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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-1 TEST S-02-5 (BLOWDOWN HEAT TRANSFER TEST)

Aerojet Nuclear Company

IDAHO NATIONAL ENGINEERING LABORATORY

Idaho Falls, Idaho — 83401

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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-1

TEST S-02-5

(Blowdown Heat Transfer Test)

by

H. S. Crapo
M. F. Jensen
K. E. Sackett

AEROJET NUCLEAR COMPANY

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ABSTRACT

Recorded test data are presented for Test S-02-5 of the Semiscale Mod-1 blowdown heat transfer test series. Test S-02-5 is one of several Semiscale Mod-1 experiments conducted to investigate the thermal and hydraulic phenomena accompanying a hypothesized loss-of-coolant accident 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-02-5 was conducted from an initial cold leg fluid temperature of 544°F and an initial pressure of 2,253 psia. A simulated double-ended offset shear cold leg break was used to investigate the system response to a depressurization transient with full 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 a manner as to simulate the surface heat flux response of the LOFT nuclear fuel rods until such time that departure from nucleate boiling occurs. In order to improve the surface heat flux modeling for Test S-02-5, the core power transient was made more severe than that used on previous tests. Blowdown to the pressure suppression system was accompanied by simulated emergency core cooling injection into both the intact and broken loops. However, pressure suppression system coolant spray was not used.

The purpose of this report is to make available the uninterpreted data from Test S-02-5 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-02-5 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 (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 to a hypothesized loss-of-coolant accident.

Test S-02-5 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 38 active 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 Loss-of-Fluid Test (LOFT) nuclear fuel rods until such time as departure from nucleate boiling occurs. Based on the results of previous tests, the simulation of transient nuclear rod heat flux response in Test S-02-5 was improved by making the electrical transient more severe than for previous tests. The test objectives specific to Test S-02-5 were (a) to determine the effects of the more severe core power transient on the temperature response and heat transfer characteristics of the Mod-1 core, while operating at the design power level with radial power peaking, and (b) to investigate the effects of simulated emergency core coolant (ECC) injection under the given system conditions to aid in establishing the boundary conditions and test parameters for future test series. Test S-02-5 was conducted from initial conditions of 2,253 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 155 gpm. The instantaneous offset shear of the broken loop cold leg piping was simulated by simultaneous actuation (within 10 milliseconds) of the rupture assemblies.

During blowdown, the more severe postrupture core power transient resulted in core heater temperatures considerably higher than previously achieved in a Semiscale Mod-1 test. The higher temperatures caused the resistance of the core to increase slightly with the result that an early core power trip occurred 23.5 seconds after blowdown due to a low power indication on the heaters. Core high-temperature trips (1,550°F at full power) were avoided by a narrow margin during the early part of blowdown. The early power trip invalidated the test insofar as the secondary objective of establishing boundary conditions for future test series, although the objectives for the blowdown heat transfer studies were met. An additional malfunction occurred when a check valve in the pressure suppression tank downcomer stuck in the open position, allowing the effluent from the primary system to pass directly into the tank without being cooled or condensed by the pressure suppression water, resulting in high pressure suppression system pressures.

The instrumentation used in Test S-02-5 generally functioned as intended. Of 217 measurements attempted, all produced usable data.

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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-1 TEST S-02-5 (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-02-5 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-02-5, a 38-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 water level detector, and one rod had a burned out heater element.) 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 20.5% 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) using an improved, more severe, power transient based on the results of previous Semiscale tests. 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-02-5. 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-02-5

The following system configuration, procedures, initial test conditions, and events are specific to Test S-02-5.

1. SYSTEM CONFIGURATION AND TEST PROCEDURES

The Semiscale Mod-1 system used for Test S-02-5 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 38-rod electrically heated core; coolant injection accumulators for both the intact and blowdown loops; low-pressure injection pumps for both the intact and blowdown loops; and a pressure suppression system with a suppression tank and header. The Semiscale Mod-1 experimental system is described in greater detail in Reference 1.

For Test S-02-5, 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-02-5, 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 20 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). The core power transient used in Test S-02-5 was made more severe than the transient used in previous tests in order to more closely simulate nuclear fuel rod heat flux response. After the system was depressurized to 600 psig, coolant injection was initiated into both the intact and broken loops from separate accumulators. At approximately 150 psig, low-pressure injection was initiated from the intact and broken loop LPIS pumps into the same injection points used for the accumulators.

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	66.3°F	66 ± 1°F
Pressurizer pressure	2,253 psia	2,263 ± 5 psia
Pressurizer water volume	0.56 ft^3	[b]
Steam generator feedwater temperature	442°F	435 ± 10°F
Steam generator liquid level (from bottom of tube sheet)	116 in.	116 ± 2 in.
Fluid temperature in broken loop (pump side)	591°F	605 ± 5°F[c]
Intact loop cold leg flow	155 gpm	[d]
Pressure suppression tank water level	47.5 in.	47.5 ± 2 in.
Pressure suppression tank pressure	30.5 psia	30.0 ± 1 psia
Pressure suppression tank water temperature	155°F	156 ± 2°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	544
Hot leg, intact loop (near vessel)	RBU-2	610
Hot leg, intact loop (104 in. from vessel center)	TFU-5	610
Hot leg, intact loop (near pump inlet)	TFU-10)	541
Cold leg, intact loop	RBU-14A	543
Cold leg, broken loop (near nozzle)	TFB-23	533
Hot leg, broken loop (near vessel)	TFB-30	607
Hot leg, broken loop (near nozzle)	TFB-42	591

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

TABLE III

WATER CHEMISTRY PRIOR TO BLOWDOWN[a]

ph	10.2
Conductivity (μmhos/cm)	59.9
Lithium (ppm)	2.0
Chlorides (ppm)	<1.0
Fluorides (ppm)	<0.07
Oxygen (ppm)	<0.1
Total gas (cc/l)	47.0

[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	-19 min
Bypass lines valved out of system	-2.5 sec
Initiation of blowdown	0
Reduced pump power	0
Steam generator feedwater and discharge valves closed	+1 sec
Valve in ECC accumulators[b]	+5 sec
Start LPIS pumps[b]	+20 sec
Core power tripped off[c]	+23.5 sec

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

[b] Injection from ECC accumulators and LPIS pumps does not start until system pressure drops below accumulator or pump pressure, respectively.

[c] Core power trip was caused by a low core heater power indication resulting from an increase in core heater resistance accompanying the high temperature levels achieved with the more severe postrupture core power transient. Core power had been specified to remain on at the 6% level until the end of the test.

III. DATA PRESENTATION

The data from Semiscale Mod-1 Test S-02-5 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.

The performance of the system during Test S-02-5 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 152. 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-02-5 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 152 present all the blowdown data obtained. Time zero on the graphs is the time of rupture initiation.

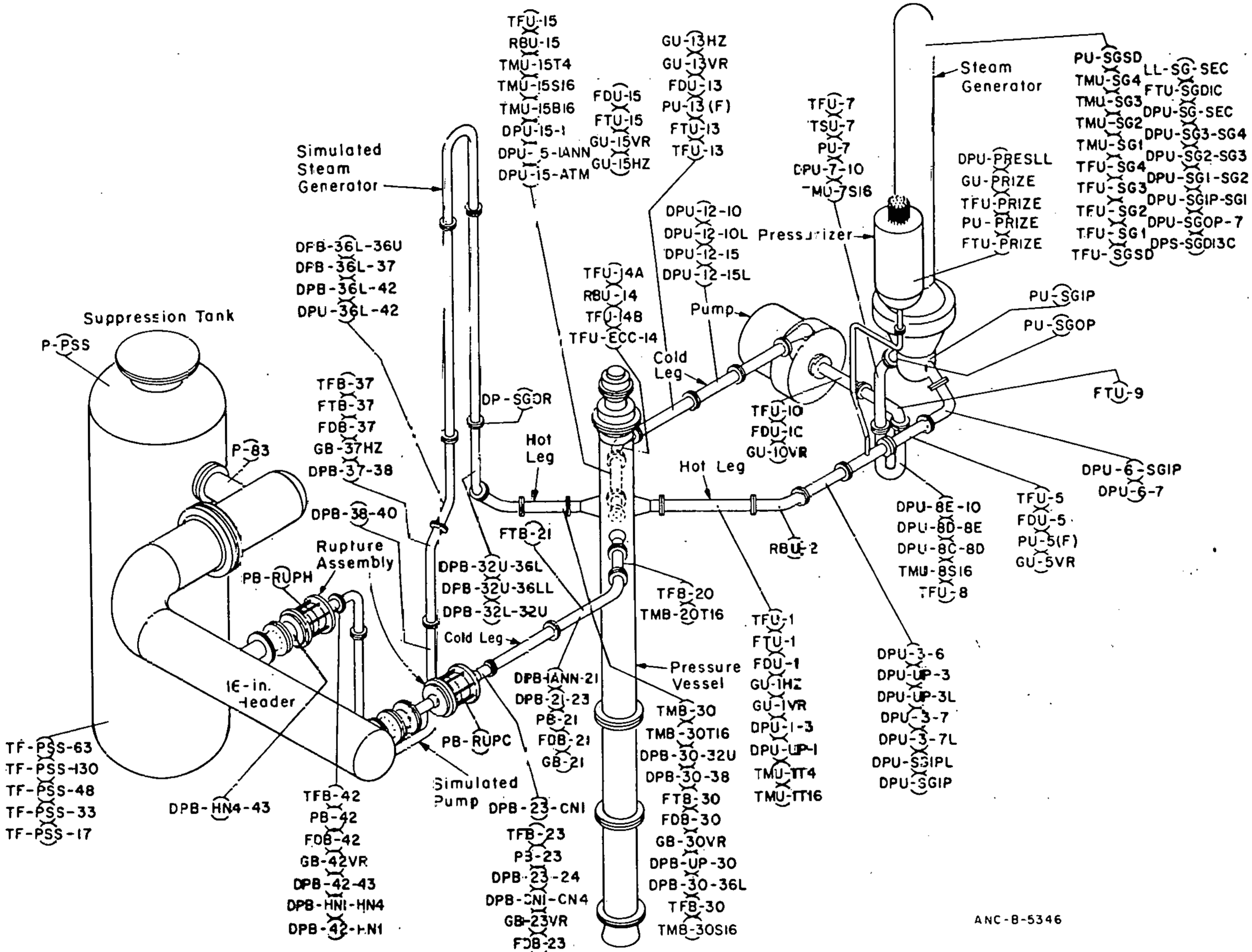

Fig. 1 Semiscale Mod-1 system and instrumentation for cold leg break configuration -- isometric.

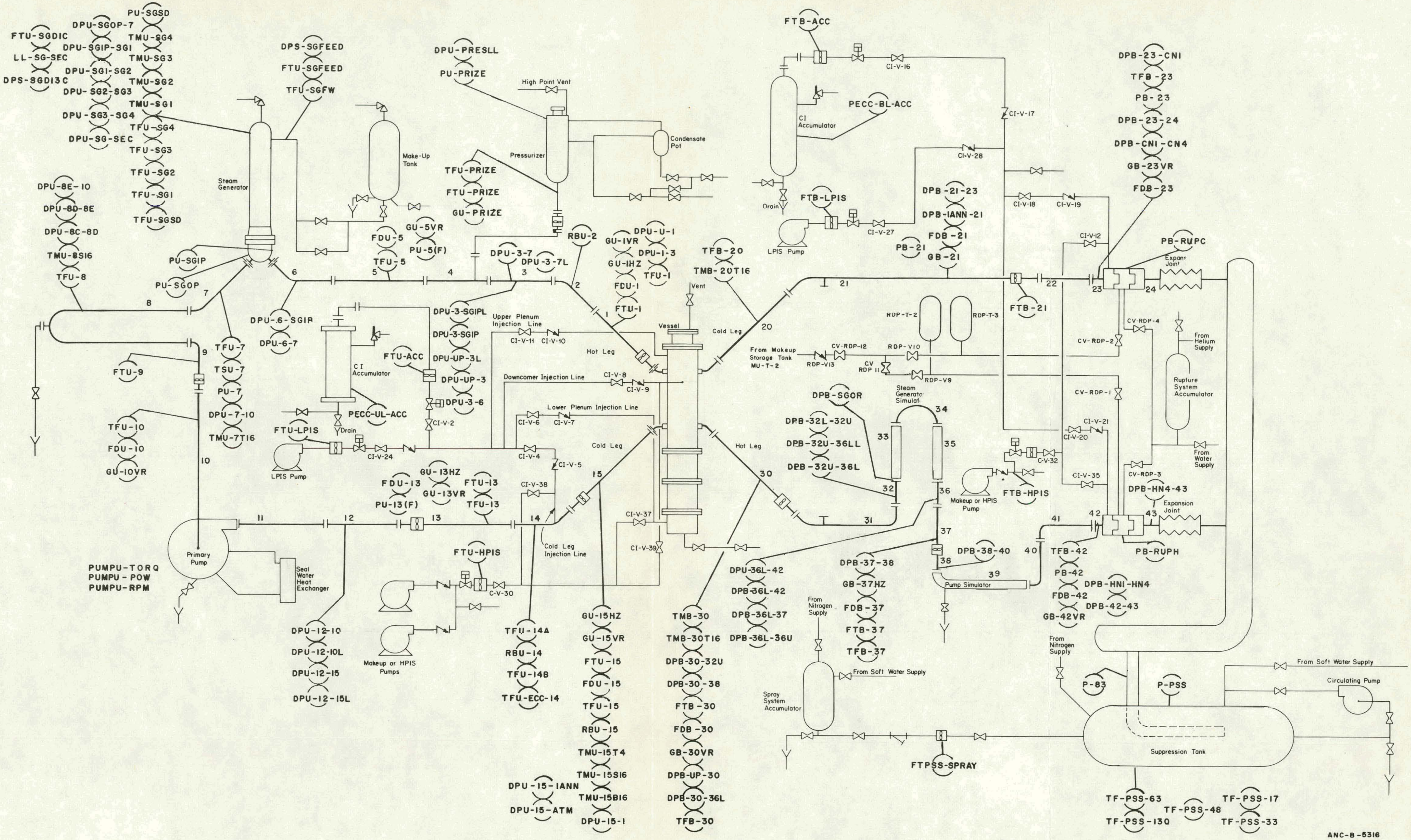

Fig. 2 Semiscale Mod-1 system and instrumentation for cold leg break configuration -- schematic.

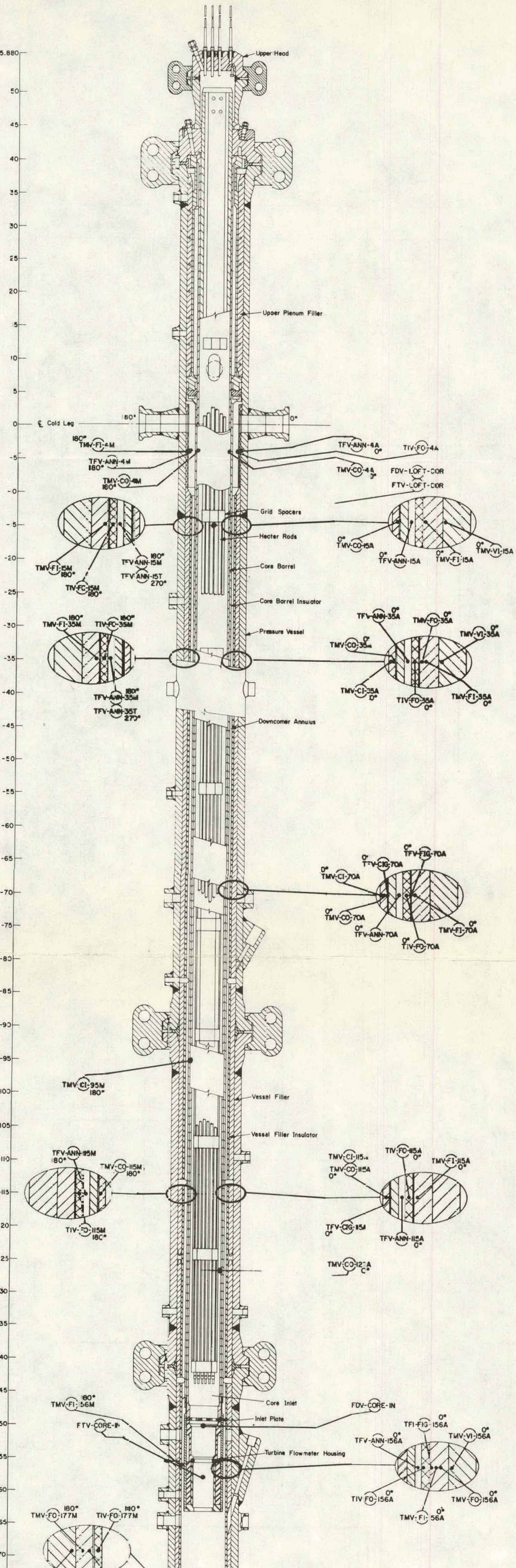

Fig. 3 Semiscale Mod-1 pressure vessel -- cross section showing instrumentation.

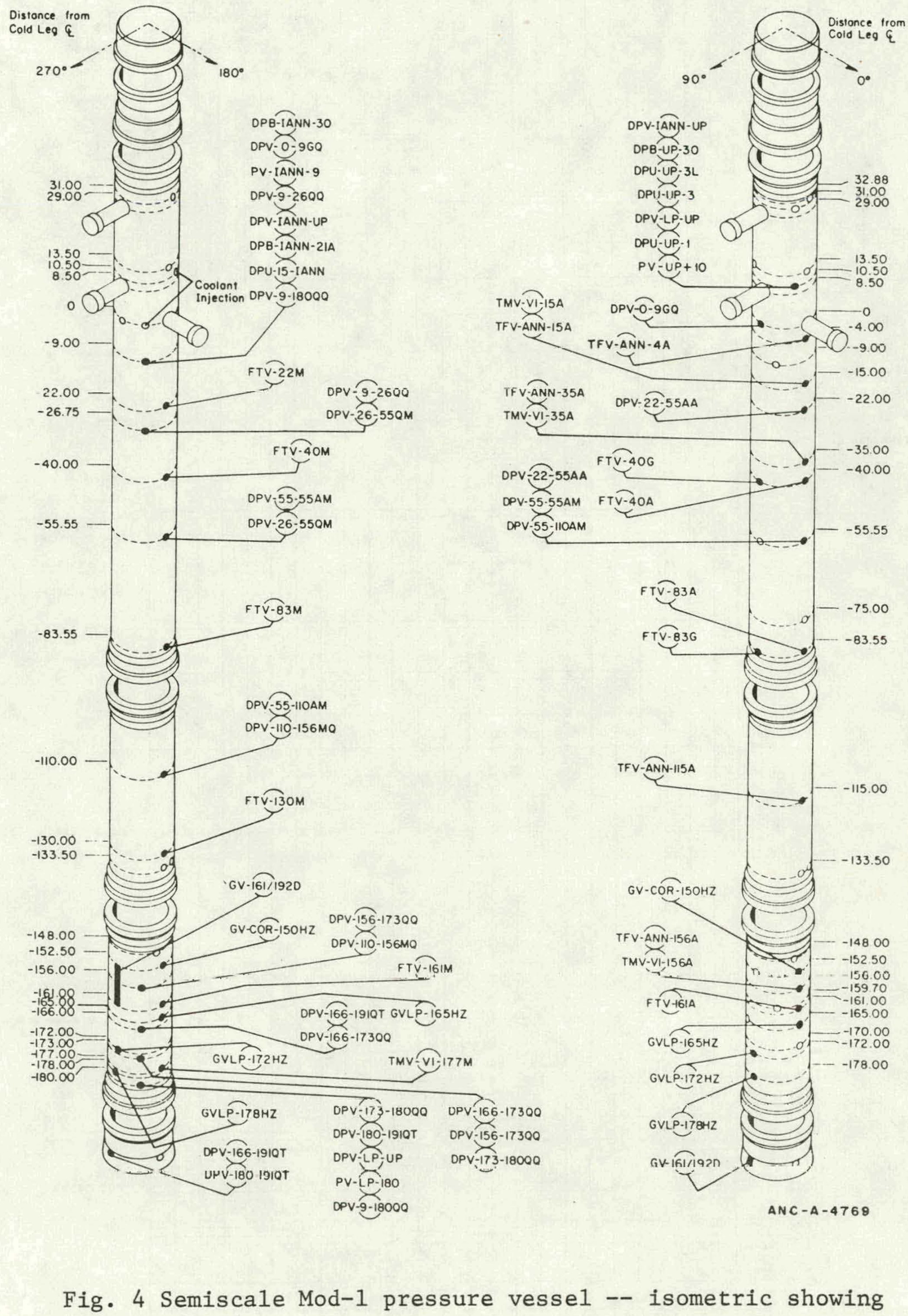

Fig. 4 Semiscale Mod-1 pressure vessel -- isometric showing instrumentation.

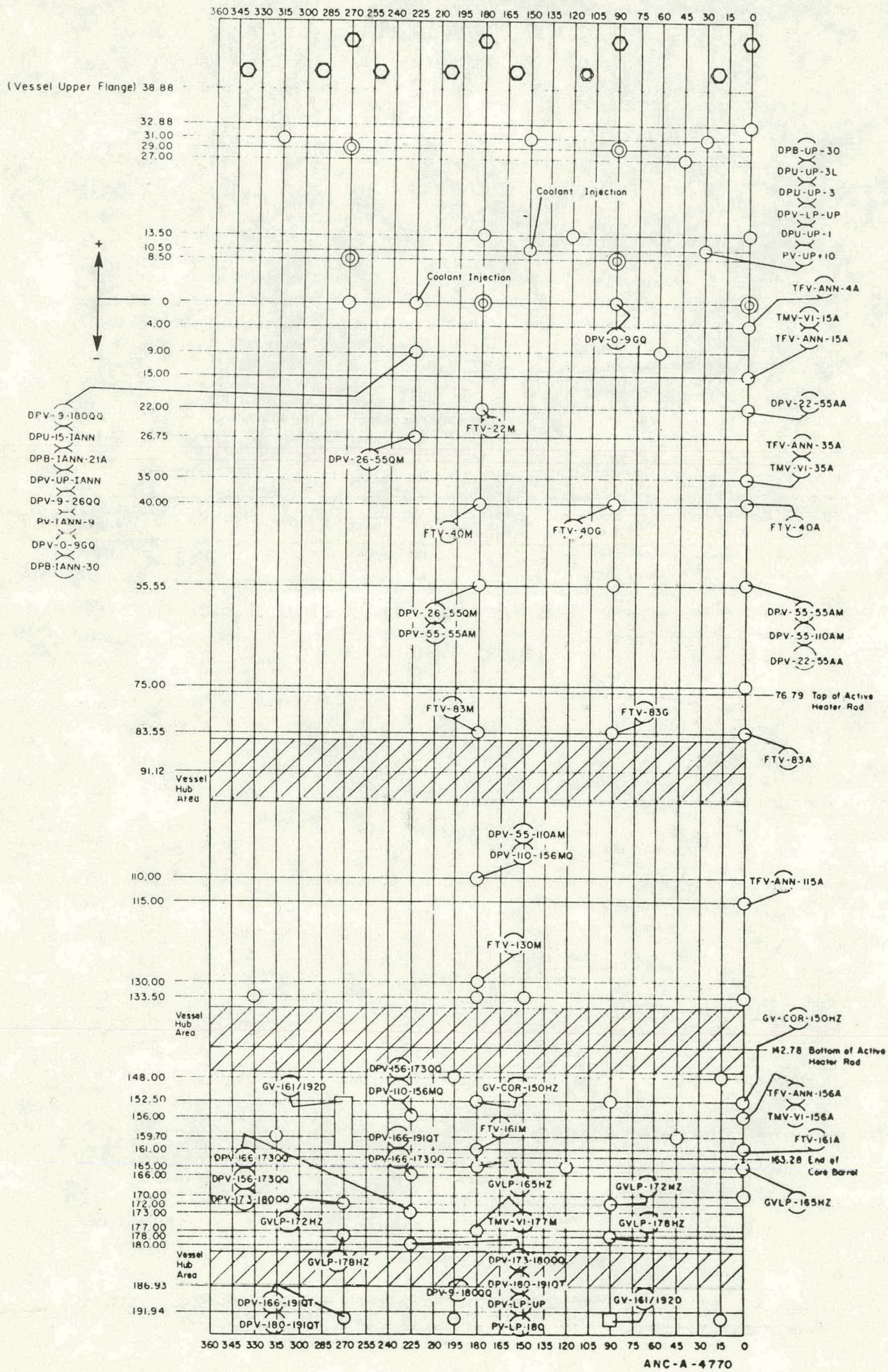

Fig. 5 Semiscale Mod-1 pressure vessel -- penetrations and instrumentation.

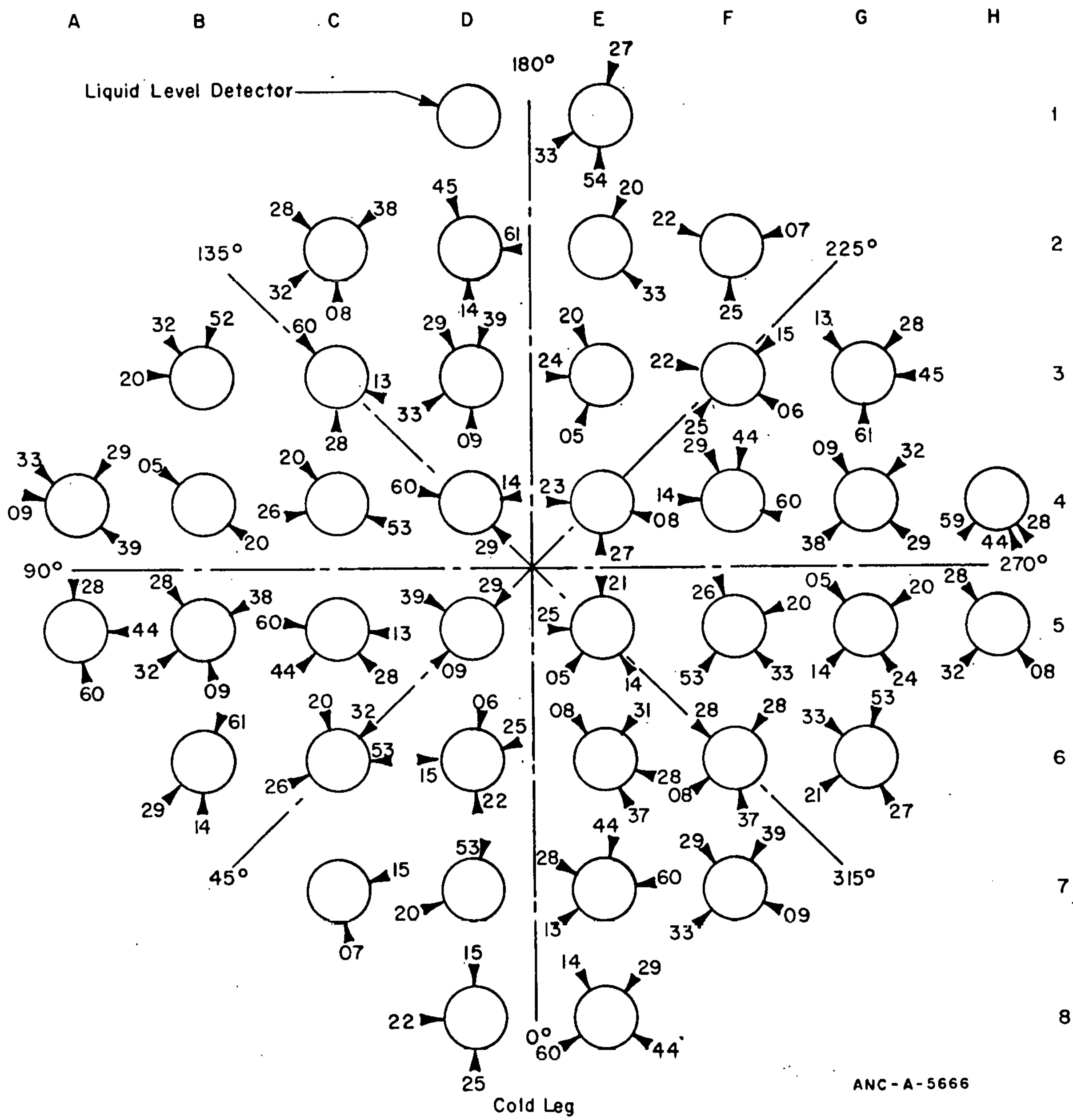

Fig. 6 Semiscale Mod-1 heated core, plan view.

