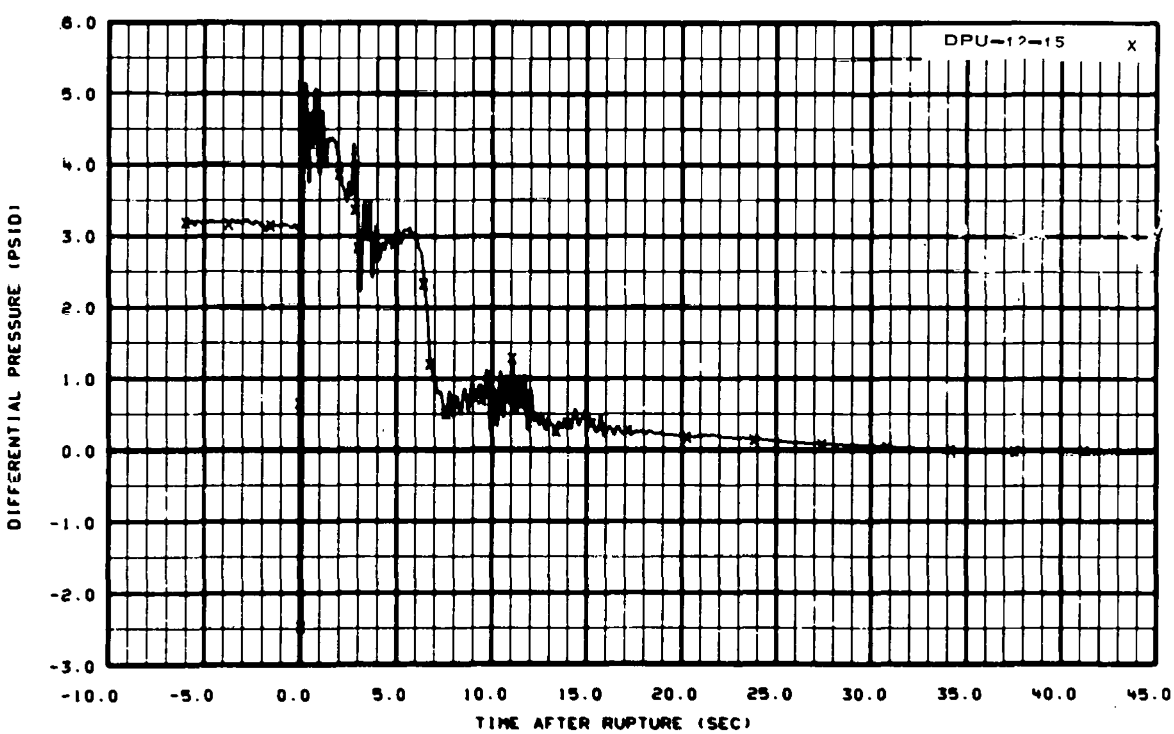

Fig. 80 Differential pressure in intact loop (Spool 12 to Spool 15).

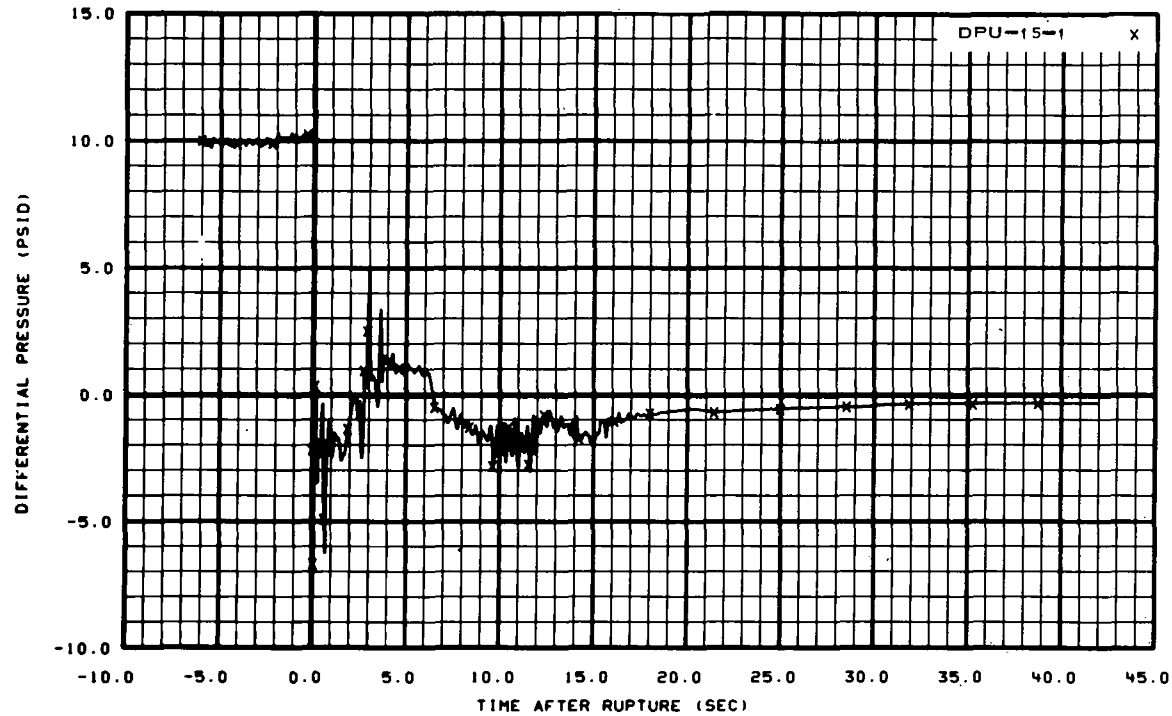

Fig. 81 Differential pressure in intact loop (Spool 15 to Spool 1).

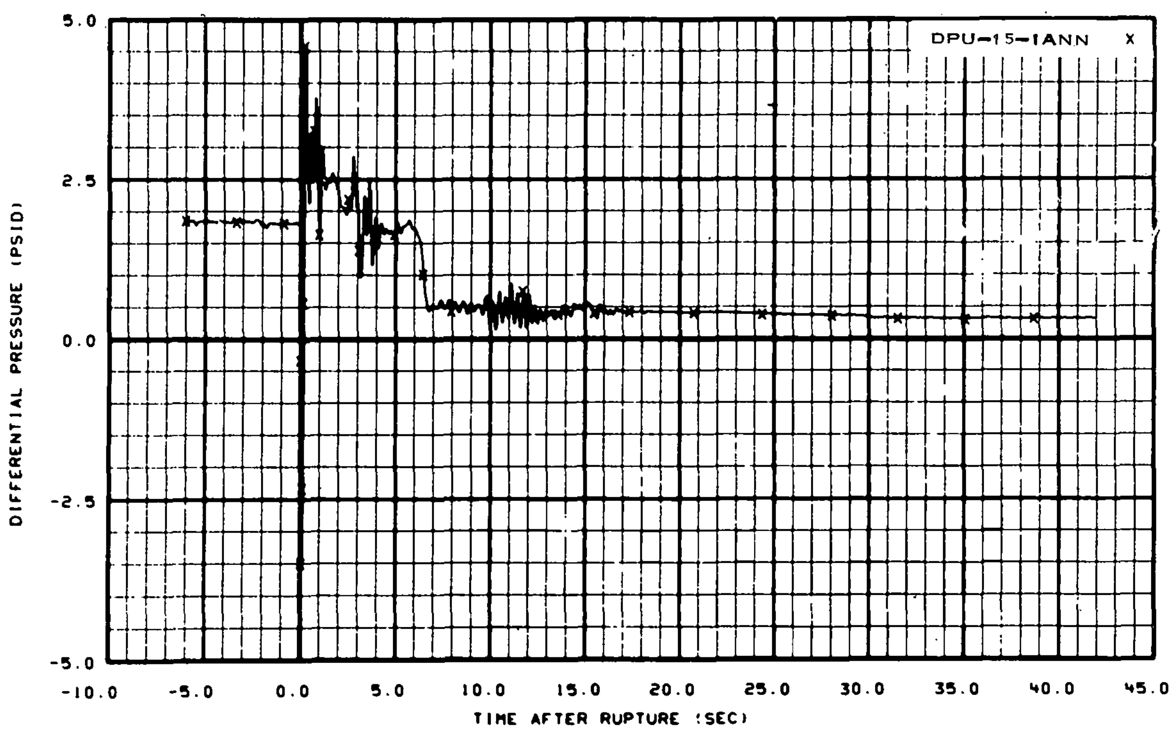

Fig. 82 Differential pressure in intact loop (Spool 15 to vessel inlet annulus).

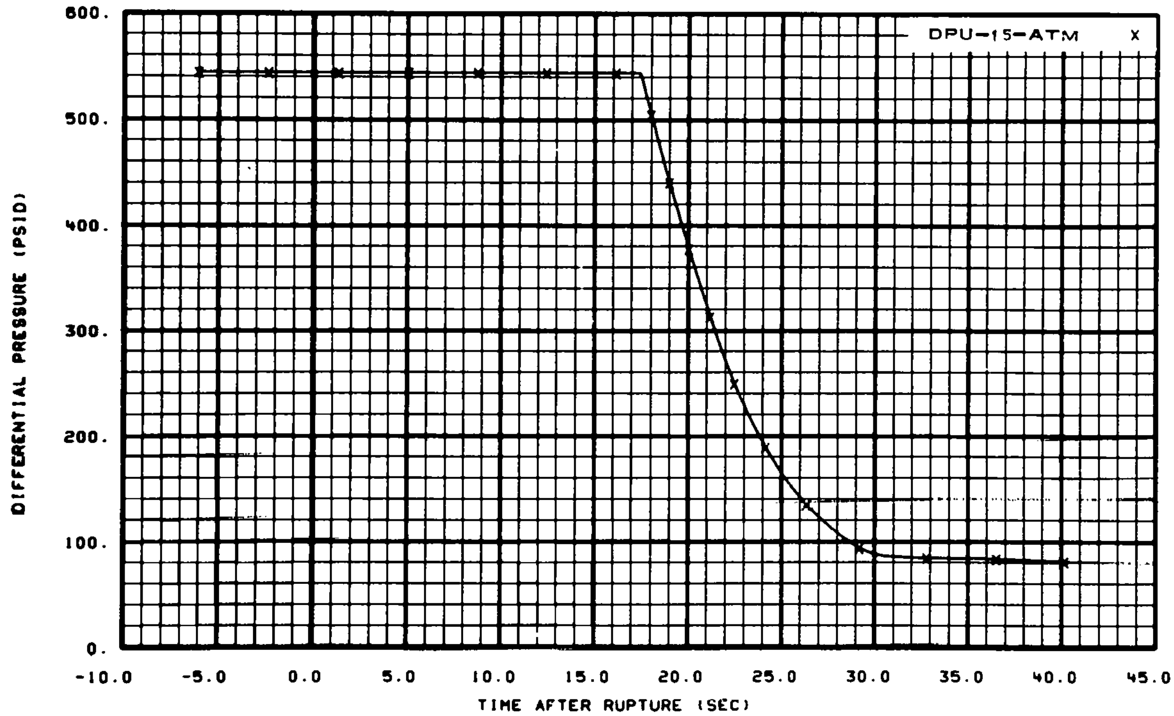

Fig. 83 Differential pressure in intact loop (Spool 15 to atmosphere).

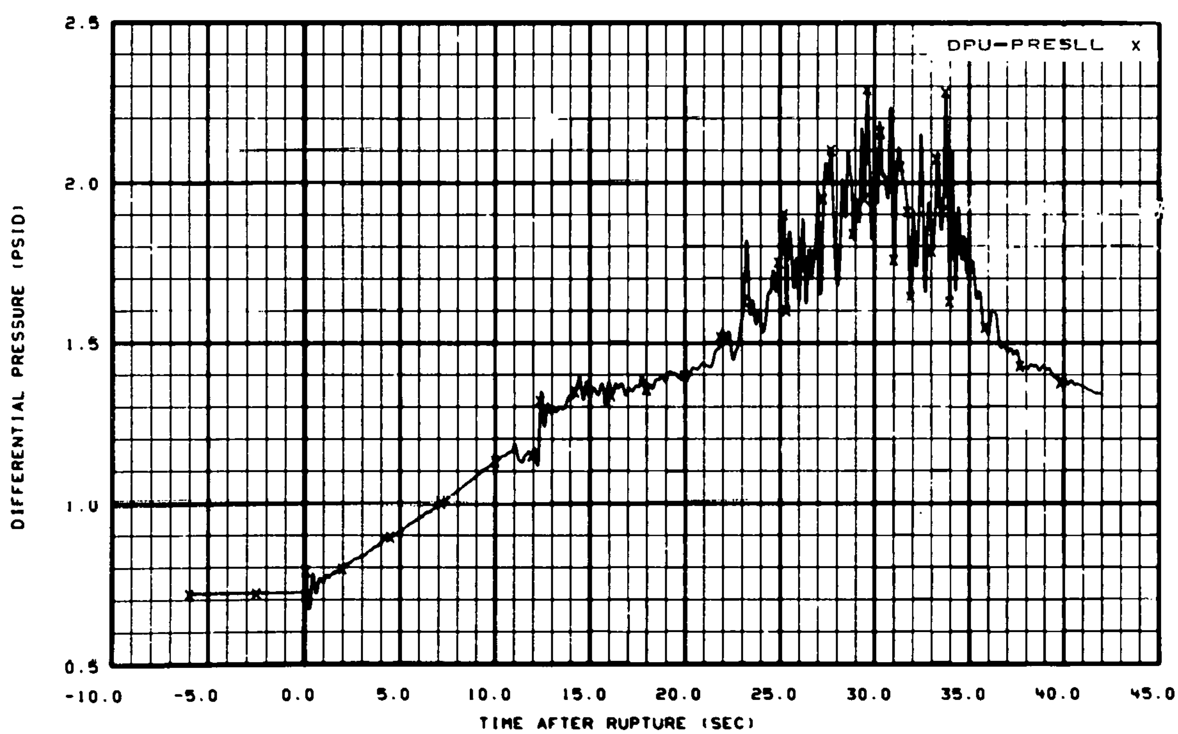

Fig. 84 Differential pressure in intact loop (pressurizer liquid level).

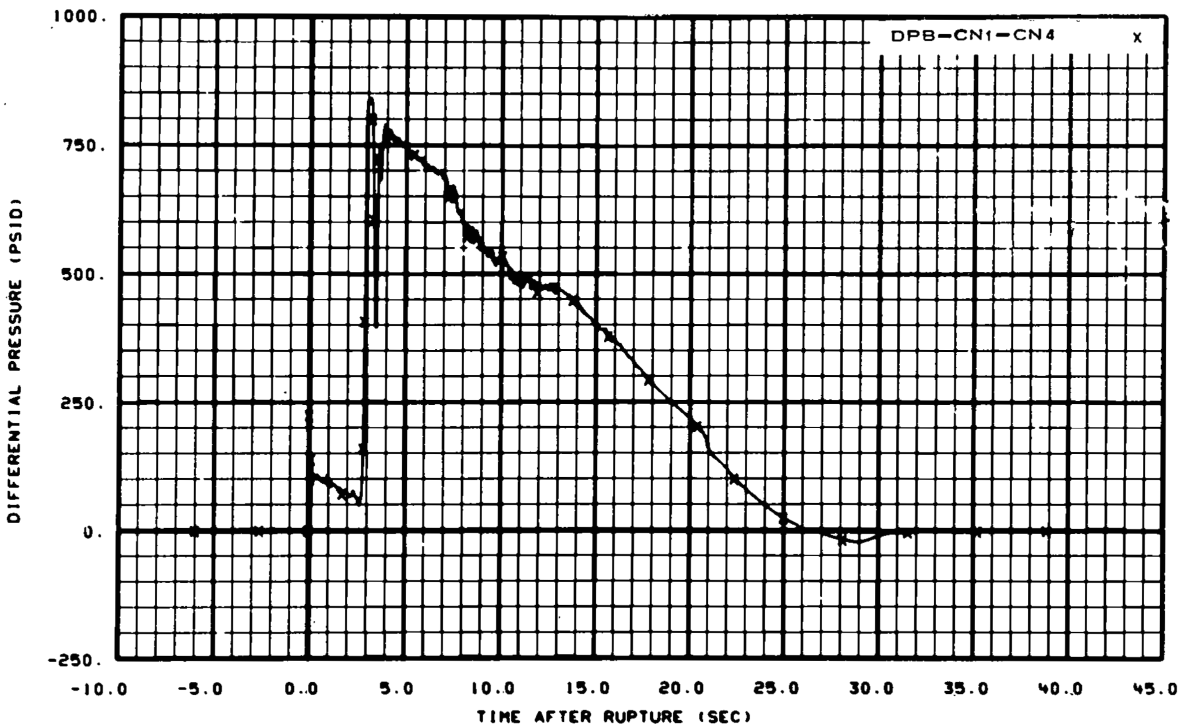

Fig. 85 Differential pressure in broken loop (vessel-side nozzle throat to divergent section).

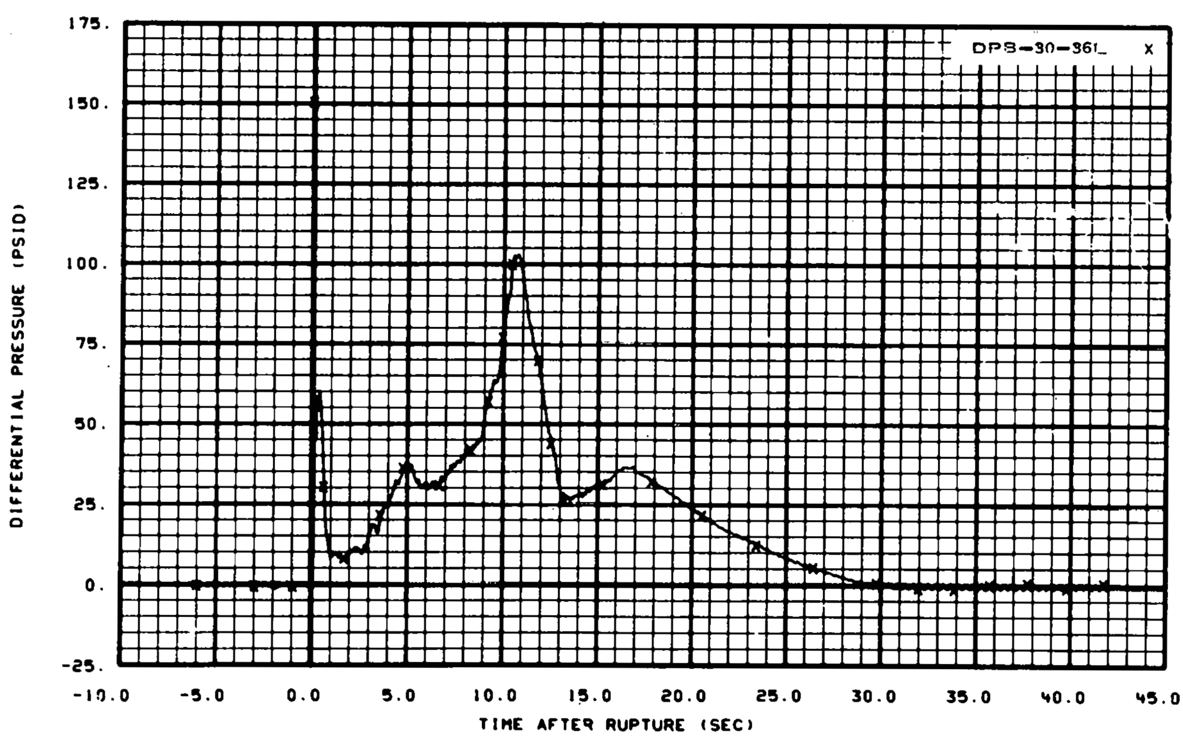

Fig. 86 Differential pressure in broken loop (Spool 30 to Spool 36L).

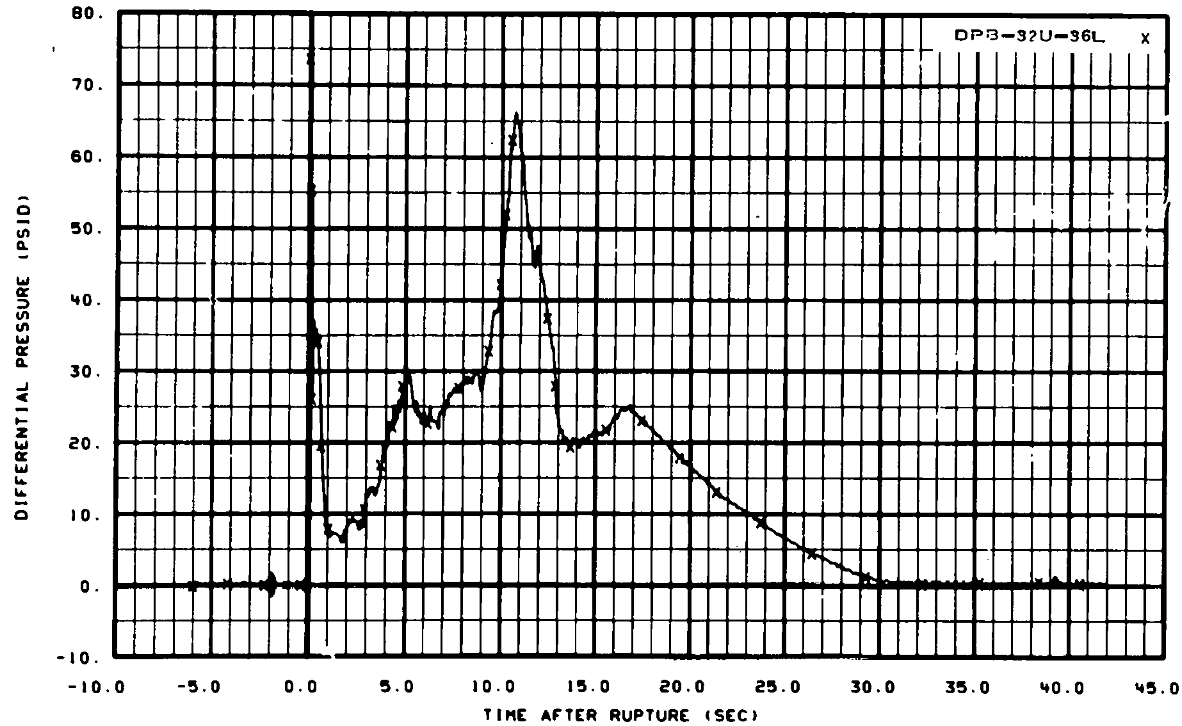

Fig. 87 Differential pressure in broken loop (Spool 32U to Spool 36L).