TABLE V

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-5

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					
RBU-2	Hot leg, Spool 2, 46 in. from vessel center (platinum resistance bulb)	0-1000°F	0-1000°F	7	
TFU-5	Hot leg, Spool 5, 104 in. from vessel center			7	
TFU-10	Cold leg, Spool 10, 144 in. from vessel center			8	
TFU-13	Cold leg, Spool 13, 51 in. from vessel center		0-591°F	8	
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	8	
TFU-14B	Cold leg, Spool 14, 59 in. from vessel center, downstream of cold leg injection port		0-591°F	8	
Broken Loop		0-2300°F			
TFB-20	Cold leg, Spool 20, 21 in. from vessel center		0-591°F	9	
TFB-23	Cold leg, Spool 23, 91 in. from vessel center, upstream of vessel-side nozzle		0-591°F	9	
TFB-30	Hot leg, Spool 30, 16 in. from vessel center		0-1017°F	10	
TFB-42	Hot leg, Spool 42, 414 in. from vessel center along cold leg, upstream of pump-side nozzle		0-1017°F	10	Open circuit from t=2 to t=31 sec
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°			11	
TFV-ANN-35A	35 in. below cold leg centerline, 0°			11	
TFV-ANN-35T	35 in. below cold leg centerline, 270°			11	
TFV-ANN-115A	115 in. below cold leg centerline, 0°			11	
TFV-ANN-115M	115 in. below cold leg centerline, 180°			12	
Upper Plenum		0-2300°F	0-1017°F	13	
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		14	
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			15	
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			16	
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				

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-5

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement Comments[b]
Core Grid Spacers (contd.)					
Grid Spacer 8	109 in. below cold leg centerline at center of heated length			17	
TFG-8CD-45	Thermocouple in space defined by Columns C and D, Rows 4 and 5				
TFG-8DE-23 -45 -67	Thermocouples in space defined by Columns D and E, Rows 2 and 3, and 4 and 5, 6 and 7				TFG-8DE-45 failed at t=29.5 sec
TFG-8EF-45	Thermocouple in space defined by Columns E and F, Rows 4 and 5				
Grid Spacer 10	143 in. below cold leg centerline at bottom of heated length			18	
TFG-10CD-45	Thermocouple in space defined by Columns C and D, Rows 4 and 5				
TFG-10DE-67	Thermocouple in space defined by Columns D and E, Rows 6 and 7				
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		0-2300°F	0-591°F		
TFU-ECC-14	On centerline of ECC line at junction with Spool 14			19	
TFB-ECC-42	In line leading to Spool 42			20	
Steam Generator		0-2300°F	0-591°F		
TFU-SGFW	In feedwater line leading to steam generator			21	
TFU-SGSD	In steam dome, 129.5 in. from bottom of tube sheet			21	
TFU-SG1	Secondary side, 12 in. above bottom of tube sheet			22	
TFU-SG2	Secondary side, 24 in. above bottom of tube sheet			22	
TFU-SG3	Secondary side, 48 in. above bottom of tube sheet			22	
TFU-SG4	Secondary side, 96 in. above bottom of tube sheet			22	
Pressurizer		0-2300°F	0-1017°F		
TFU-PRIZE	In surge line, near pressurizer exit, between turbine flowmeter and pressurizer			23	
Pressure Suppression System		0-2300°F	0-591°F	24	
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				25	
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		26	
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		

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-5

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement Comments[b]
MATERIAL TEMPERATURE (contd.)					
Vessel Wall	1/8 in. from vessel ID	0–2300°F	0–591°F	27	
TMV-VI-15A	15 in. below cold leg centerline, 0°				
Vessel Filler	Type J iron-constantan thermocouples	0–1400°F	0–803°F	28	
TMV-FO-35A	35 in. below cold leg centerline, 0.65 in. from filler ID, 0°				
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	29	
TIV-FO-35A	35 in. below cold leg centerline, 0°				
Core Barrel	Type J iron-constantan thermocouples	0–1400°F	0–803°F	30	
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°				Data may be affected by a bad ground connection in the data acquisition system
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			31	
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			32	
TH-E4-23 -27	Heater at Column E Row 4. Thermocouples 23 in. (90°) and 27 in. (0°) above bottom of core			33	
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			34	
Low Power Heaters					
TH-A4-09 -29 -33 39	Heater at Column A Row 4. Thermocouples 9 in. (105°), 29 in. (240°), 33 in. (135°), and 39 in. (300°) above bottom of core			35	
TH-A5-29	Heater at Column A Row 5. Thermocouple 29 in. (180°) above bottom of core			36	
TH-B3-32	Heater at Column B Row 3. Thermocouple 32 in. (135°) above bottom of core			37	
TH-B5-29	Heater at Column B Row 5. Thermocouple 29 in. (150°) above bottom of core			38	
TH-B6-29	Heater at Column B Row 6. Thermocouple 29 in. (45°) above bottom of core			39	
TH-C2-28	Heater at Column C Row 2. Thermocouple 28 in. (135°) above bottom of core			40	
TH-C3-13 -28 -60	Heater at Column C Row 3. Thermocouples 13 in. (285°), 28 in. (0°), and 60 in. (150°) above bottom of core			41	
TH-C4-26	Heater at Column C Row 4. Thermocouple 26 in. (75°) above bottom of core			42	
TH-C5-28	Heater at Column C Row 5. Thermocouple 28 in. (315°) above bottom of core			43	
TH-C6-20 -32	Heater at Column C Row 6. Thermocouples 20 in. (165°) and 32 in. (225°) above bottom of core			44	TH-C6-20; open circuit, t=2.8 to t=4 sec
TH-C7-15	Heater at Column C Row 7. Thermocouple 15 in. (225°) above bottom of core			45	

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-5

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement Comments[b]
MATERIAL TEMPERATURE (contd.)					
Low Power Heaters (contd.)					
TH-D2-14	Heater at Column D Row 2. Thermocouple 14 in. (0°) above bottom of core			46	
TH-D3-29	Heater at Column D Row 3. Thermocouple 29 in. (150°) above bottom of core			47	
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			48	
TH-D7-20	Heater at Column D Row 7. Thermocouple 20 in. (60°) above bottom of core			49	
TH-D8-25	Heater at Column D Row 8. Thermocouple 25 in. (0°) above bottom of core			50	Rod D-8 is not heated
TH-E1-27 -33	Heater at Column E Row 1. Thermocouples 27 in. (195°) and 33 in. (60°) above bottom of core			51	
TH-E2-21 -33	Heater at Column E Row 2. Thermocouples 21 in. (210°) and 33 in. (315°) above bottom of core			52	
TH-E3-05 -20	Heater at Column E Row 3. Thermocouples 5 in. (15°) and 20 in. (165°) above bottom of core			53	
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			54	
TH-E7-13 -29 -44	Heater at Column E Row 7. Thermocouples 13 in. (45°), 29 in. (120°), and 44 in. (195°) above bottom of core			55	
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			56	
TH-F2-22 -25	Heater at Column F Row 2. Thermocouples 22 in. (105°) and 25 in. (0°) above bottom of core			57	
TH-F3-22 -25	Heater at Column F Row 3. Thermocouples 22 in. (105°) and 25 in. (30°) above bottom of core			58	
TH-F4-14 -28	Heater at Column F Row 4. Thermocouples 14 in. (90°) and 28 in. (165°) above bottom of core			59	
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			60	
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			61	
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			62	
TH-G4-33	Heater at Column G Row 4. Thermocouple 33 in. (225°) above bottom of core			63	
TH-G5-14 -24	Heater at Column G Row 5. Thermocouples 14 in. (45°) and 24 in. (330°) above bottom of core			64	
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			65	
TH-H4-28	Heater at Column E Row 4. Thermocouple 28 in. (315°) above bottom of core			66	

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-5

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement and Comments[b]
PRESSURE		0-3000 psi			
Intact Loop				67	
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)		0-4837 psia	68	
PB-CN1	Vessel-side nozzle, nozzle throat, 96 in. from vessel center, (tee off DP tap)		0-4658 psia	68	
PB-42	Cold leg, Spool 42, 415 in. from vessel center along hot leg, upstream of pump-side nozzle (tee off DP tap)		0-4351 psia	69	
PB-HN1	Pump-side nozzle, nozzle throat, 419 in. from vessel center along hot leg (tee off DP tap)		0-4624 psia	69	
Vessel		0-3000 psi		70	
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		0-750 psi			
PECC-IL-ACC	In intact loop accumulator		0-720 psia	71	
PECC-BL-ACC	In broken loop accumulator		0-746 psia	72	
Steam Generator		0-3000 psi			
PU-SGSD	Secondary side, steam dome		0-2080 psia	73	
PU-SGIP	Inlet plenum, 13 in. below bottom of tube sheet (flush mount)		0-4603 psia	74	
Pressurizer		0-3000 psi	0-4810 psia		
PU-PRIZE	Steam dome			75	
Pressure Suppression System				76	
P-PSS-HD	In suppression tank header	0-200 psi	0-380 psia		Reading affected by high velocity fluid
P-83	In suppression tank header outlet 6 in. from entrance to suppression tank	0-750 psi	0-772 psia		
P-PSS	Suppression tank top	0-750 psi	0-321 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	77	
DPU-1-3	Hot leg Spool 1, 31 in. from vessel center to hot leg Spool 3, 62 in. from vessel center	±20 in. water	±1.0 psid	78	
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	79	
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	80	

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-5

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-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	81	
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	82	
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	±100 psid	±100 psid	83	
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	84	
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	85	
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	86	
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	87	
DPU-15-ATM	Cold leg Spool 15, 16 in. from vessel center to atmosphere	±500 psid	±500 psid	88	
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	89	
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	90	
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 lower tap	±500 psid	±500 psid	91	
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	92	
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	93	
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	94	
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	95	
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	96	

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-5

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	97	
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	98	
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	99	
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	87	
Steam Generator					
DPS-SGFEED	In steam generator feed line	±100 in. water	±5.0 psid	100	
DPS-SGDISC	In steam generator discharge line	±100 in. water	±5.0 psid	101	
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	81	
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	102	
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	89	
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	103	
FTU-9	Cold leg, Spool 9, 154 in. from vessel center	±20–±400 gpm	±800 gpm	103	
FTU-13	Cold leg, Spool 13, 64 in. from vessel center	±20–±400 gpm	±800 gpm	104	
FTU-15	Cold leg, Spool 15, 29 in. from vessel center	±10–±200 gpm	±300 gpm	104	
Broken Loop	All measurements bidirectional, Schedule 160 pipe			105	
FTB-21	Cold leg, Spool 21, 58 in. from vessel center, 3-in. pipe	±20–±400 gpm	±1500 gpm		
FTB-30	Hot leg, Spool 30, 25 in. from vessel center, 3-in. pipe	±20–±400 gpm	±700 gpm		
Core					
FTV-CORE-IN	Entrance to core, approximately 158 in. below cold leg centerline	±20–±400 gpm	±400 gpm	106	Detector saturated from t=26 to t=27 sec

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-5

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement Comments[b]
VOLUMETRIC FLOW RATE (contd.)					
ECC System					
FTU-LPIS	In line leading from LPIS for intact loop, 1/2-in. line	±0.5–±5 gpm	±5 gpm	107	
FTB-LPIS	In line leading from LPIS for broken loop, 3/4-in. line	±0.5–±5 gpm	±2 gpm	108	
FTU-ACC	In line immediately after intact loop accumulator, 1-in. line	±5–±60 gpm	±75 gpm	109	Spike at t=2.5 sec due to valve operation at AC interference
FTB-ACC	In line immediately after broken loop accumulator, 1-in. line	±5–±60 gpm	±35 gpm	110	Spike before t=6 sec due to valve operation and/or AC interference
Pressurizer	1-1/2-in. turbine	±5–±100 gpm	±75 gpm	111	
FTU-PRIZE	Surge line				
FLUID VELOCITY	Turbine flowmeter, bidirectional				
Downcomer Gap				112	
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		Plot 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	±4256 lbm/ft-sec^2	113	
FDU-5	Hot leg, Spool 5, 100 in. from vessel center, target size 1.0 in.	±1–±2000 lbm/ft-sec^2	±3250 lbm/ft-sec^2	114	
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	115	
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	116	
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	117	
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	118	
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	119	
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	120	
FDB-42	Cold leg, Spool 42, 416 in. from vessel center along hot 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	121	
Vessel					
FDV-CORE-IN	In core flow mixer box, 150 in. below cold leg centerline, target size 1.0 in.	±200–±5000 lbm/ft-sec^2	±1500 lbm/ft-sec^2	122	
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			123	
GU-1HZ	Hot leg, Spool 1, 26 in. from vessel center, horizontal			123	
GU-5VR	Hot leg, Spool 5, 96 in. from vessel center, vertical			124	
GU-10VR	Cold leg, Spool 10, 141 in. from vessel center, vertical			124	

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-5

Measurement	Location and Comments[a]	Range[a] Detector	Range[a] Data Acquisition System	Figure[a]	Measurement Comments[b]
DENSITY (contd.)					
Intact Loop (contd.)		0.1-100 lbm/ft^3	0-100 lbm/ft^3		
GU-13VR	Cold leg, Spool 13, 59 in. from vessel center, vertical			125	
GU-15HZ	Cold leg, Spool 15, 20 in. from vessel center, horizontal			126	
GU-15VR	Cold leg, Spool 15, 23 in. from vessel center, vertical			126	
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			127	
GB-23VR	Cold leg, Spool 23, 92 in. from vessel center, vertical			127	
GB-30VR	Hot leg, Spool 30, 10 in. from vessel center, vertical			128	
GB-42VR	Cold leg, Spool 42, 415 in. from vessel center along hot leg, vertical			128	
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, 0-100°			129	
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			129	
GVLP-165HZ	Upper part of lower plenum, 165 in. below cold leg centerline, 1.724 in. below downcomer exit, horizontal, 0-180°			130	
GVLP-172HZ	Lower plenum, 172 in. below cold leg centerline, 8.729 in. below downcomer exit, horizontal, 90-270°			130	
Pressurizer		0.1-100 lbm/ft^3	0-100 lbm/ft^3	131	
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	102	
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	89	
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 use in calculation			
Intact Loop					
FDU-1 GU-1VR FTU-1 GU-1VR	Hot leg, Spool 1			132 133	
FDU-5 GU-5VR	Hot leg, Spool 5			134	
FTU-9 GU-10VR	Cold leg, Spool 9			135	
FDU-10 GU-10VR	Cold leg, Spool 10			136	
FDU-13 GU-13VR FTU-13 GU-13VR	Cold leg, Spool 13			137 138	
FDU-15 GU-15VR FTU-15 GU-15VR	Cold leg, Spool 15			139 140	
FTU-PRIZE GU-PRIZE	Pressurizer surge line			141	

TABLE V (contd.)

DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-02-5

Measurement	Location and Comments[a]	Detector	Data Acquisition System	Figure[a]	Measurement Comments[b]
MASS FLOW RATE (contd.)					
Broken Loop					
FDB-21 GB-21VR FTB-21 GB-21VR	Cold leg, Spool 21			142 143	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			144	
FDB-30 GB-30VR FTB-30 GB-30VR	Hot leg, Spool 30			145 146	
FDB-42 GB-42VR	Cold leg, Spool 42			147	
Vessel					
FTV-CORE-IN GV-COR-150HZ	Entrance to core			148	
FDV-CORE-IN GV-COR-150HZ	Entrance to core			149	
CORE CHARACTERISTICS				150	
PWRCOR T-1	Core power		1600 kW		
PWRCOR T-2	Core power		1600 kW		
PUMP CHARACTERISTICS					
PUMPU-TORQ	Pump torque	0-500 in.-lb	0-500 in.-lb	151	
PUMPU-RPM	Pump speed	0-3600 rpm	0-3600 rpm	152	Indicated initial pump speed is below actual pump rpm due to a resonant vibration in pickup probe mounting

[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.

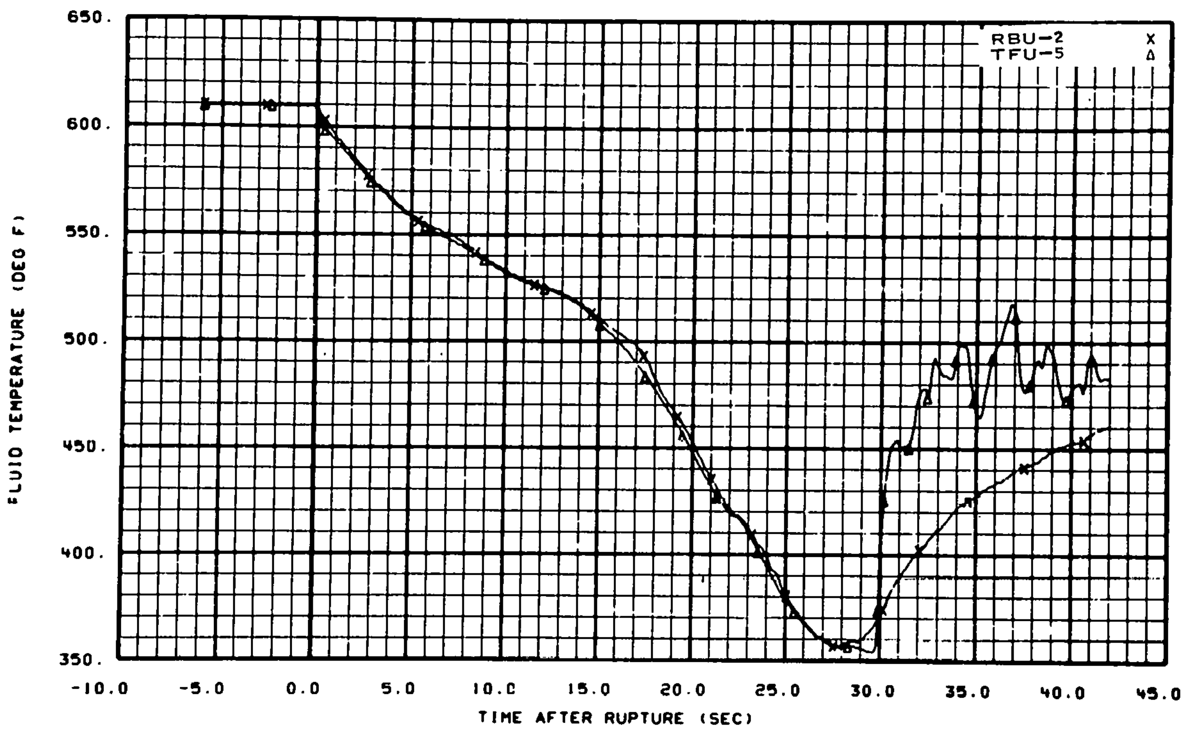

Fig. 7 Fluid temperature in intact loop hot leg.

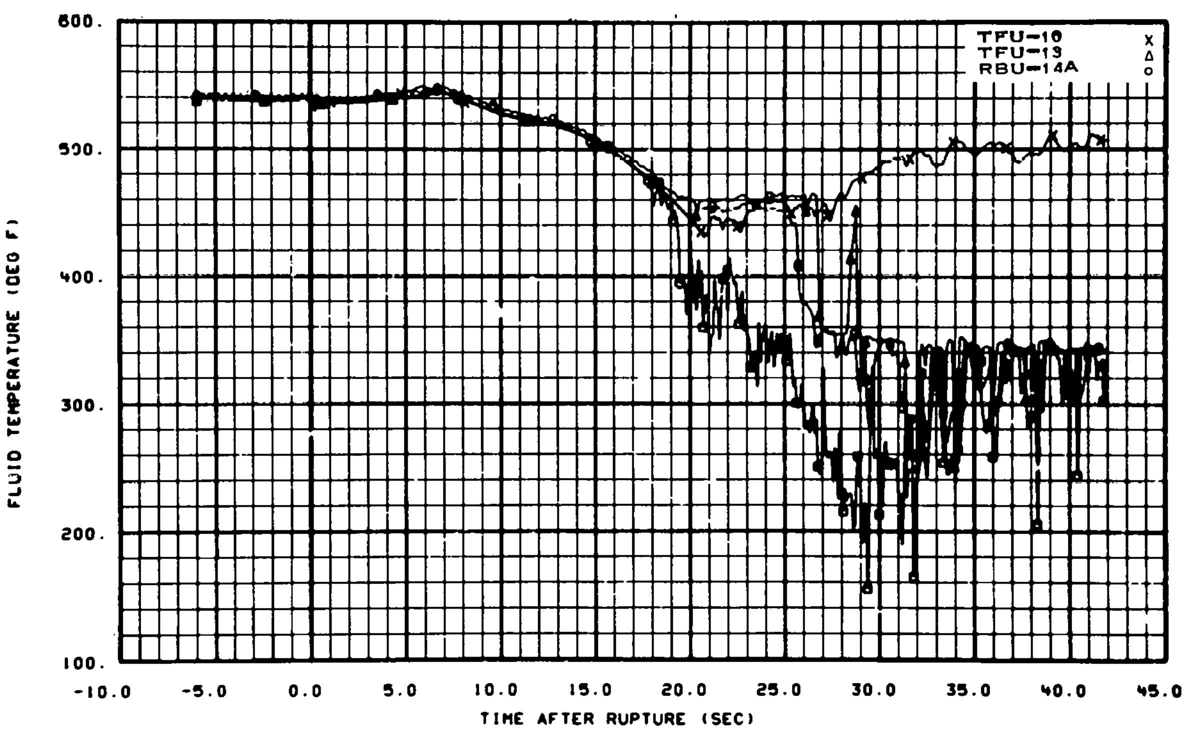

Fig. 8 Fluid temperature in intact loop cold leg.

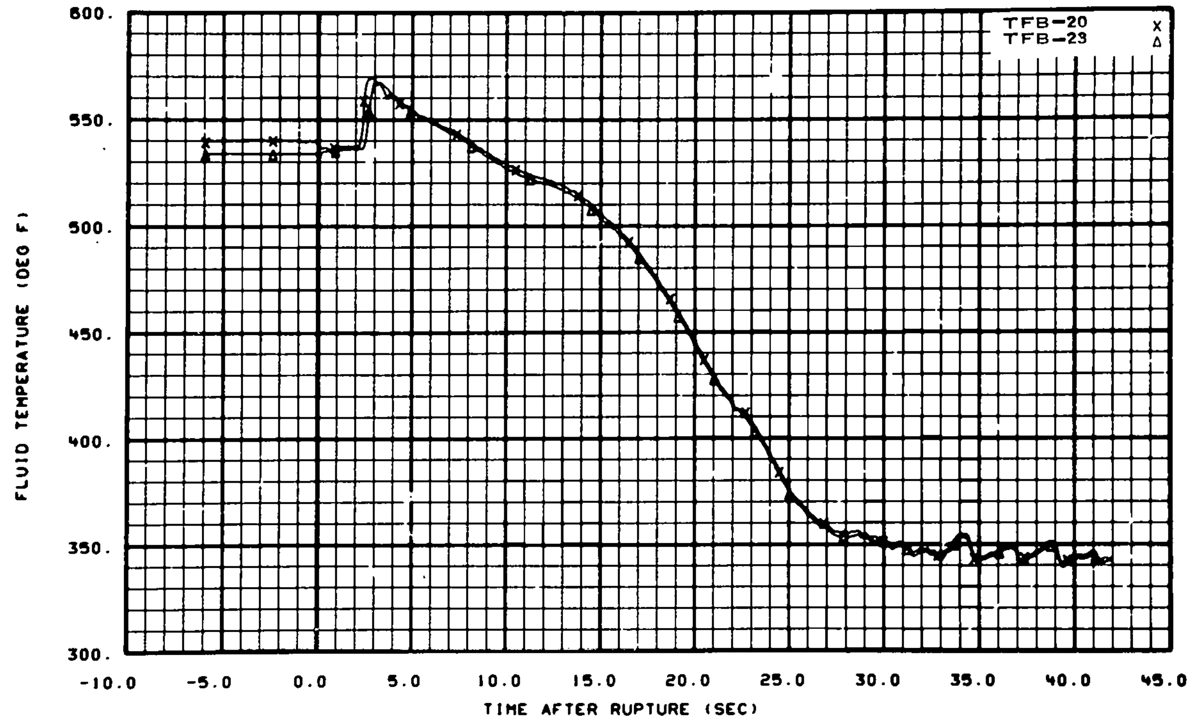

Fig. 9 Fluid temperature in broken loop (vessel side).

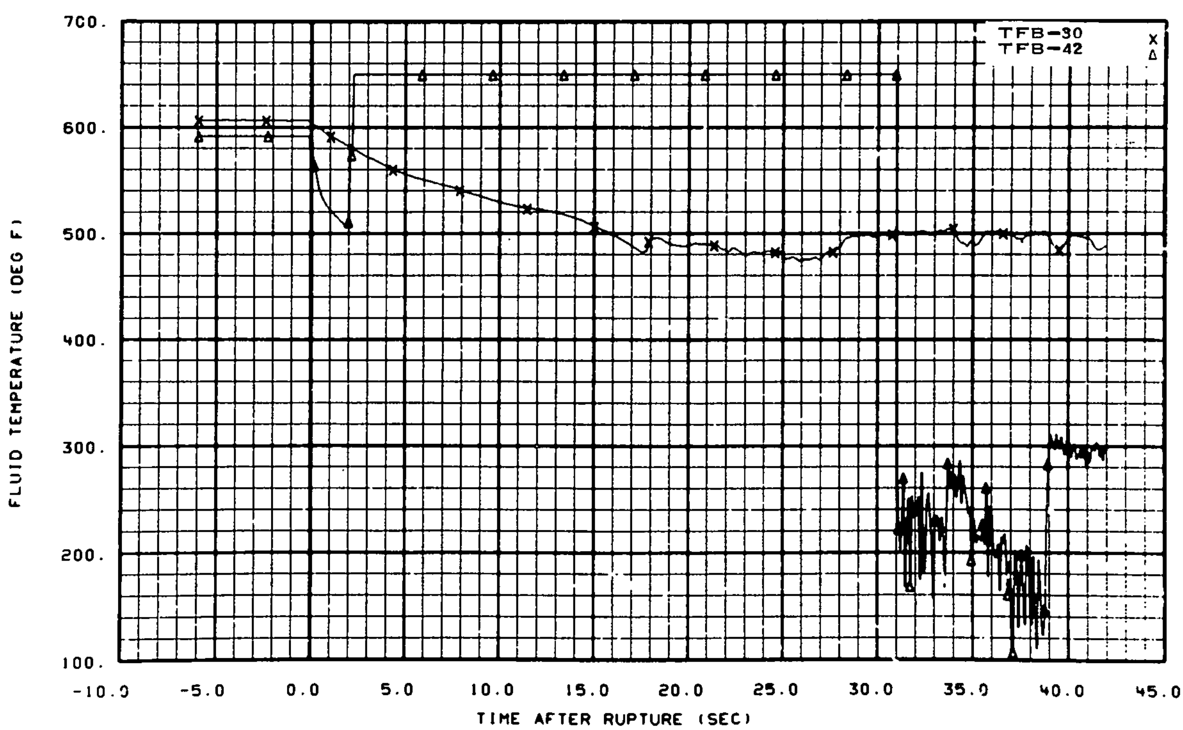

Fig. 10 Fluid temperature in broken loop (pump side).

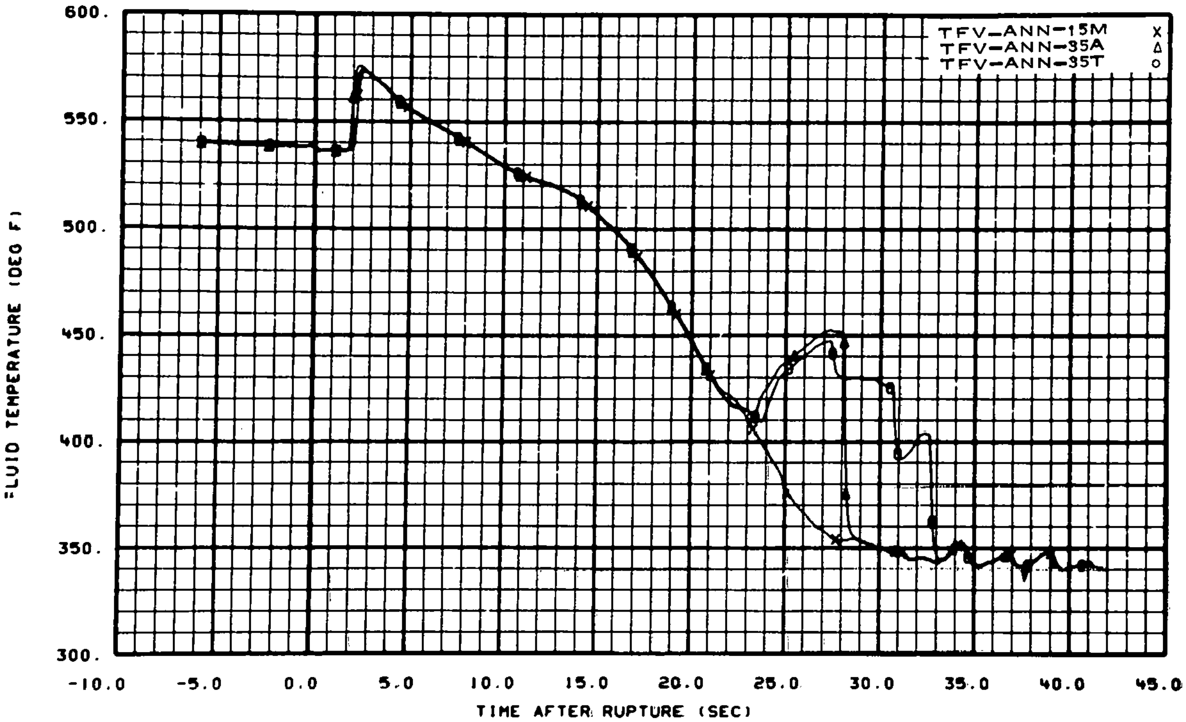

Fig. 11 Fluid temperature in downcomer annulus (upper).

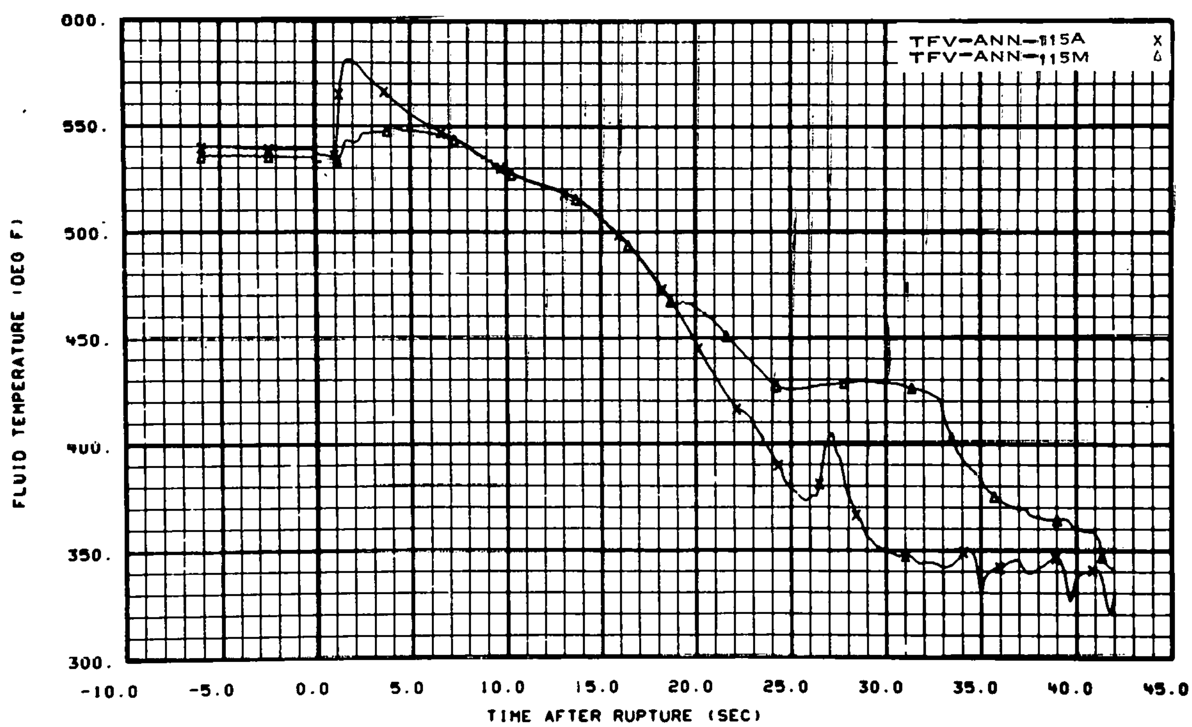

Fig. 12 Fluid temperature in downcomer annulus (lower).

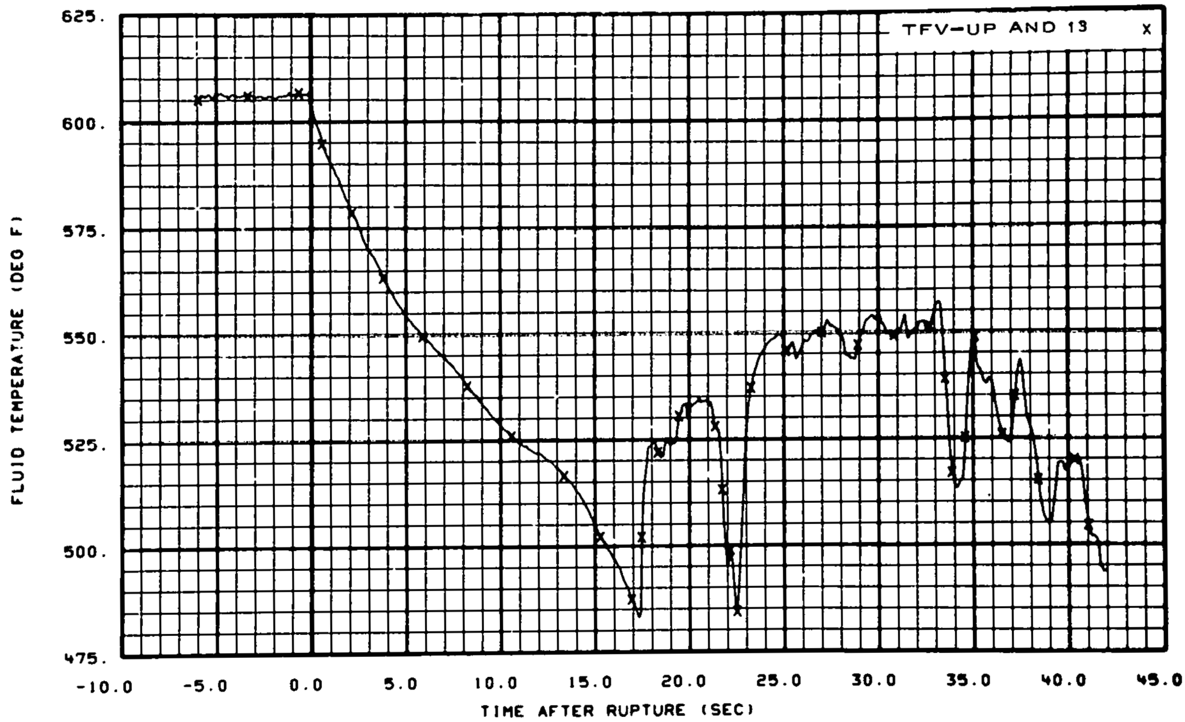

Fig. 13 Fluid temperature in upper plenum.

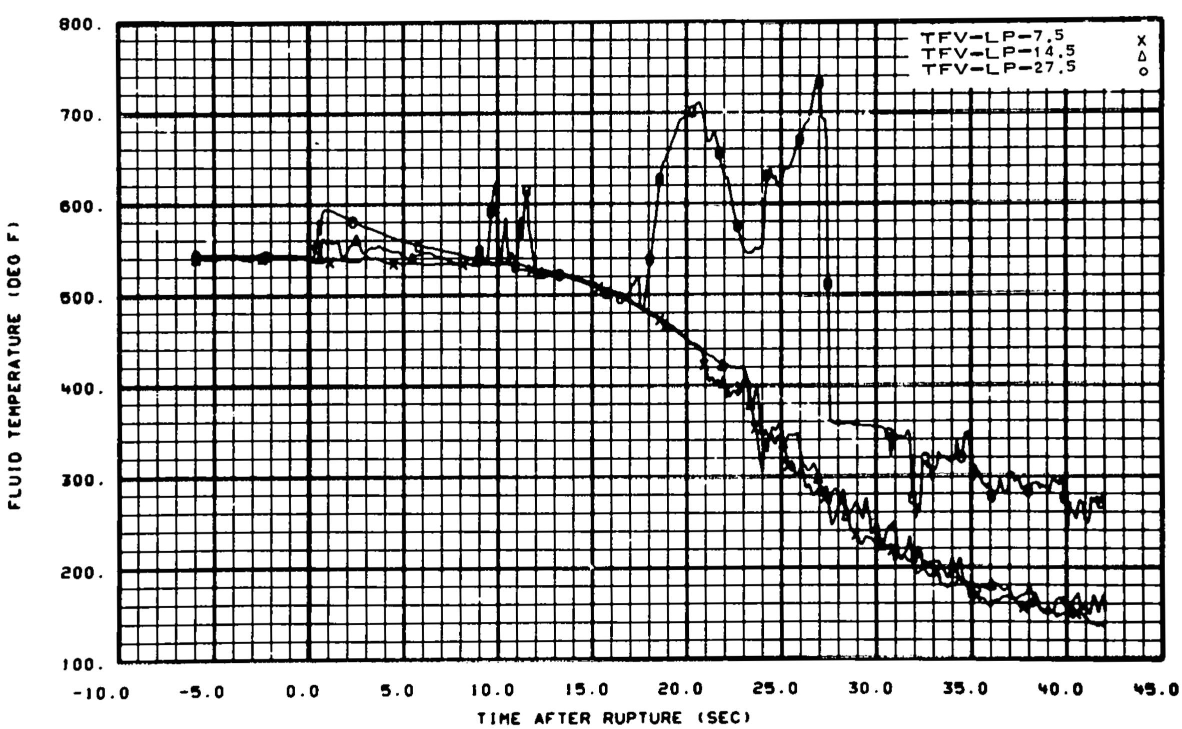

Fig. 14 Fluid temperature in lower plenum.

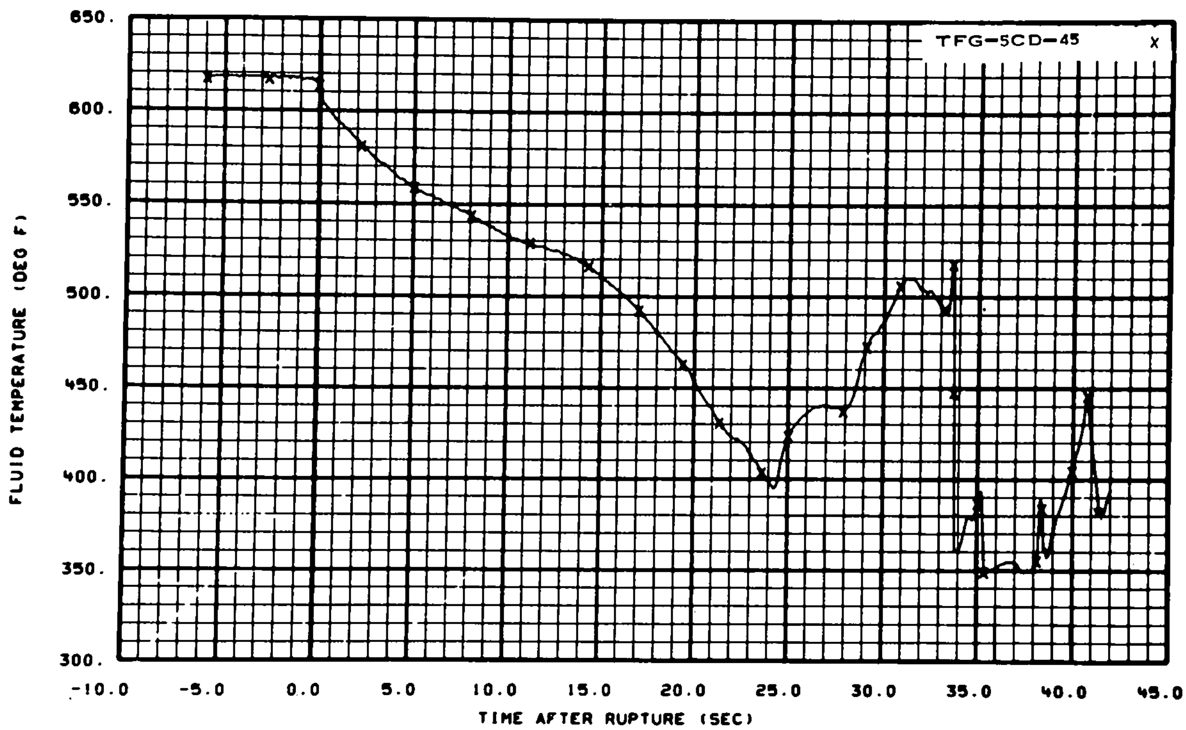

Fig. 15 Fluid temperature in core (Grid Spacer 5).

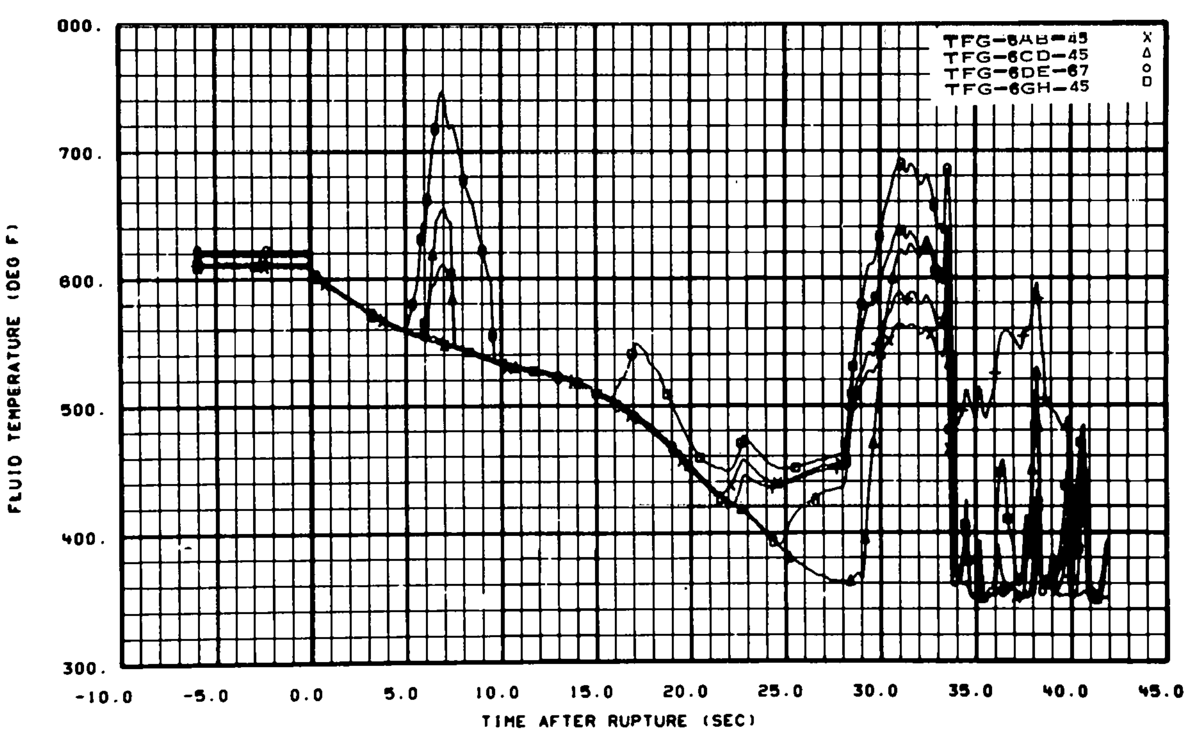

Fig. 16 Fluid temperature in core (Grid Spacer 6).

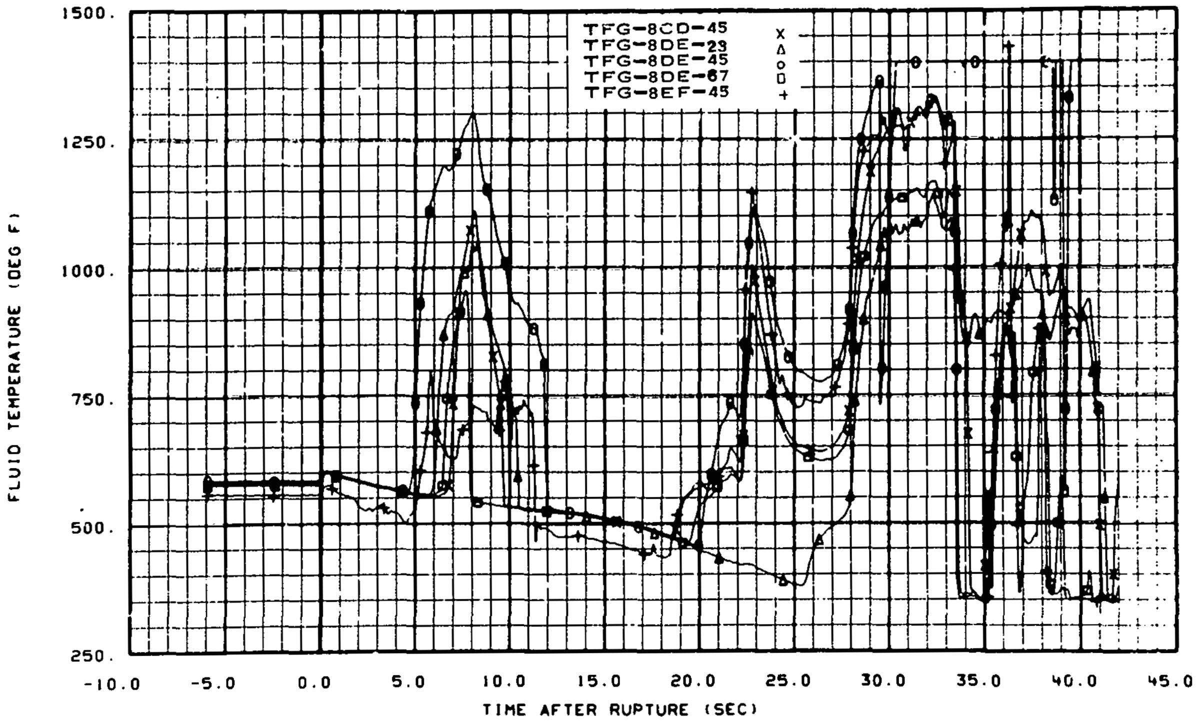

Fig. 17 Fluid temperature in core (Grid Spacer 8).

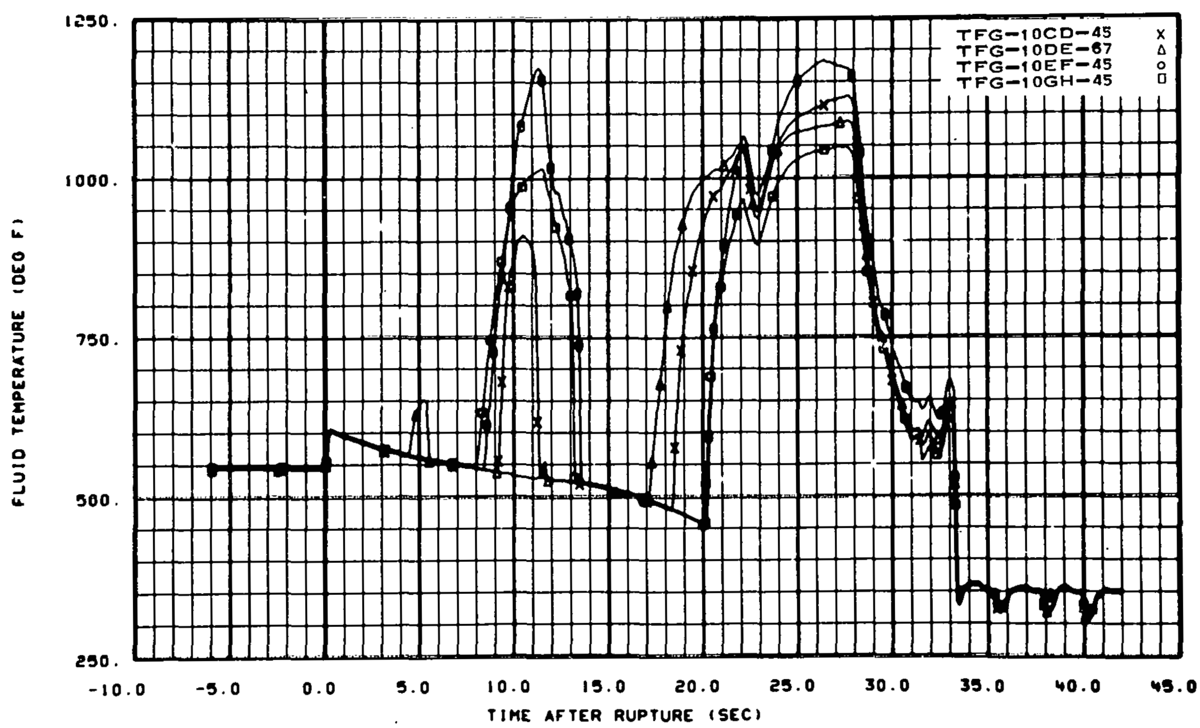

Fig. 18 Fluid temperature in core (Grid Spacer 10).

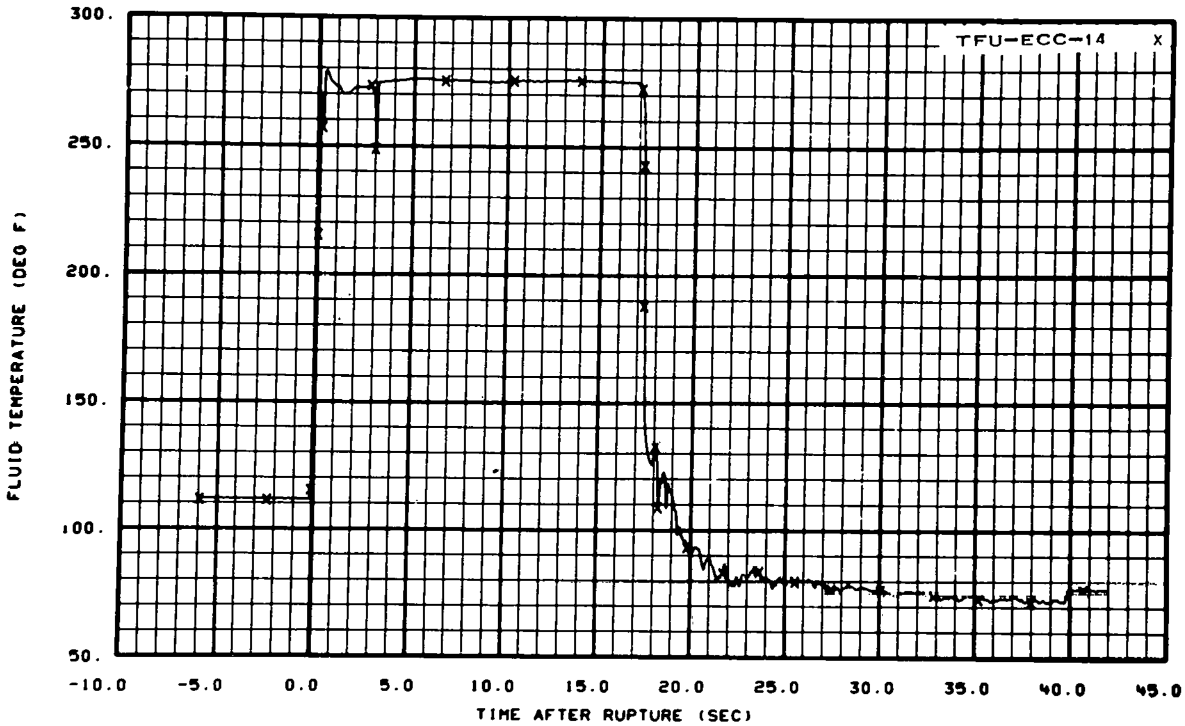

Fig. 19 Fluid temperature in intact loop coolant injection line (at Spool 14).

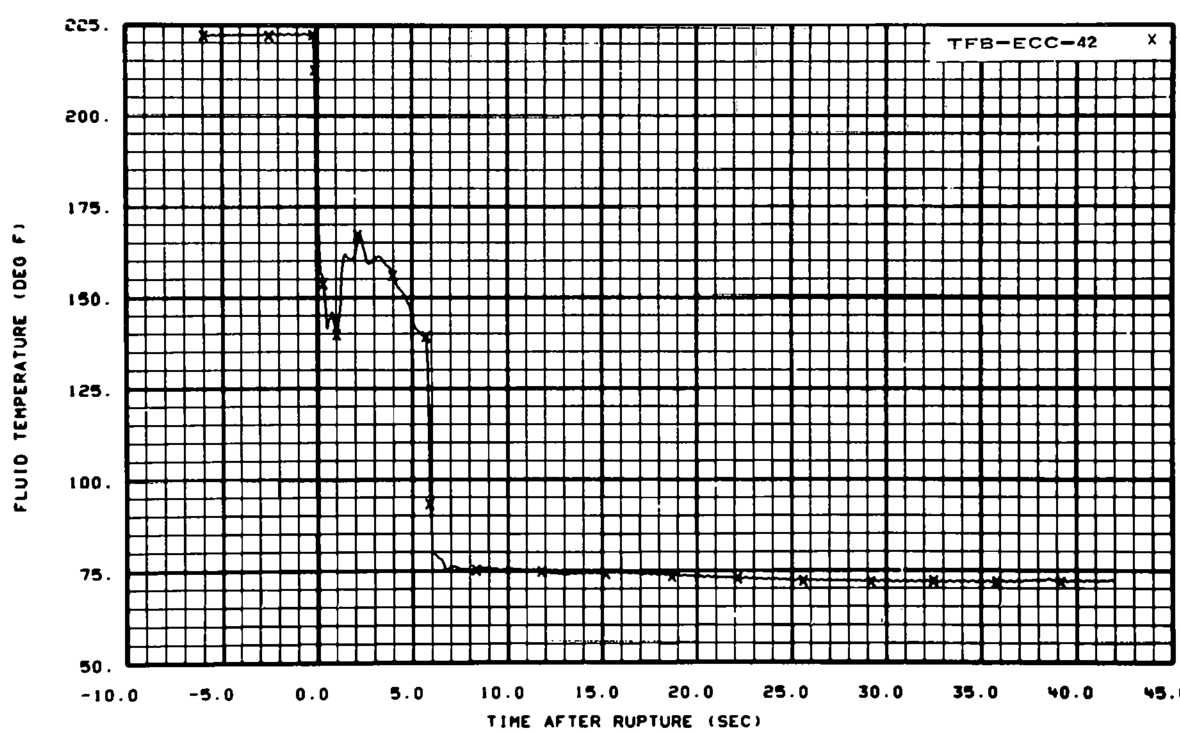

Fig. 20 Fluid temperature in broken loop coolant injection line (at Spool 42).

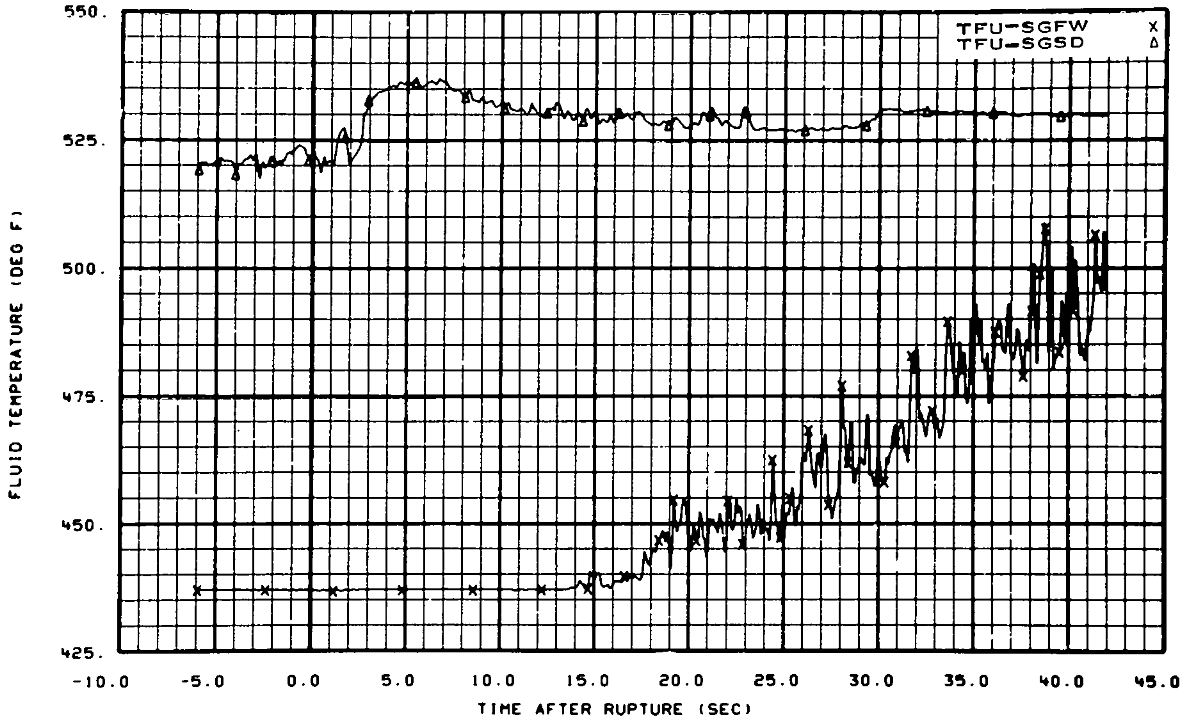

Fig. 21 Fluid temperature in steam generator inlet and outlet.

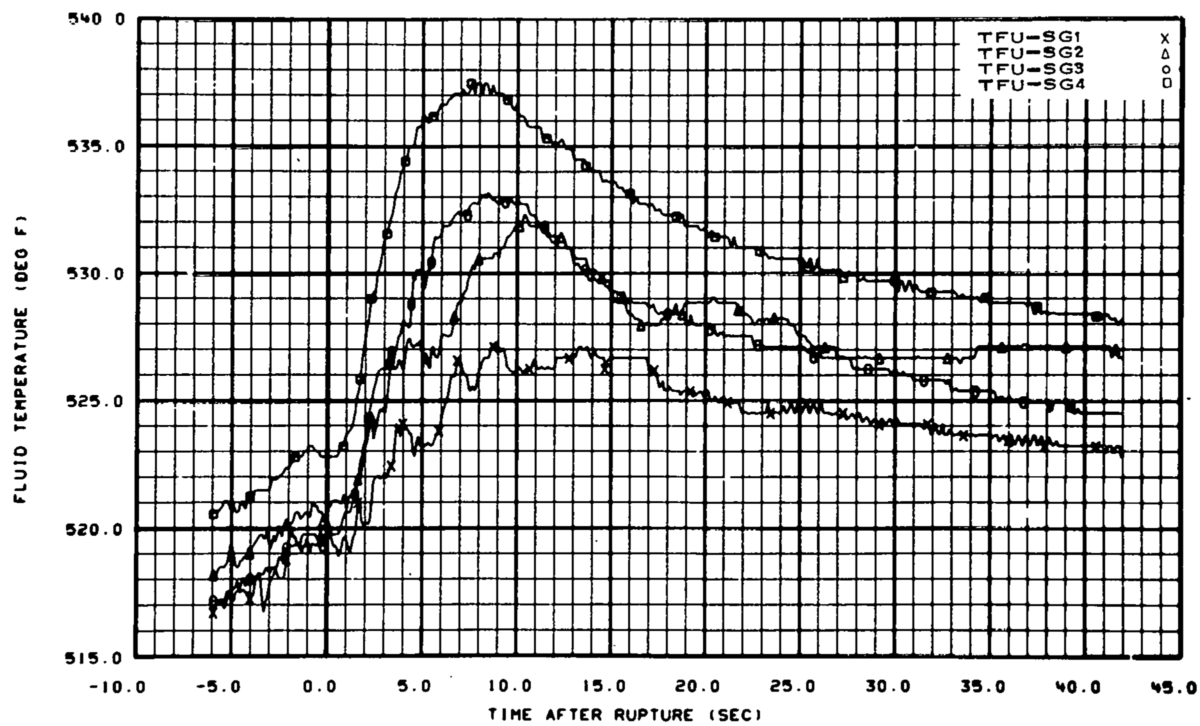

Fig. 22 Fluid temperature in steam generator.

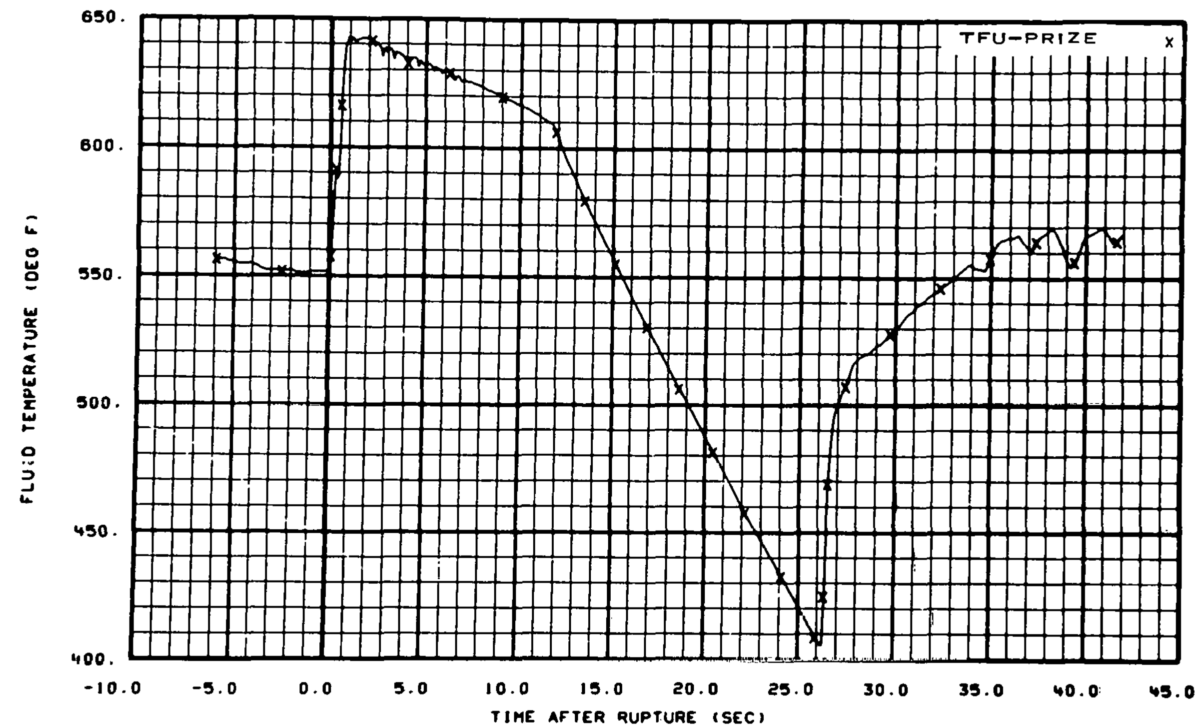

Fig. 23 Fluid temperature in pressurizer surge line.

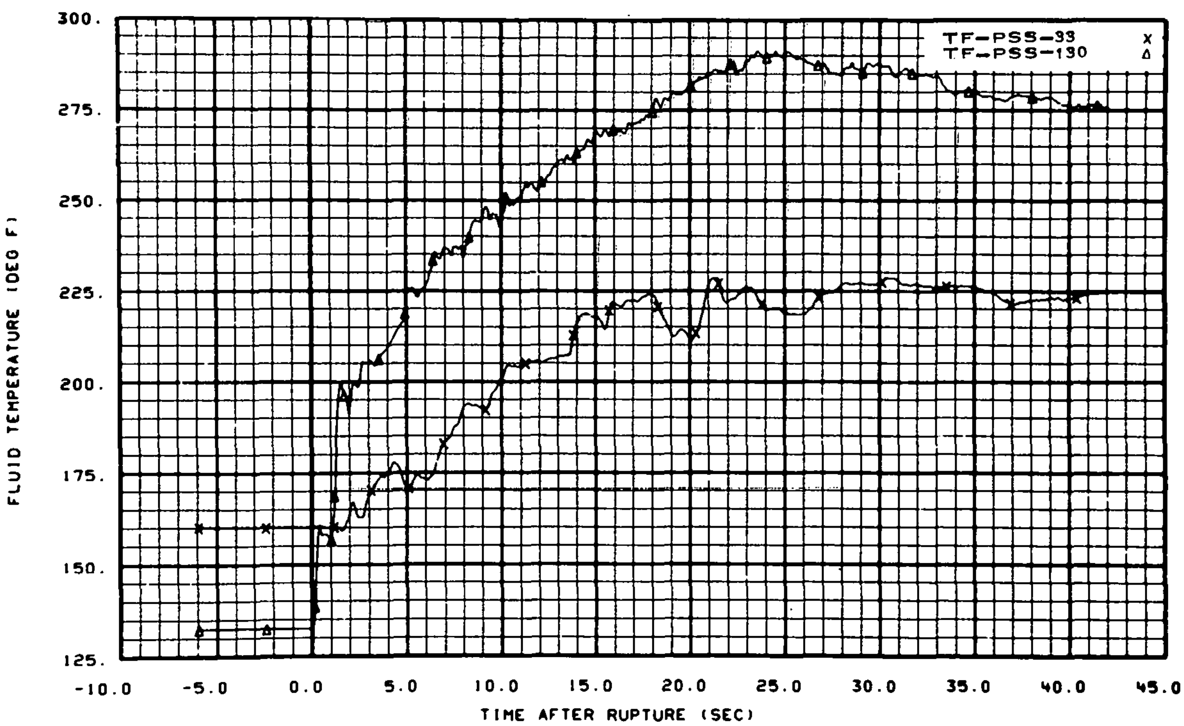

Fig. 24 Fluid temperature in pressure suppression system.

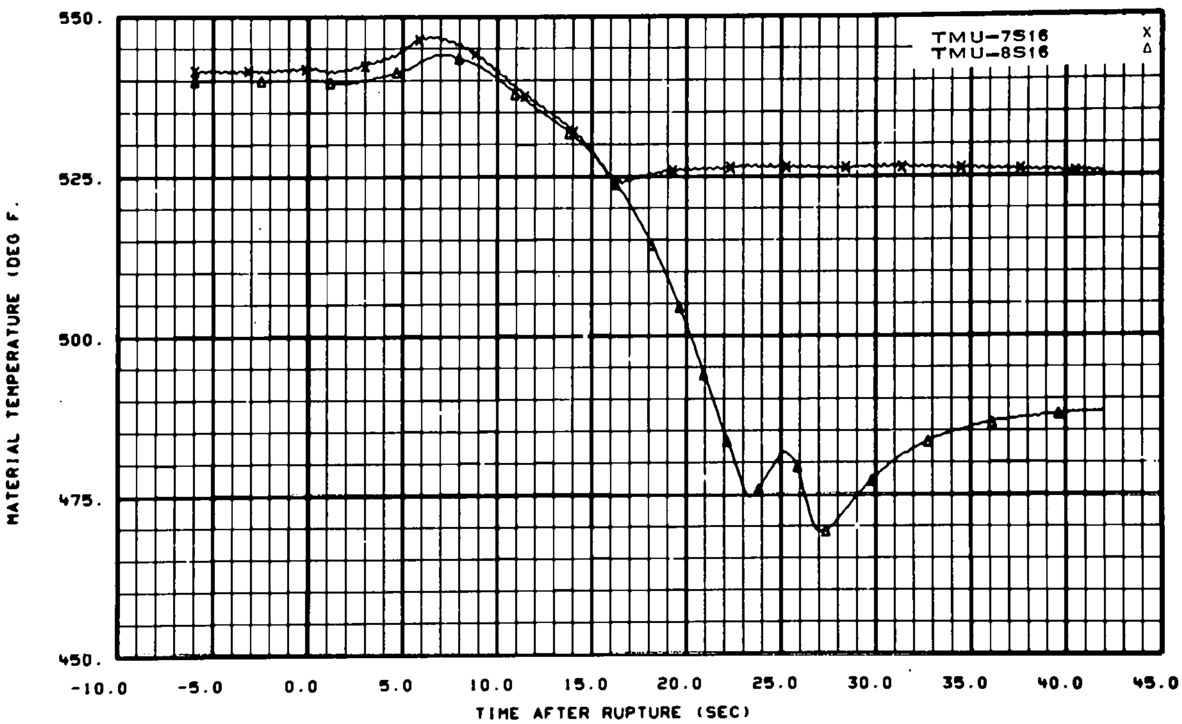

Fig. 25 Material temperature in intact loop.