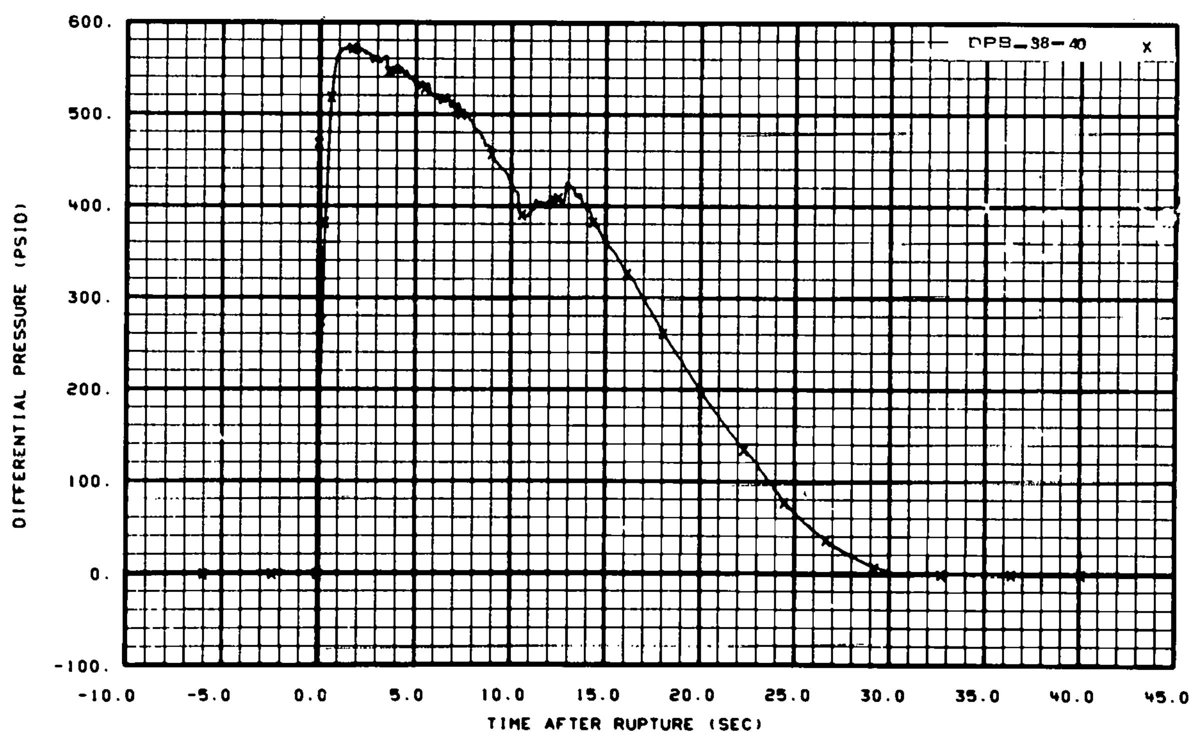

Fig. 88 Differential pressure in broken loop (Spool 38 to Spool 40).

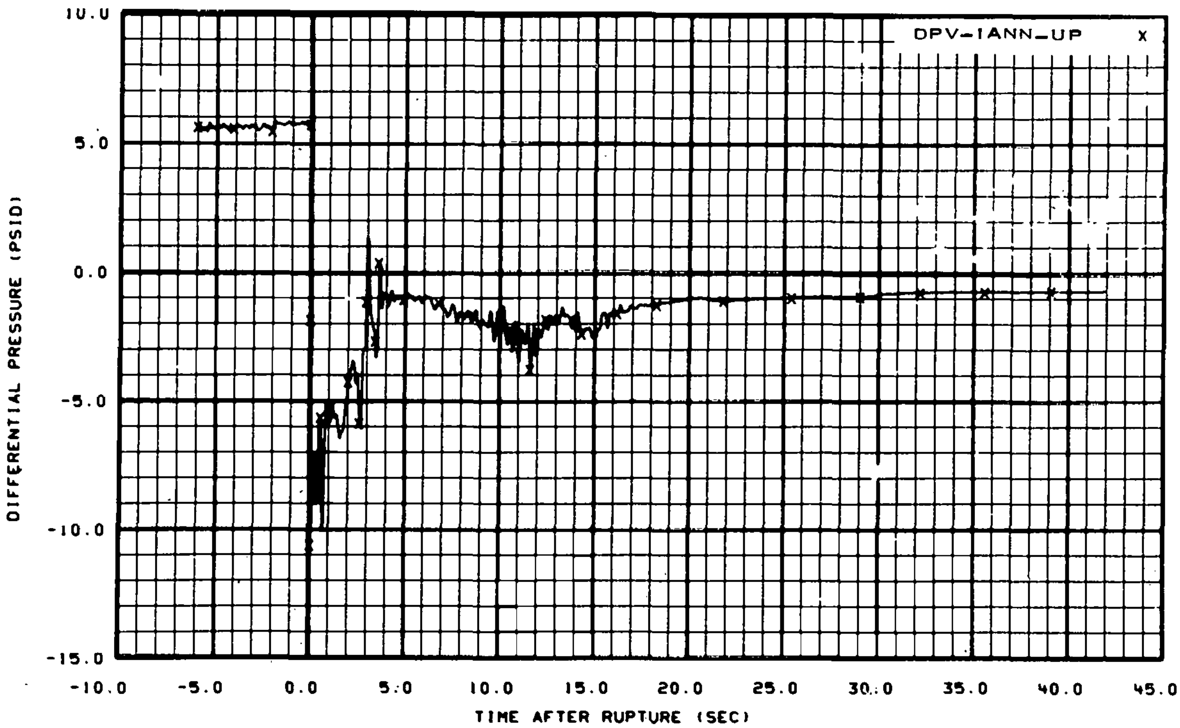

Fig. 89 Differential pressure in vessel (inlet annulus to upper plenum).

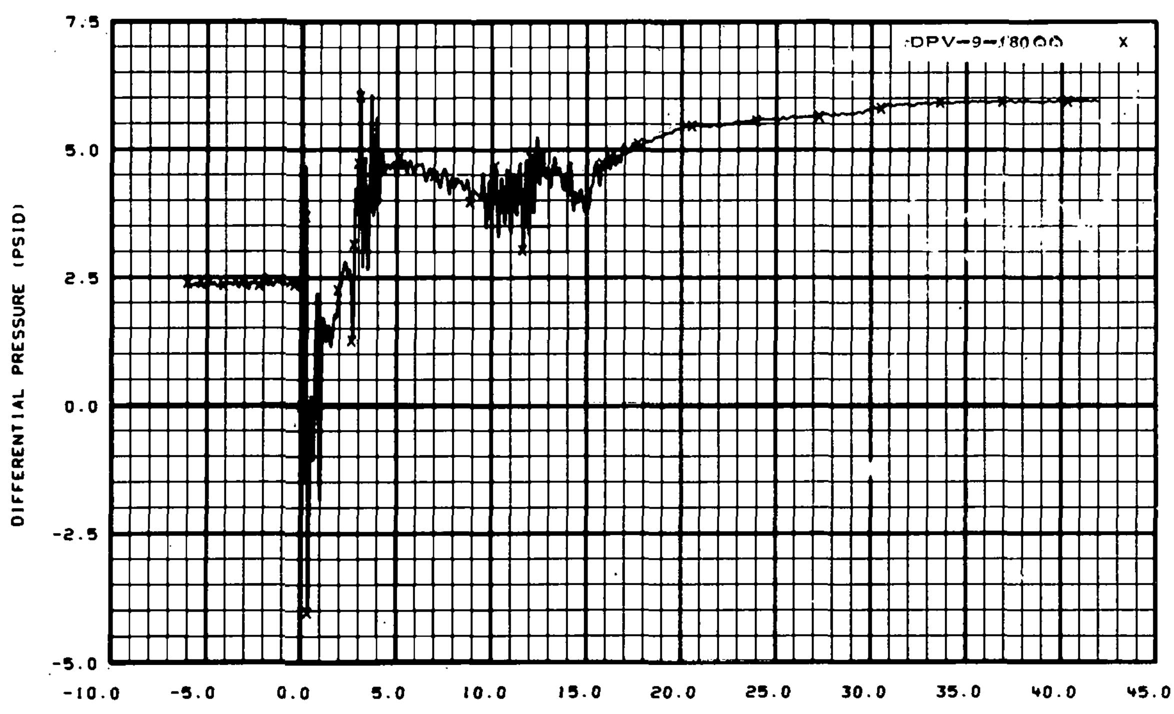

Fig. 90 Differential pressure in vessel (DPV-9-180QQ).

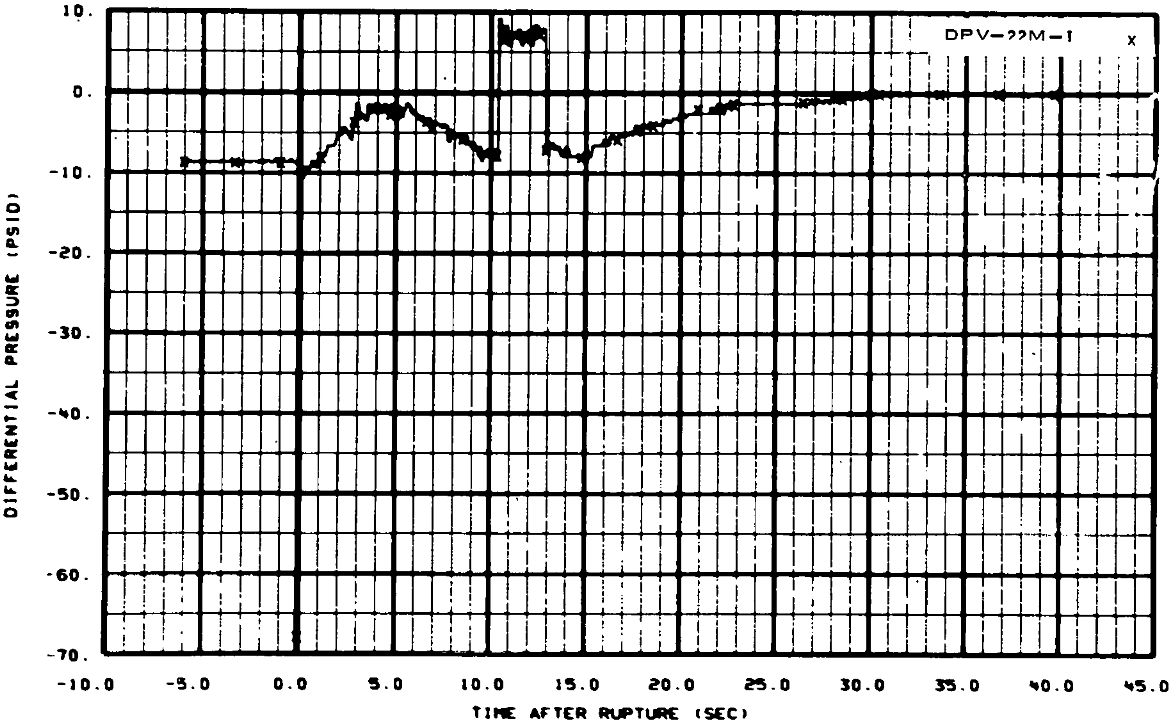

Fig. 91 Differential pressure in vessel (DPV-22M-I).

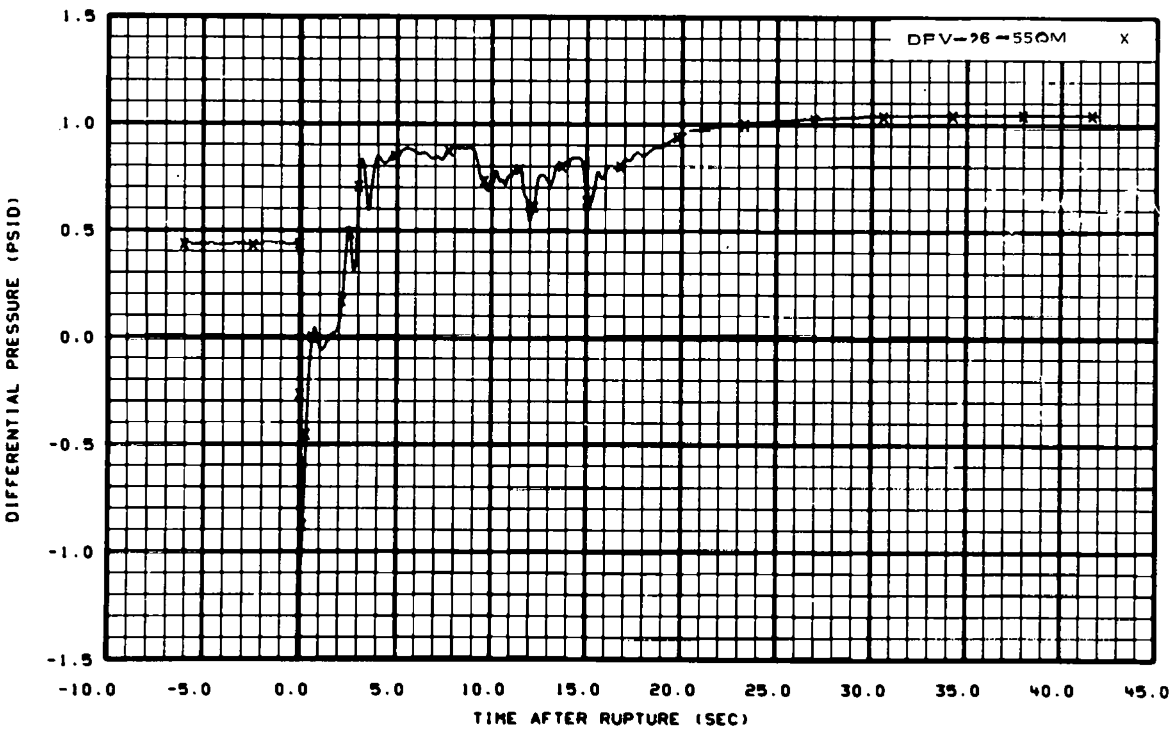

Fig. 92 Differential pressure in vessel (DPV-26-55QM).

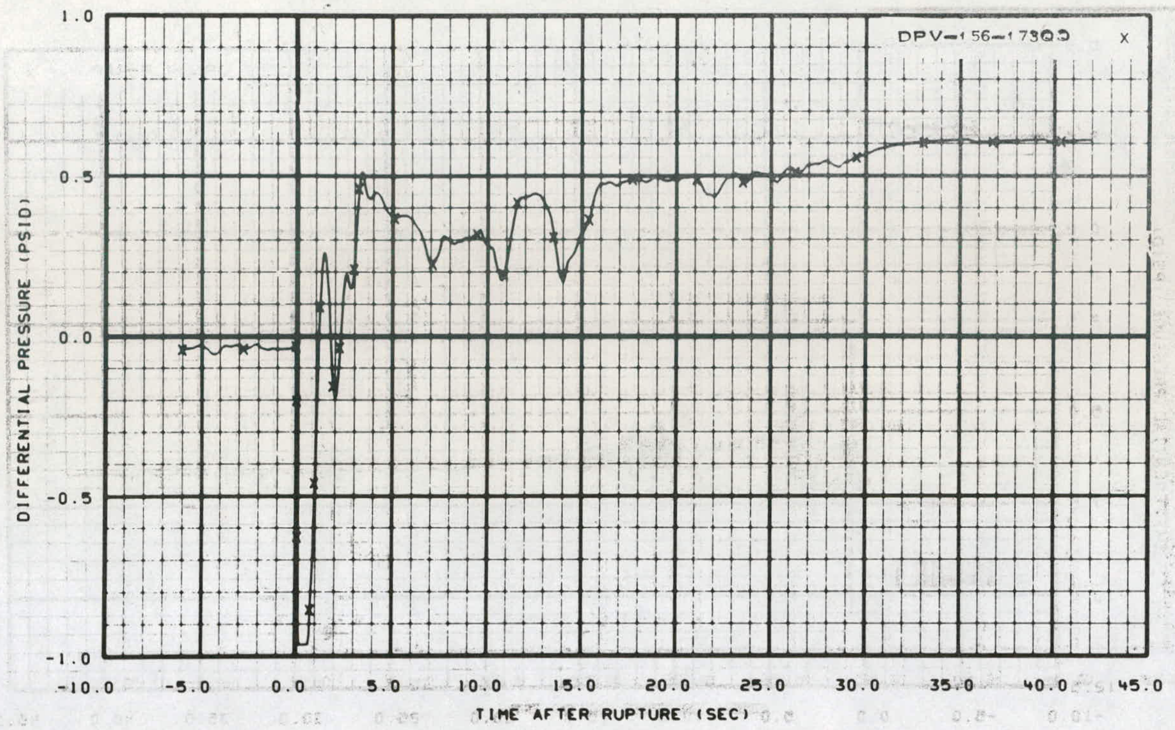

Fig. 93 Differential pressure in vessel (DPV-156-173QQ).

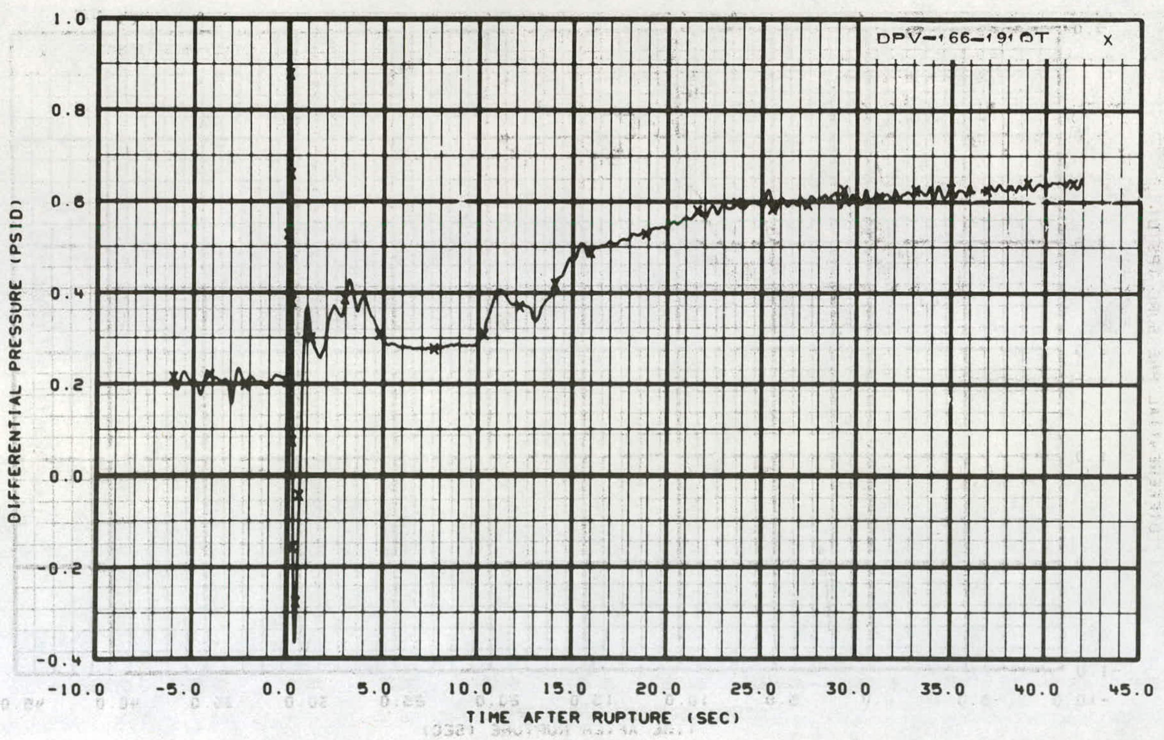

Fig. 94 Differential pressure in vessel (DPV-166-191QT).

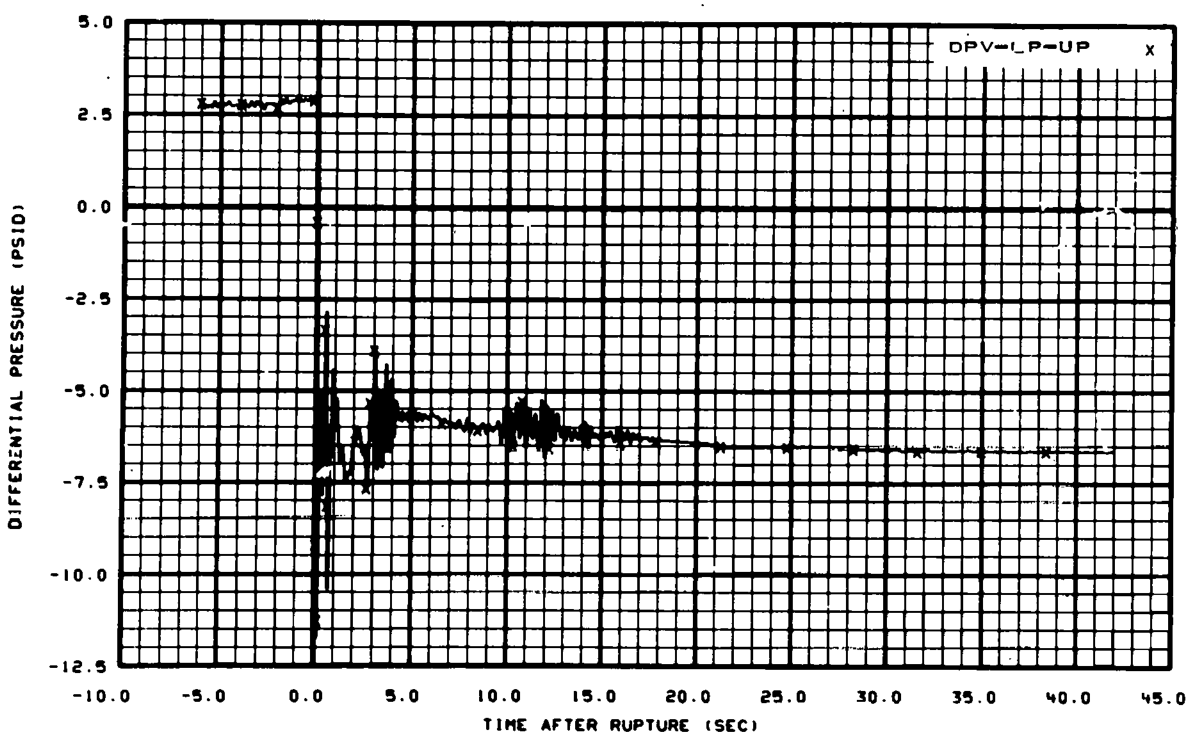

Fig. 95 Differential pressure in vessel (DPV-LP-UP).

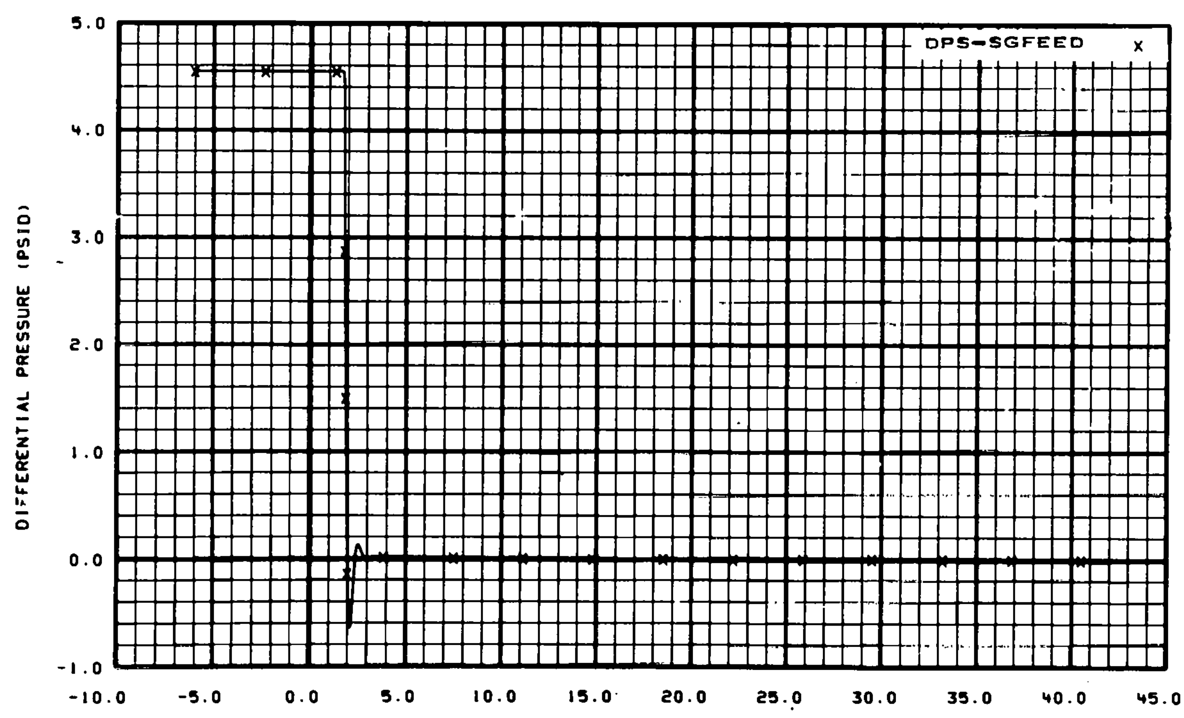

Fig. 96 Differential pressure across steam generator inlet orifice.

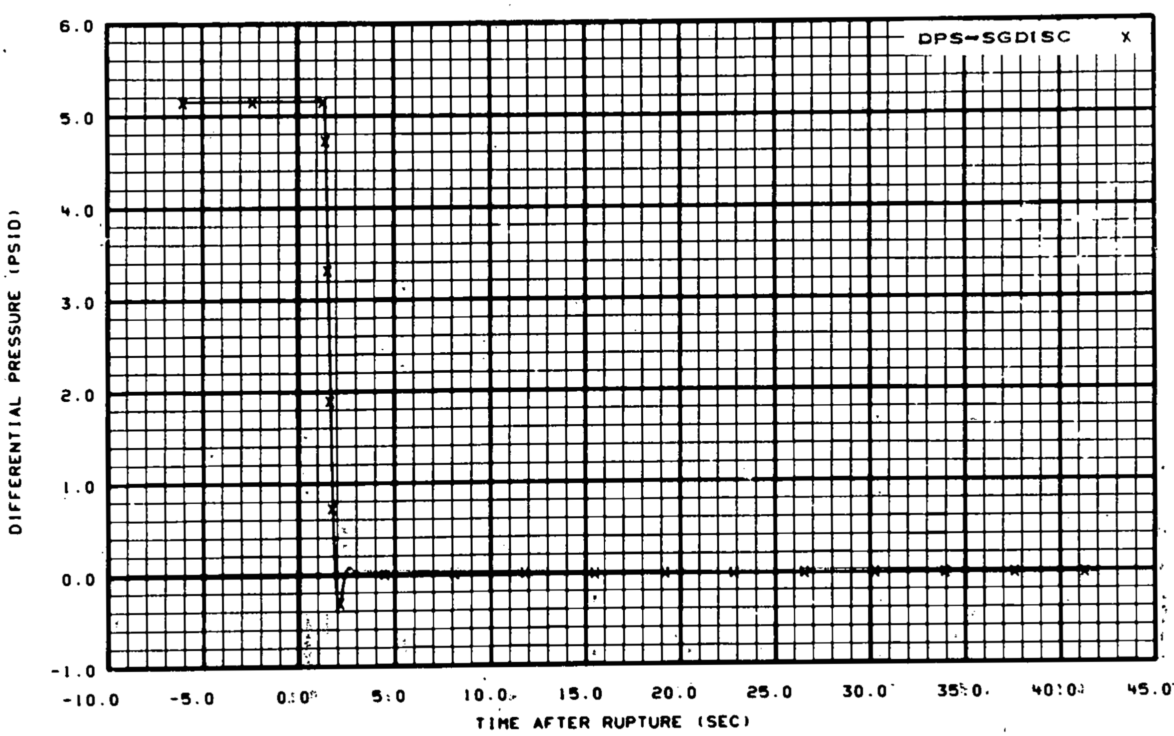

Fig. 97 Differential pressure across steam generator outlet orifice.

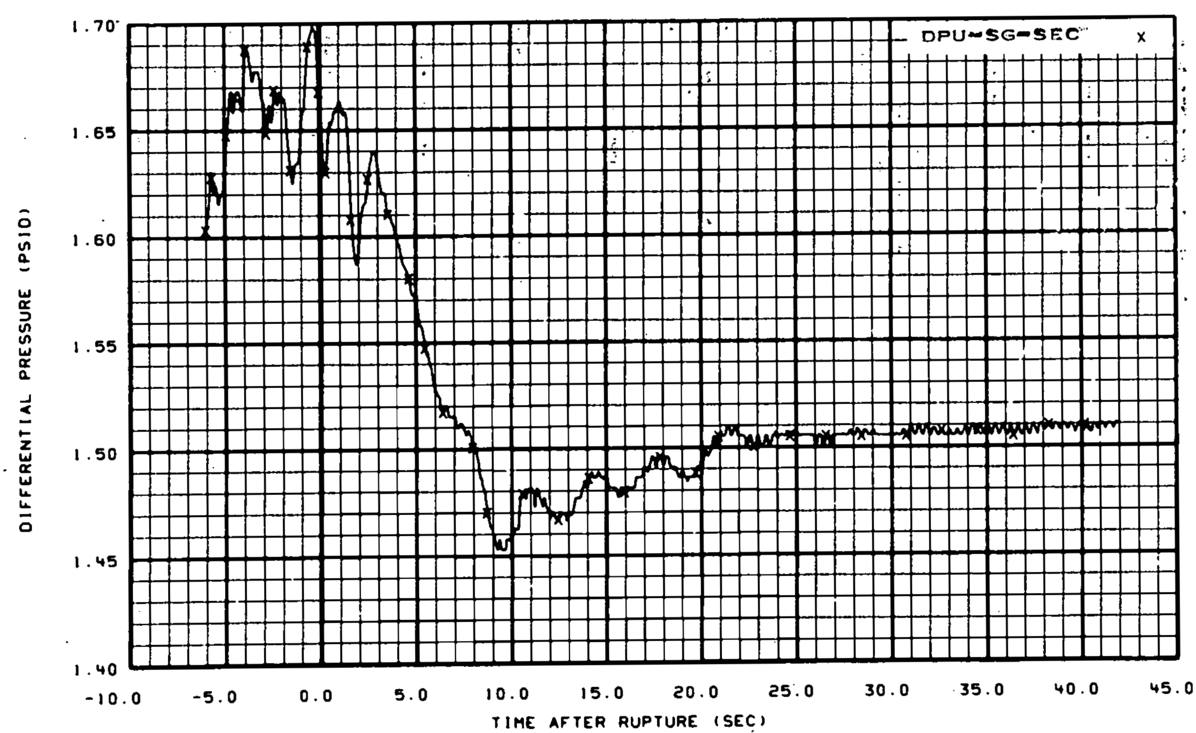

Fig. 98 Differential pressure in steam generator secondary.

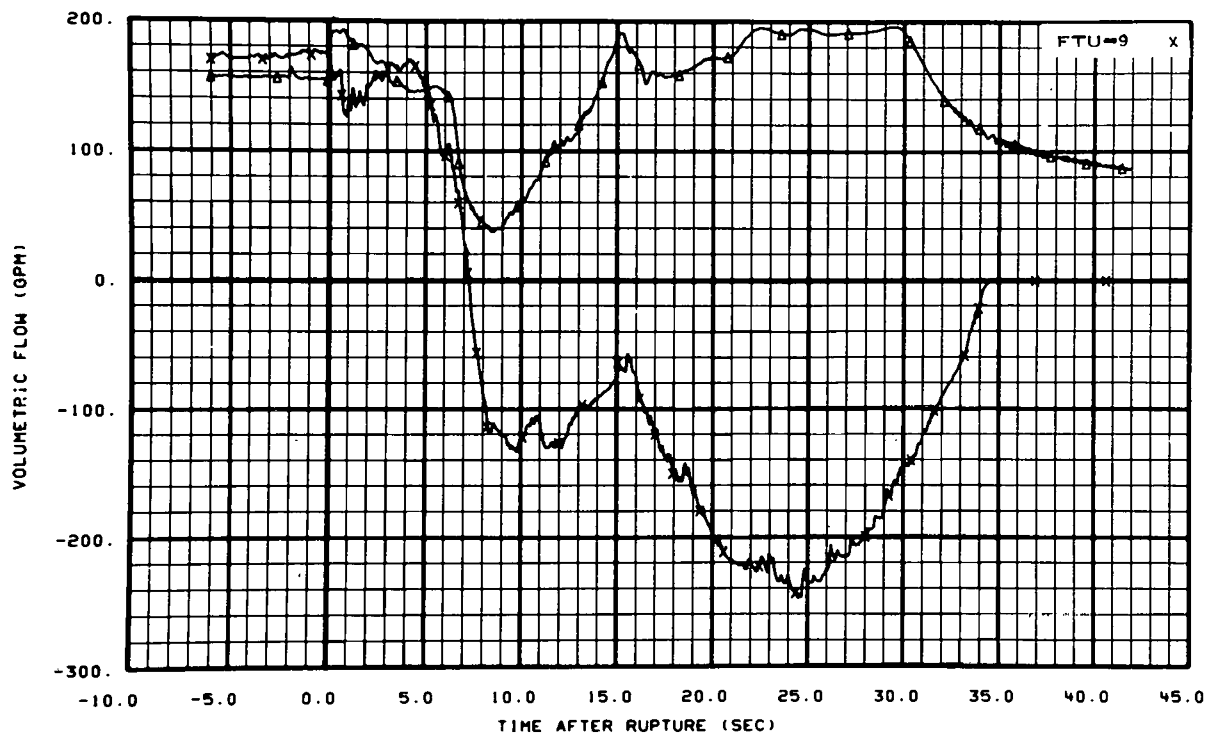

Fig. 99 Volumetric flow in intact loop (FTU-1, FTU-9).

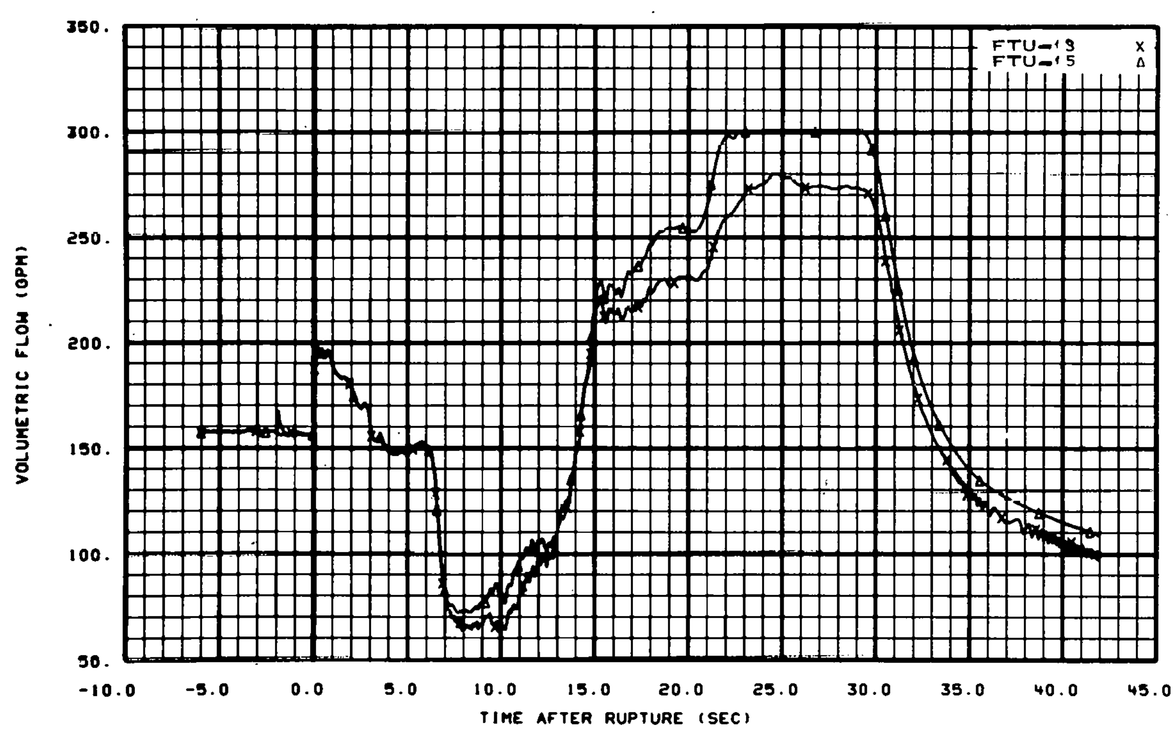

Fig. 100 Volumetric flow in intact loop (FTU-13, FTU-15)

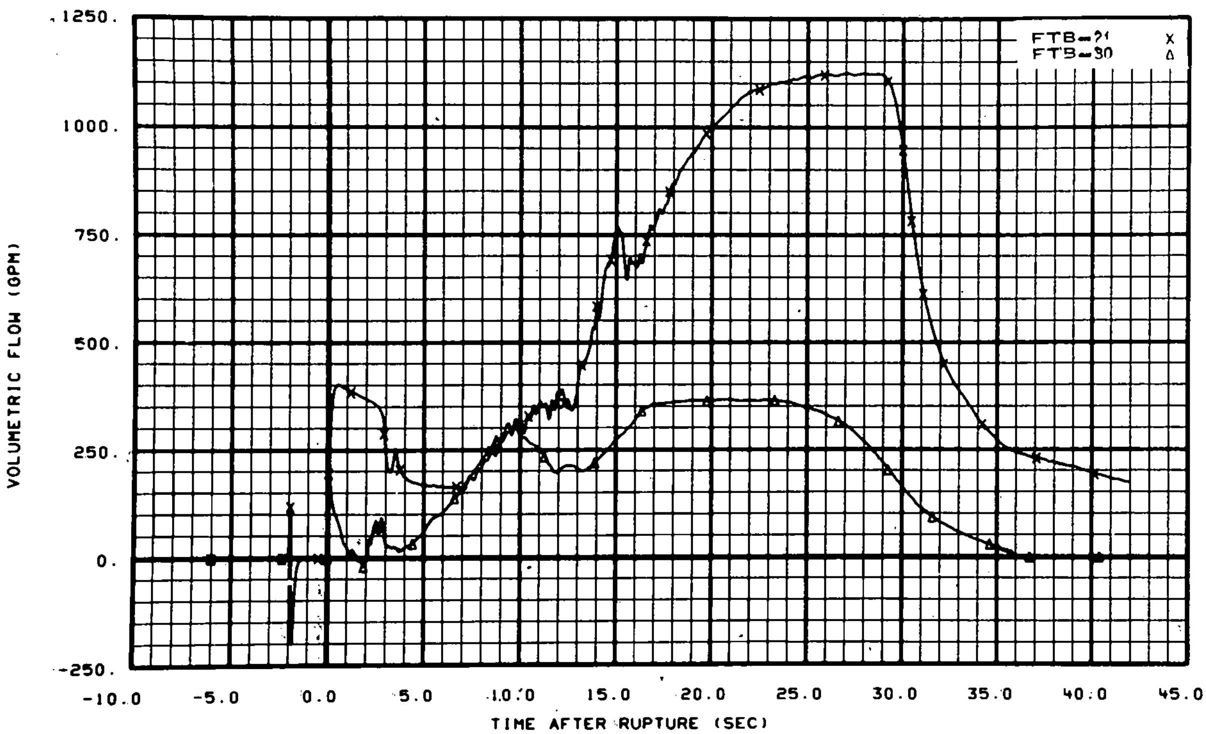

Fig. 101 Volumetric flow in broken loop (FTB-21, FTB-30).

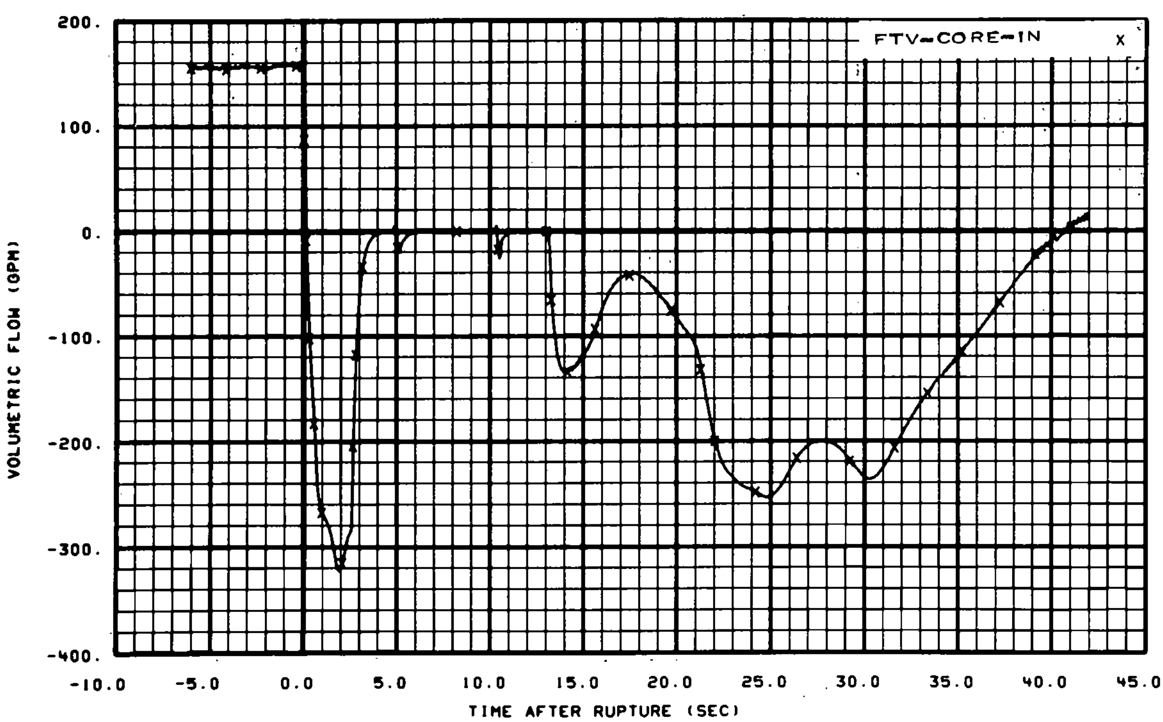

Fig. 102 Volumetric flow in core entrance.

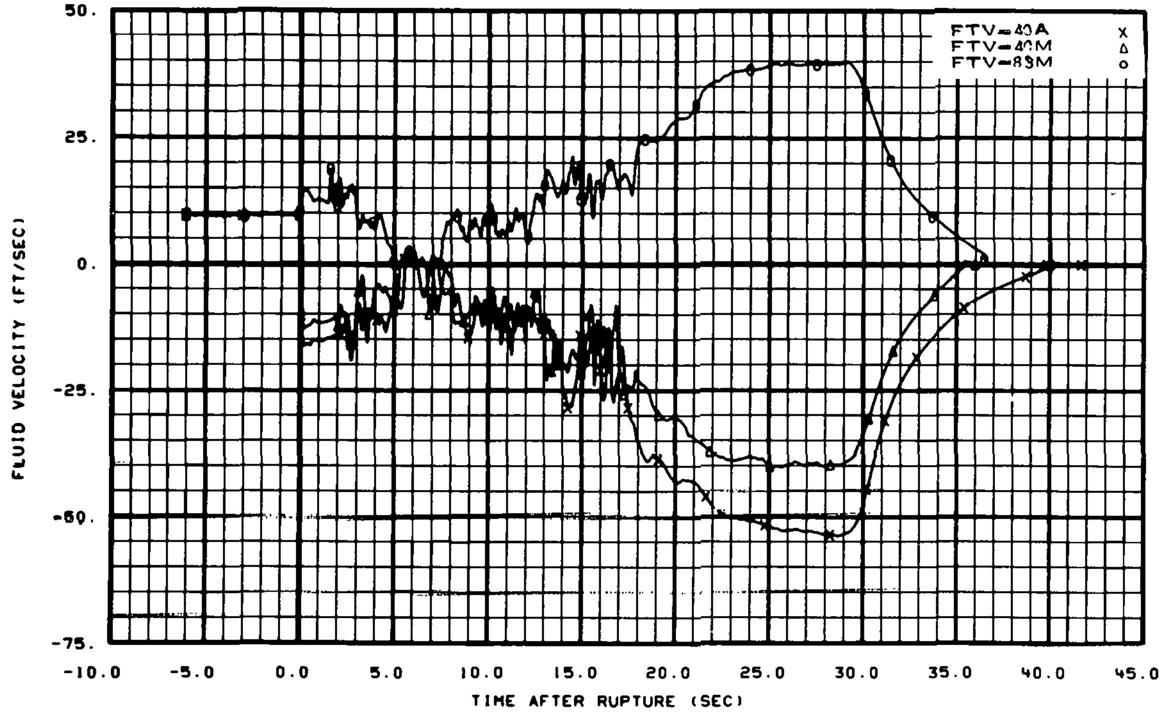

Fig. 103 Fluid velocity in vessel.

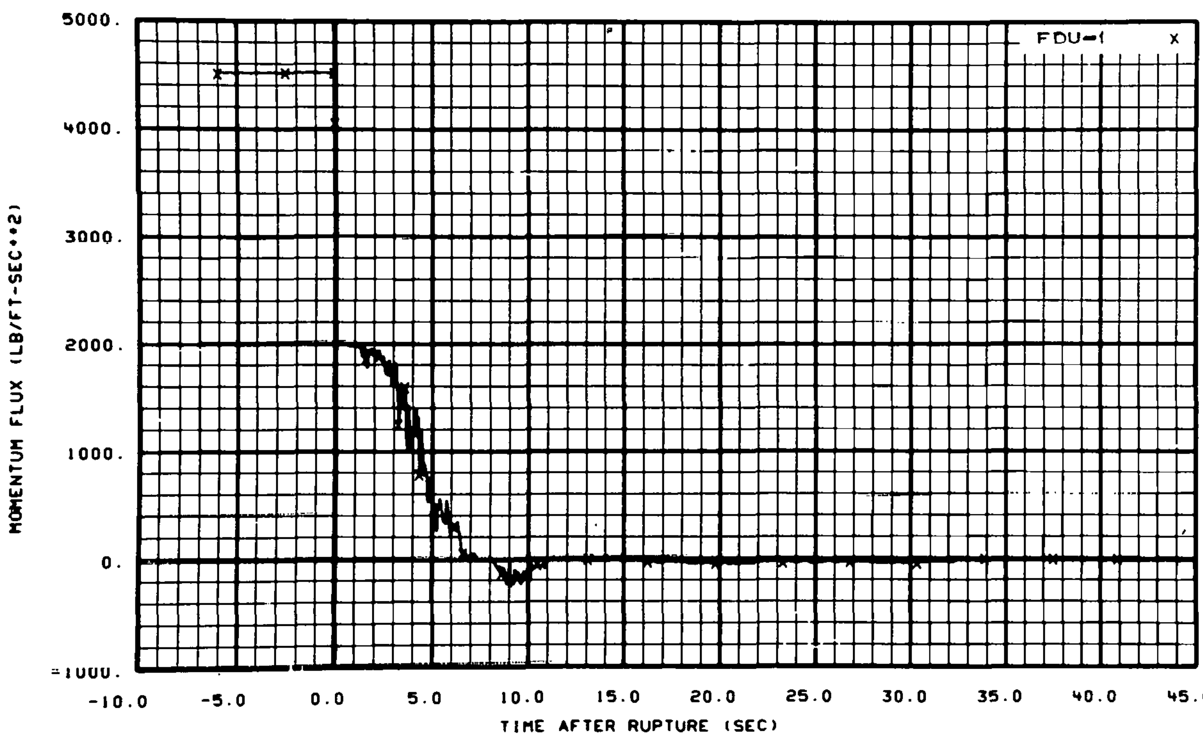

Fig. 104 Momentum flux in intact loop (Spool 1).