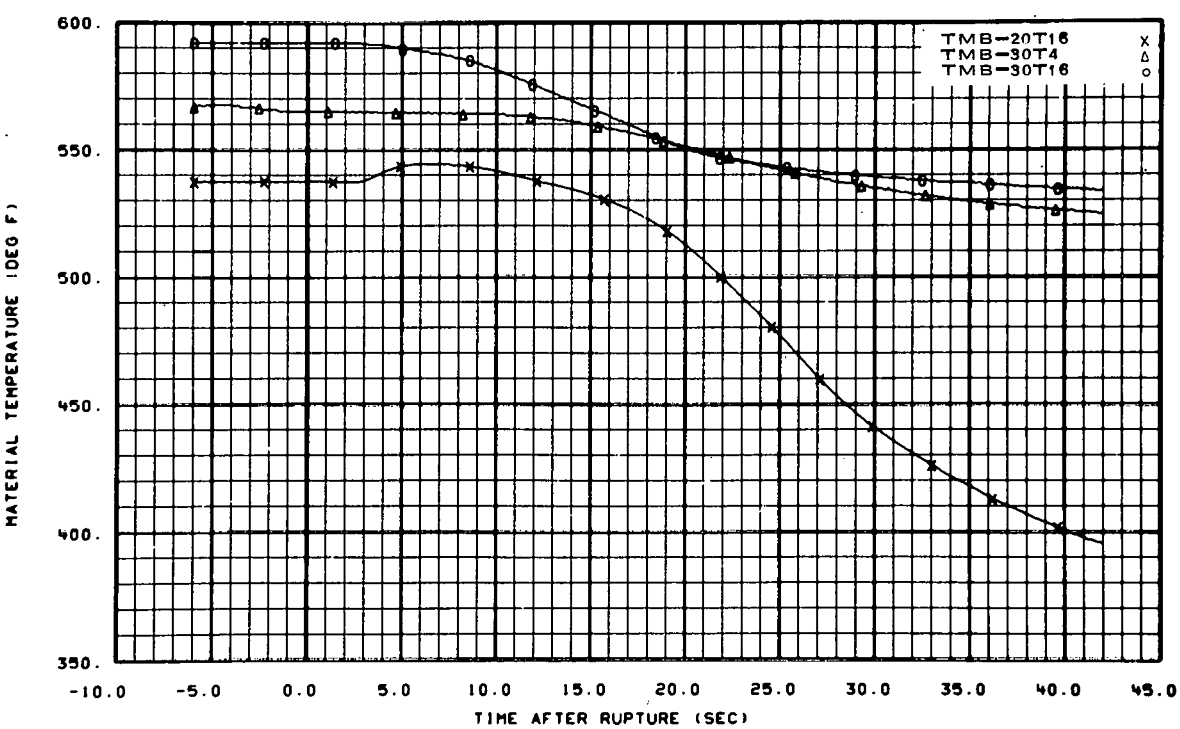

Fig. 26 Material temperature in broken loop.

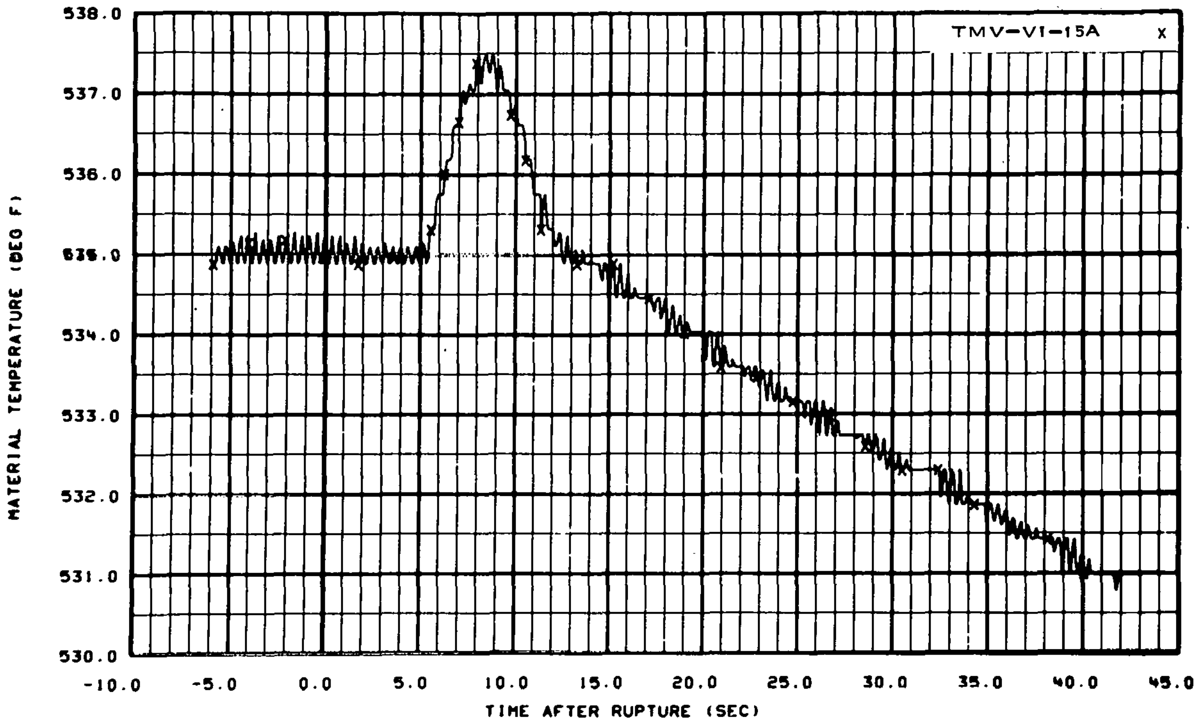

Fig. 27 Material temperature in vessel wall.

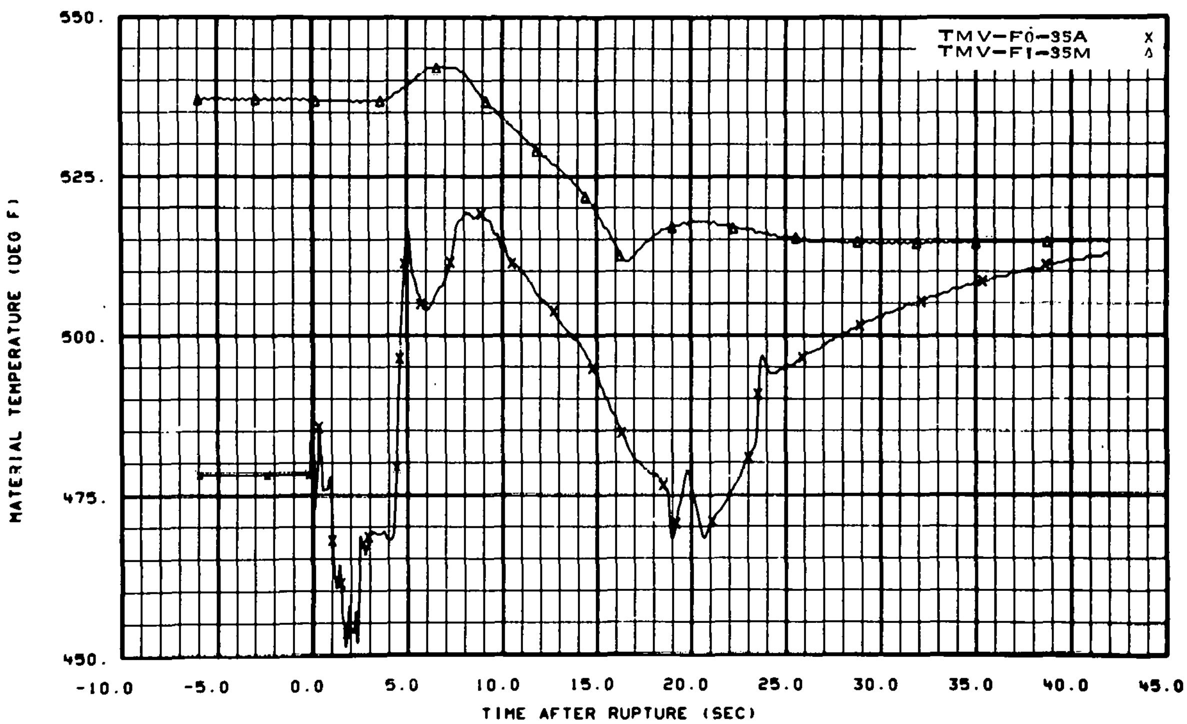

Fig. 28 Material temperature in vessel filler.

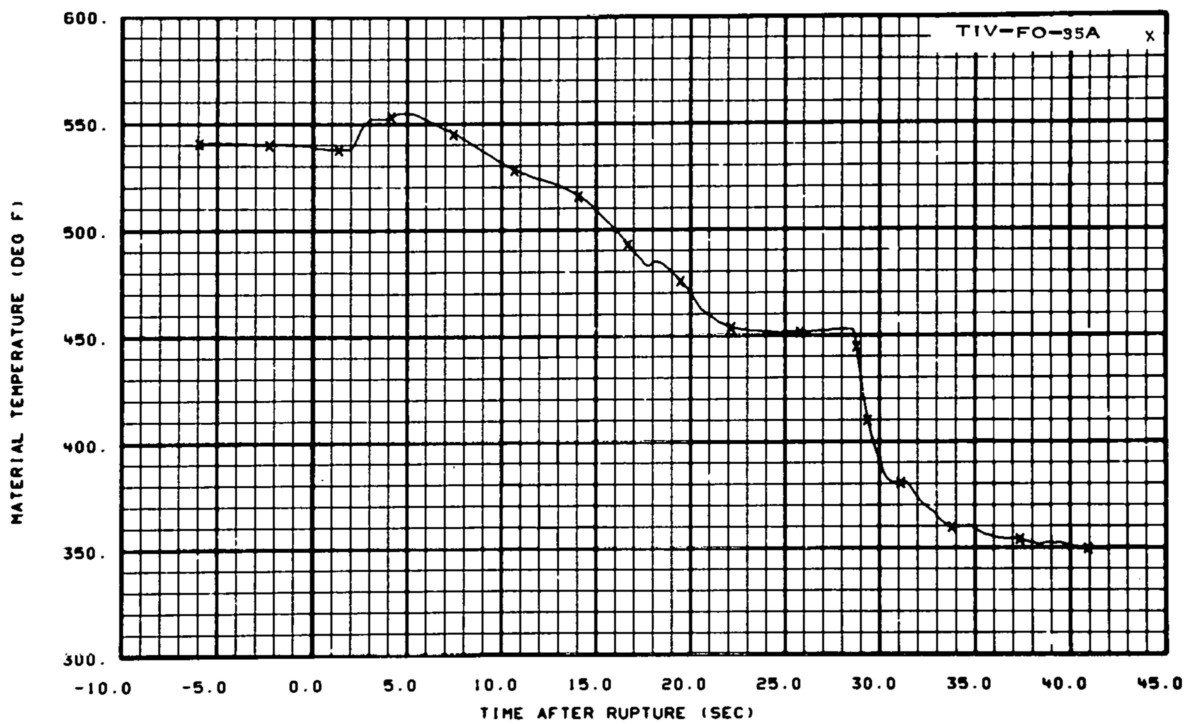

Fig. 29 Material temperature vessel filler insulator.

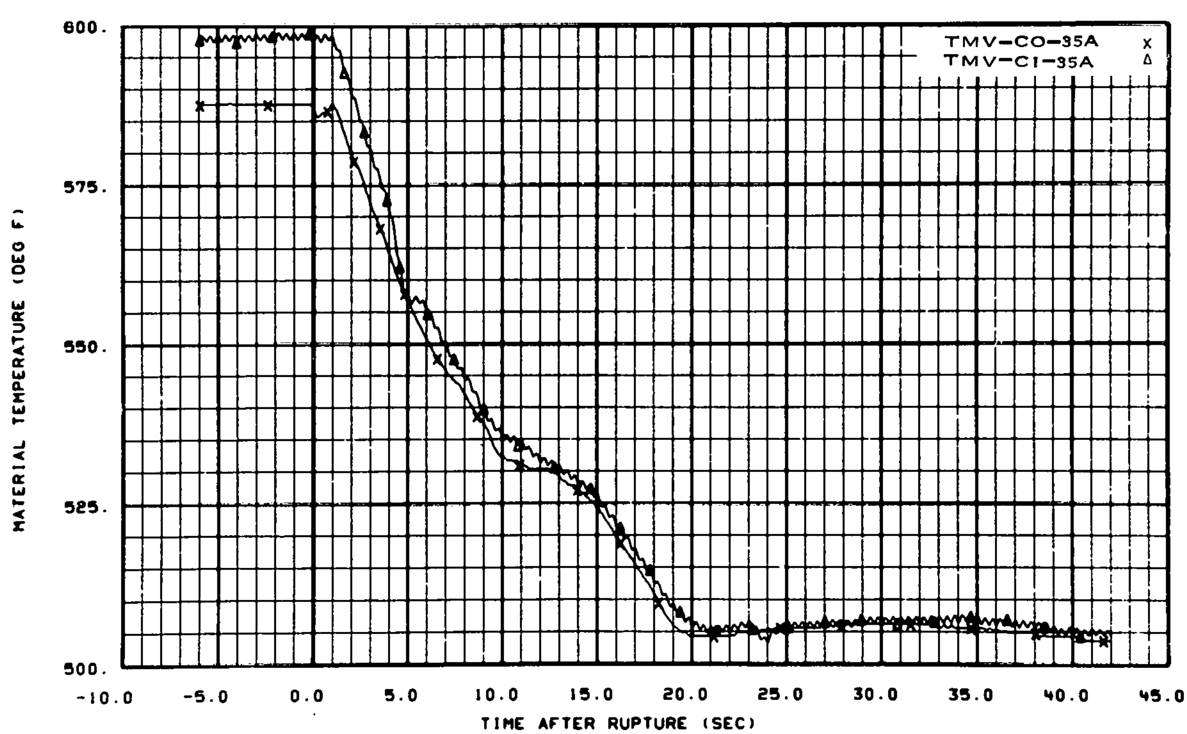

Fig. 30 Material temperature in core barrel.

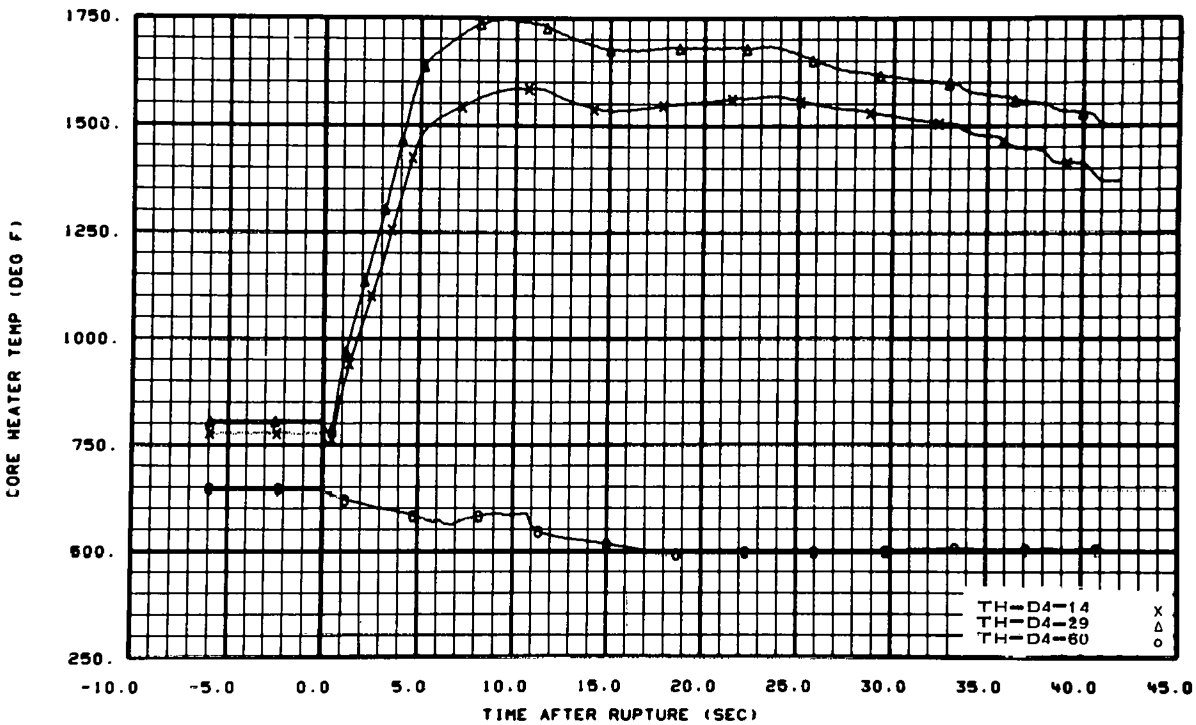

Fig. 31 Core heater temperature, Rod D-4.

Fig. 32 Core heater temperature, Rod D-5.

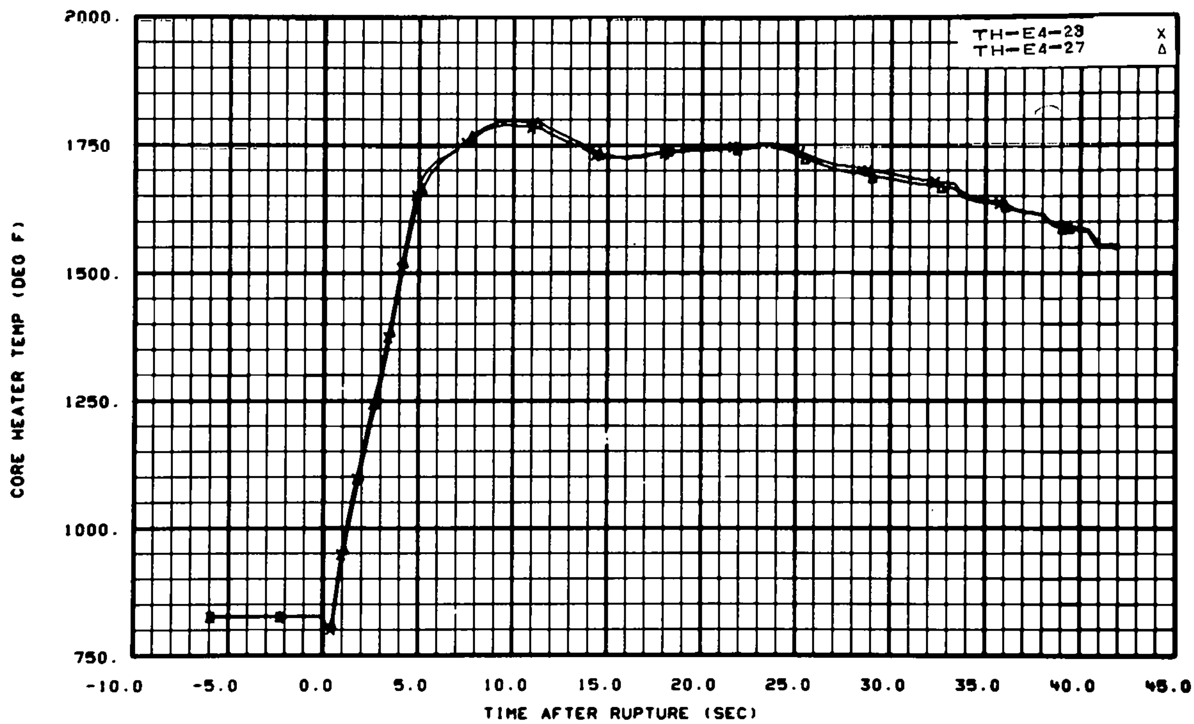

Fig. 33 Core heater temperature, Rod E-4.

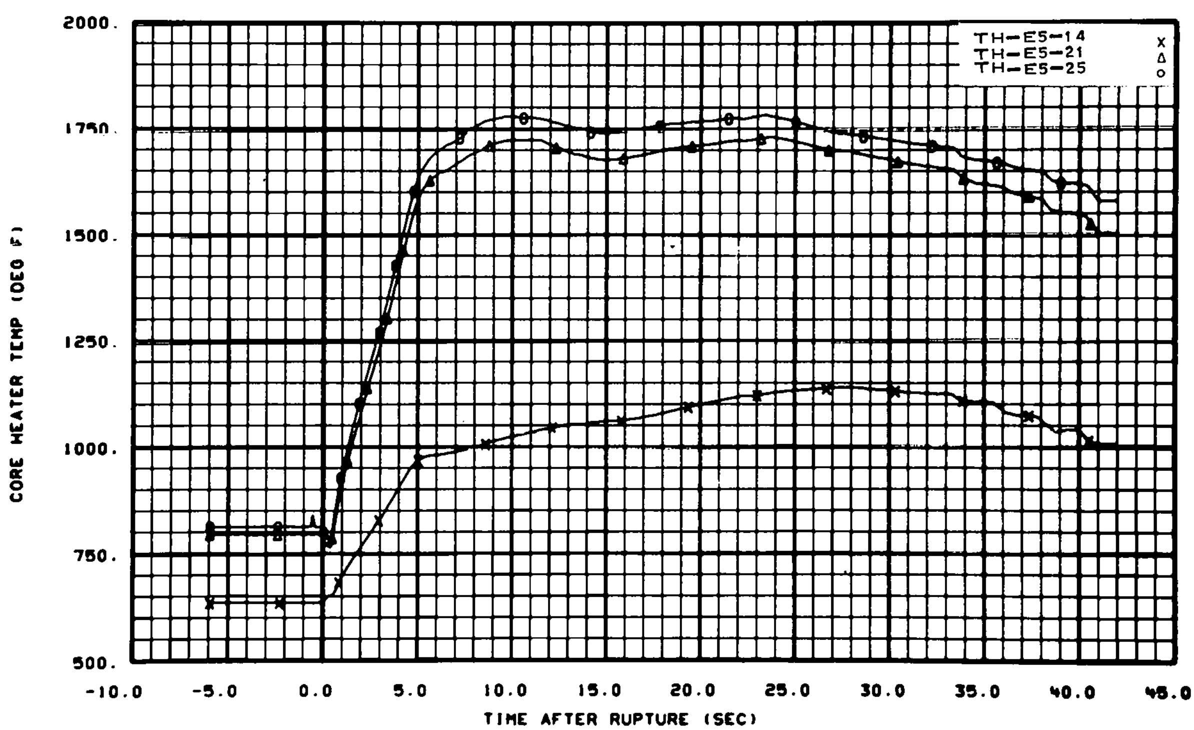

Fig. 34 Core heater temperature, Rod E-5.

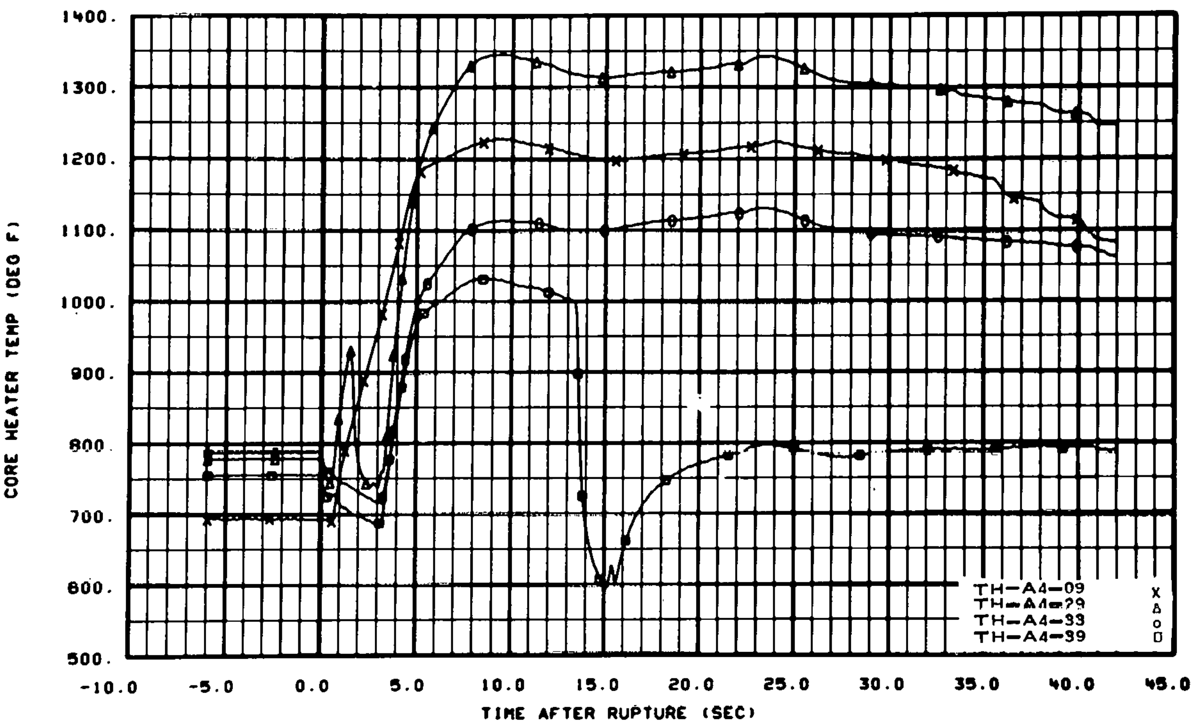

Fig. 35 Core heater temperature, Rod A-4.

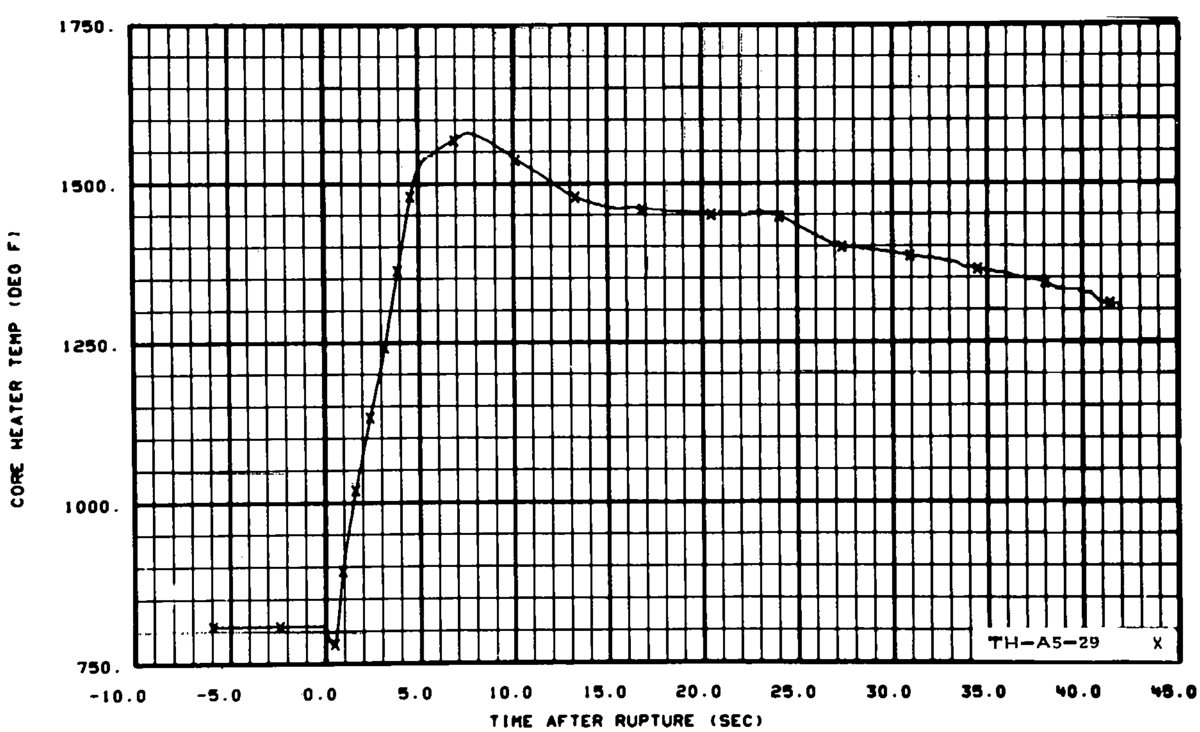

Fig. 36 Core heater temperature, Rod A-5.

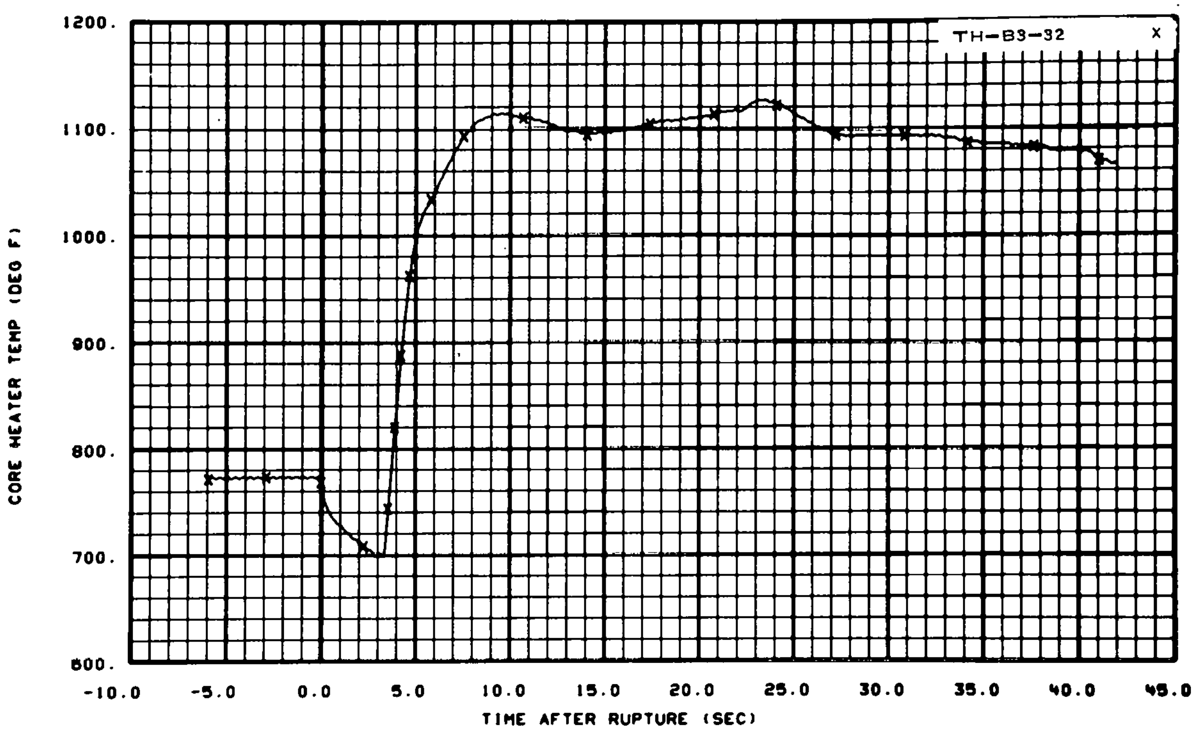

Fig. 37 Core heater temperature, Rod B-3.

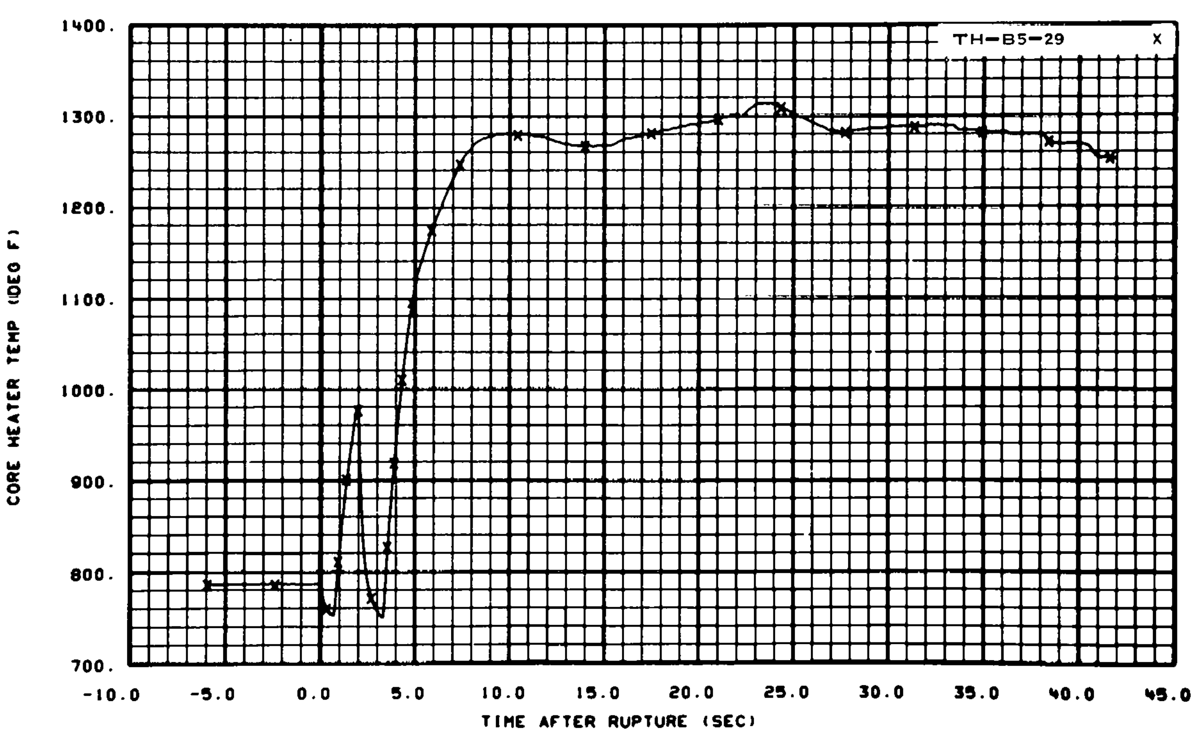

Fig. 38 Core heater temperature, Rod B-5.

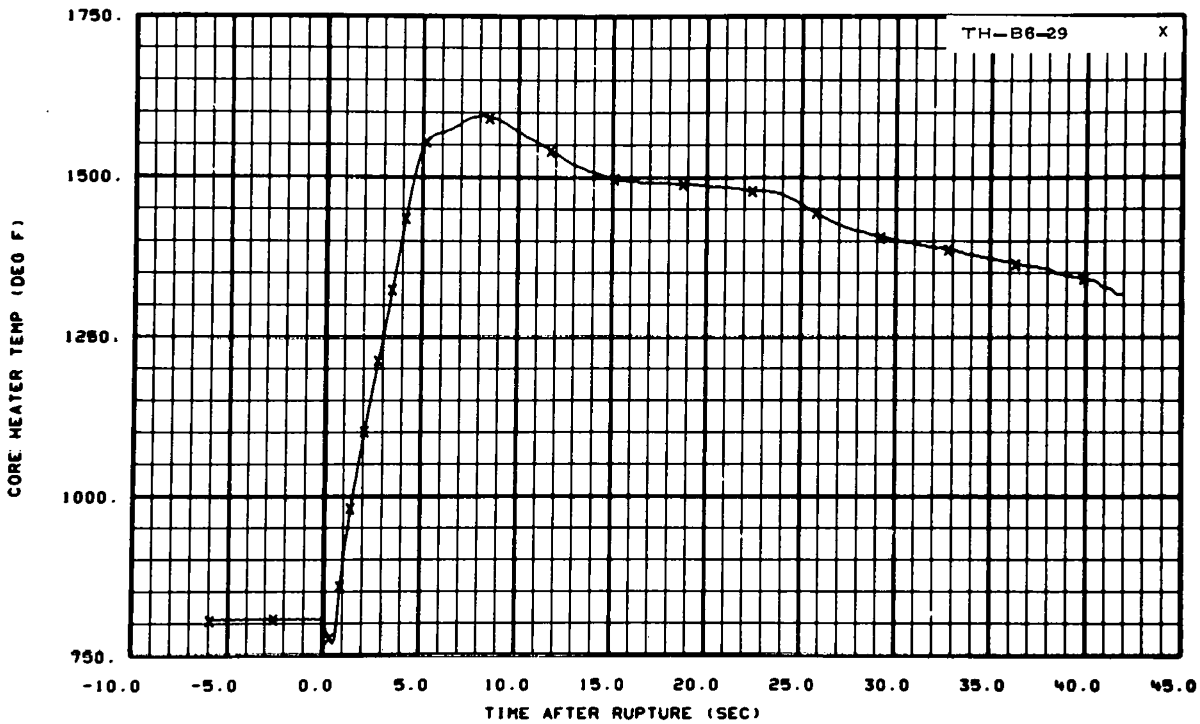

Fig. 39 Core heater temperature, Rod B-6.

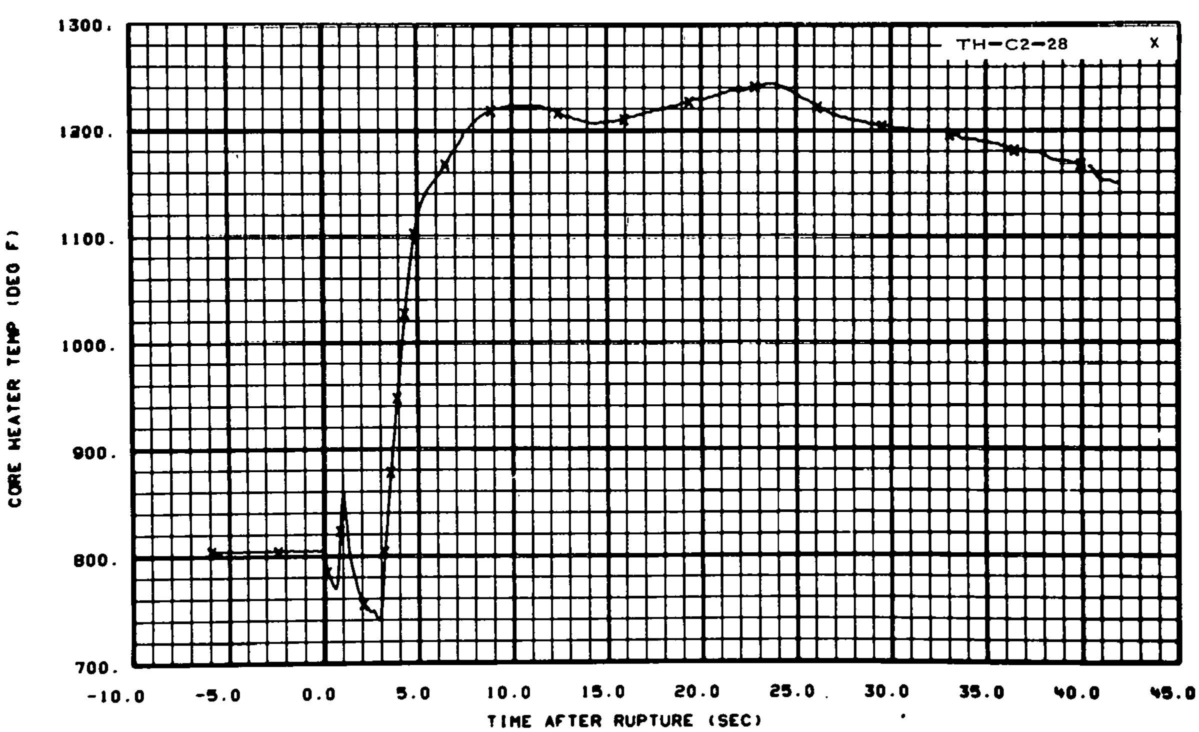

Fig. 40 Core heater temperature, Rod C-2.

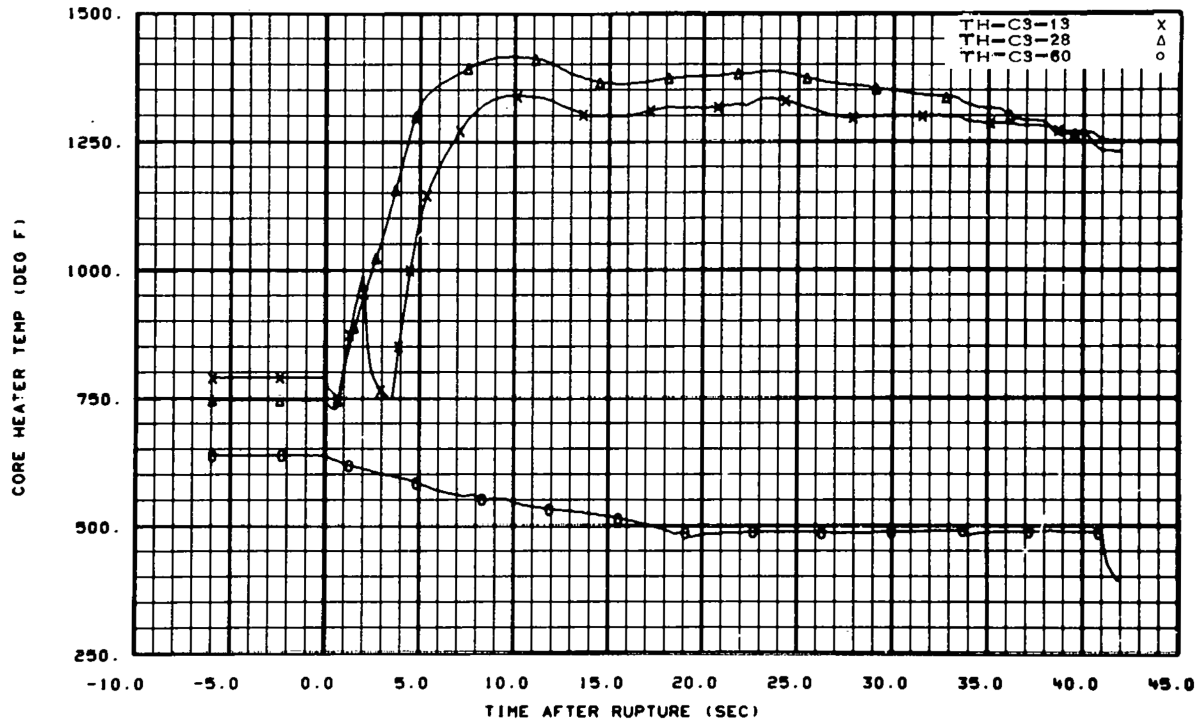

Fig. 41 Core heater temperature, Rod C-3.

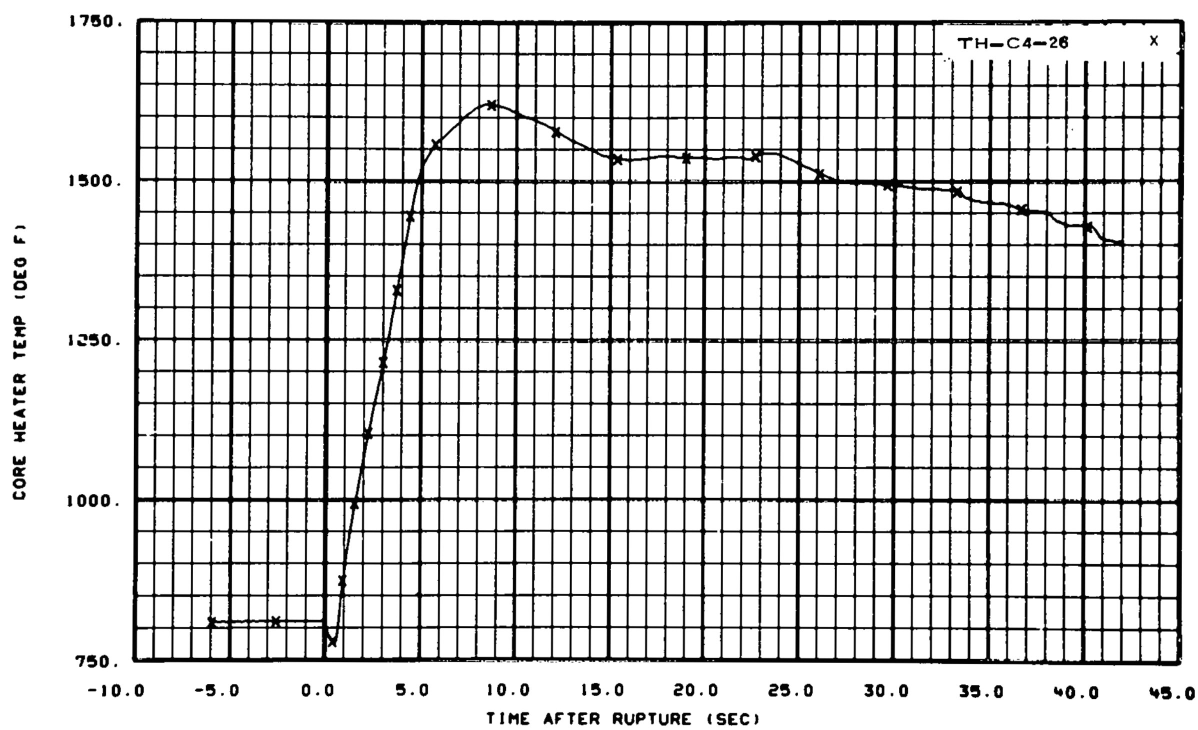

Fig. 42 Core heater temperature, Rod C-4.

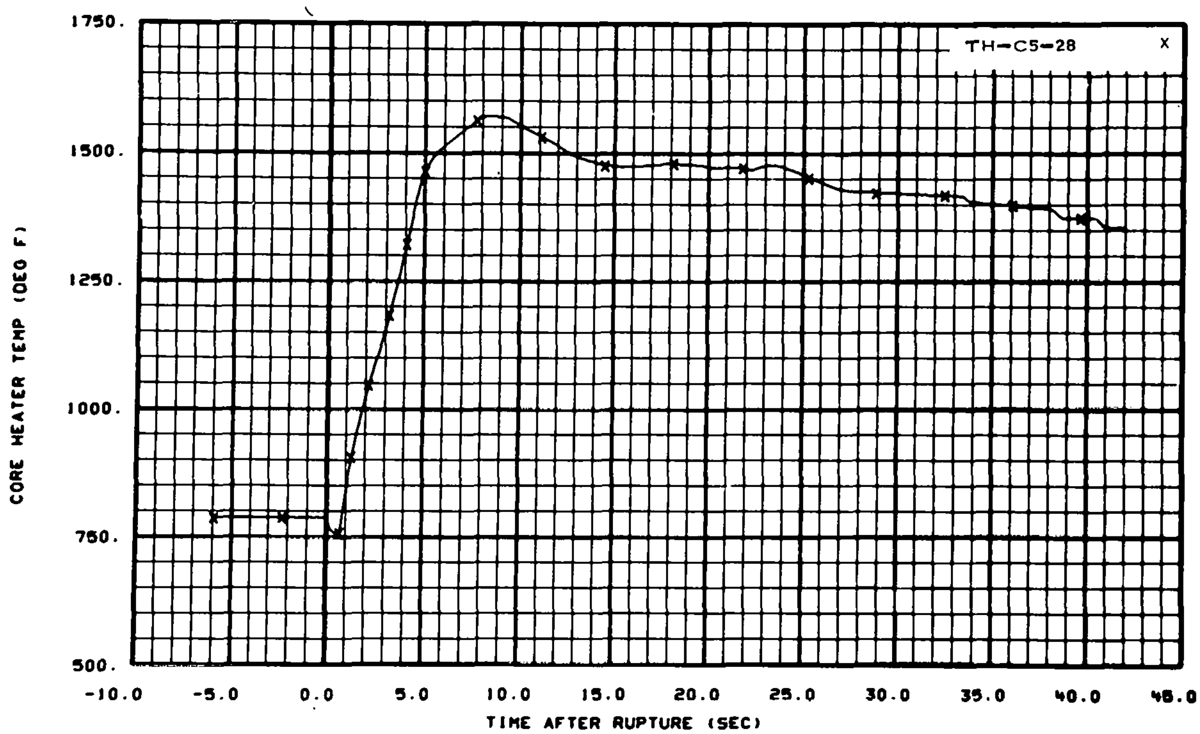

Fig. 43 Core heater temperature, Rod C-5.

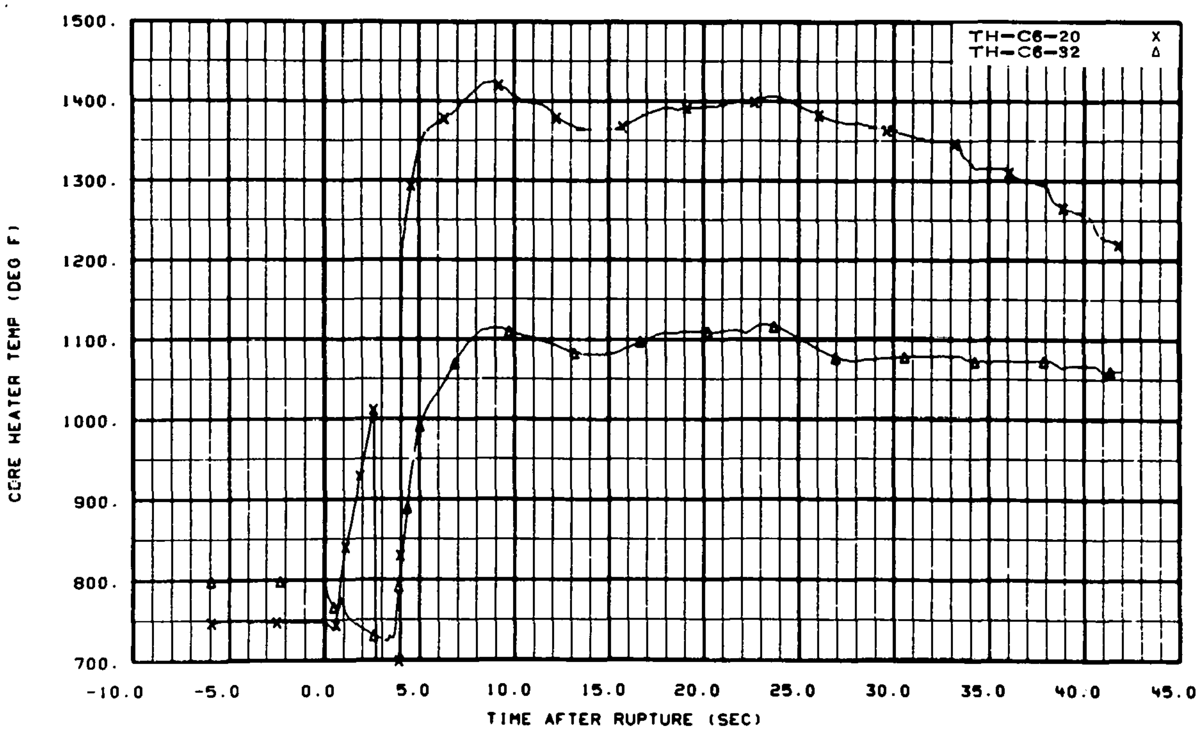

Fig. 44 Core heater temperature, Rod C-6.

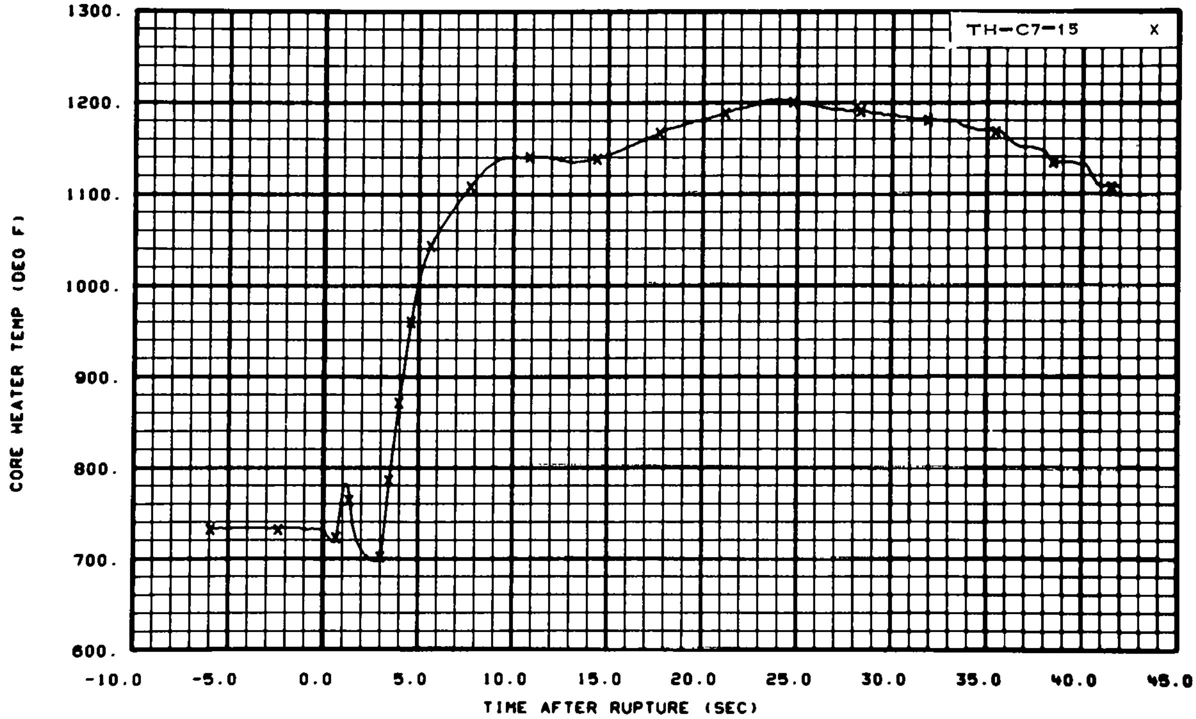

Fig. 45 Core heater temperature, Rod C-7.

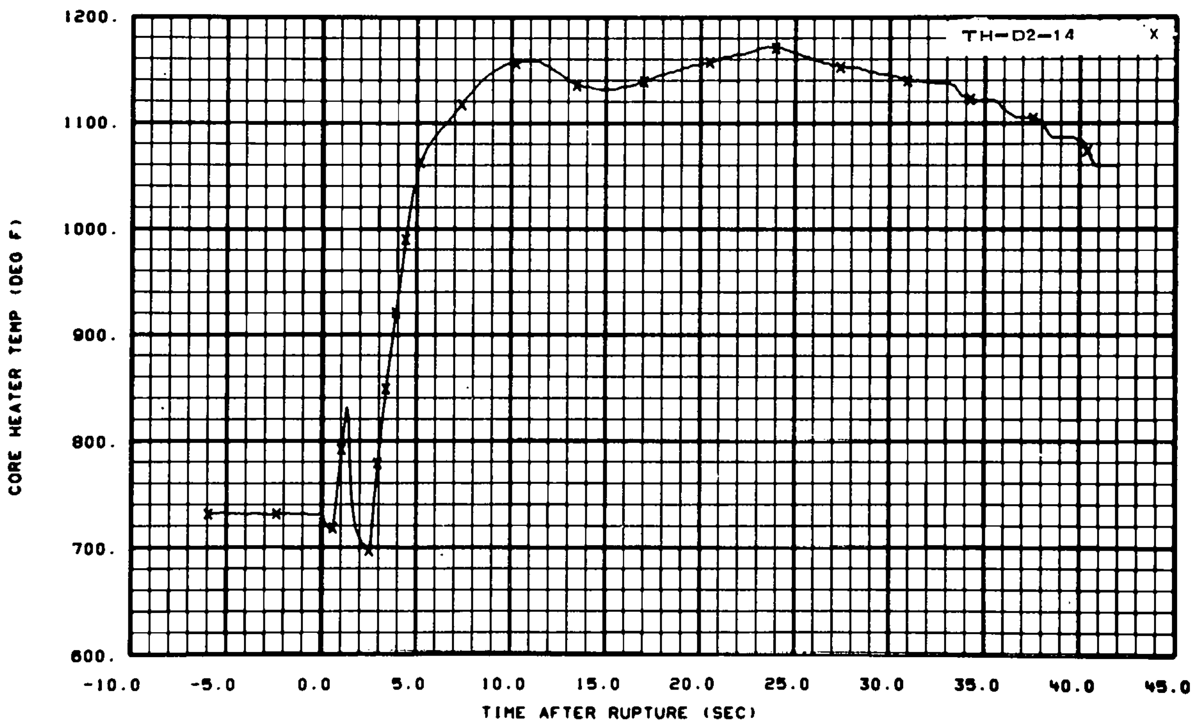

Fig. 46 Core heater temperature, Rod D-2.

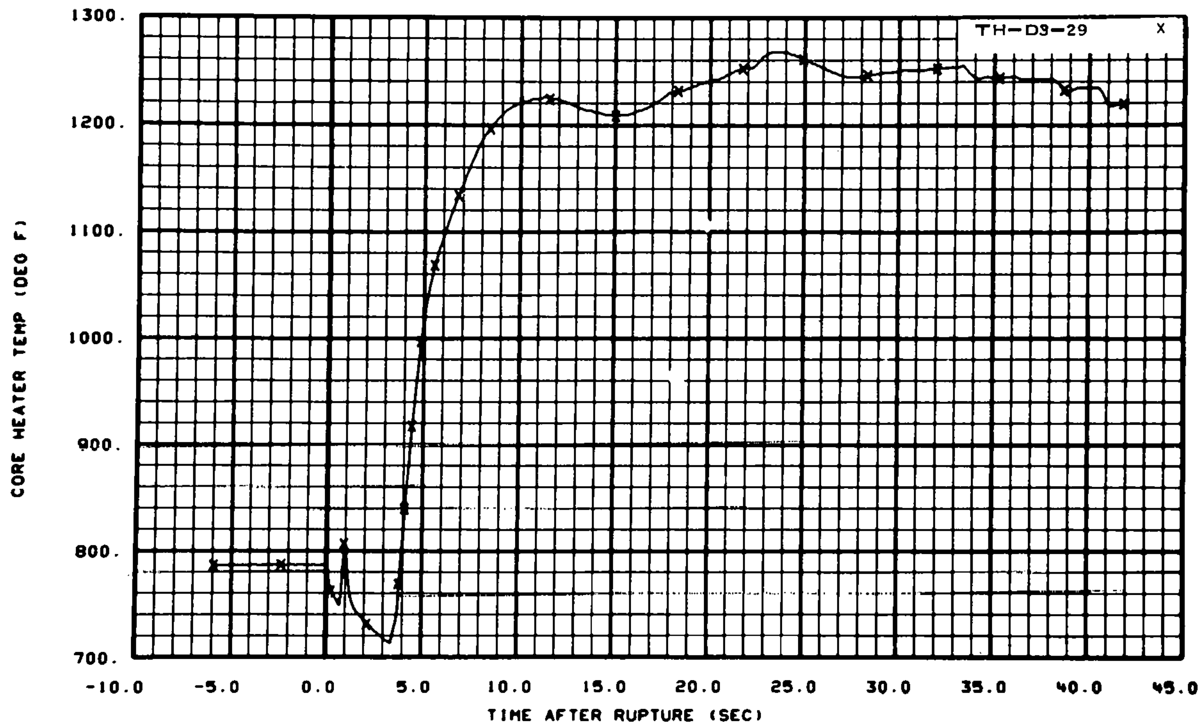

Fig. 47 Core heater temperature, Rod D-3.

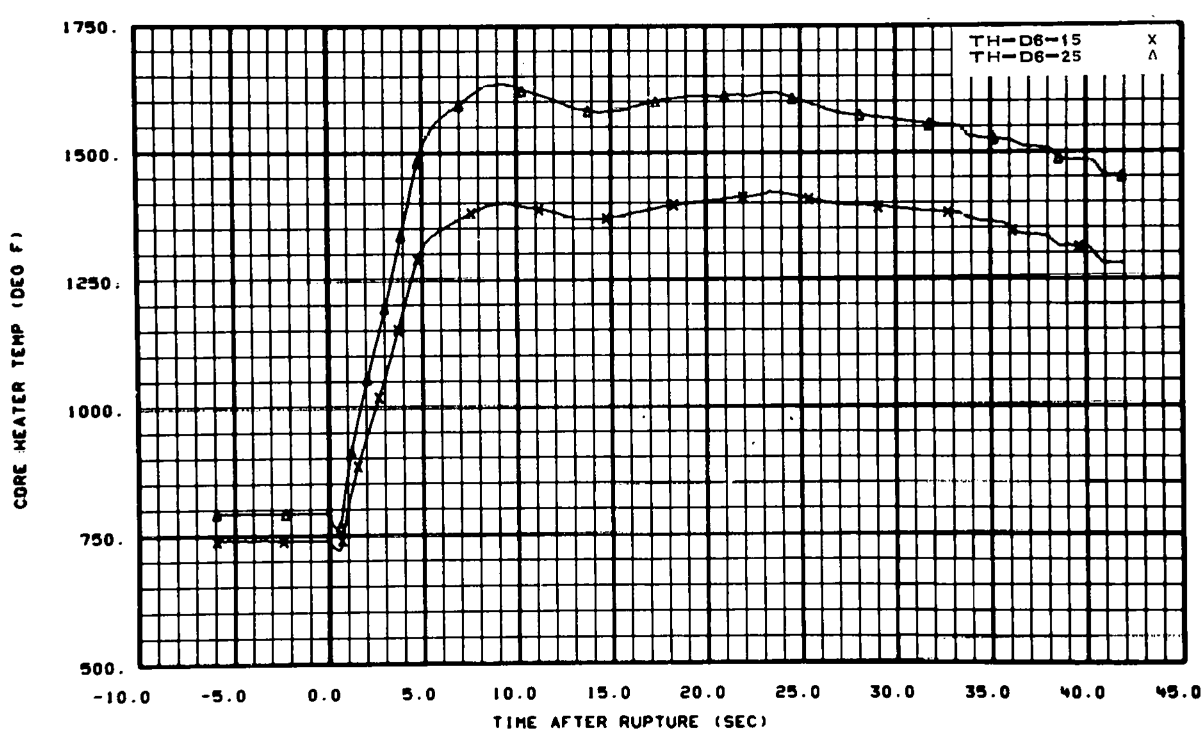

Fig. 48 Core heater temperature, Rod D-6.

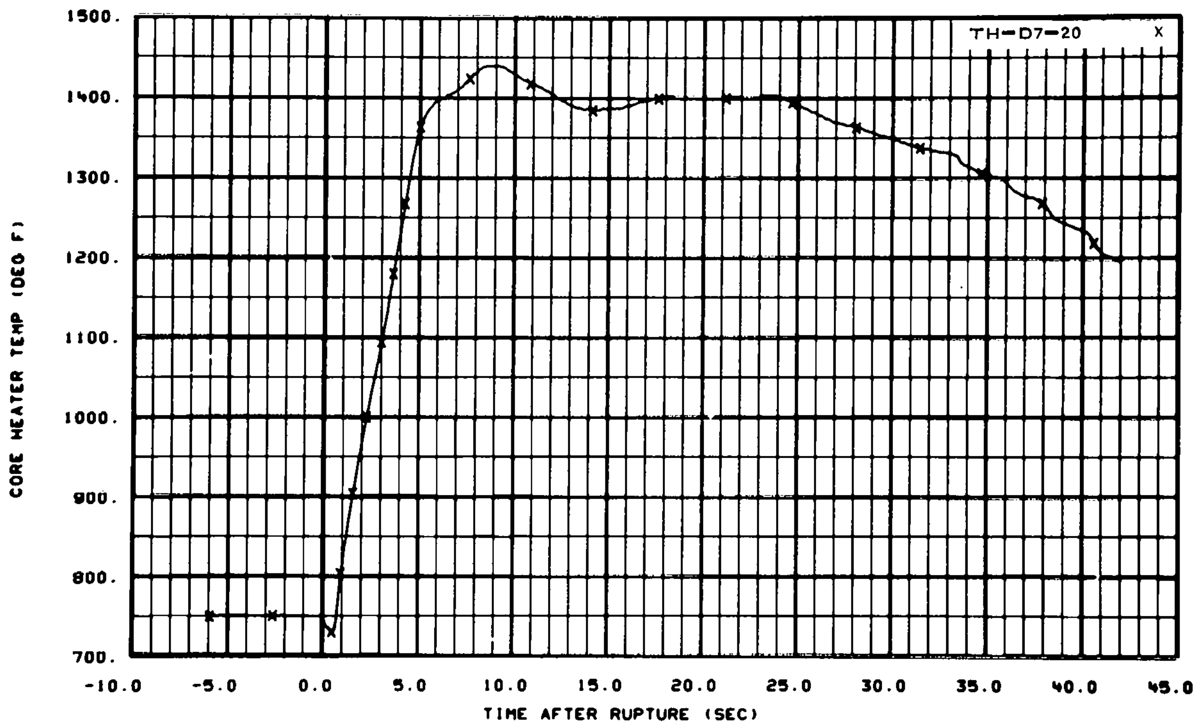

Fig. 49 Core heater temperature, Rod D-7.

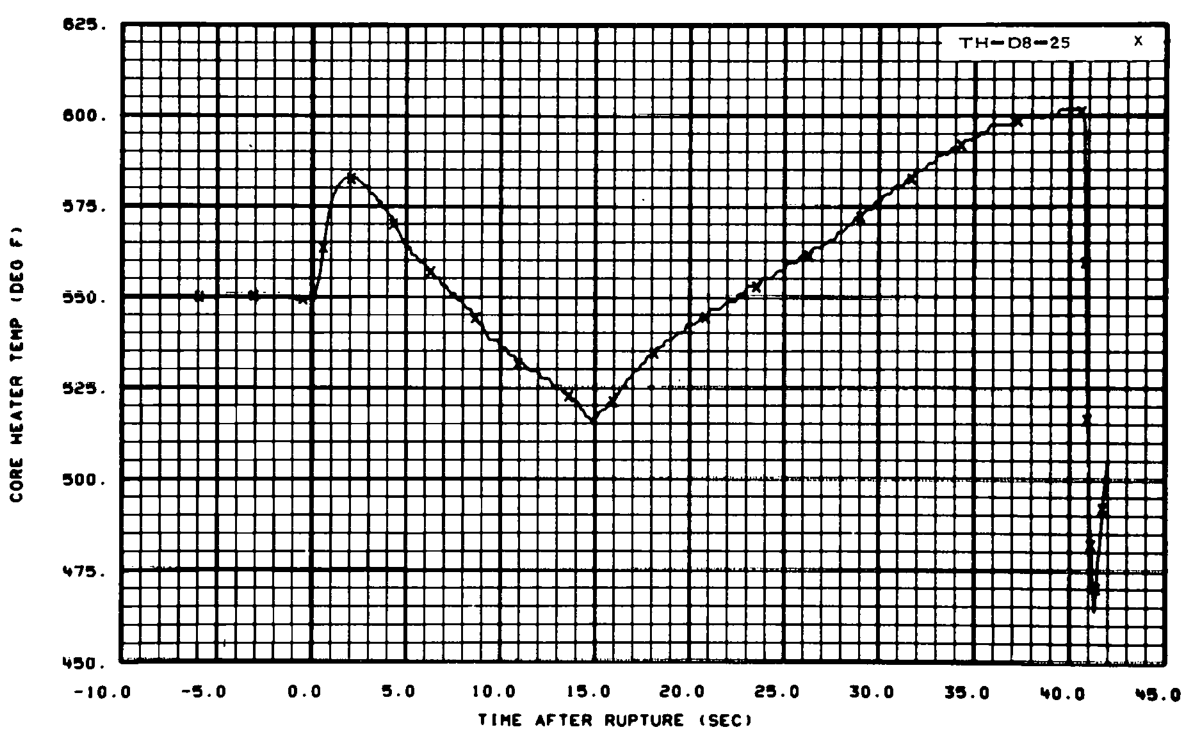

Fig. 50 Core heater temperature, Rod D-8.