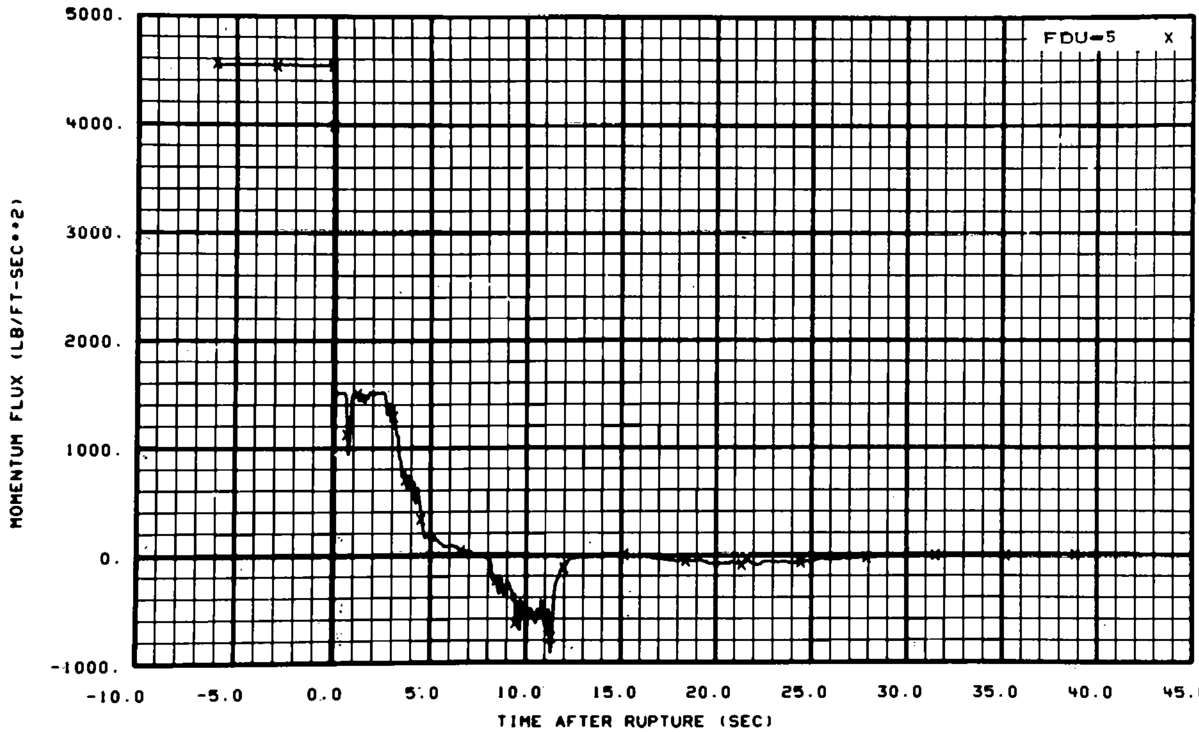

Fig. 105 Momentum flux in intact loop (Spool 5).

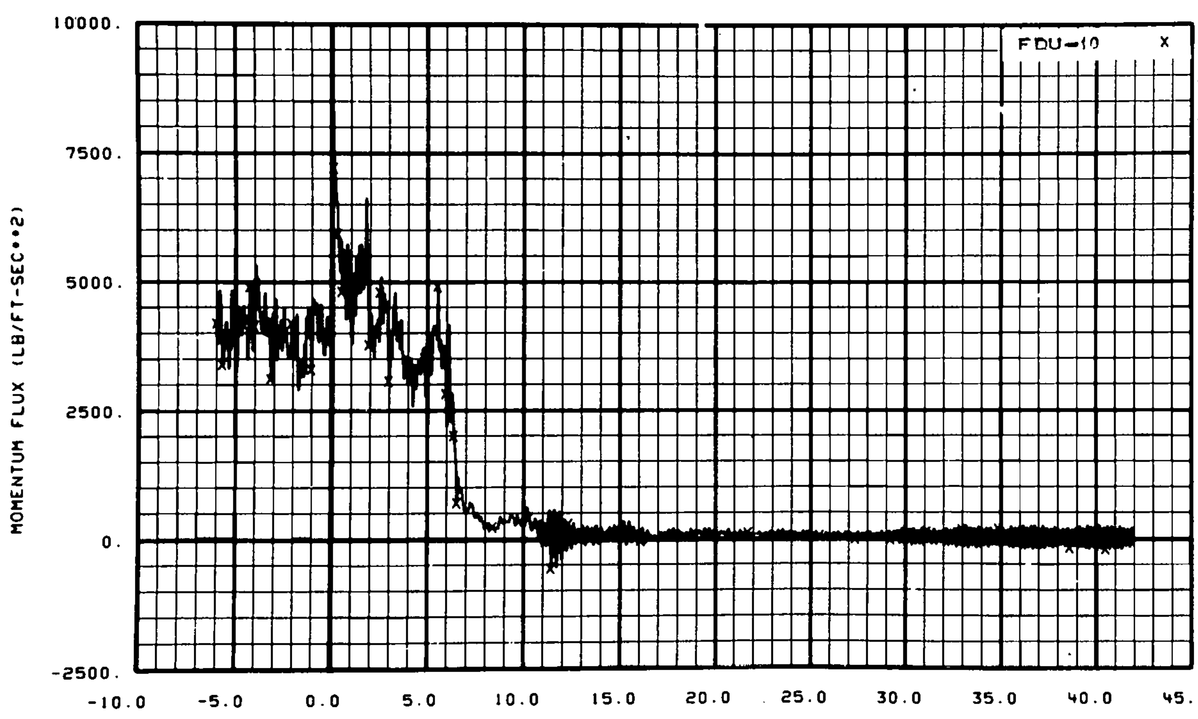

Fig. 106 Momentum flux in intact loop (Spool 10).

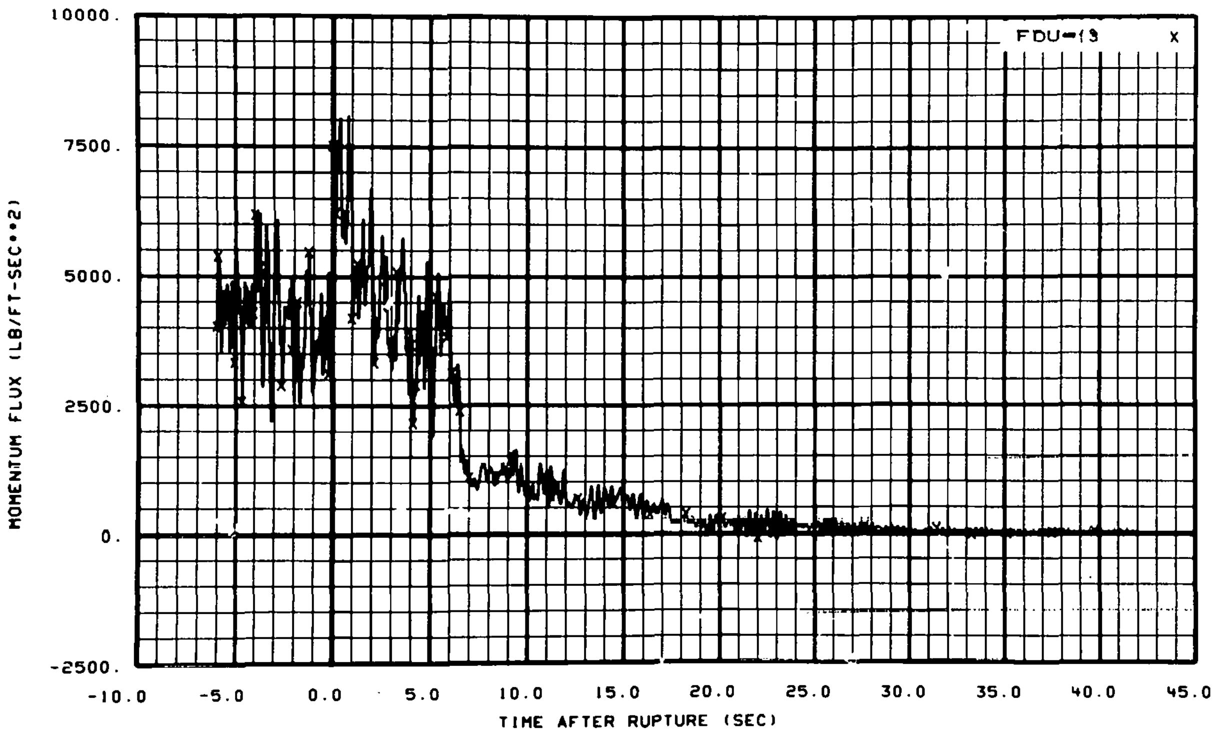

Fig. 107 Momentum flux in intact loop (Spool 13).

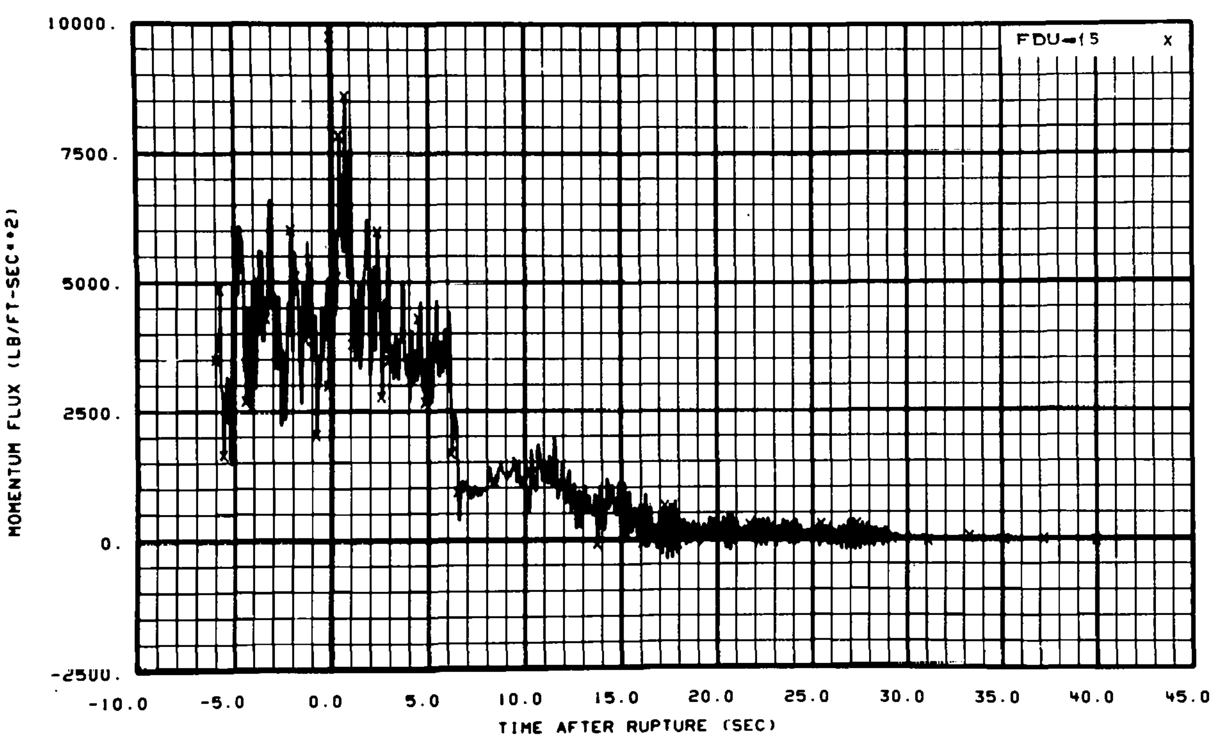

Fig. 108 Momentum flux in intact loop (Spool 15).

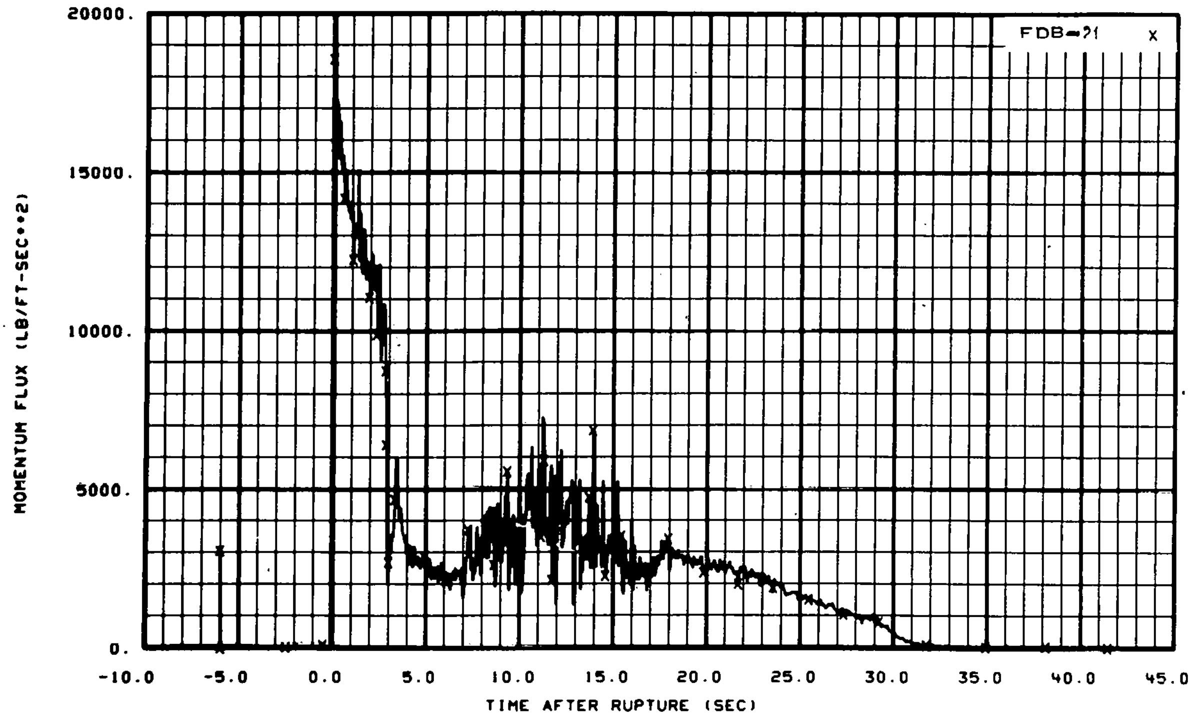

Fig. 109 Momentum flux in intact loop (Spool 21).

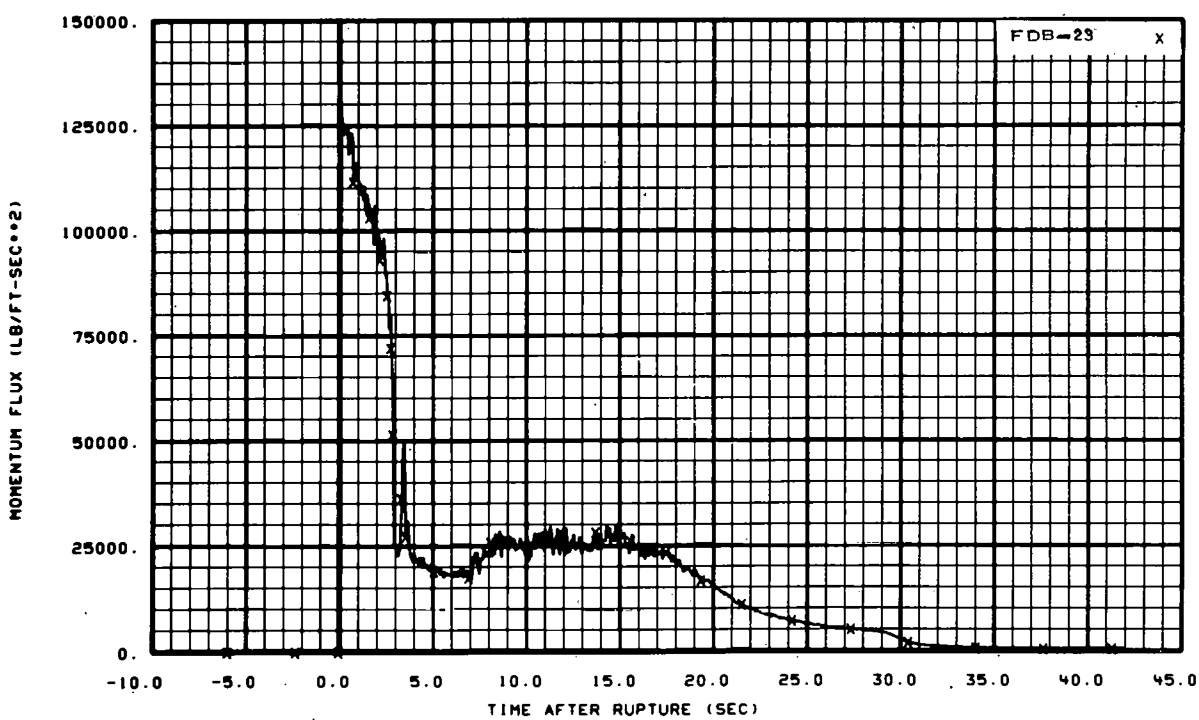

Fig. 110 Momentum flux in intact loop (Spool 23).

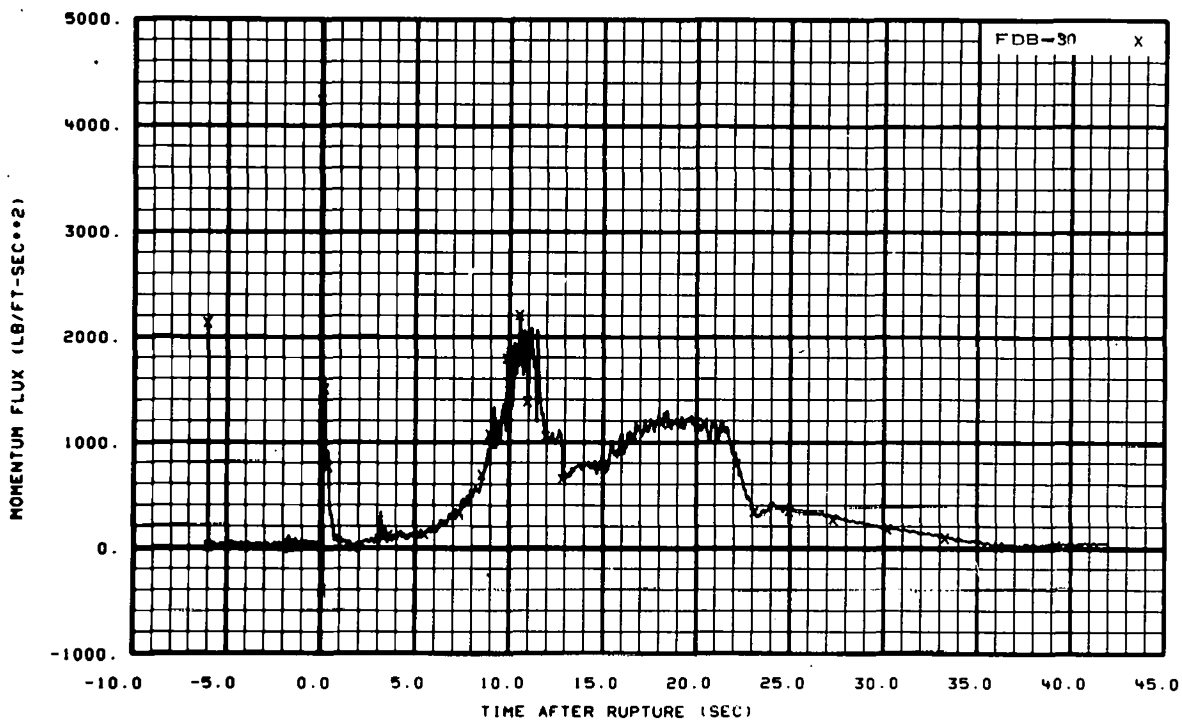

Fig. 111 Momentum flux in intact loop (Spool 30).

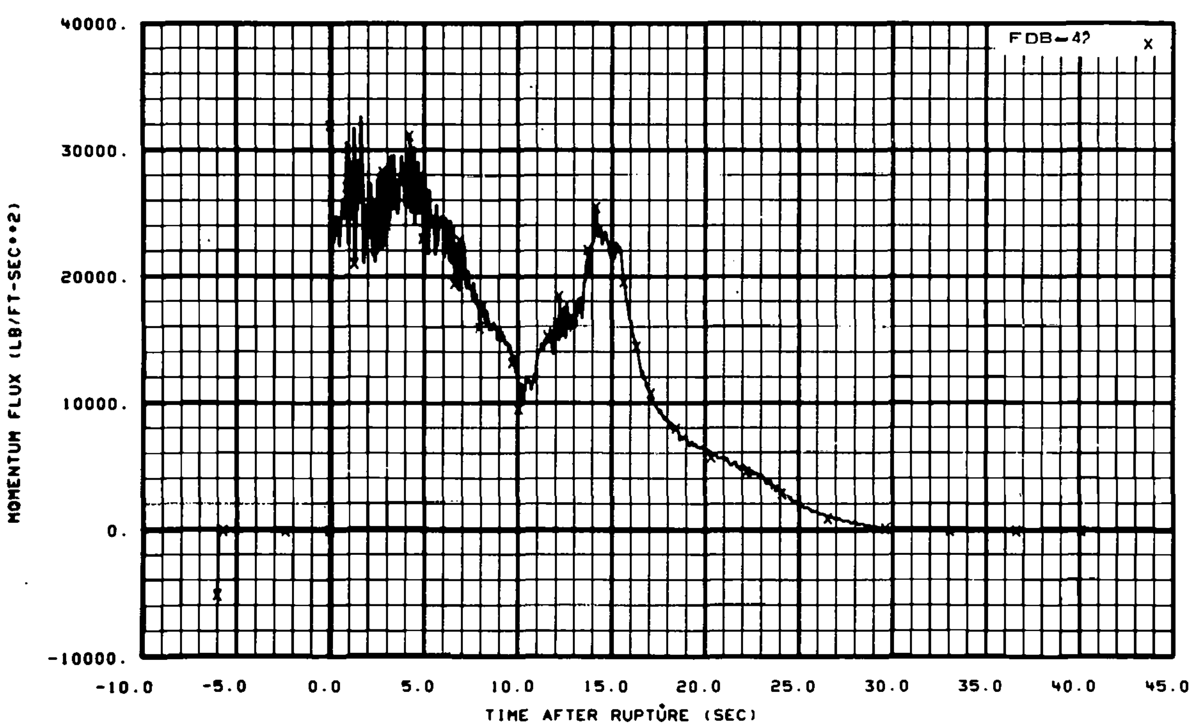

Fig. 112 Momentum flux in intact loop (Spool 42).

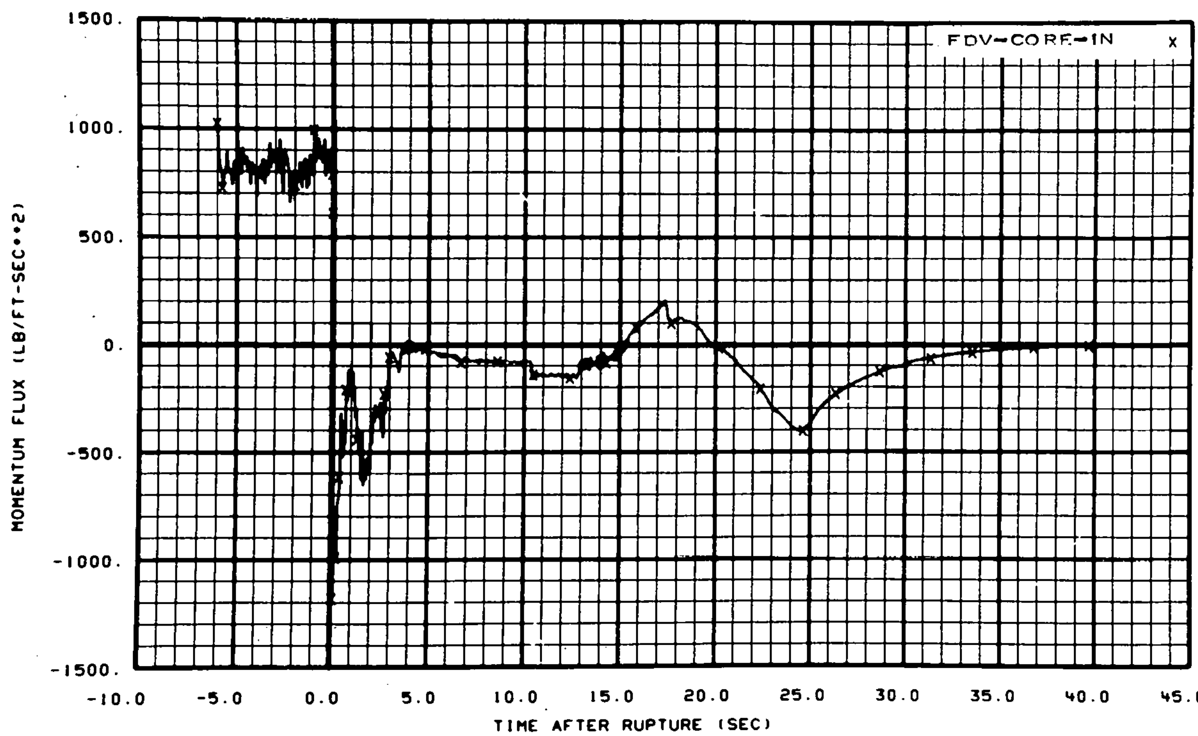

Fig. 113 Momentum flux in core entrance.

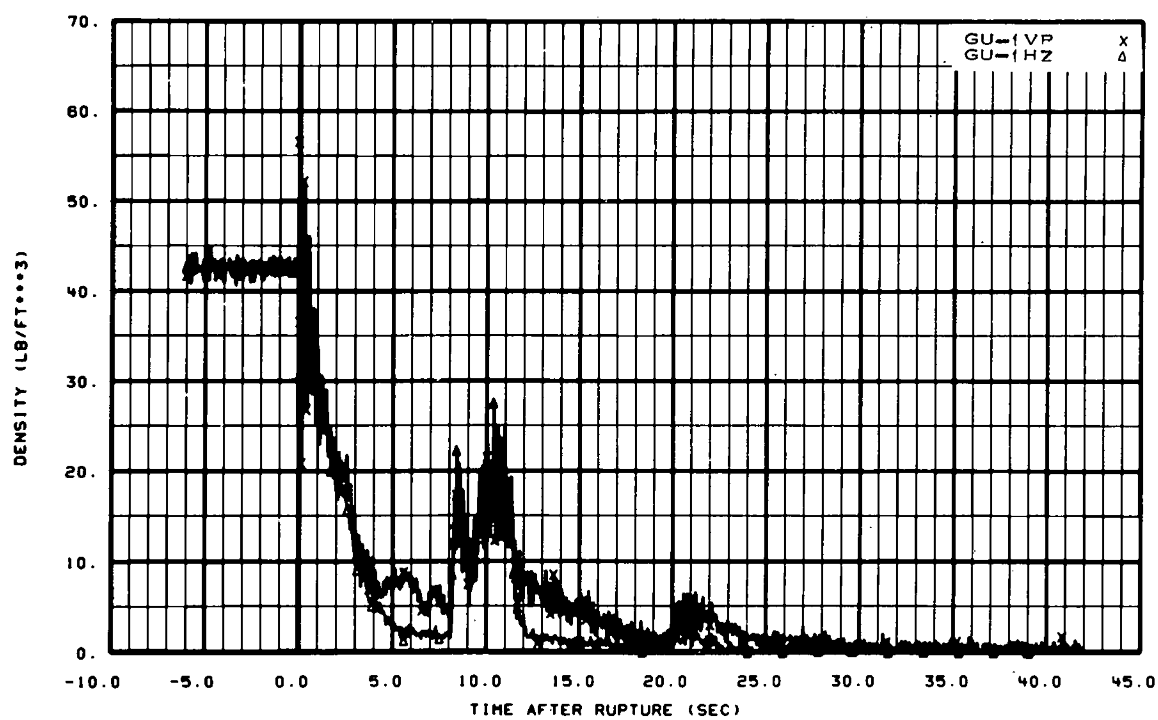

Fig. 114 Density in intact loop (GU-1VR, GU-1HZ).

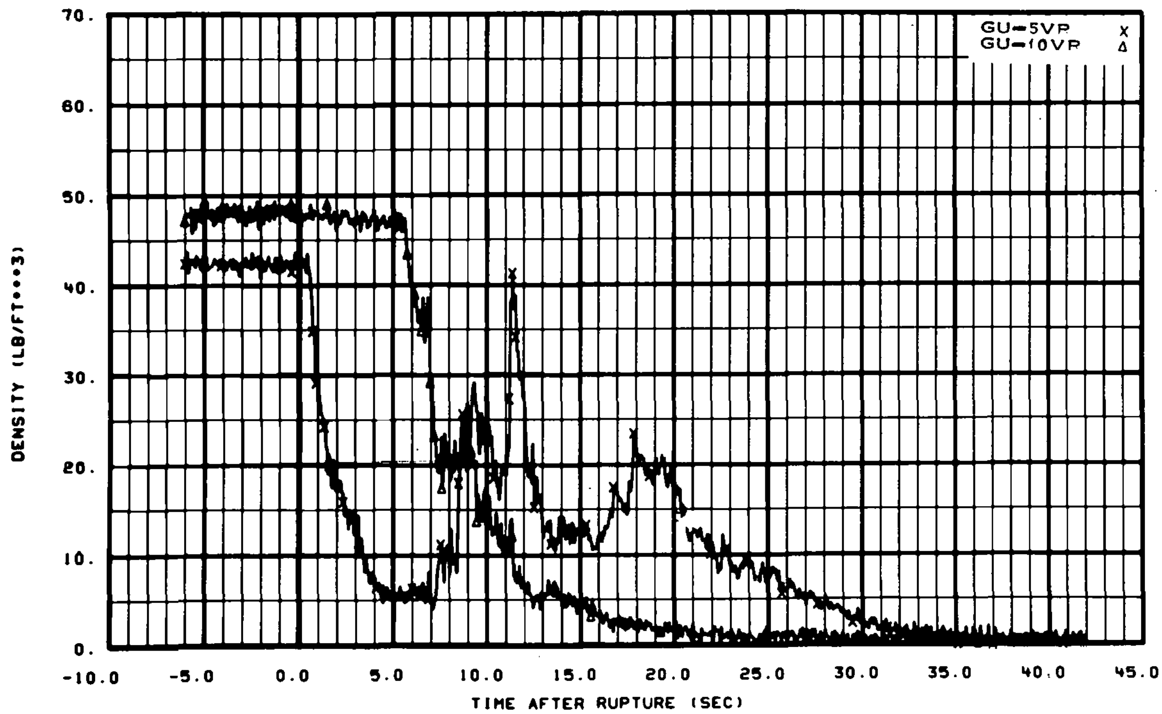

Fig. 115 Density in intact loop (GU-5VR, GU-10VR).

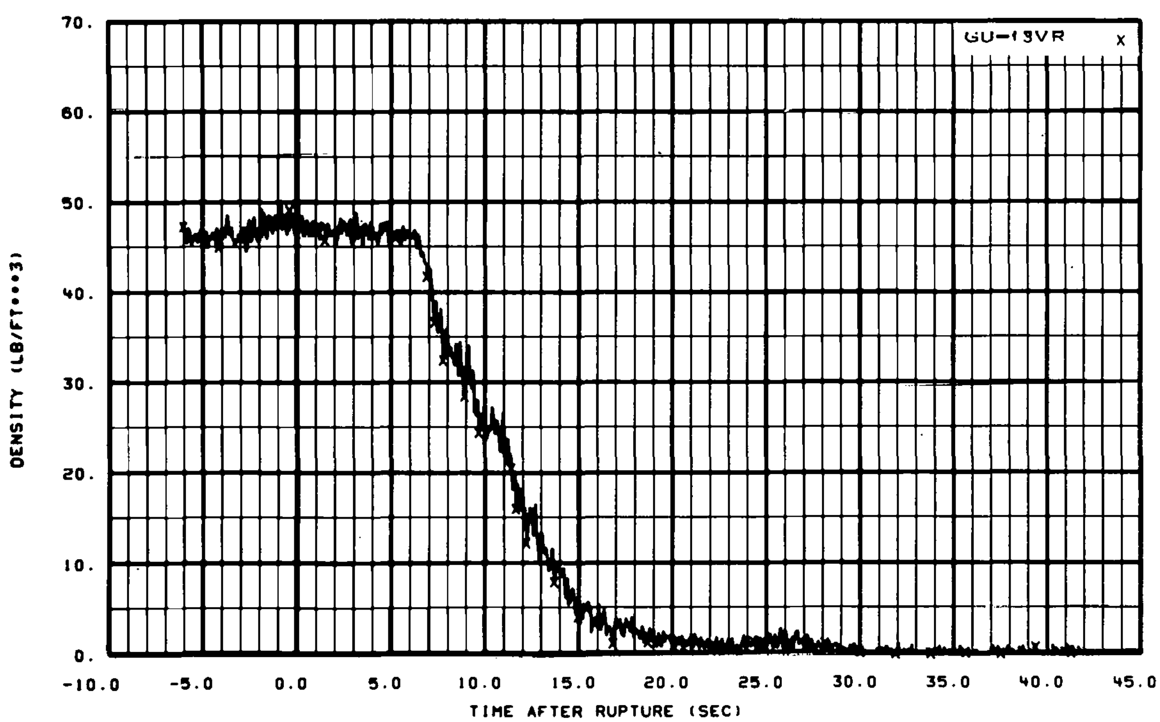

Fig. 116 Density in intact loop (GU-13VR).

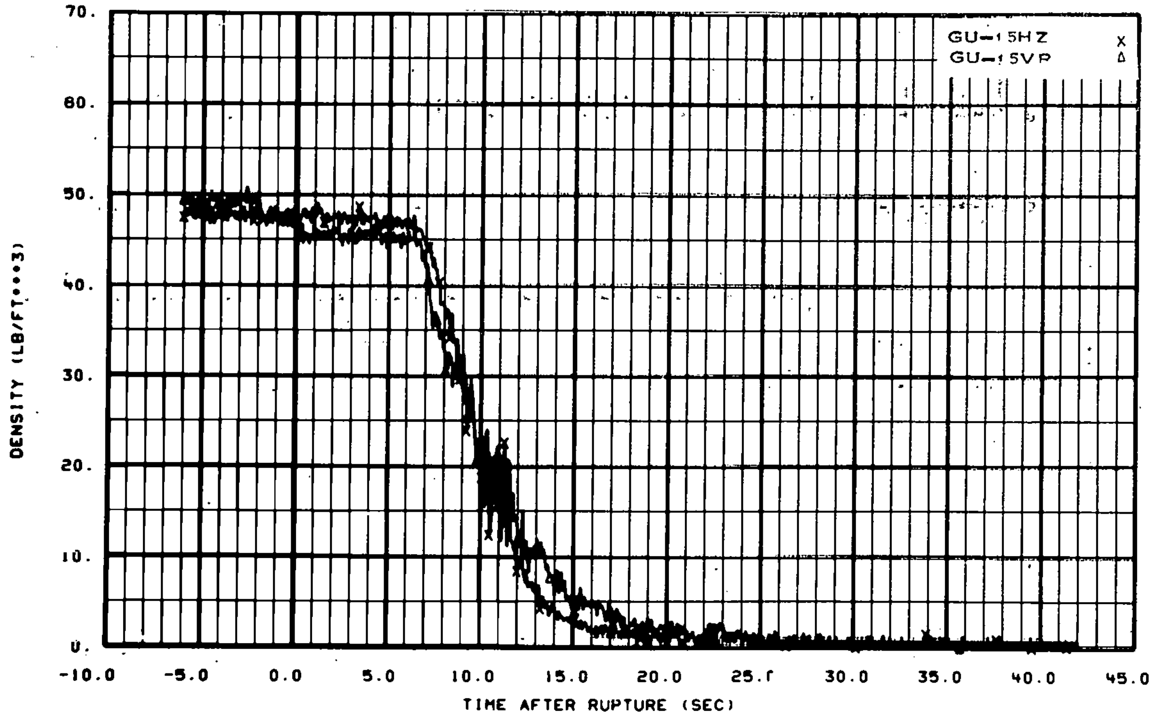

Fig. 117 Density in intact loop (GU-15HZ, GU-15VR).

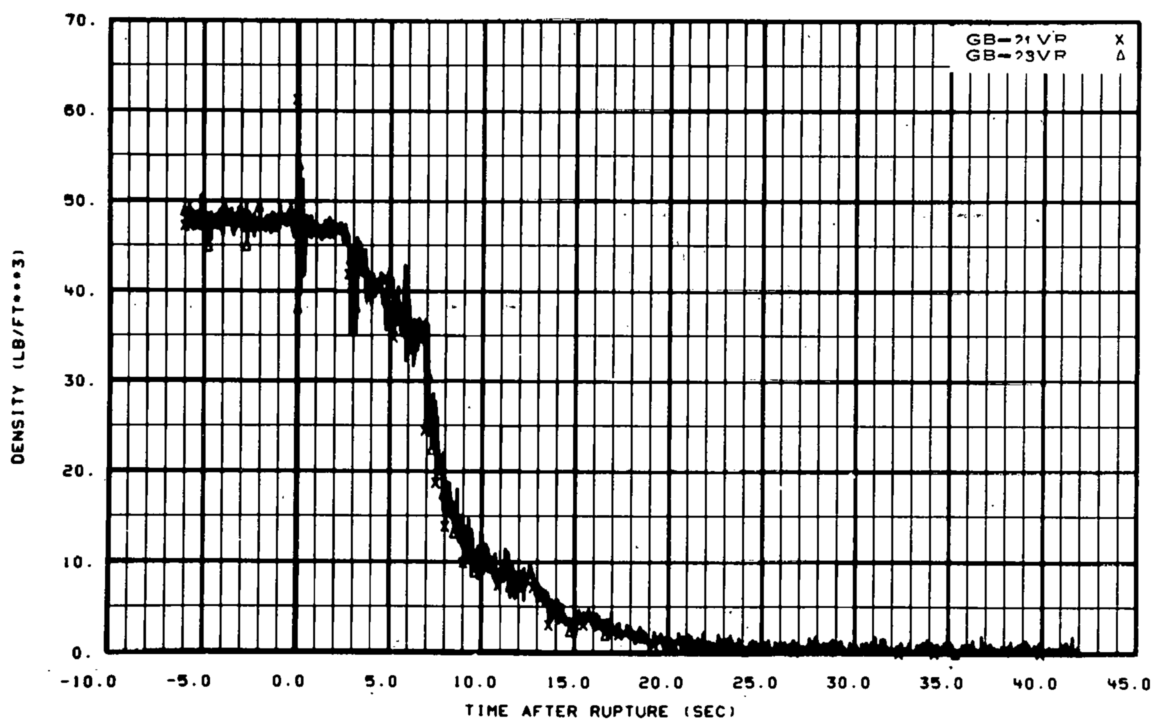

Fig. 118 Density in broken loop (GB-21VR, GB-23VR).

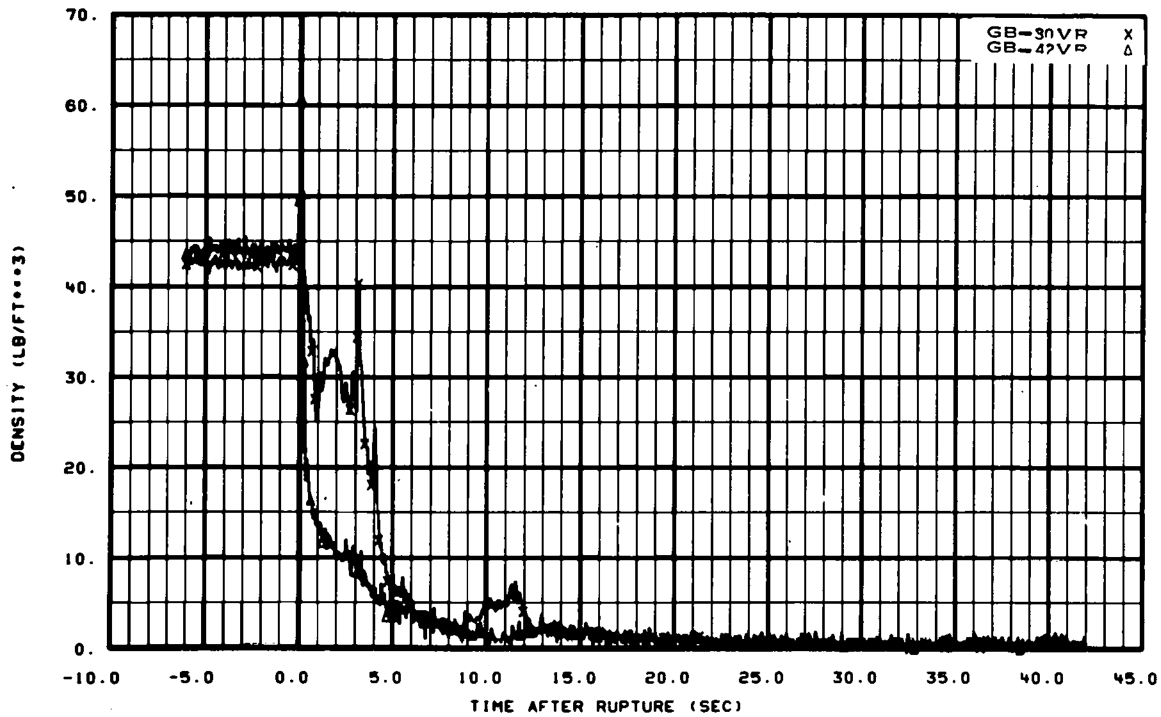

Fig. 119 Density in broken loop (GB-42VR).

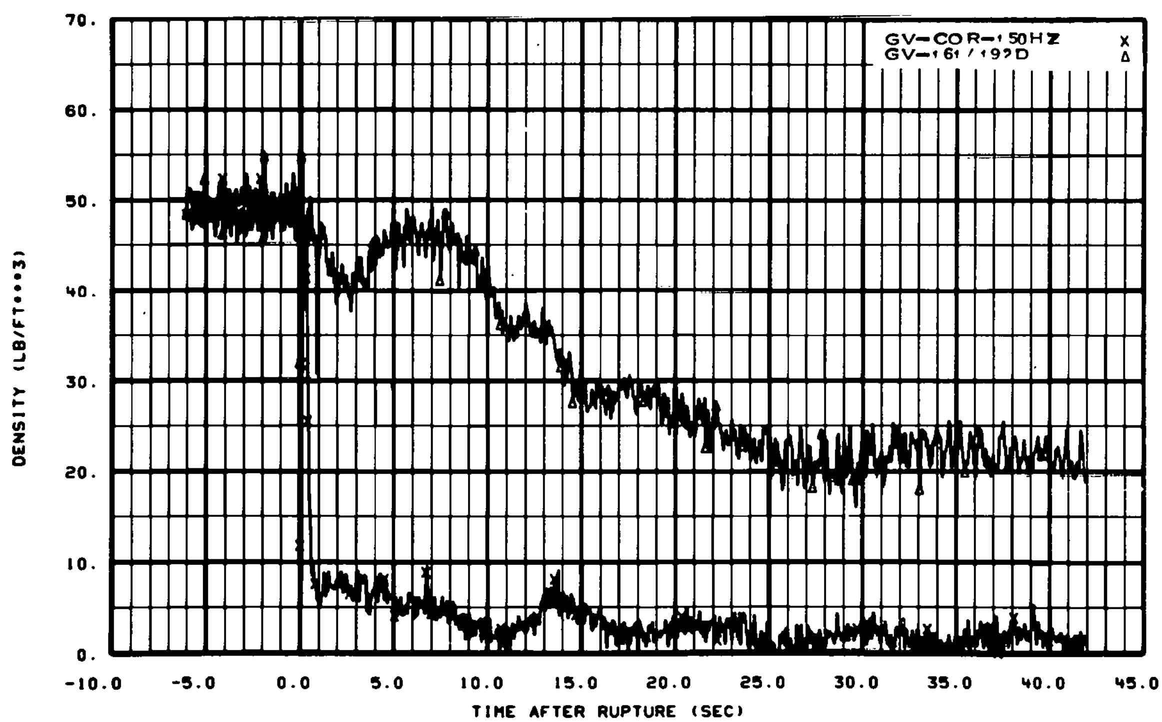

Fig. 120 Density in vessel (GV-COR-150HZ, GV-161/192).