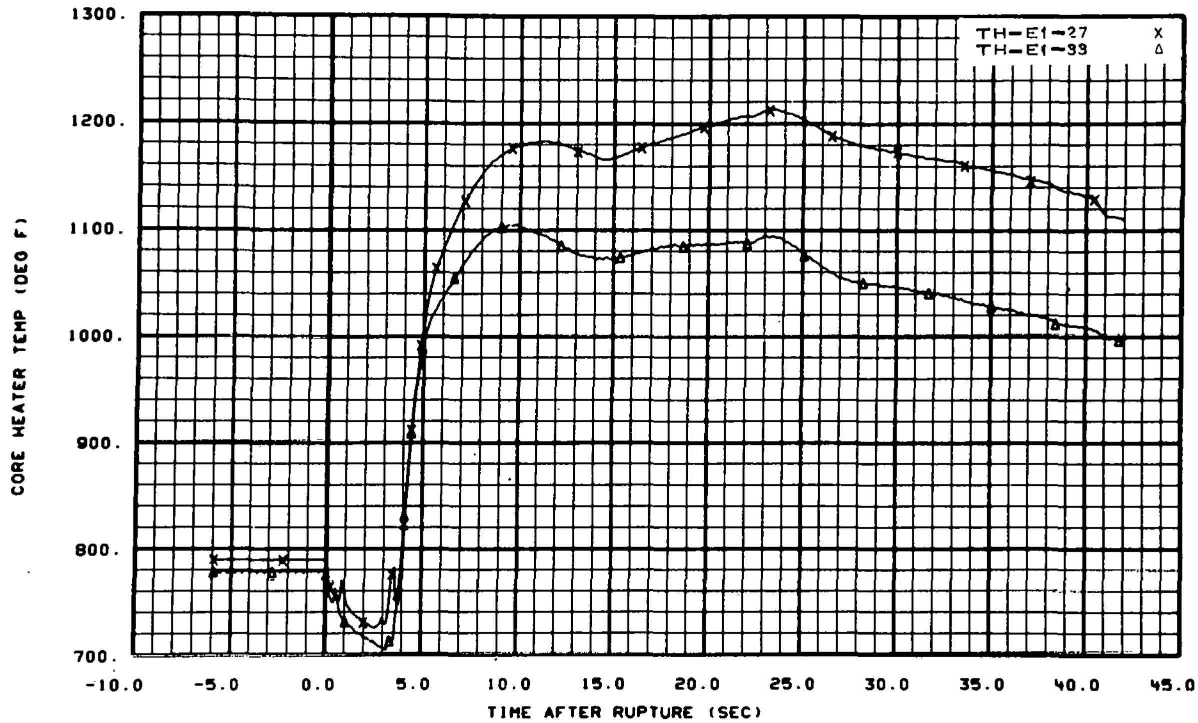

Fig. 51 Core heater temperature, Rod E-1.

Fig. 52 Core heater temperature, Rod E-2.

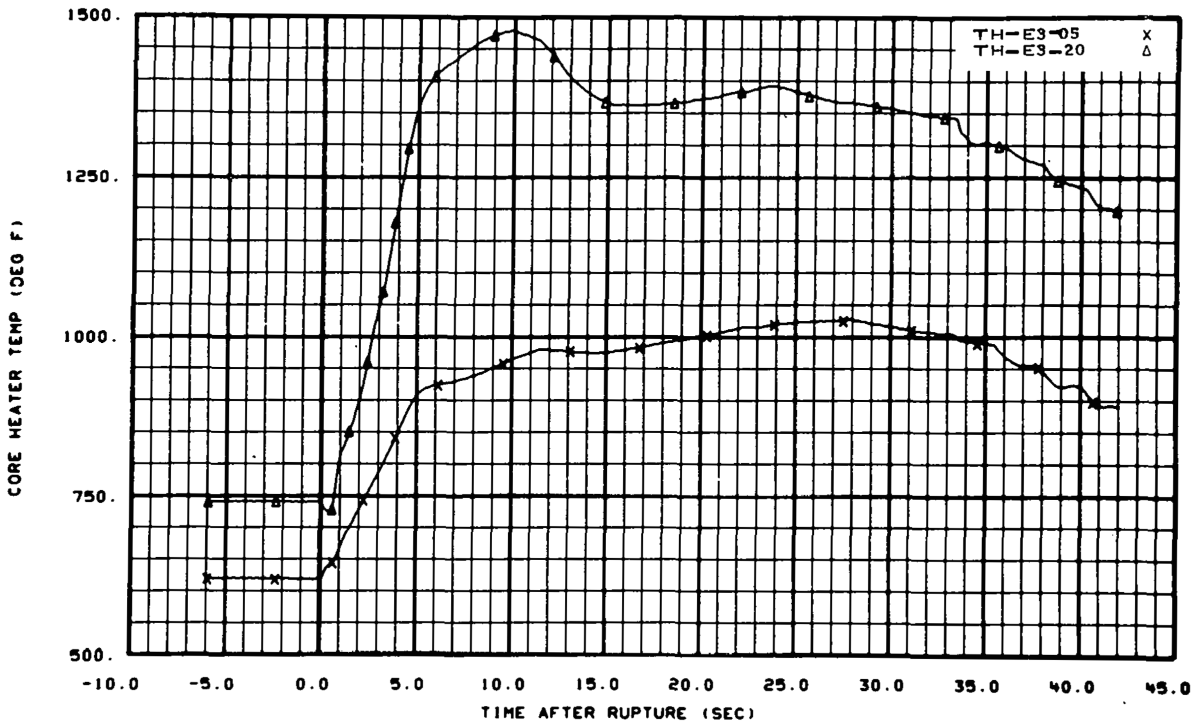

Fig. 53 Core heater temperature, Rod E-3.

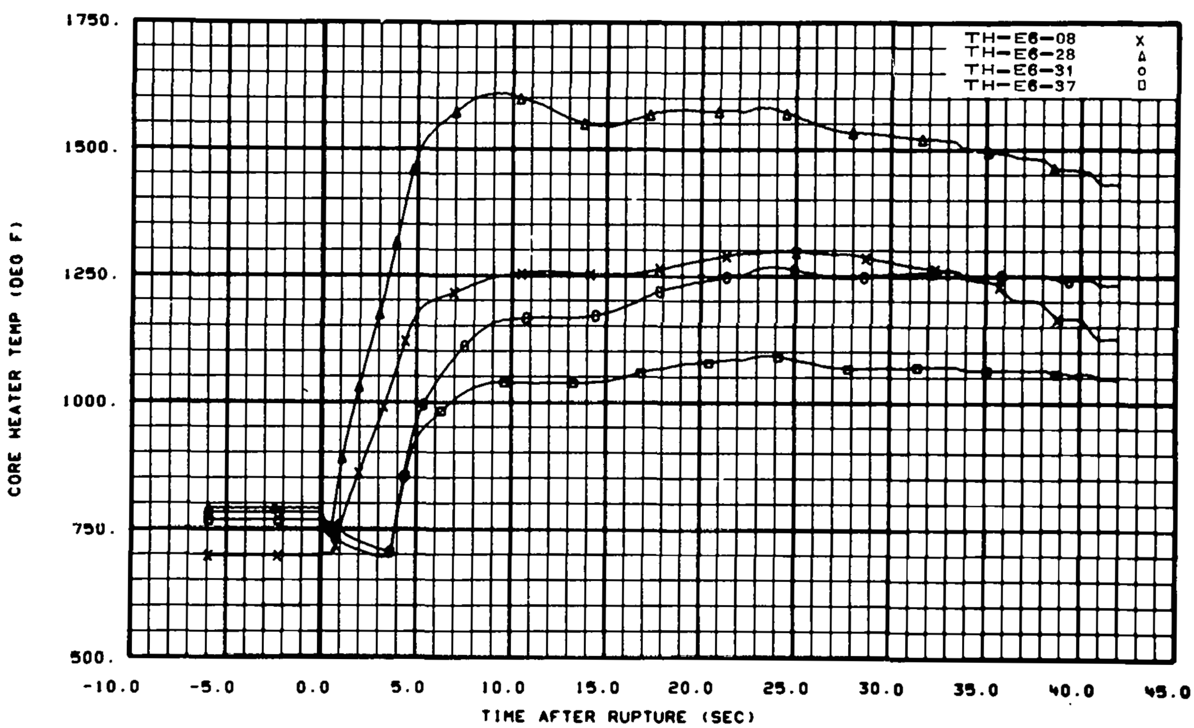

Fig. 54 Core heater temperature, Rod E-6.

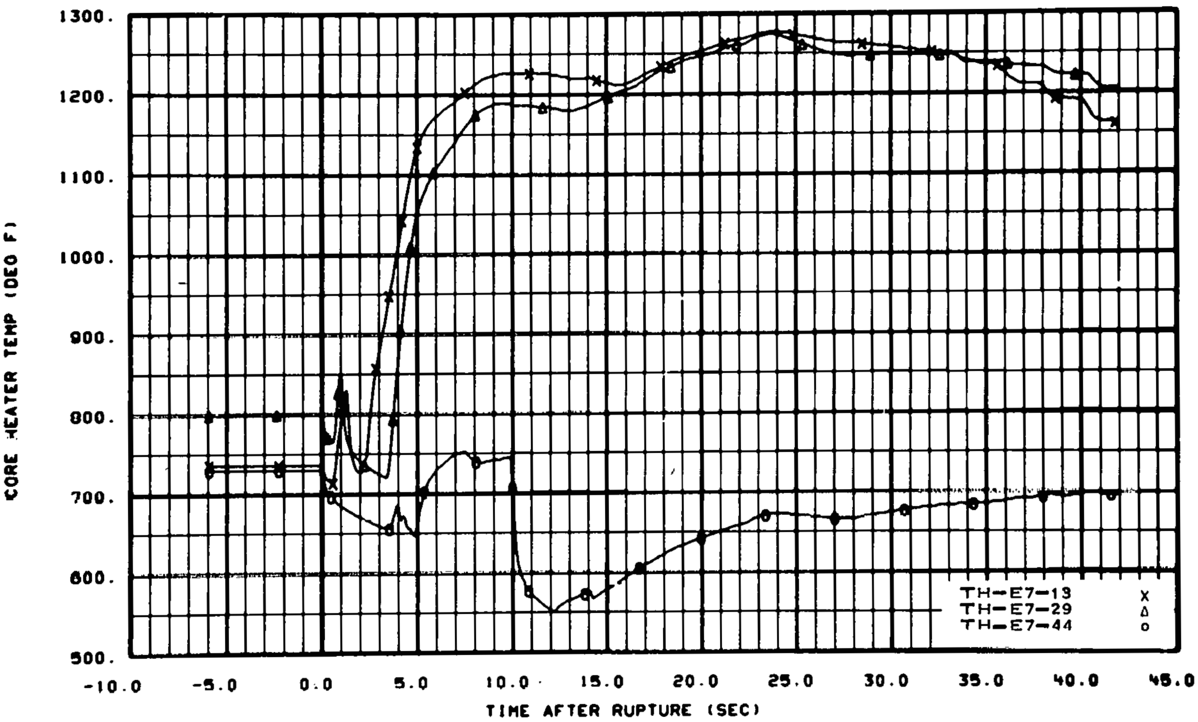

Fig. 55 Core heater temperature, Rod E-7.

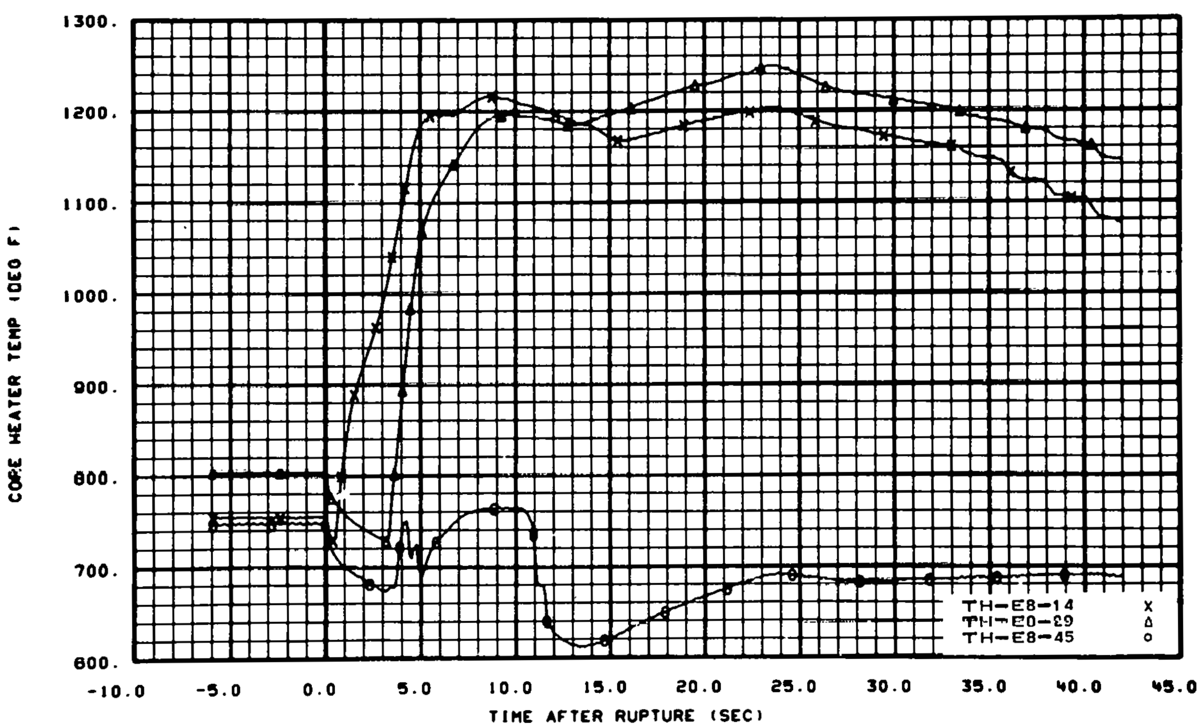

Fig. 56 Core heater temperature, Rod E-8.

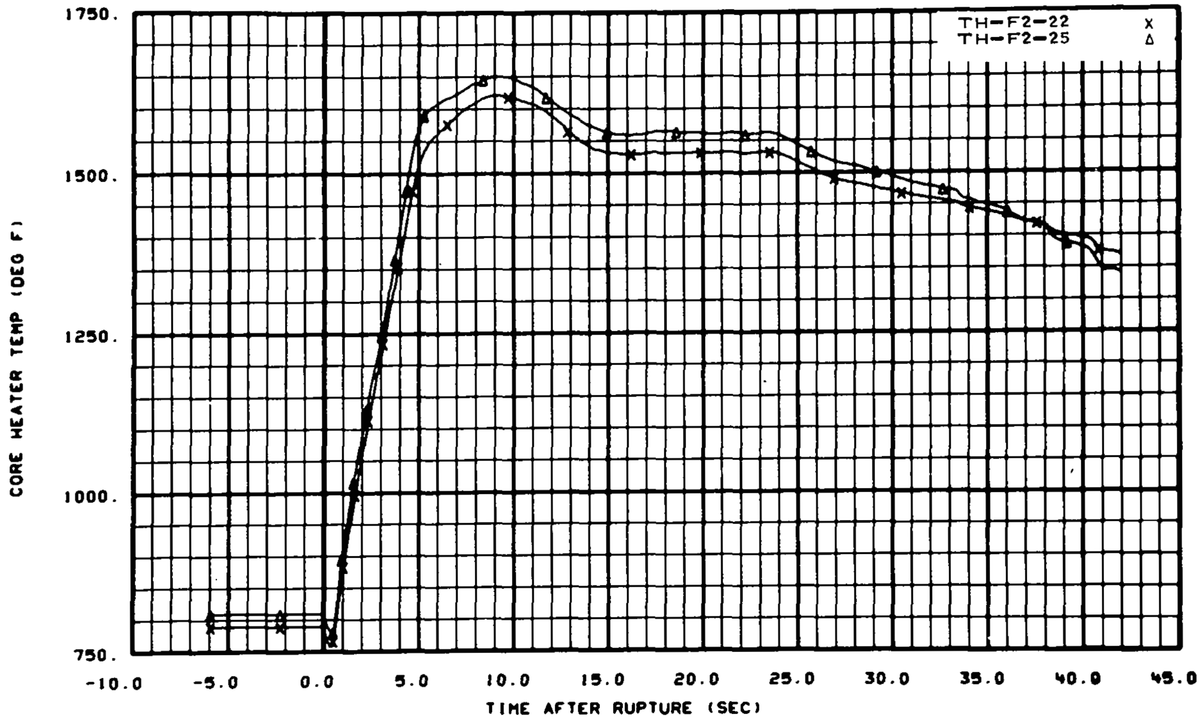

Fig. 57 Core heater temperature, Rod F-2.

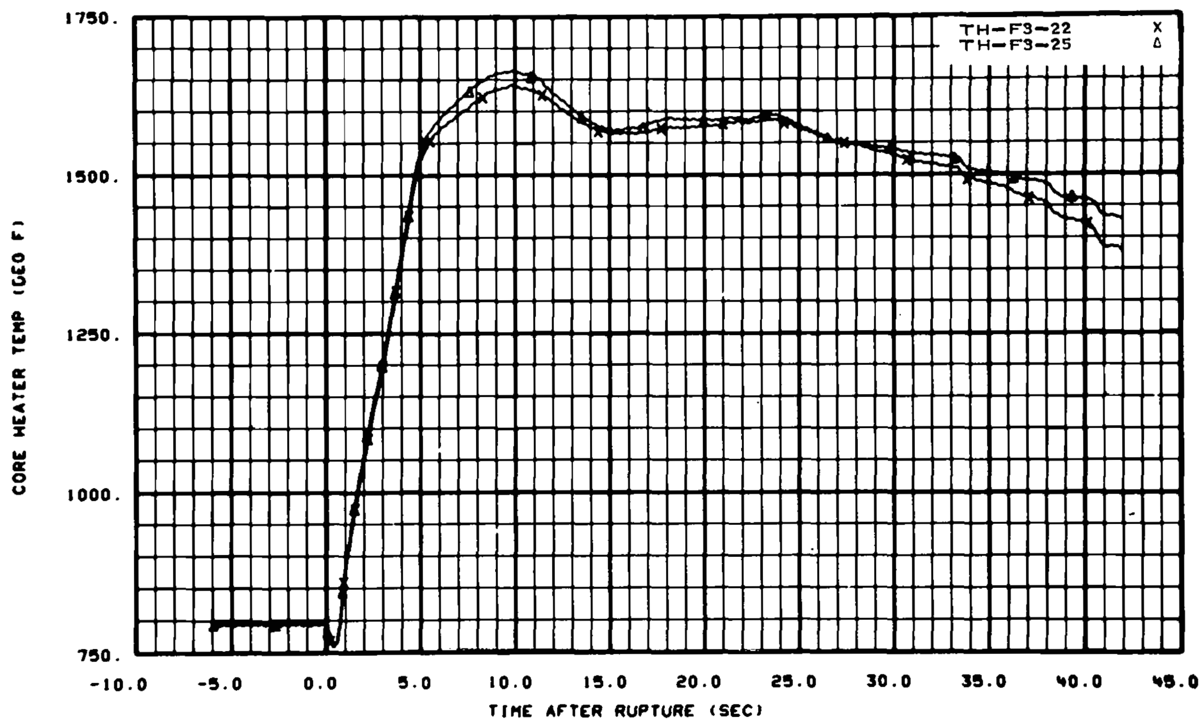

Fig. 58 Core heater temperature, Rod F-3.

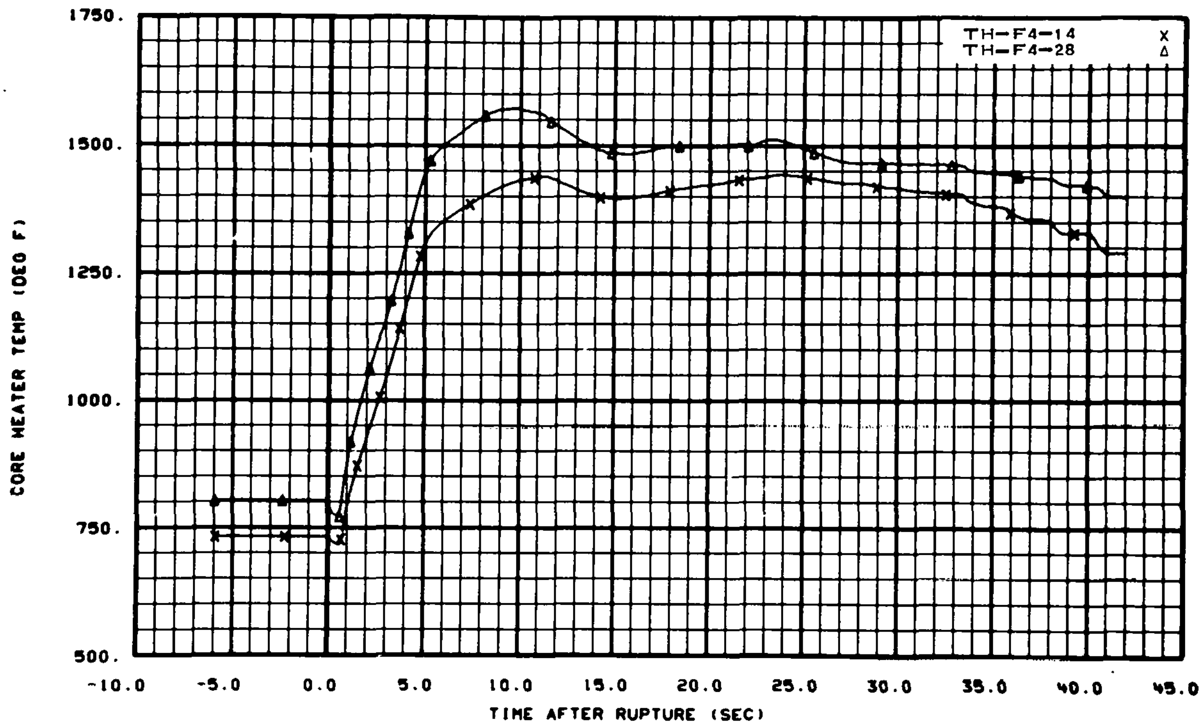

Fig. 59 Core heater temperature, Rod F-4.

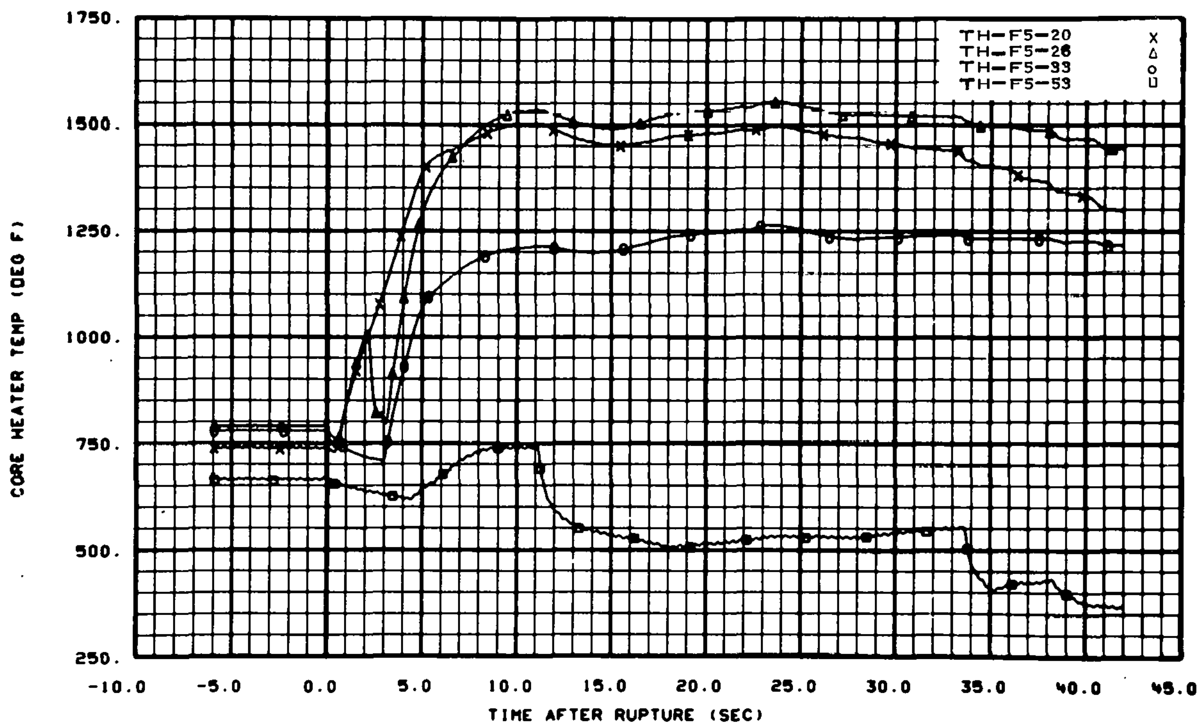

Fig. 60 Core heater temperature, Rod F-5.

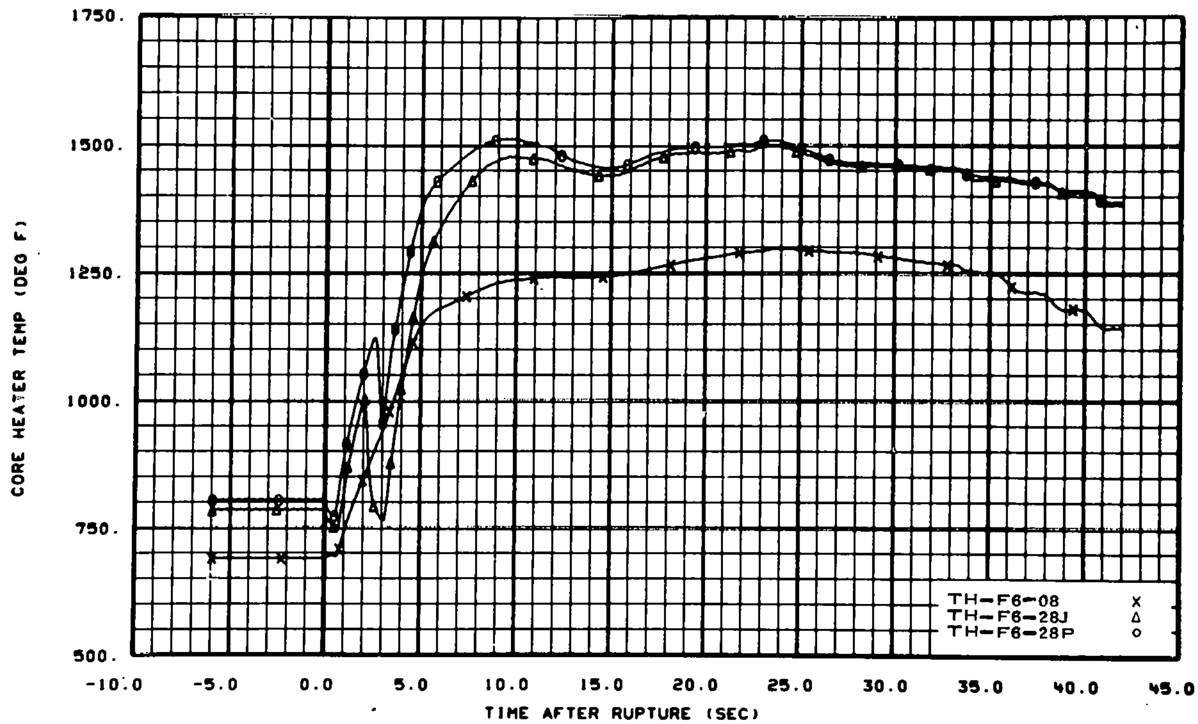

Fig. 61 Core heater temperature, Rod F-6.

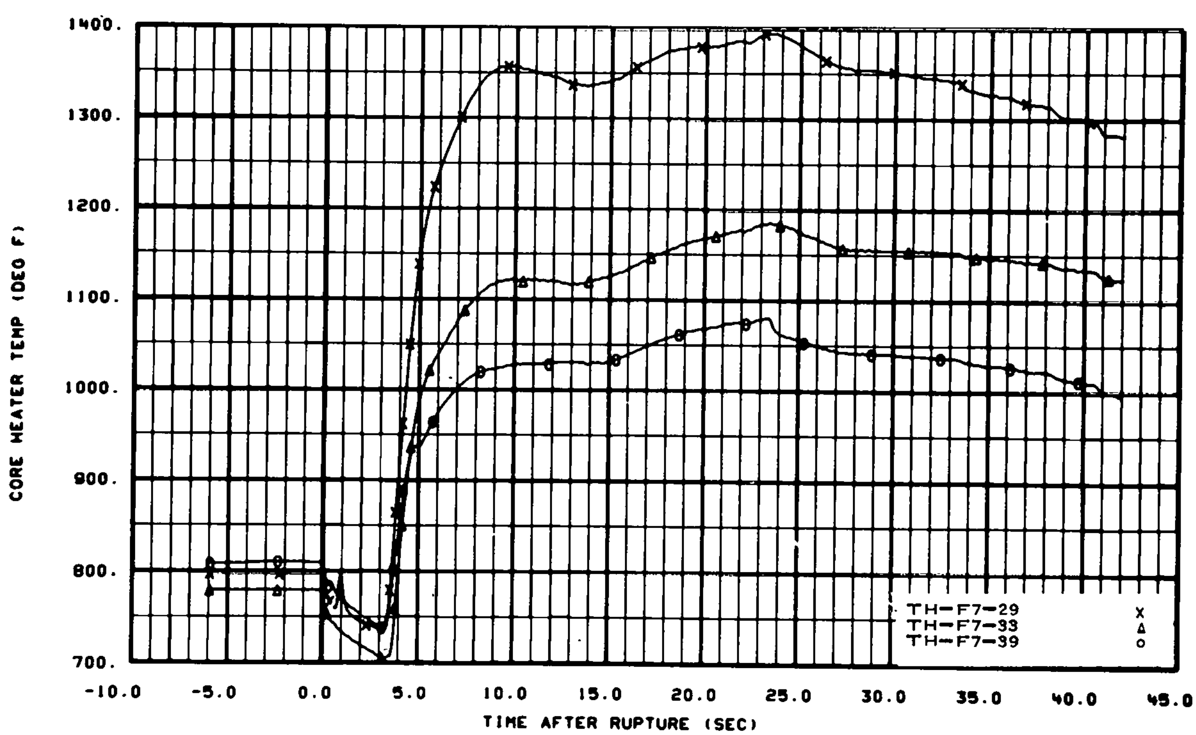

Fig. 62 Core heater temperature, Rod F-7.

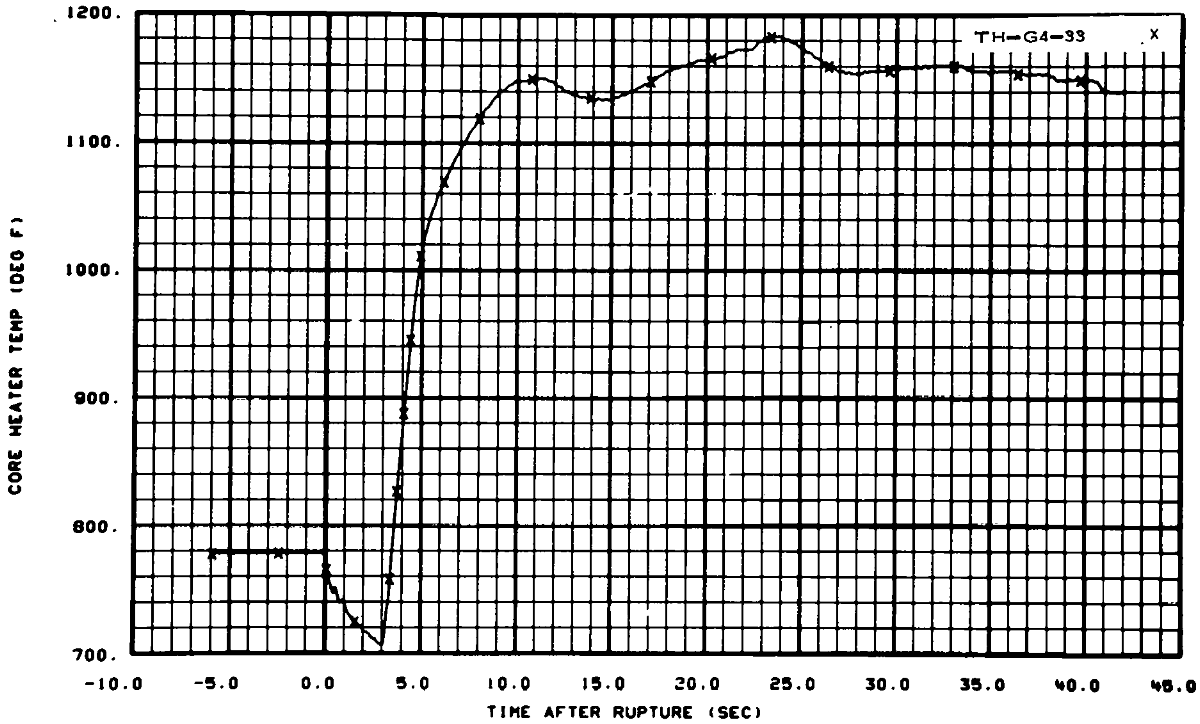

Fig. 63 Core heater temperature, Rod G-4.

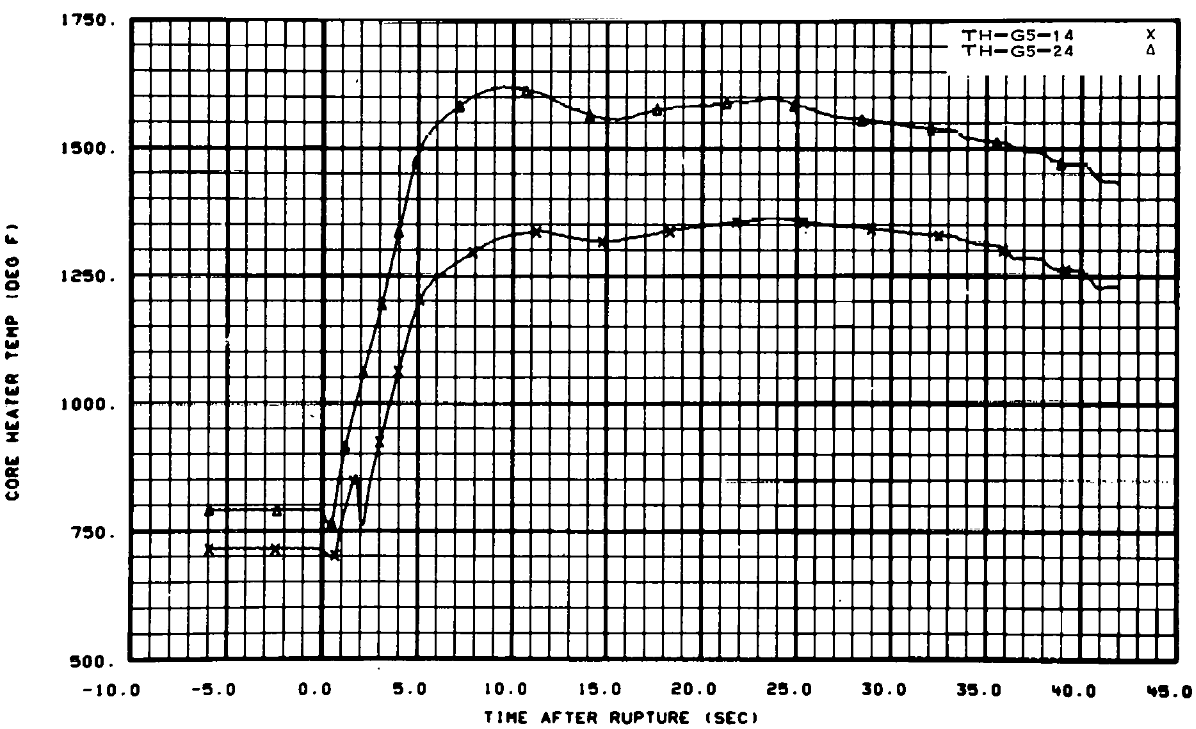

Fig. 64 Core heater temperature, Rod G-5.

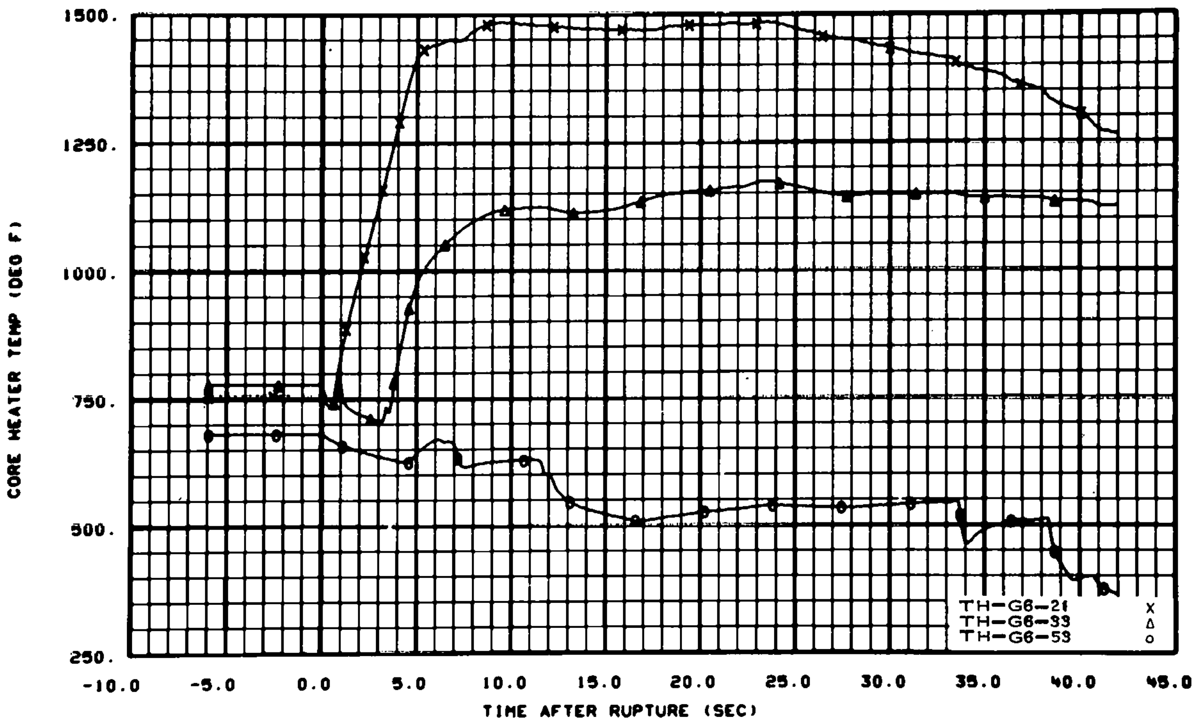

Fig. 65 Core heater temperature, Rod G-6.

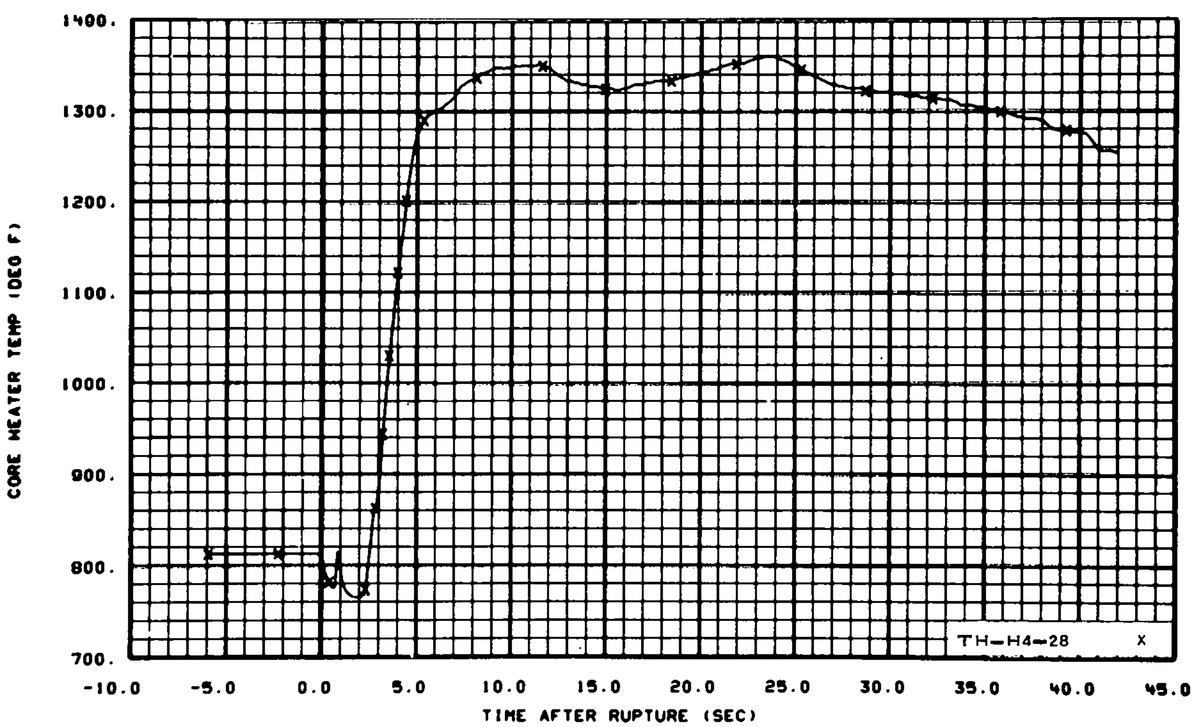

Fig. 66 Core heater temperature, Rod H-4.

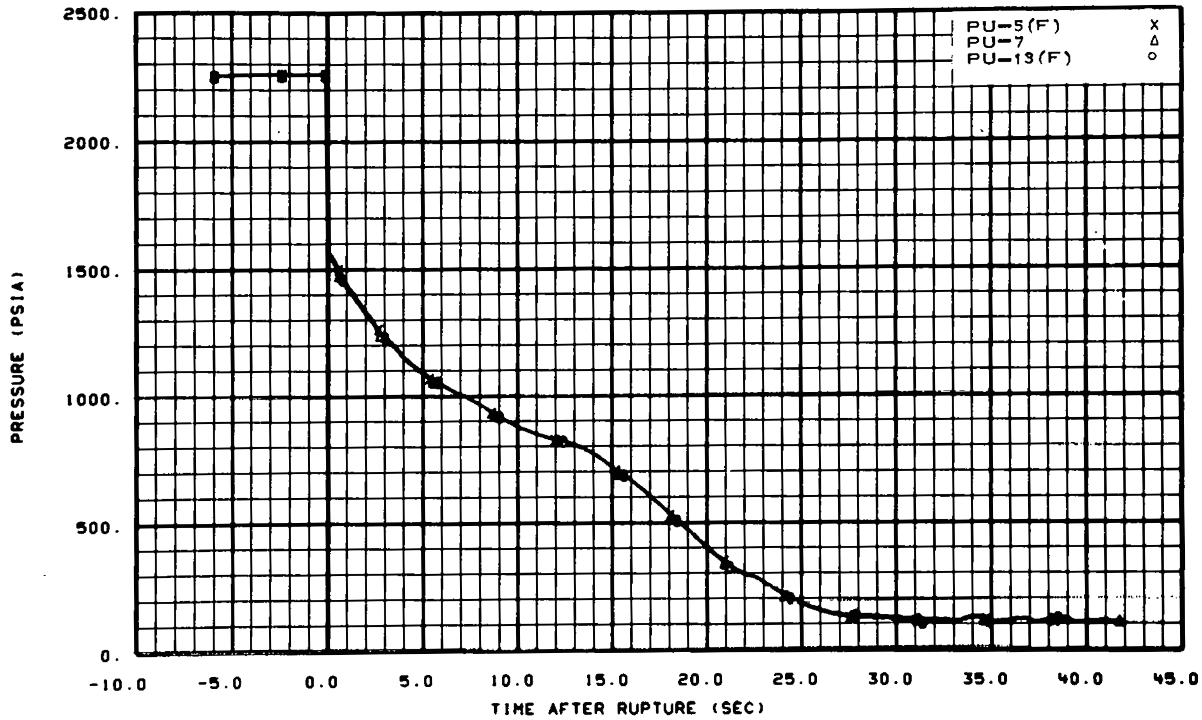

Fig. 67 Pressure in intact loop.

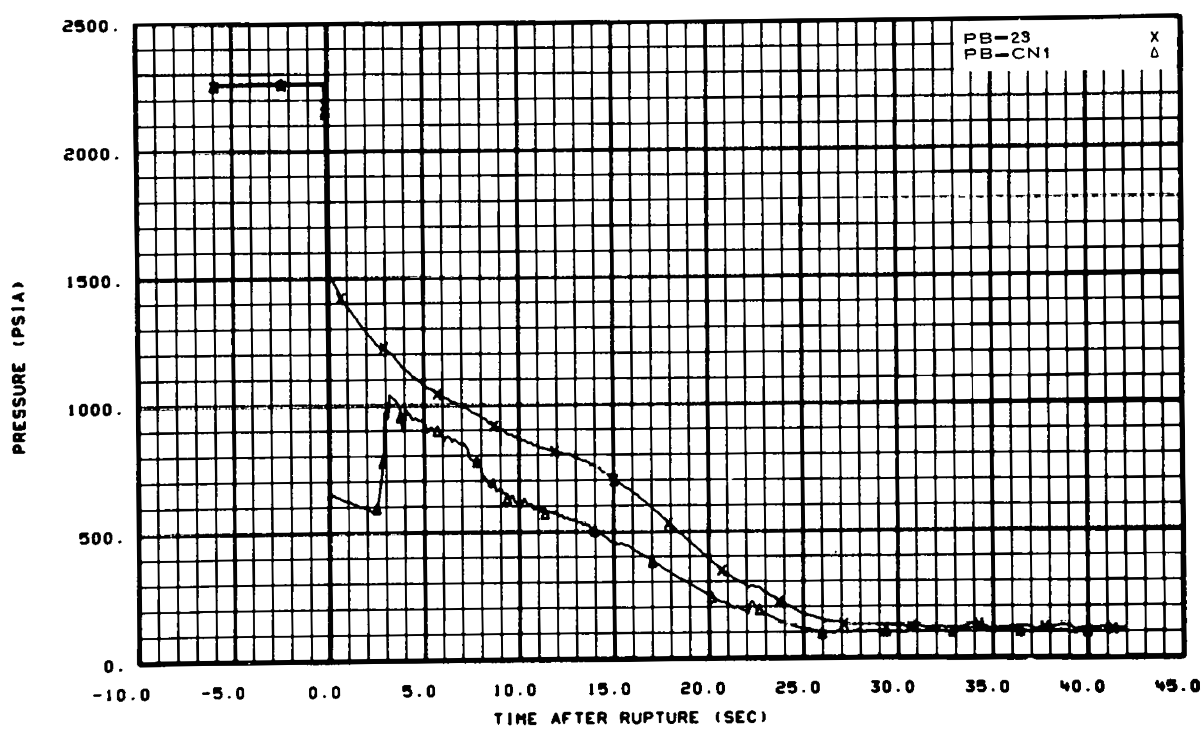

Fig. 68 Pressure in broken loop (vessel side).

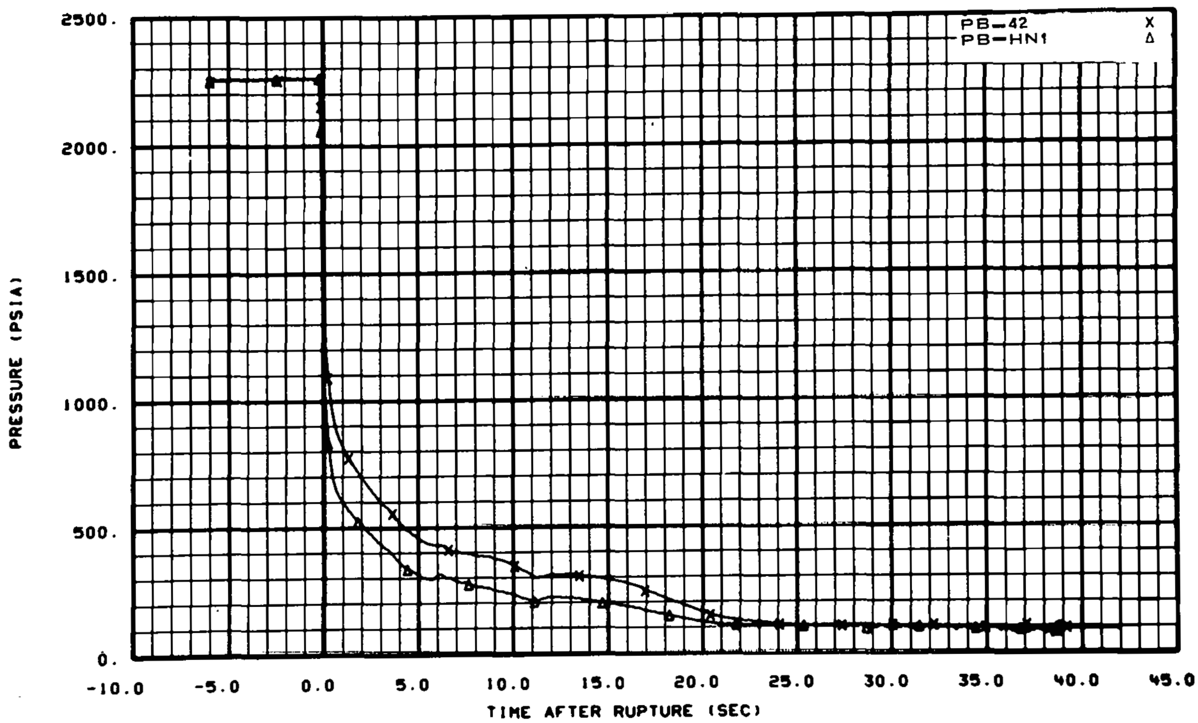

Fig. 69 Pressure in broken loop (pump side).

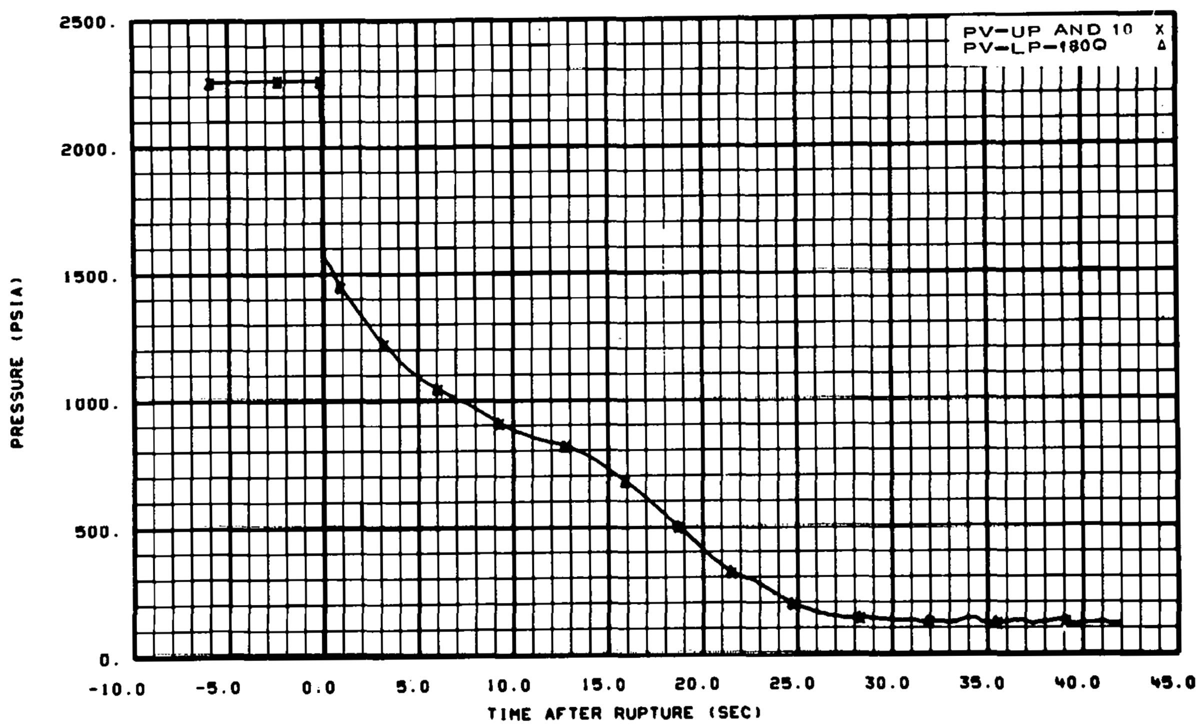

Fig. 70 Pressure in vessel.

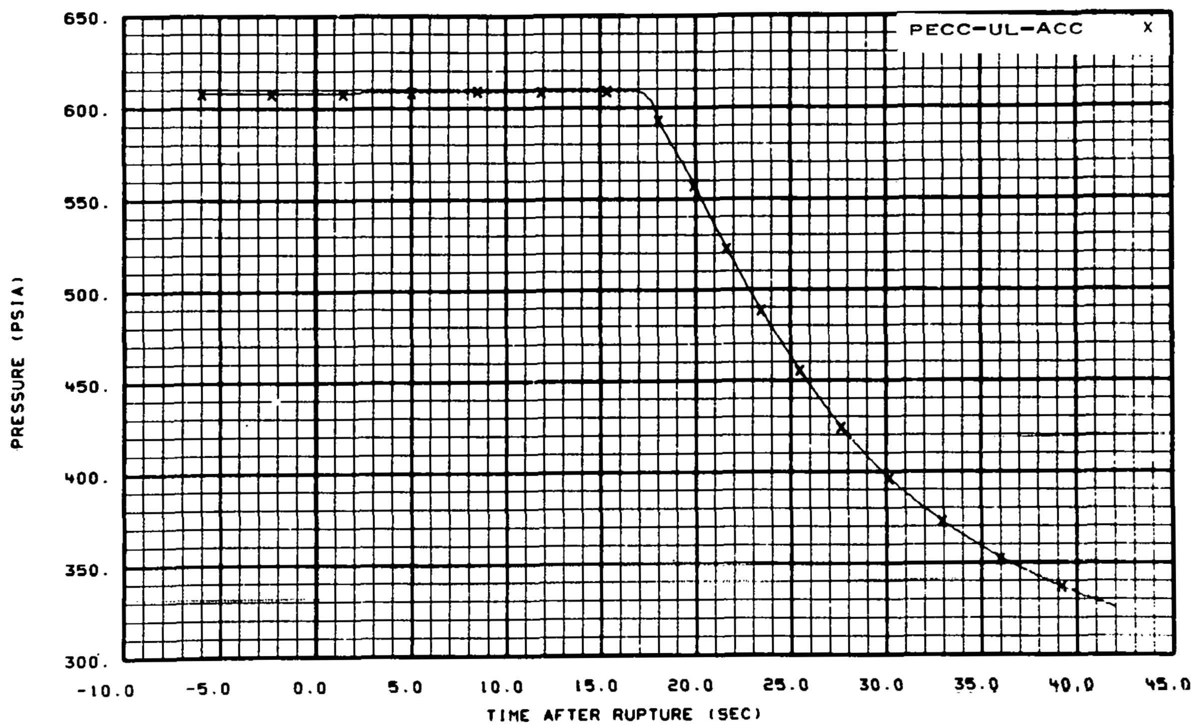

Fig. 71 Pressure in intact loop accumulator.

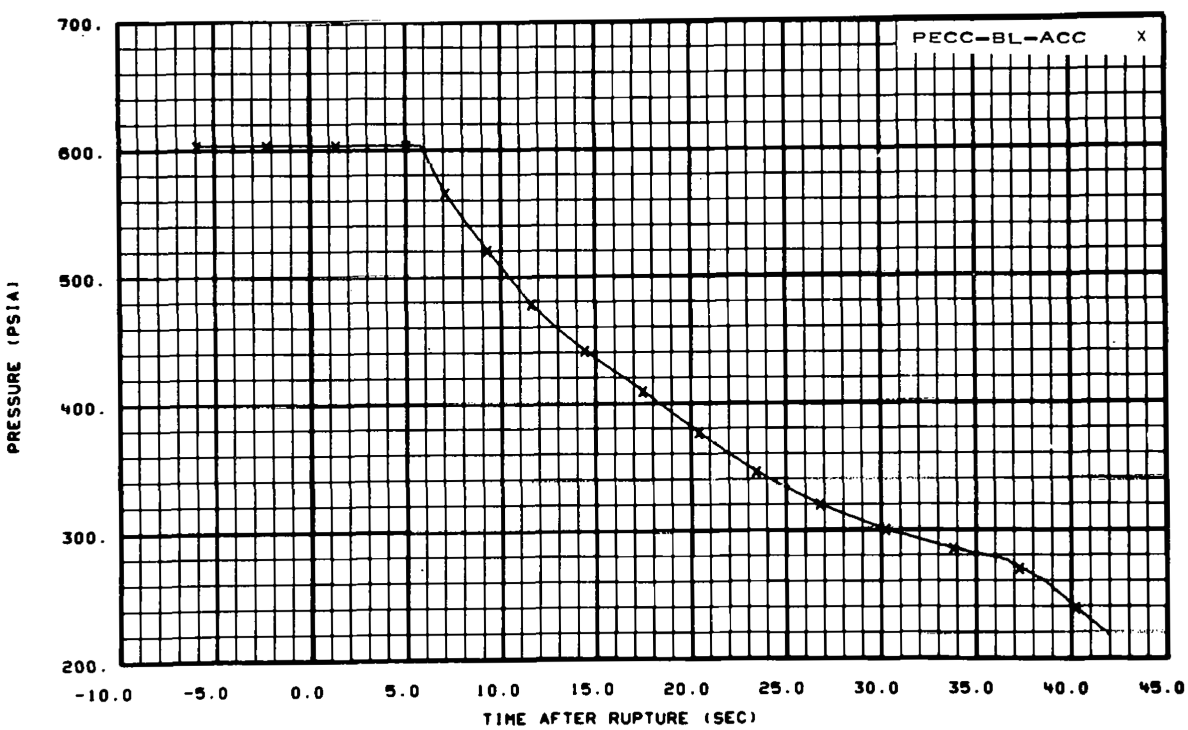

Fig. 72 Pressure in broken loop accumulator.

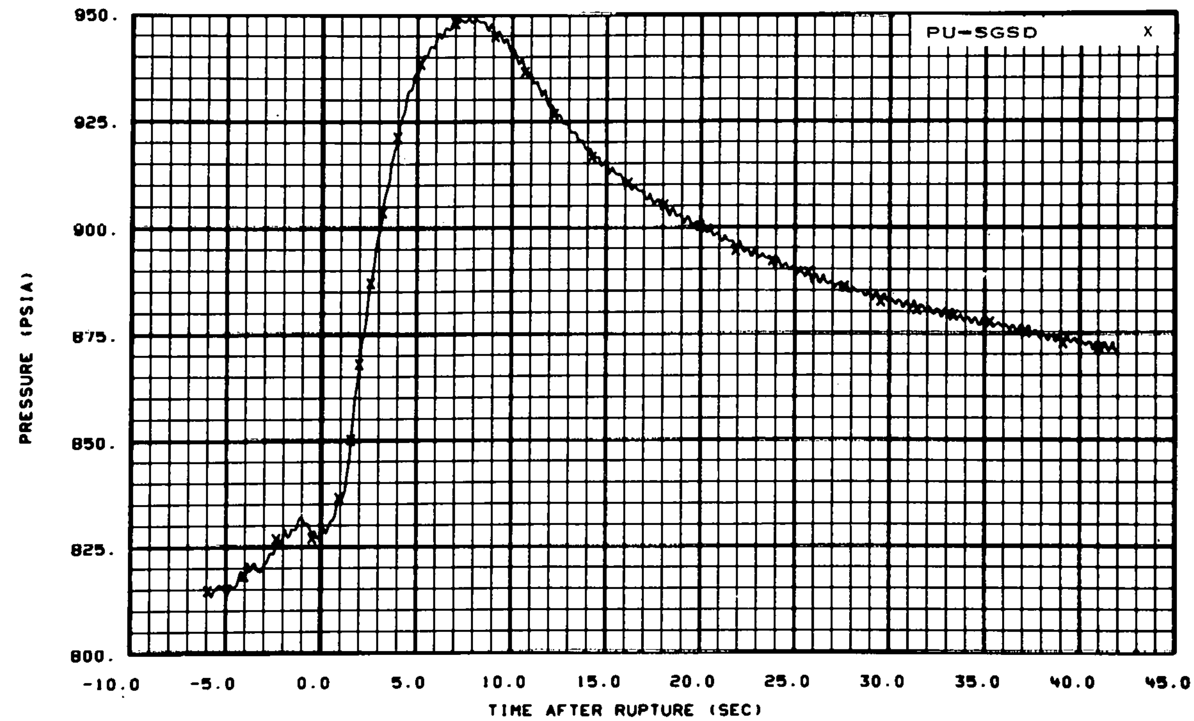

Fig. 73 Pressure in steam generator, secondary side.

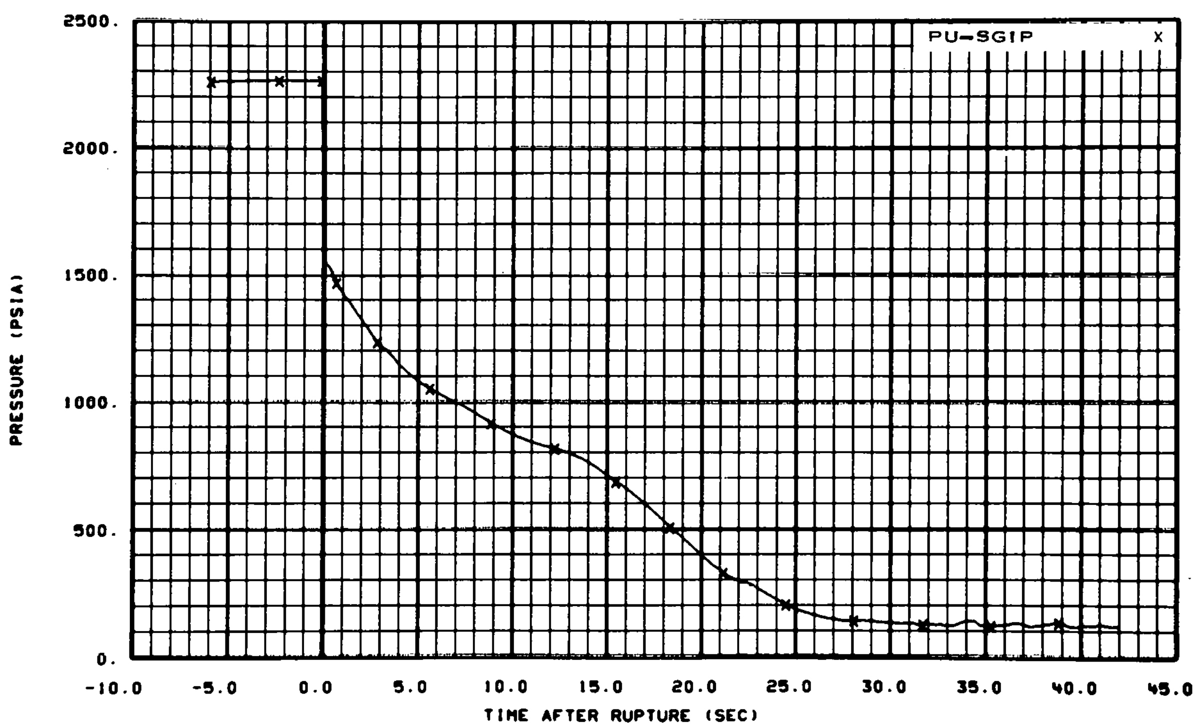

Fig. 74 Pressure in steam generator, primary side.