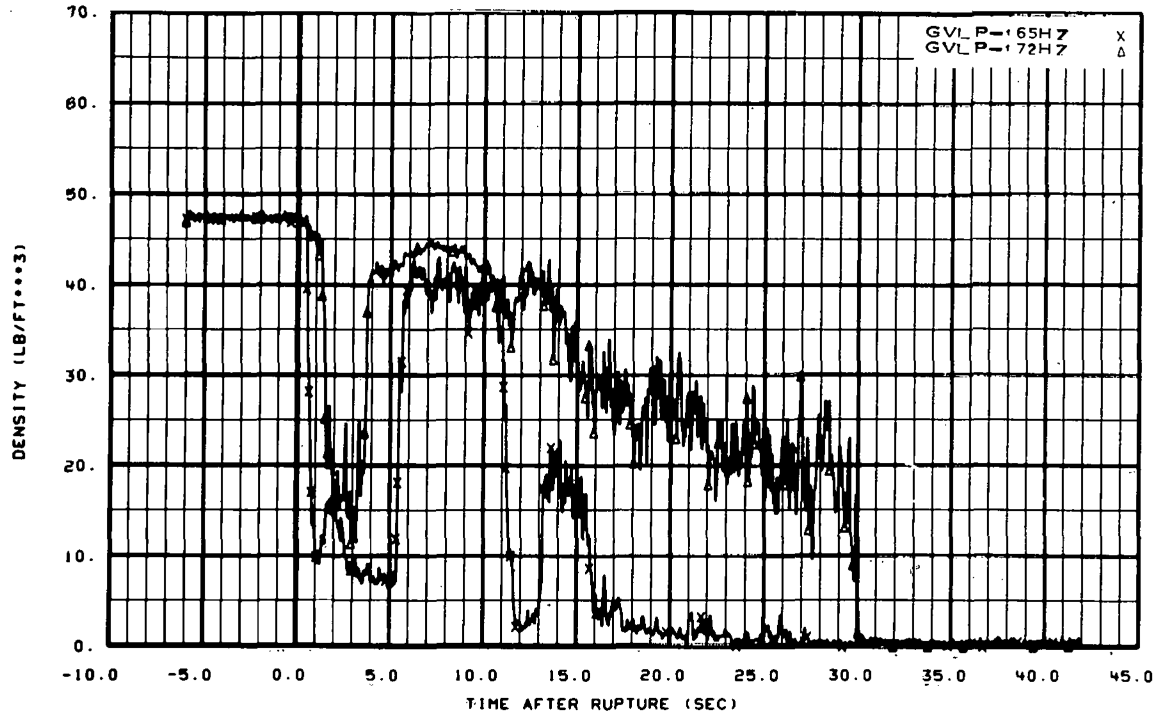

Fig. 121 Density in vessel (GVLP-165HZ, GVLP-172HZ).

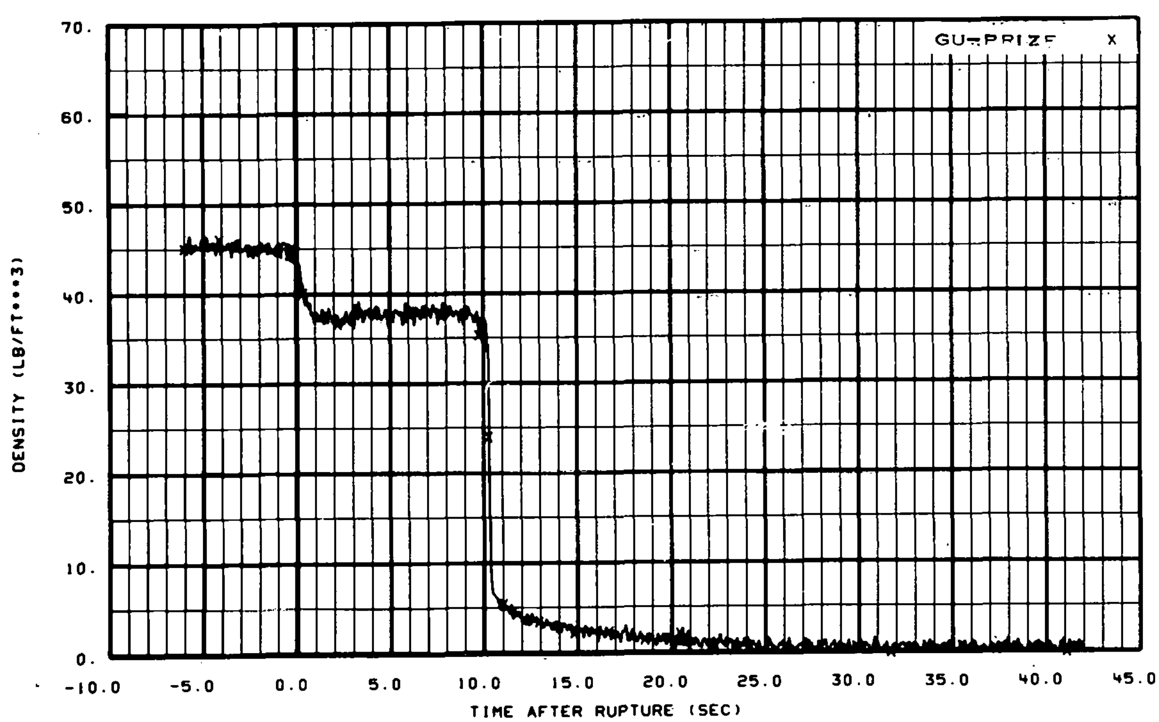

Fig. 122 Density in pressurizer.

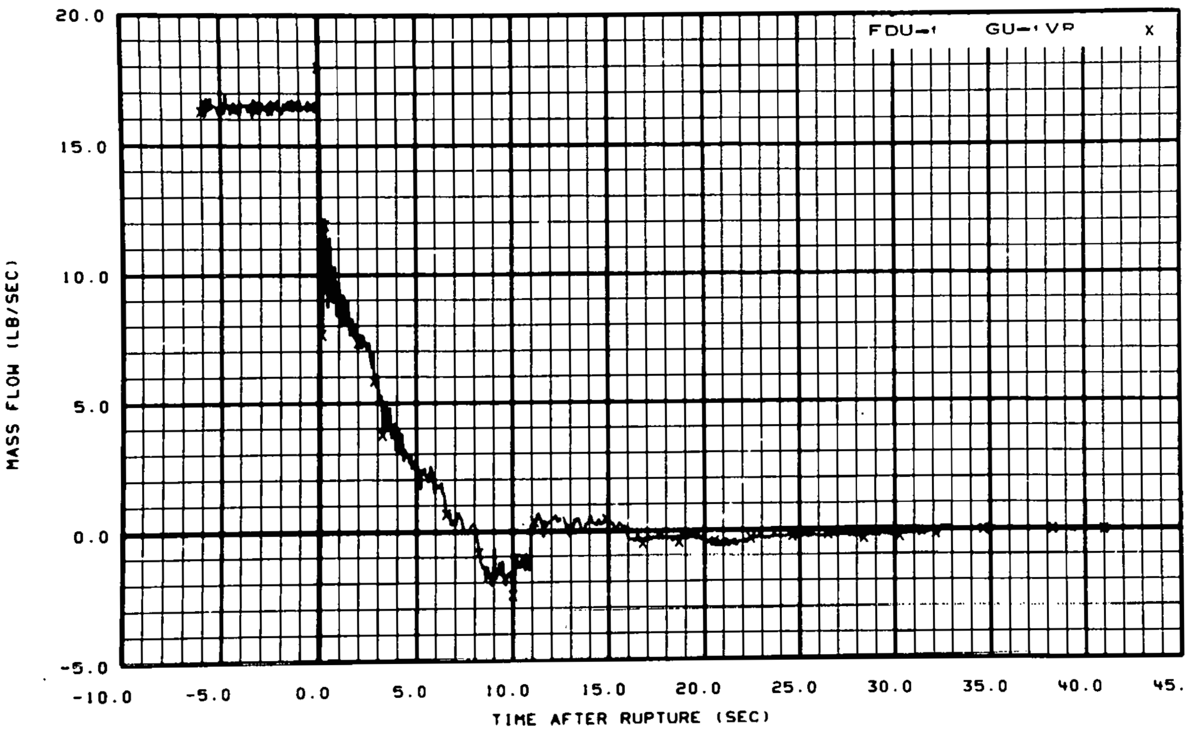

Fig. 123 Mass flow in intact loop (FDU-1 and GU-1VR).

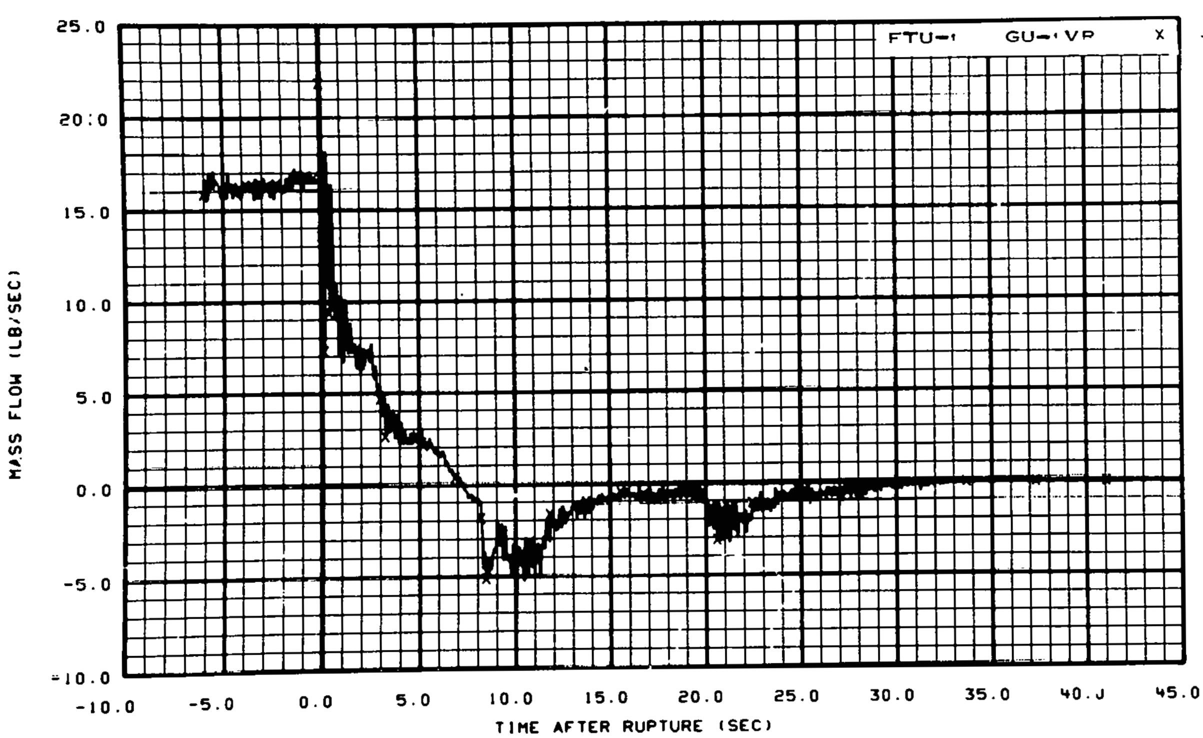

Fig. 124 Mass flow in intact loop (FTU-1 and GU-1VR).

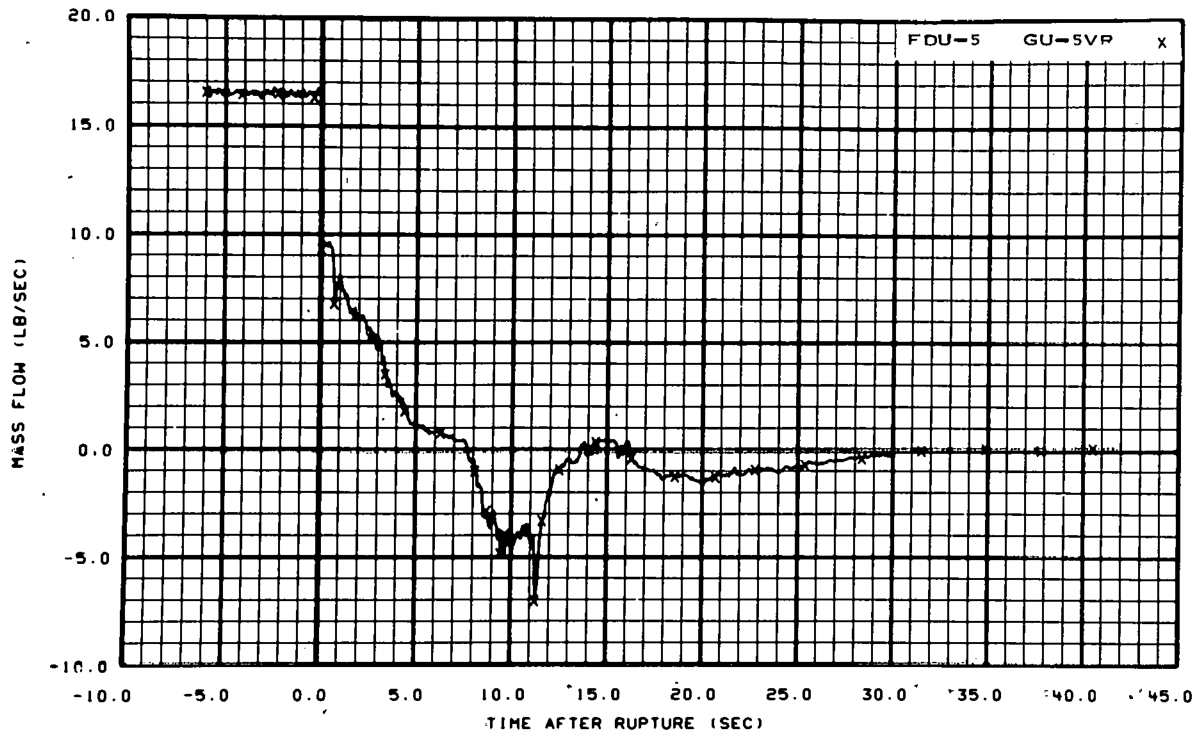

Fig. 125 Mass flow in intact loop (FDU-5 and GU-5VR).

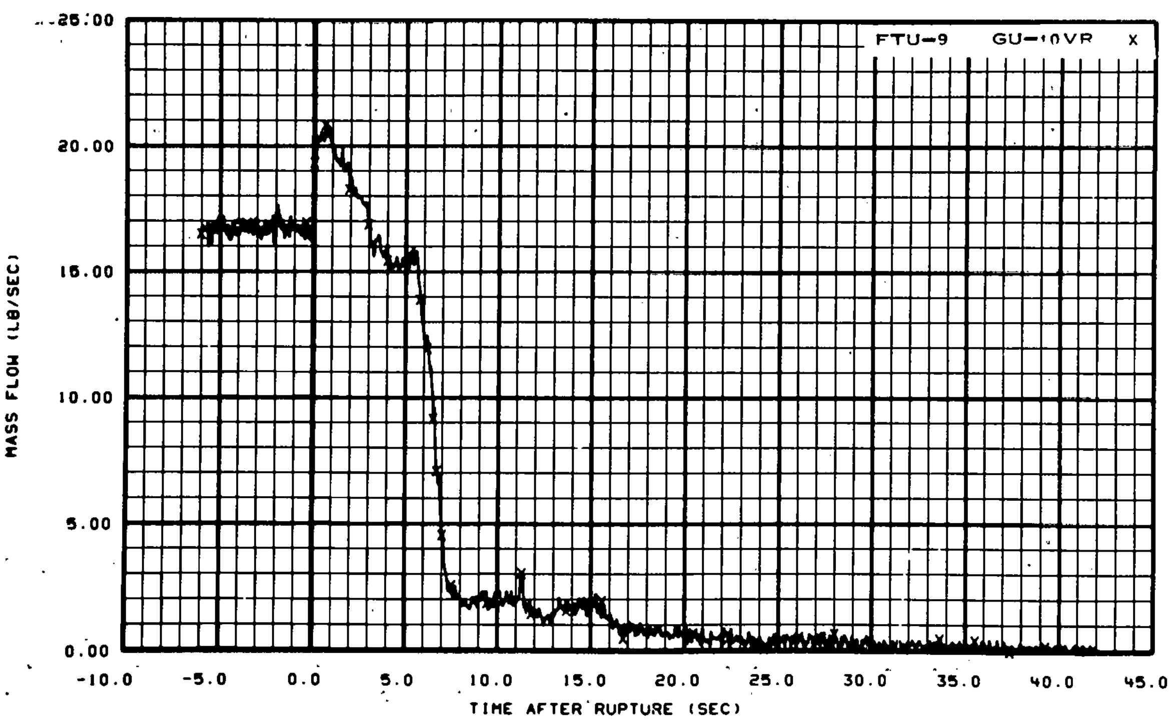

Fig. 126 Mass flow in intact loop (FTU-9 and GU-10VR).

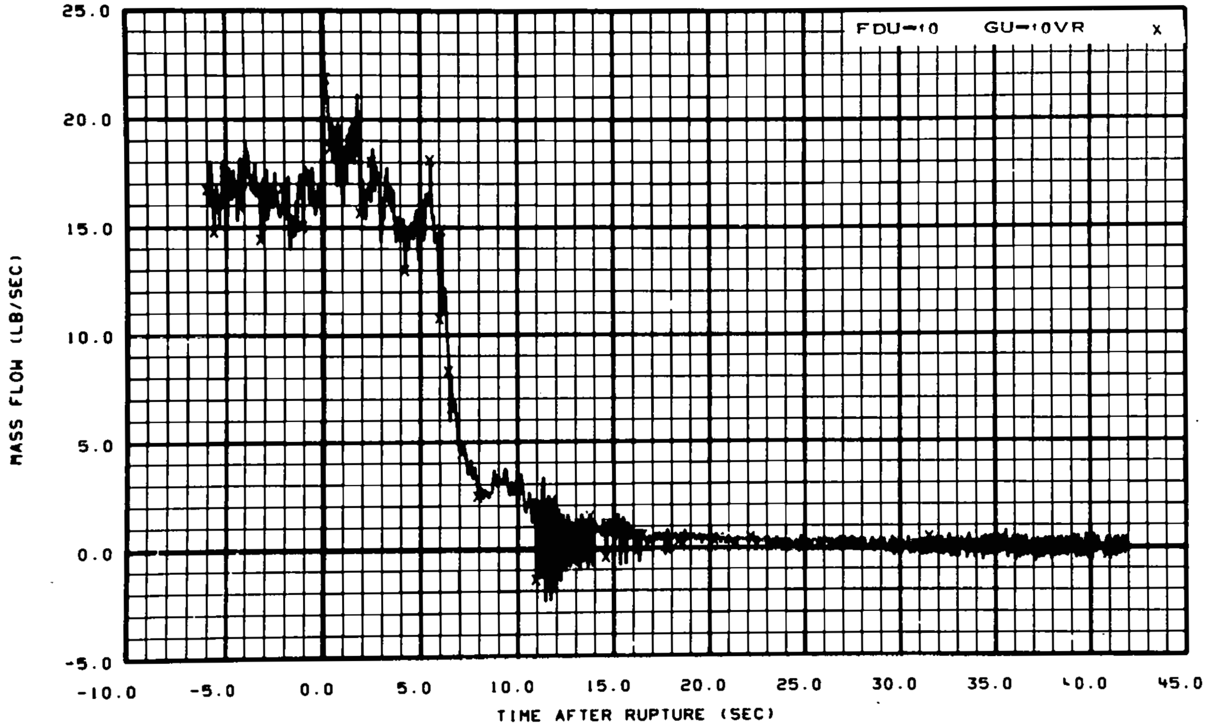

Fig. 127 Mass flow in intact loop (FDU-10 and GU-10VR).

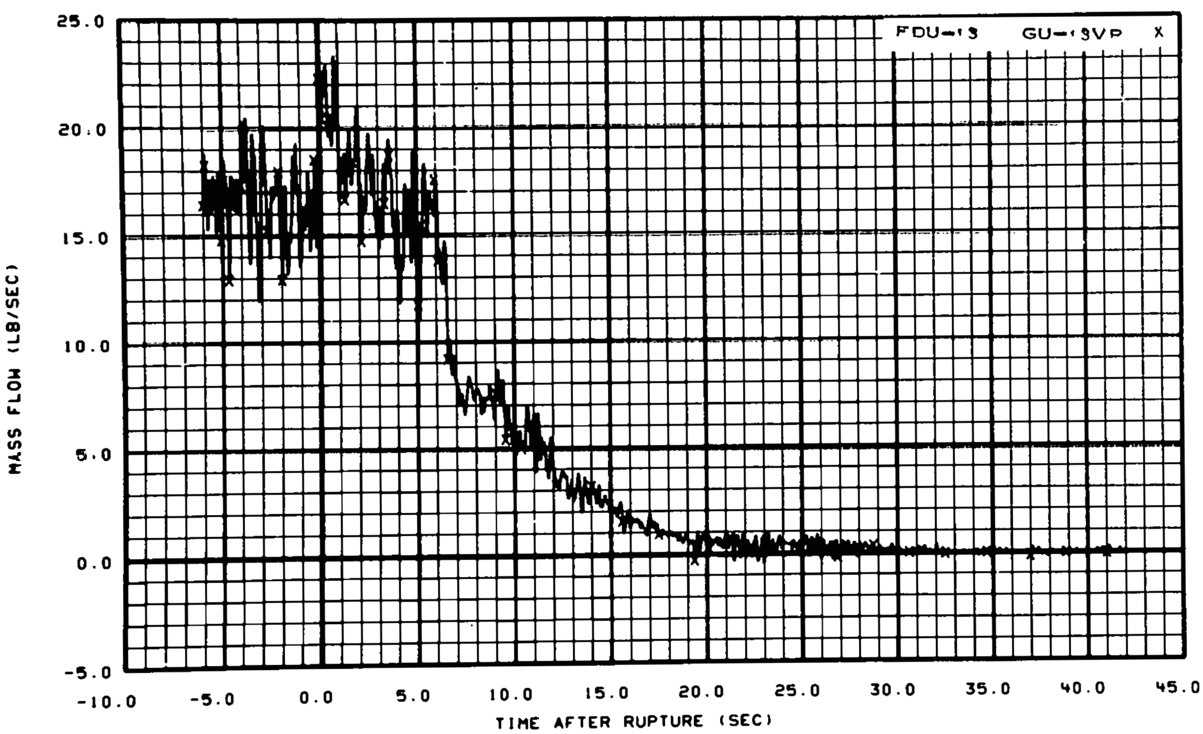

Fig. 128 Mass flow in intact loop (FDU-13 and GU-13VR).

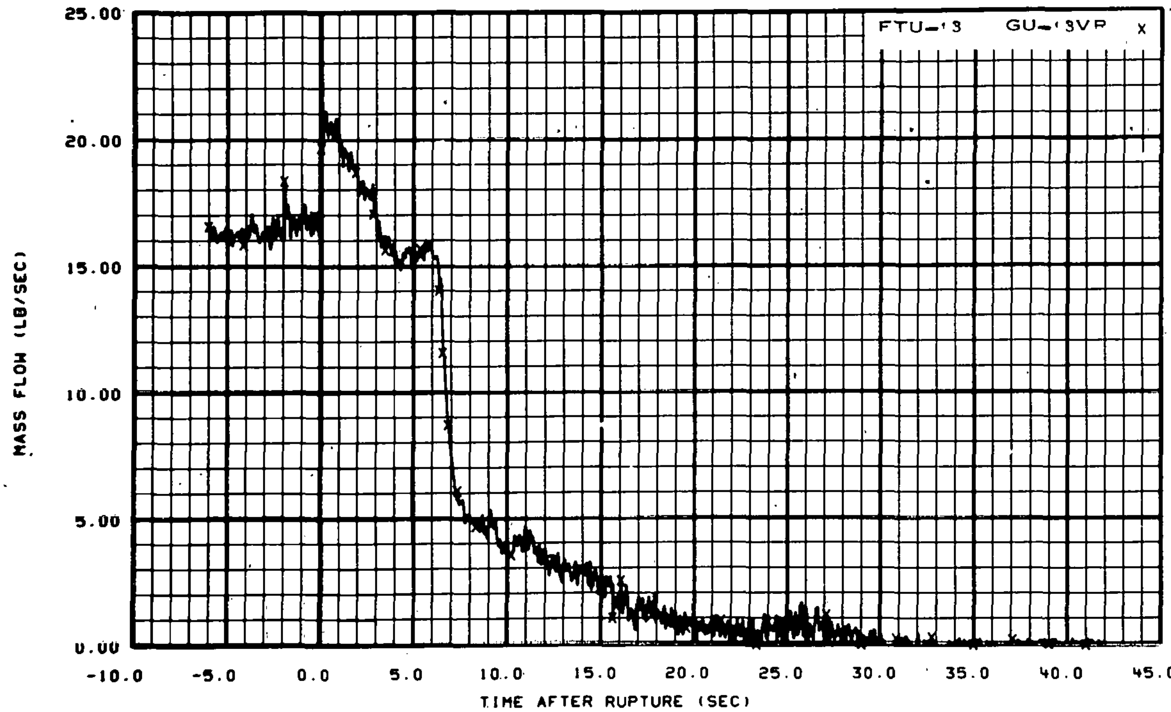

Fig. 129 Mass flow in intact loop (FTU-13 and GU-13VR).

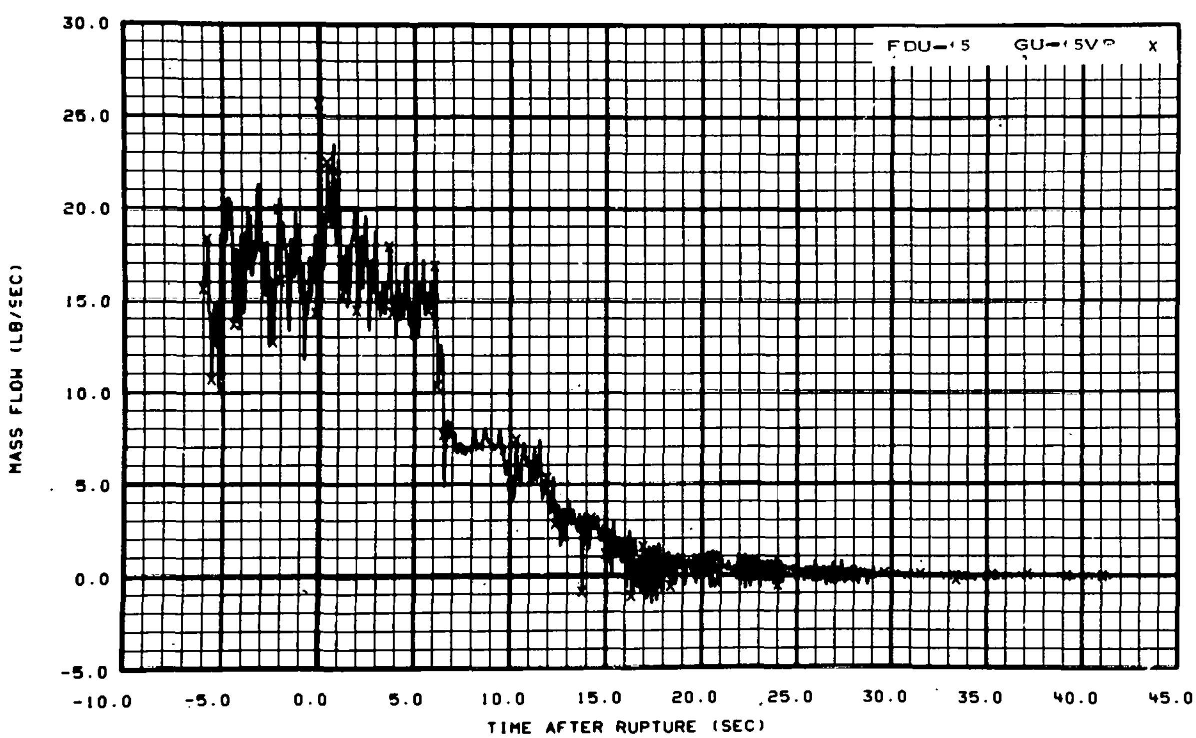

Fig. 130 Mass flow in intact loop (FDU-15 and GU-15VR).

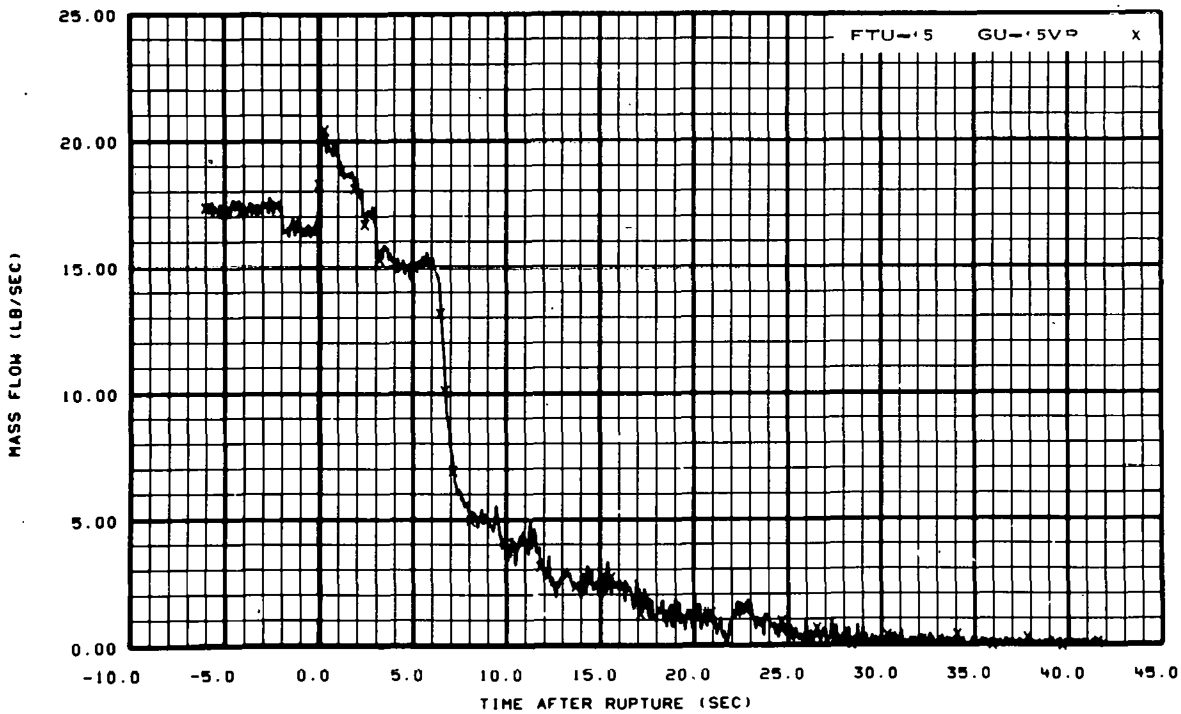

Fig. 131 Mass flow in intact loop (FTU-15 and GU-15VR).

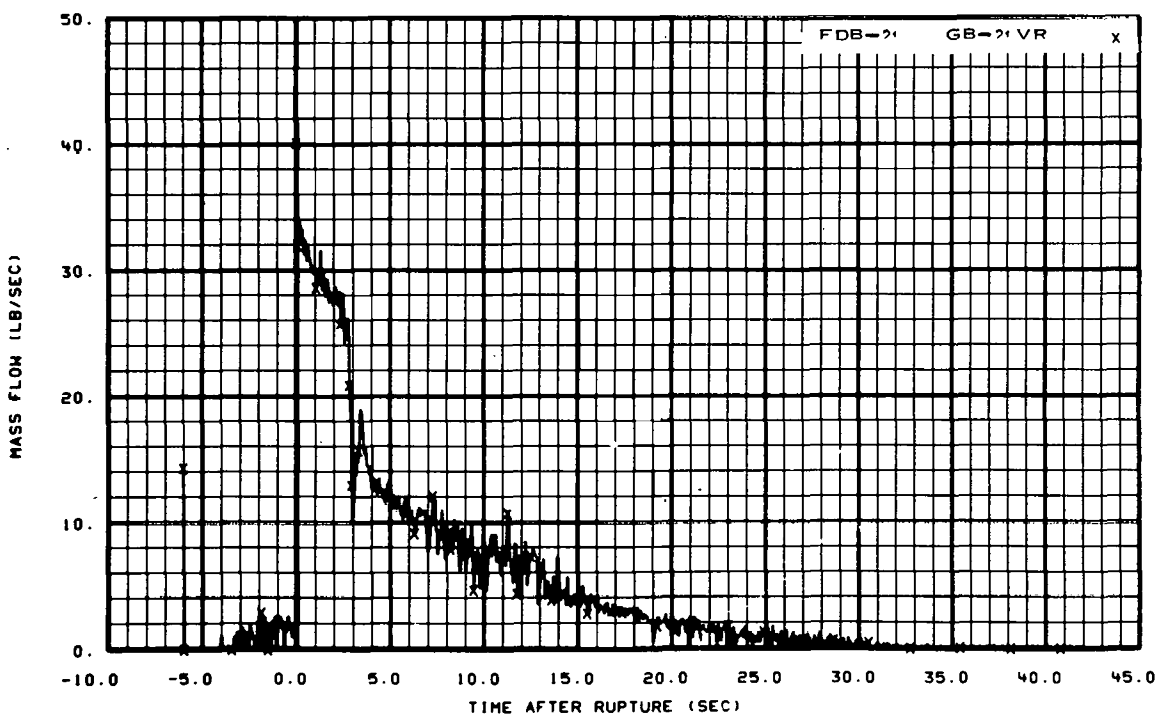

Fig. 132 Mass flow in broken loop (FDB-21 and GB-21VR).

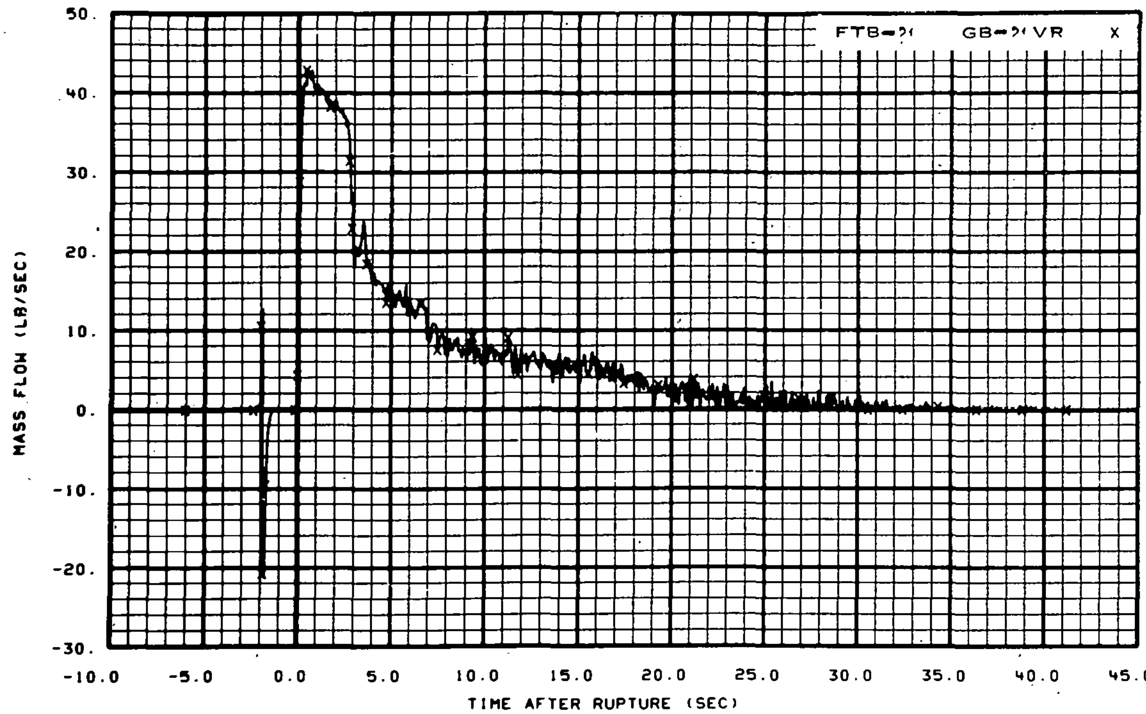

Fig. 133 Mass flow in broken loop (FTB-21 and GB-21VR).

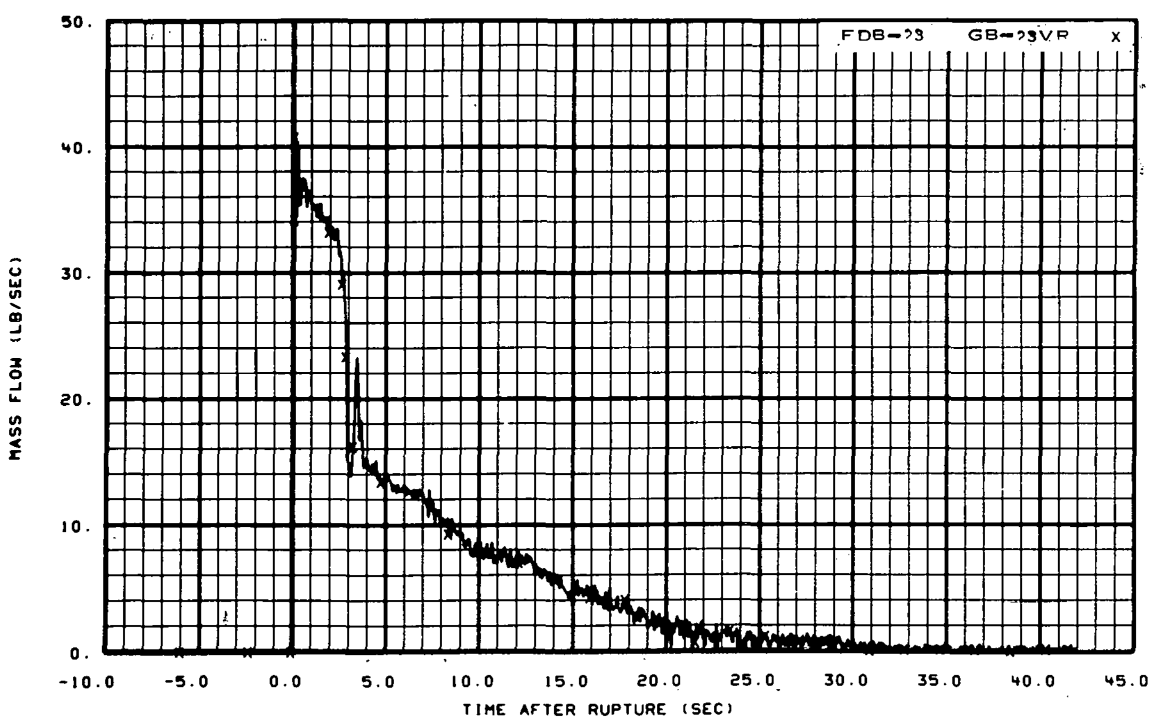

Fig. 134 Mass flow in broken loop (FDB-23 and GB-23VR).

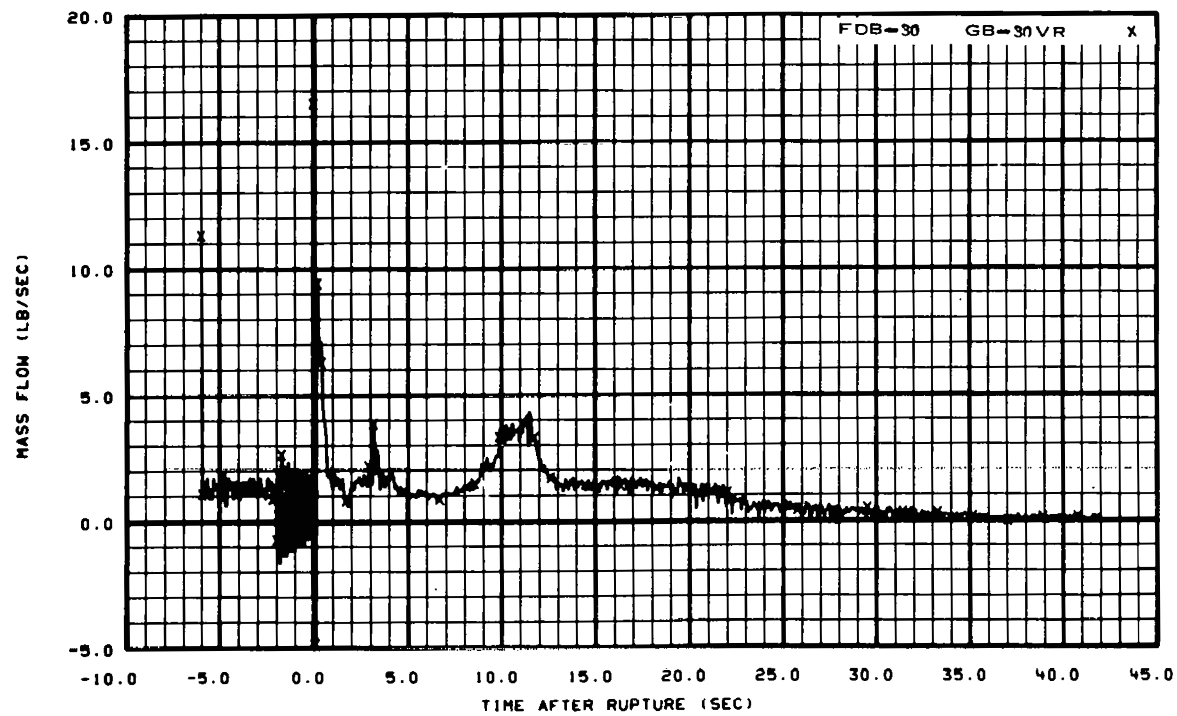

Fig. 135 Mass flow in broken loop (FDB-30 and GB-30VR).

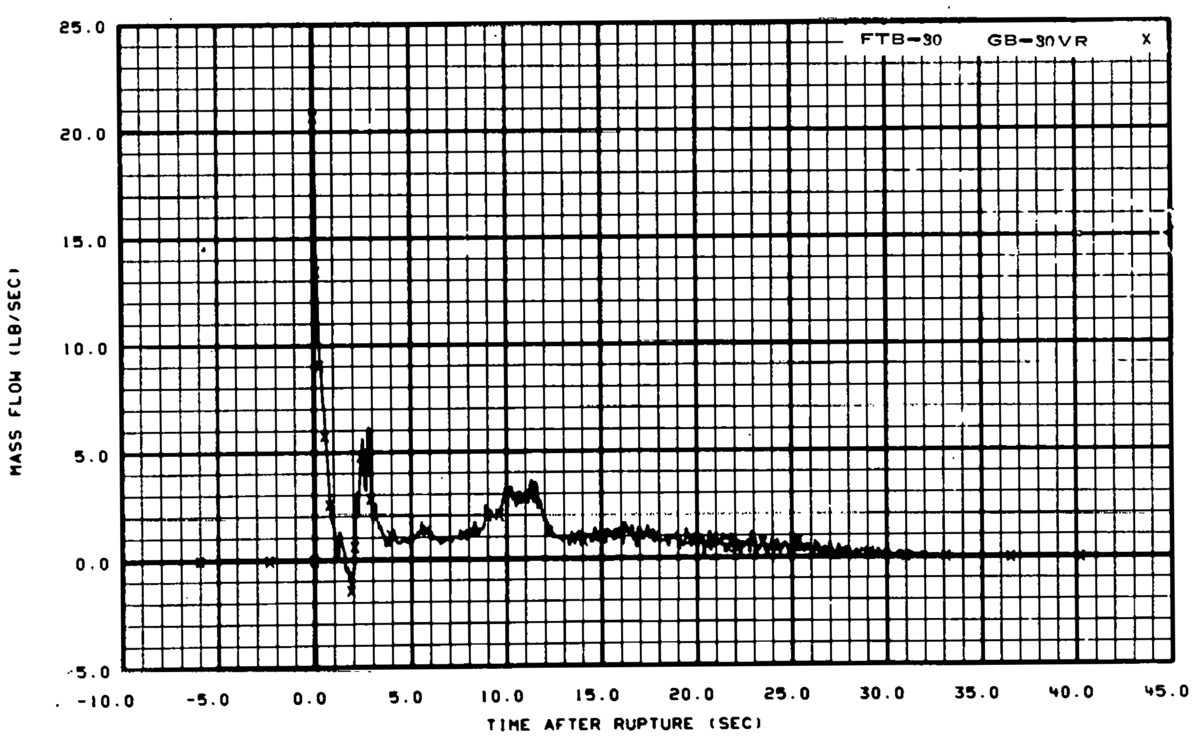

Fig. 136 Mass flow in broken loop (FTB-30 and GB-30VR).

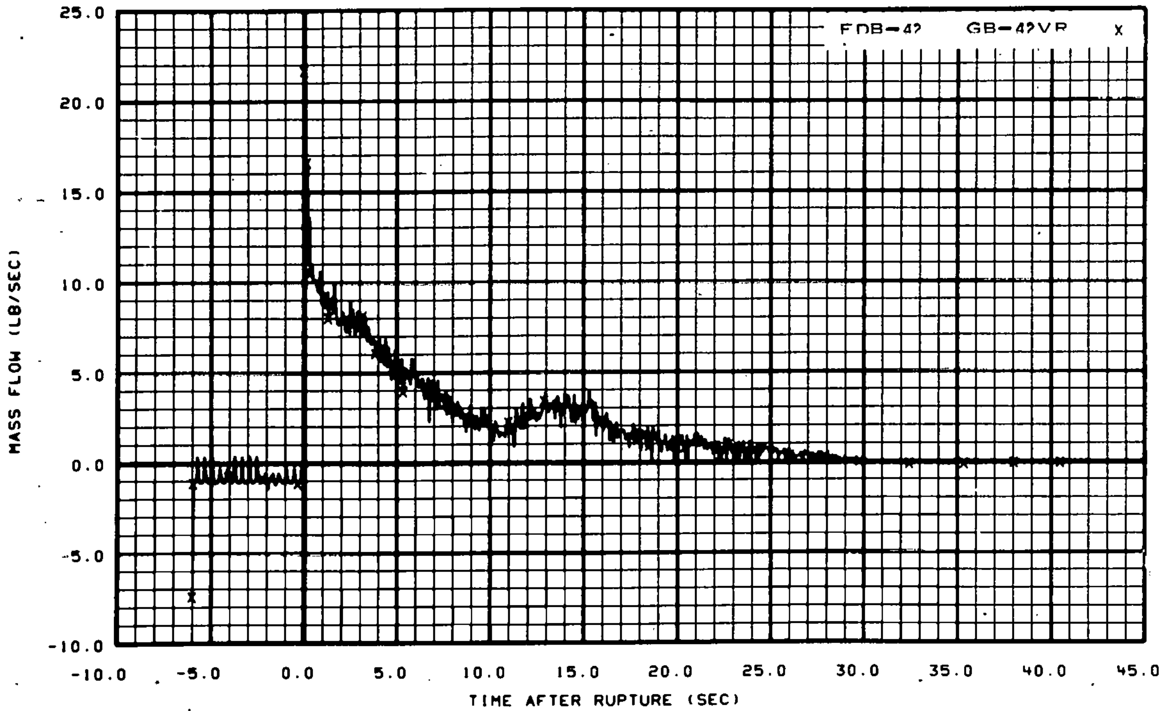

Fig. 137 Mass flow in broken loop (FDB-42 and GB-42VR).

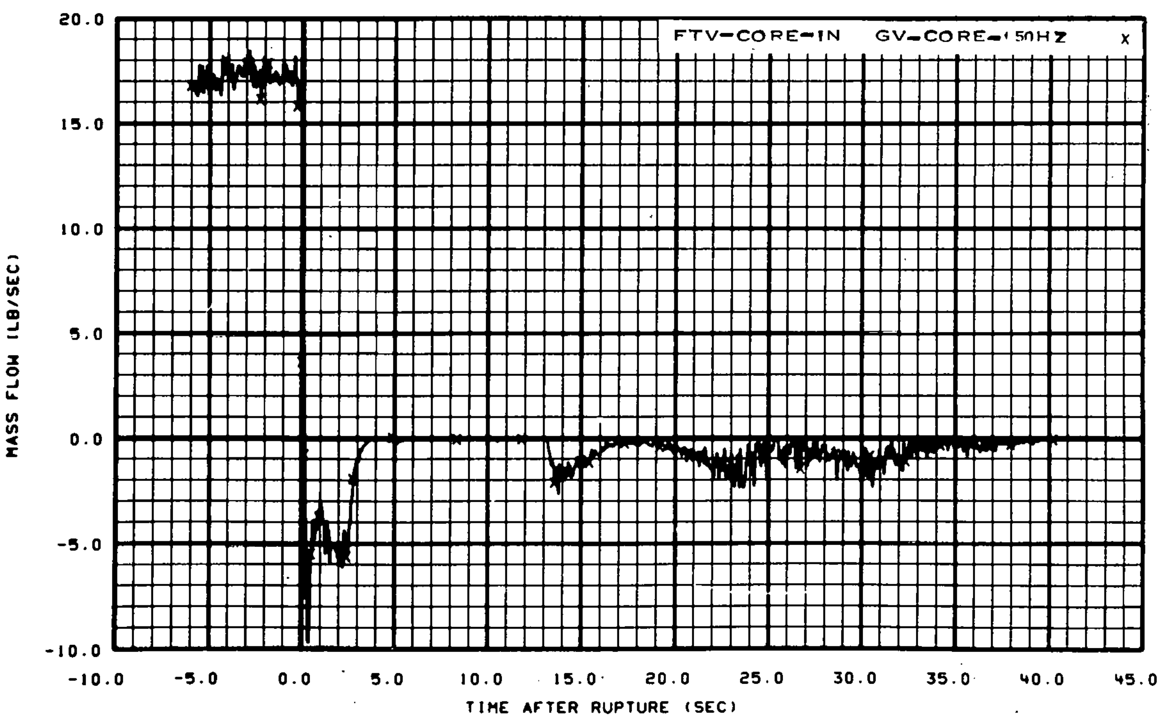

Fig. 138 Mass flow in vessel (FTV-CORE-IN and GV-COR-150HZ).

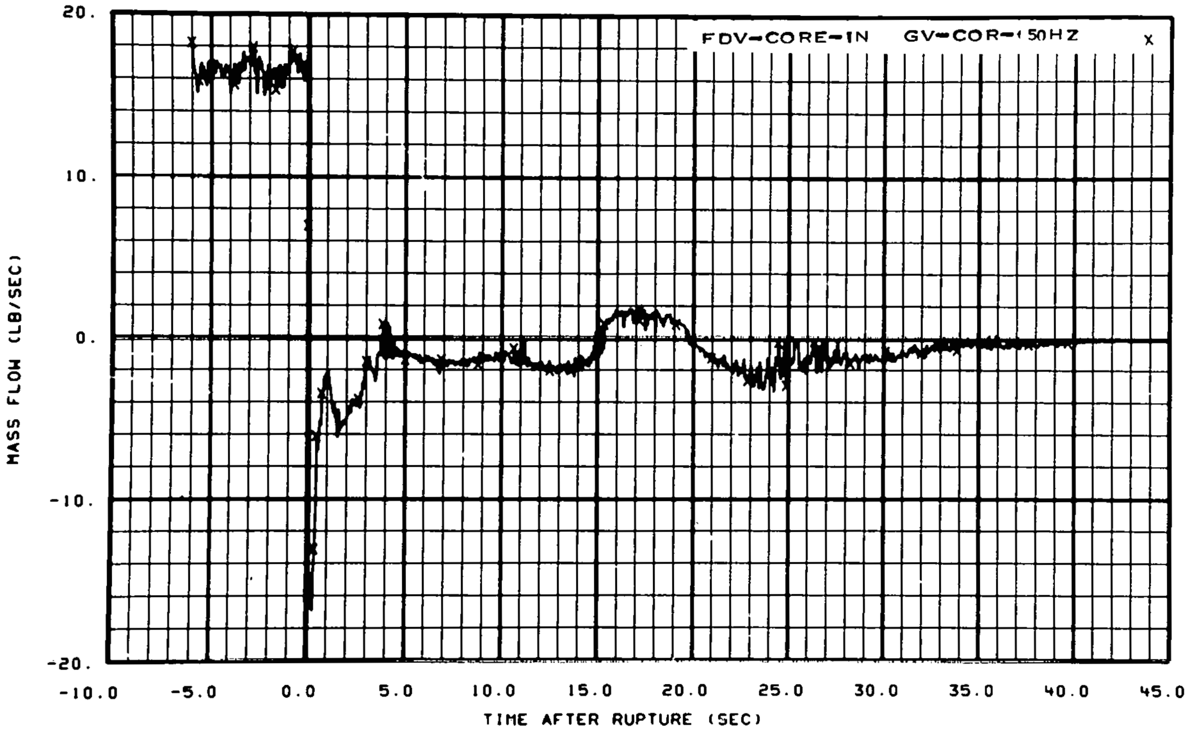

Fig. 139 Mass flow in vessel (FDV-CORE-IN and GV-COR-150HZ).

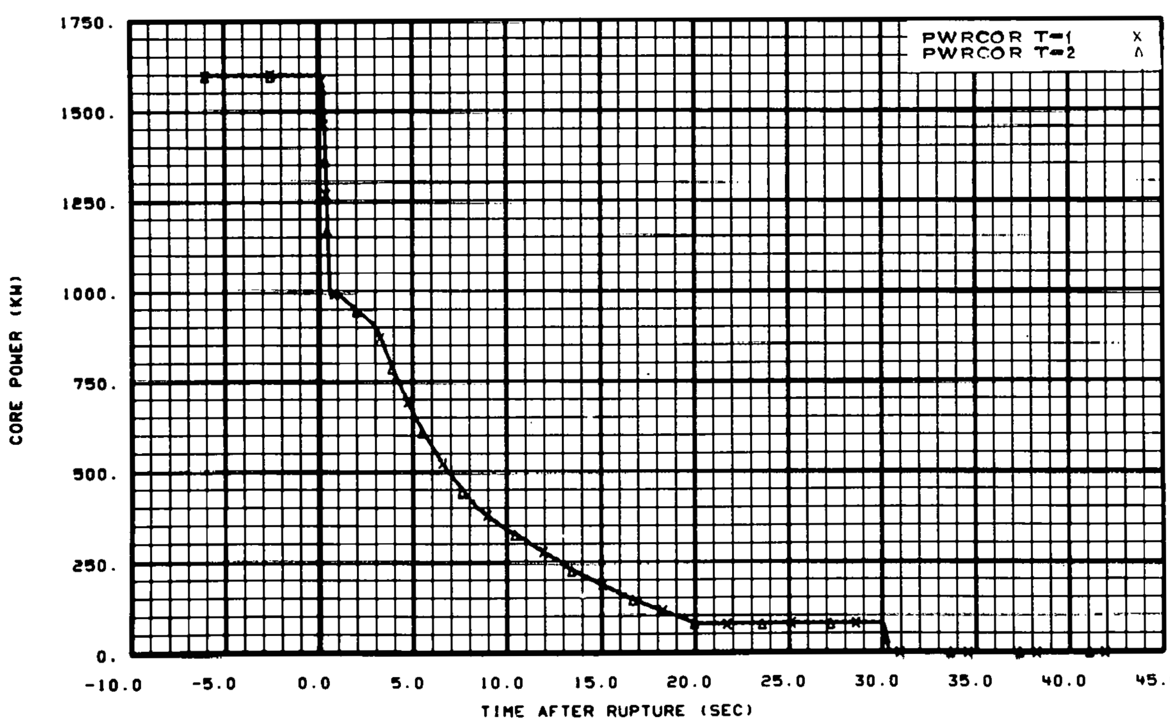

Fig. 140 Core heater pin total power.

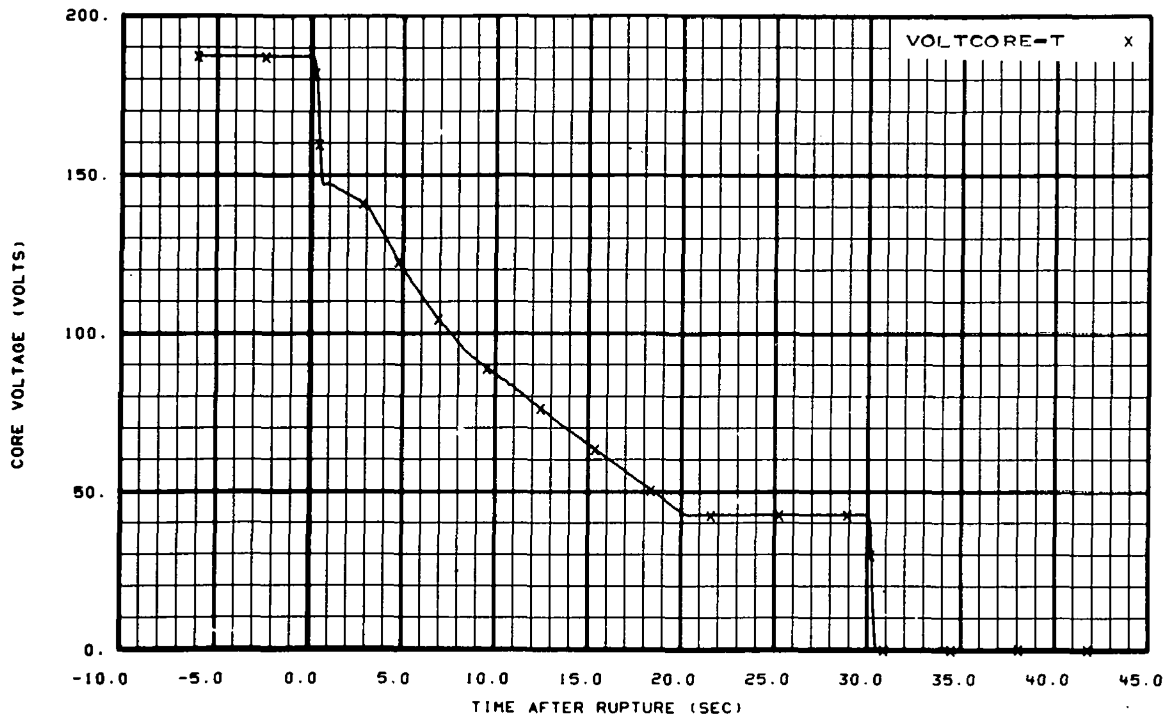

Fig. 141 Core heater voltage.

Fig. 142 Core heater total current.

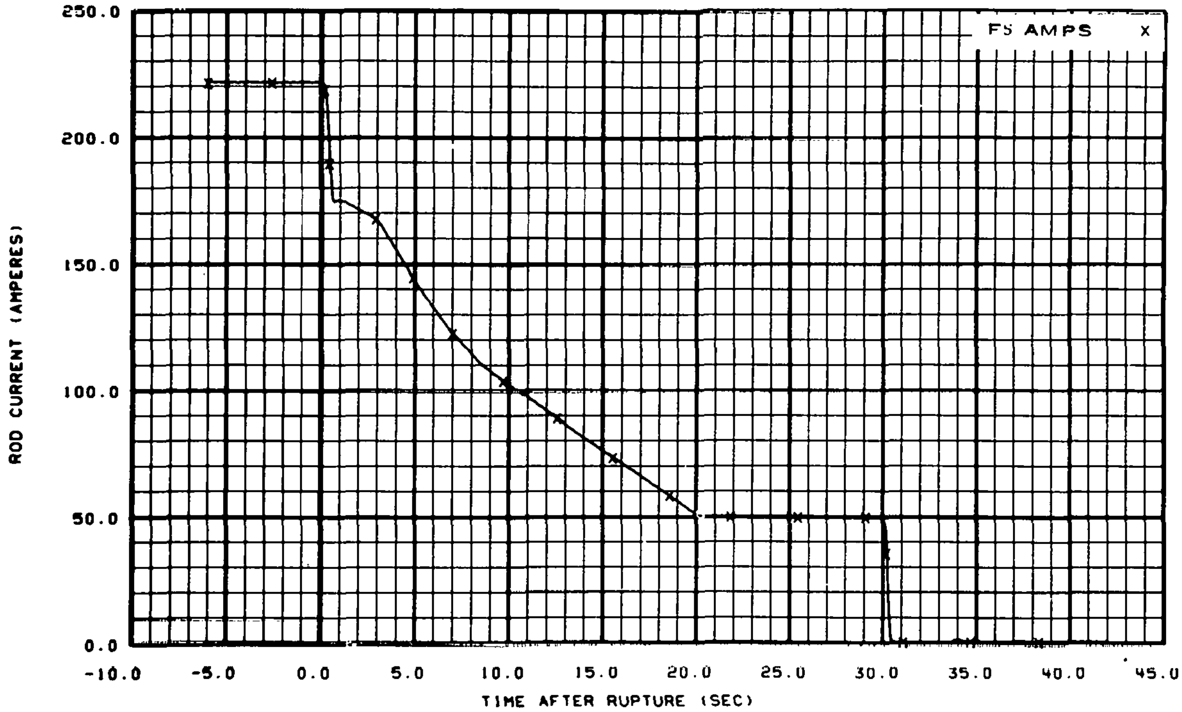

Fig. 143 Core heater current (Rod F-5).

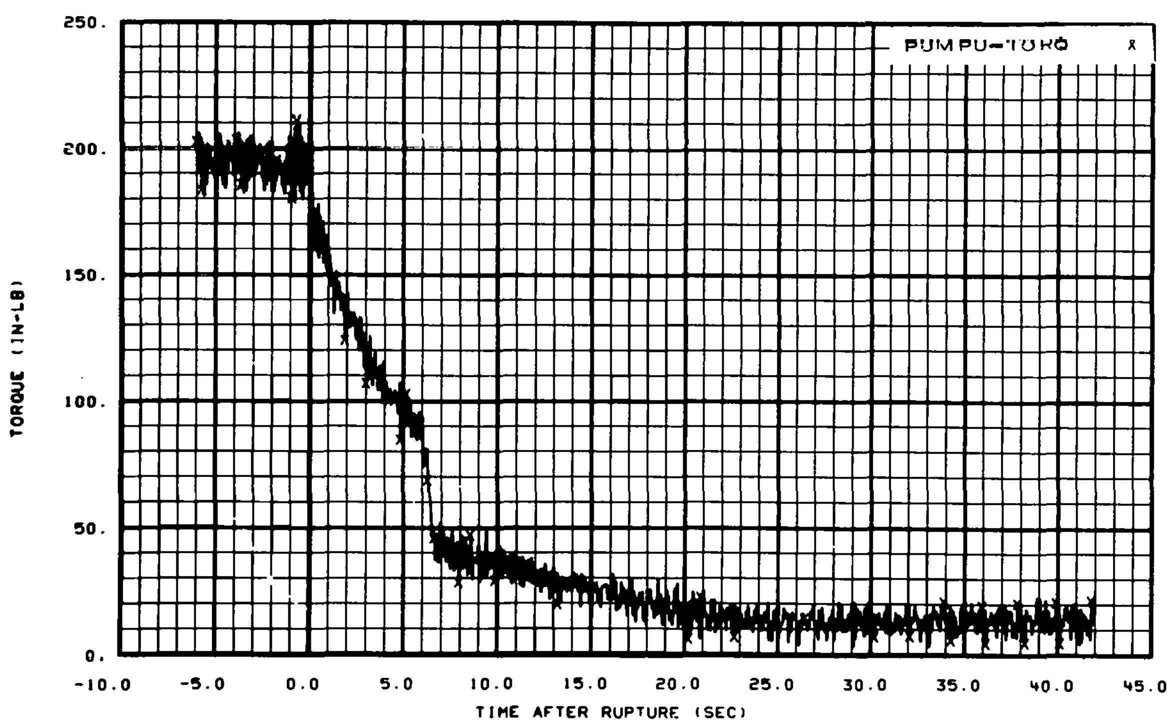

Fig. 144 Primary pump torque.

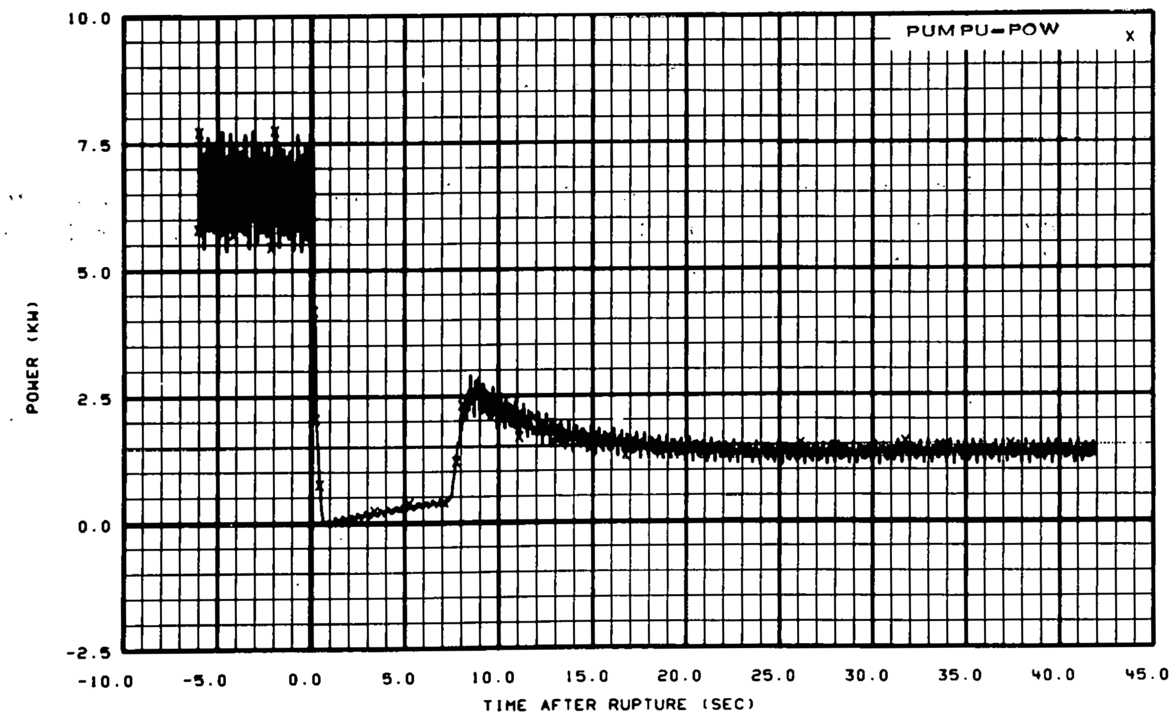

Fig. 145 Primary pump power.

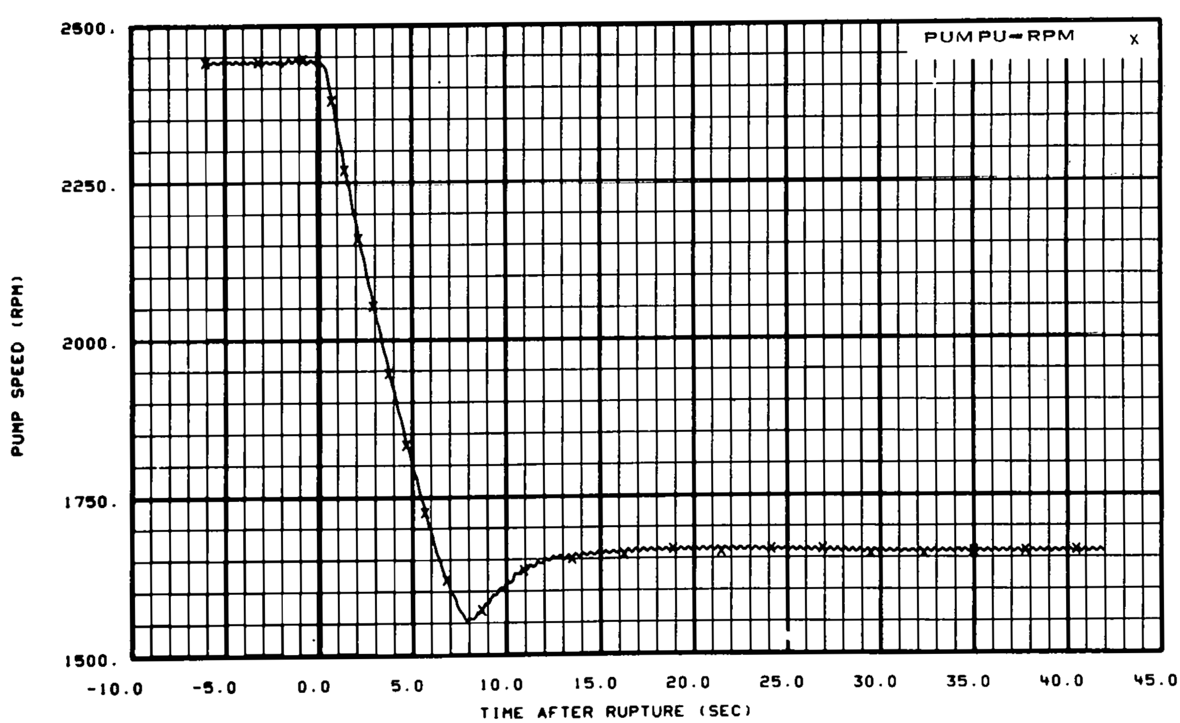

Fig. 146 Primary pump speed.

IV. REFERENCE

1. E. M. Feldman and D. J. Olson, *Semiscale Mod-1 Program and System Description for the Blowdown Heat Transfer Tests (Test Series 2),* ANCR-1230 (August 1975).

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