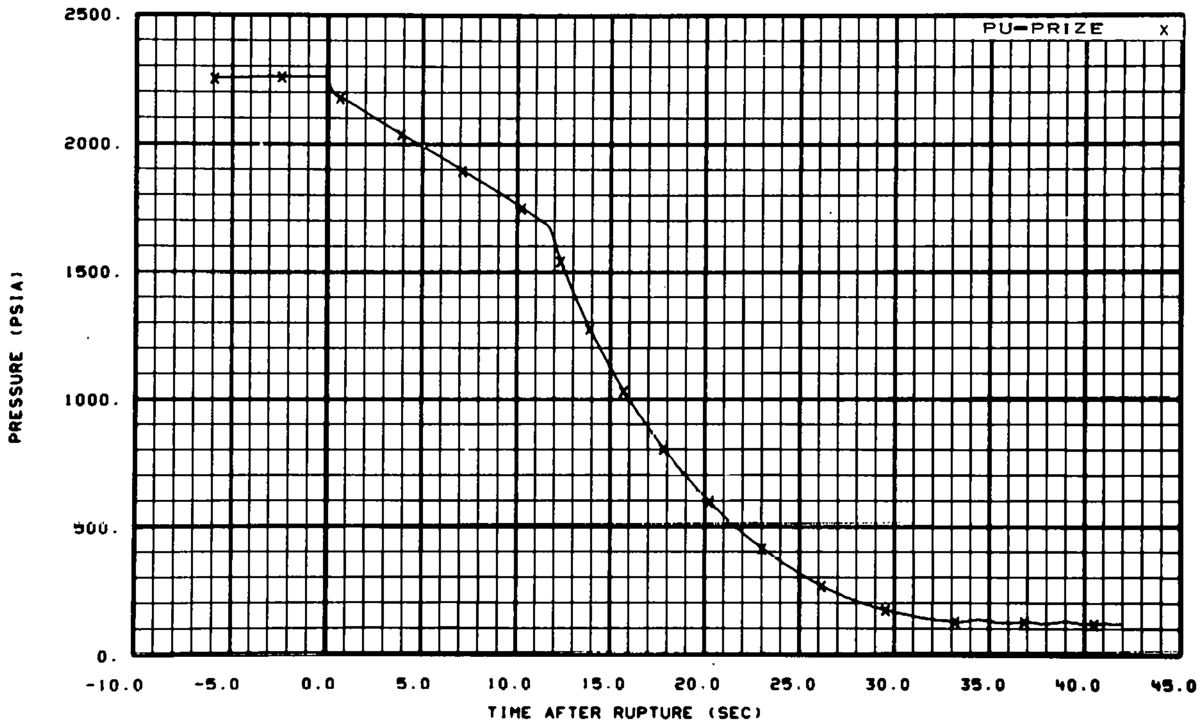

Fig. 75 Pressure in pressurizer.

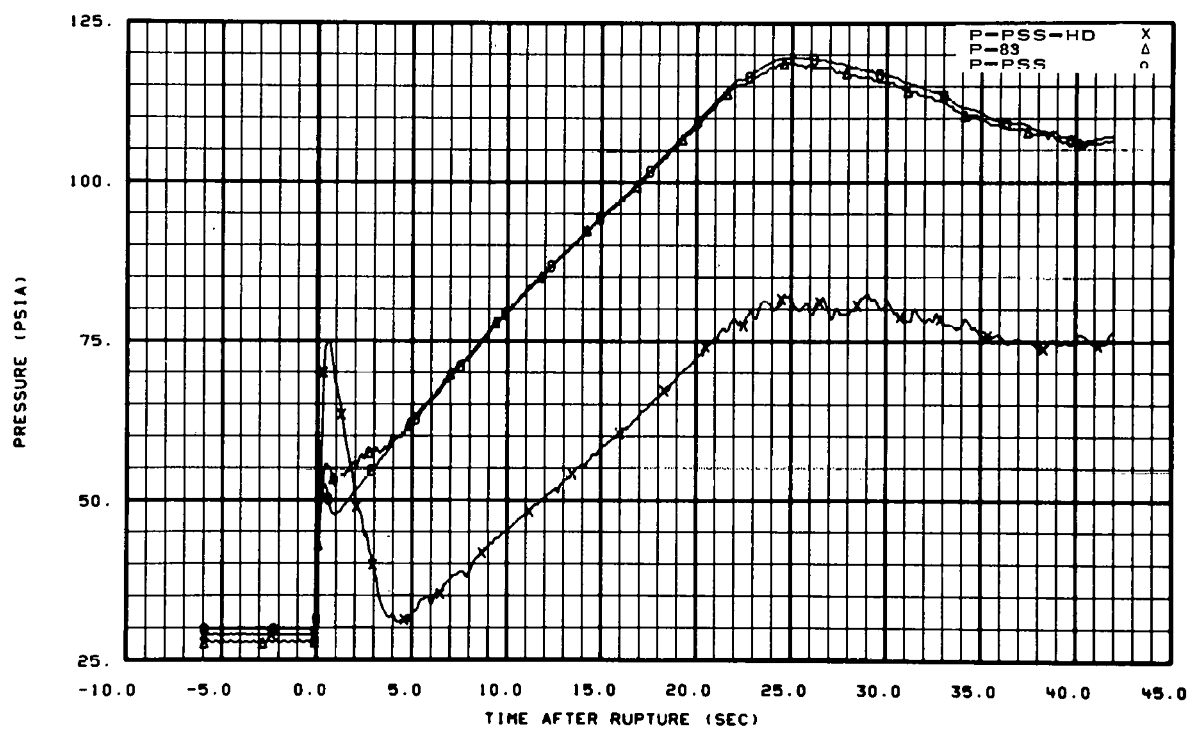

Fig. 76 Pressure in pressure suppression system.

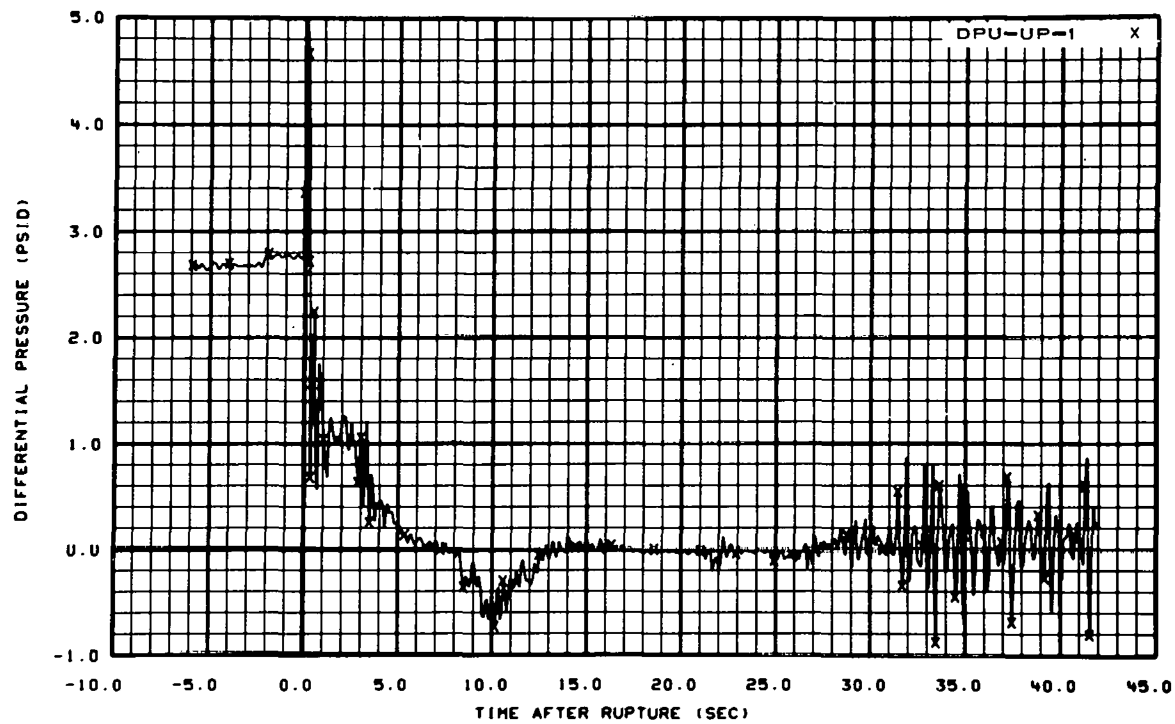

Fig. 77 Differential pressure in intact loop (upper plenum to Spool 1).

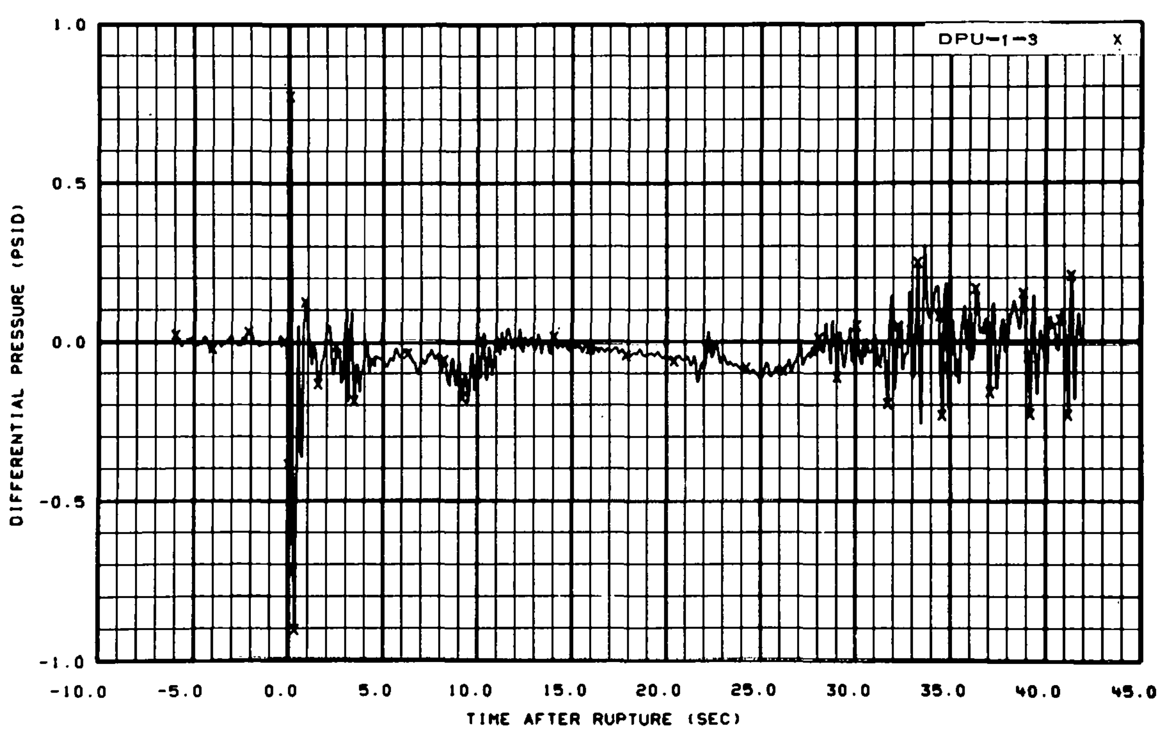

Fig. 78 Differential pressure in intact loop (Spool 1 to Spool 3).

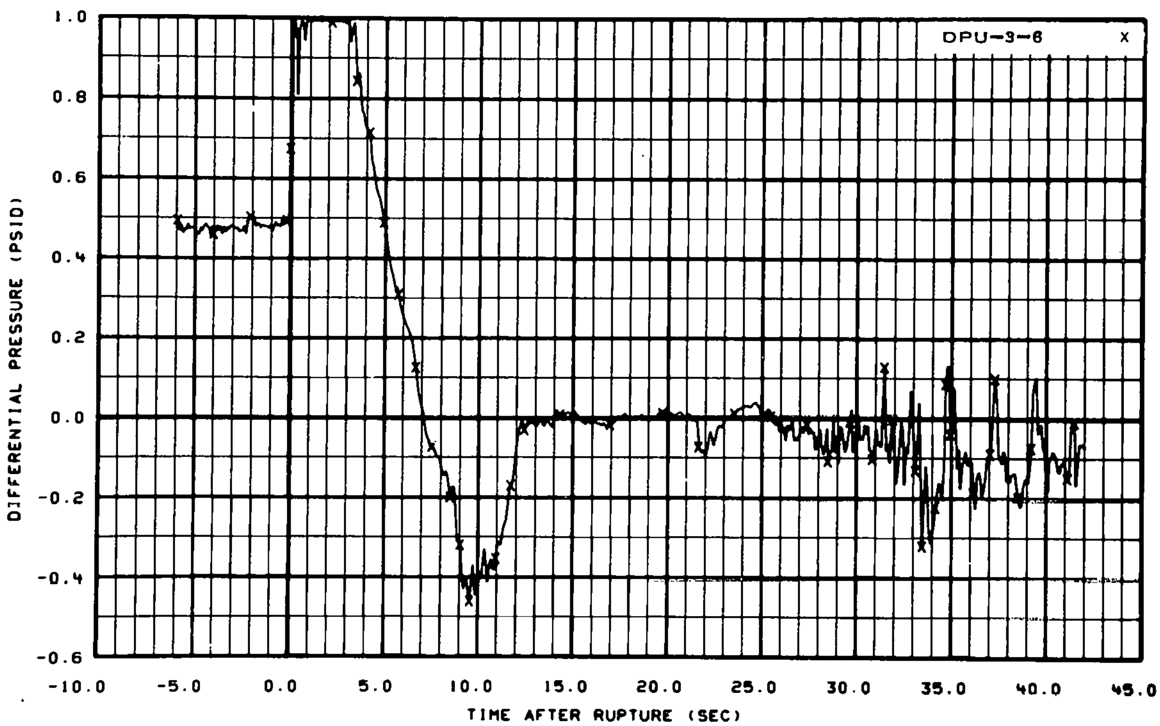

Fig. 79 Differential pressure in intact loop (Spool 3 to Spool 6).

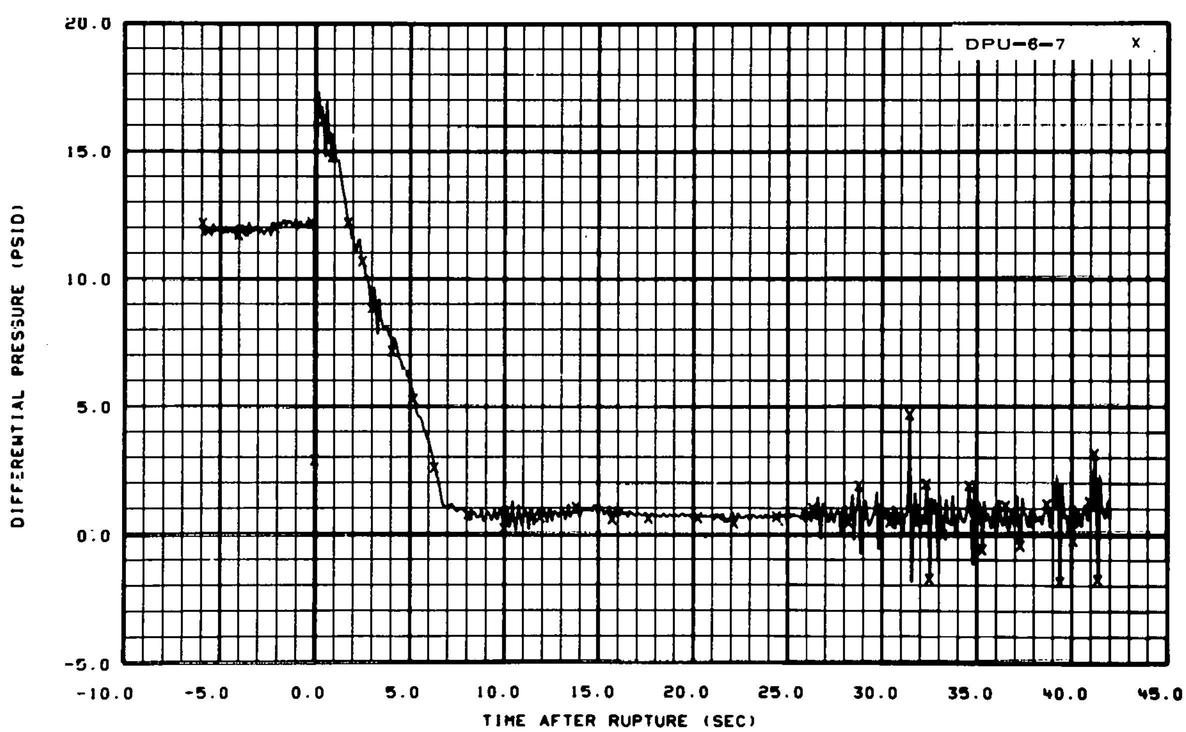

Fig. 80 Differential pressure in intact loop (Spool 6 to Spool 7).

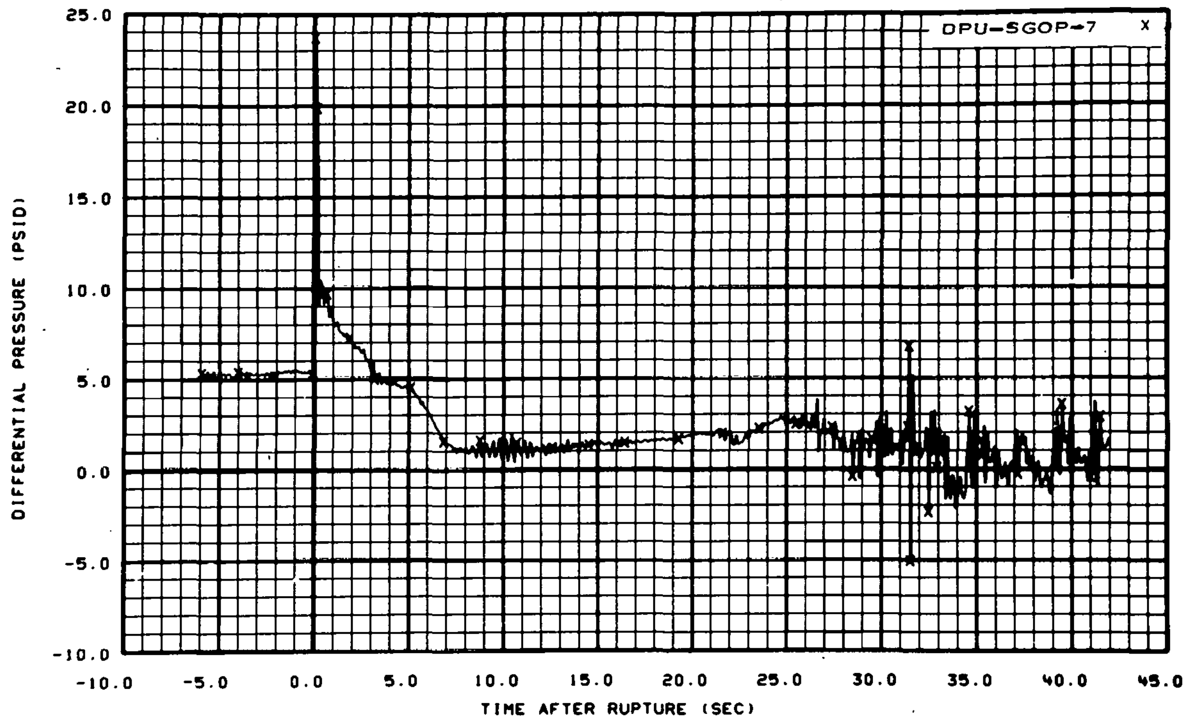

Fig. 81 Differential pressure in intact loop (steam generator outlet plenum to Spool 7).

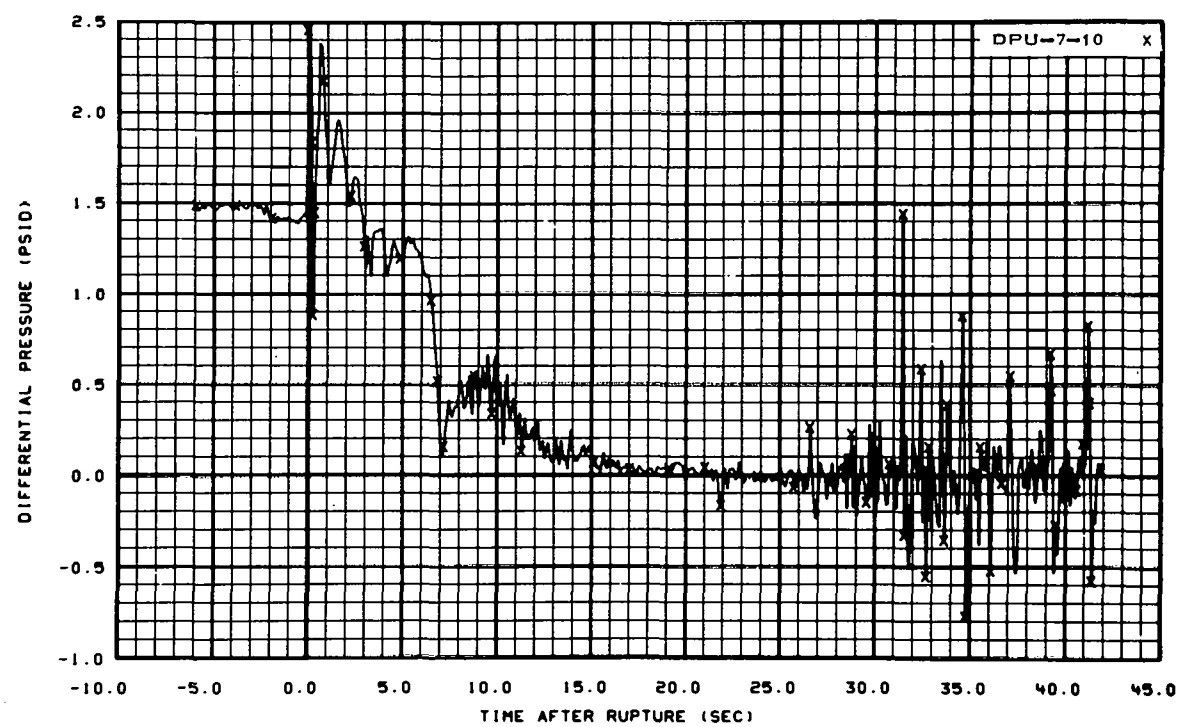

Fig. 82 Differential pressure in intact loop (Spool 7 to Spool 10).

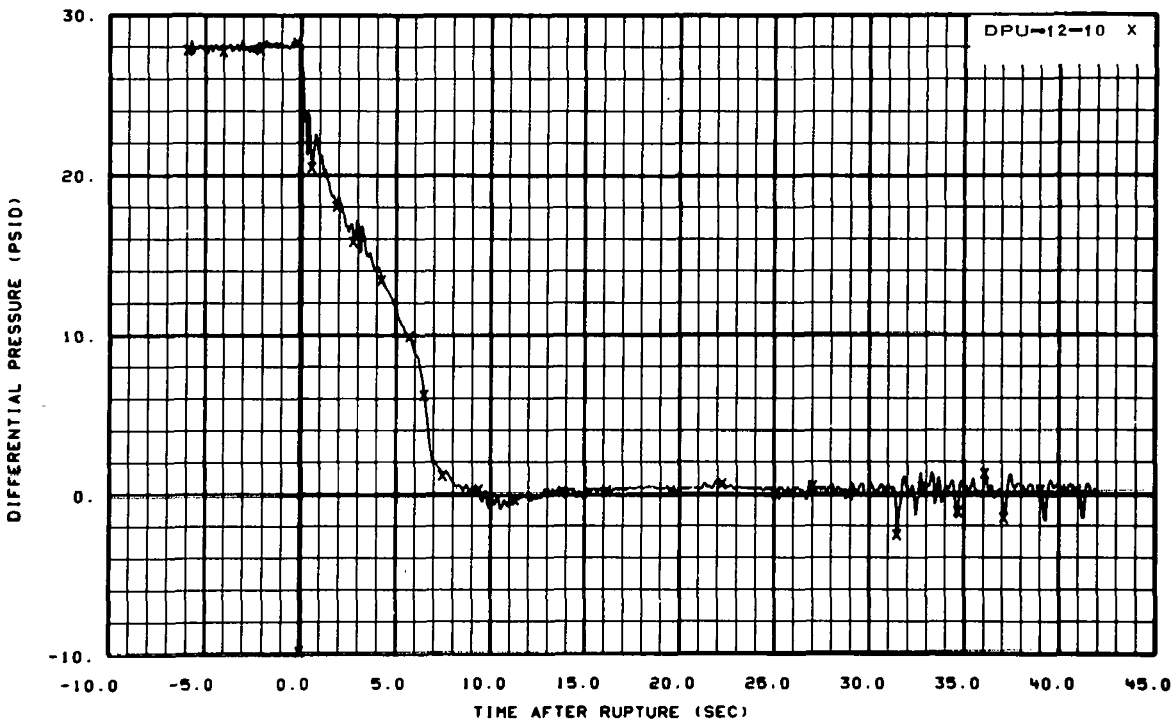

Fig. 83 Differential pressure in intact loop (Spool 12 to Spool 10).

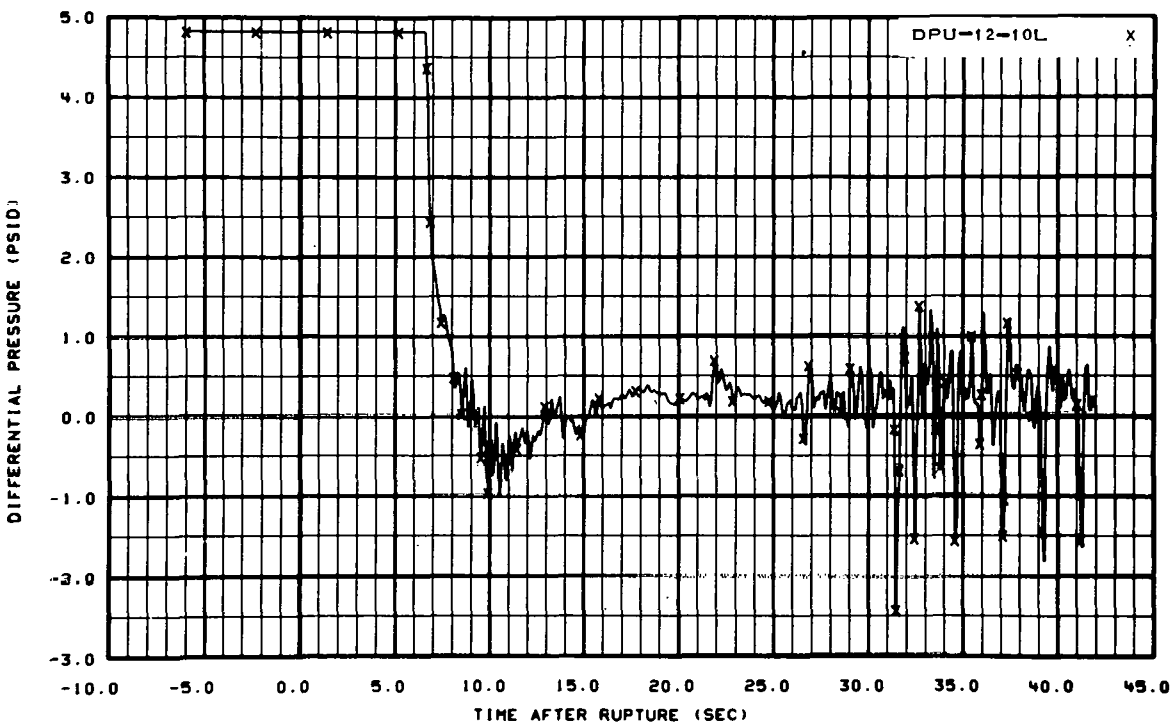

Fig. 84 Differential pressure in intact loop, low range (Spool 12 to Spool 10).

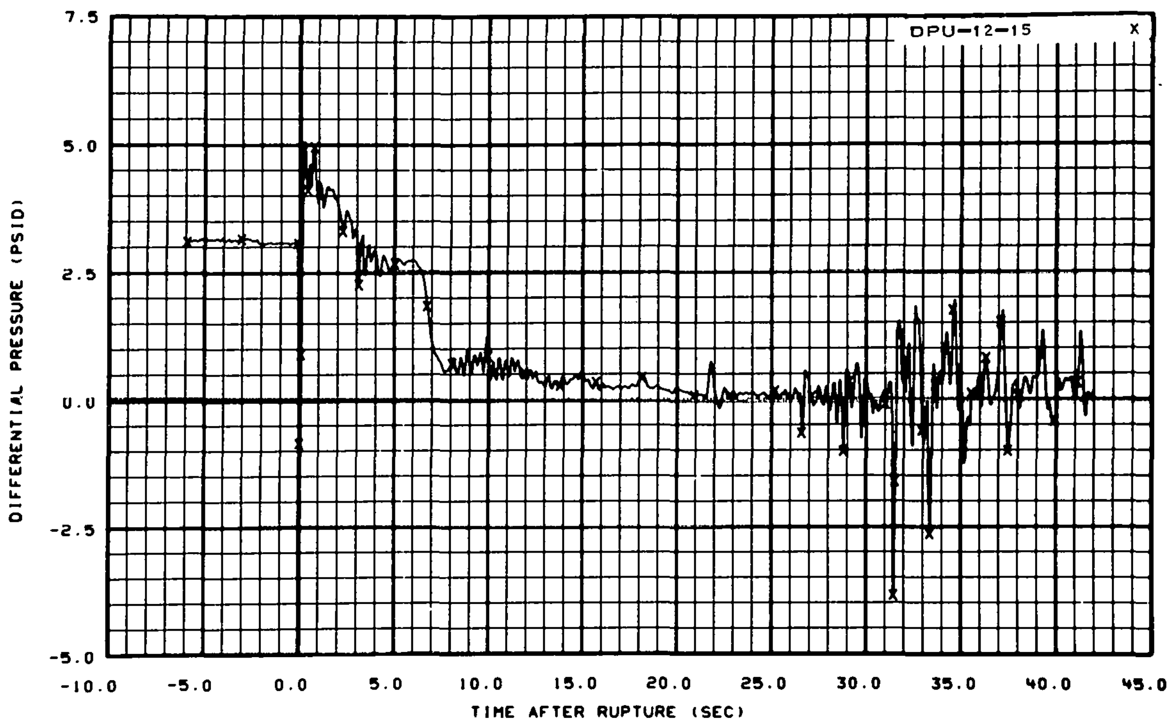

Fig. 85 Differential pressure in intact loop (Spool 12 to Spool 15).

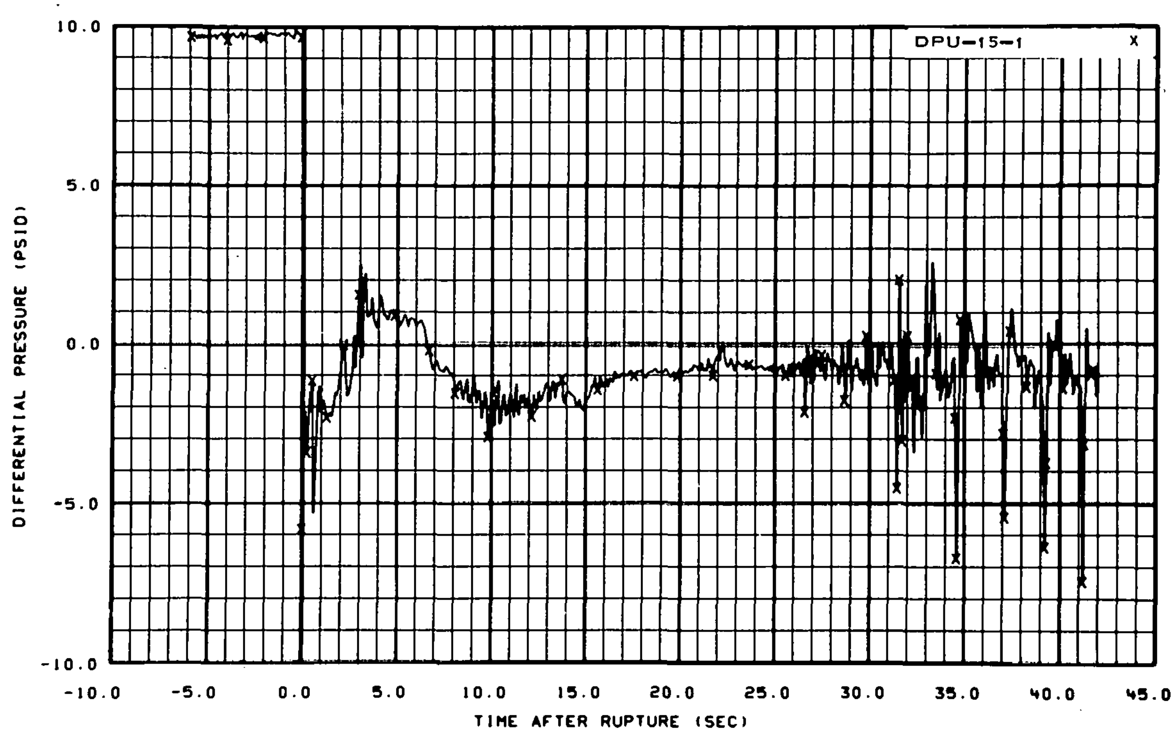

Fig. 86 Differential pressure in intact loop (Spool 15 to Spool 1).

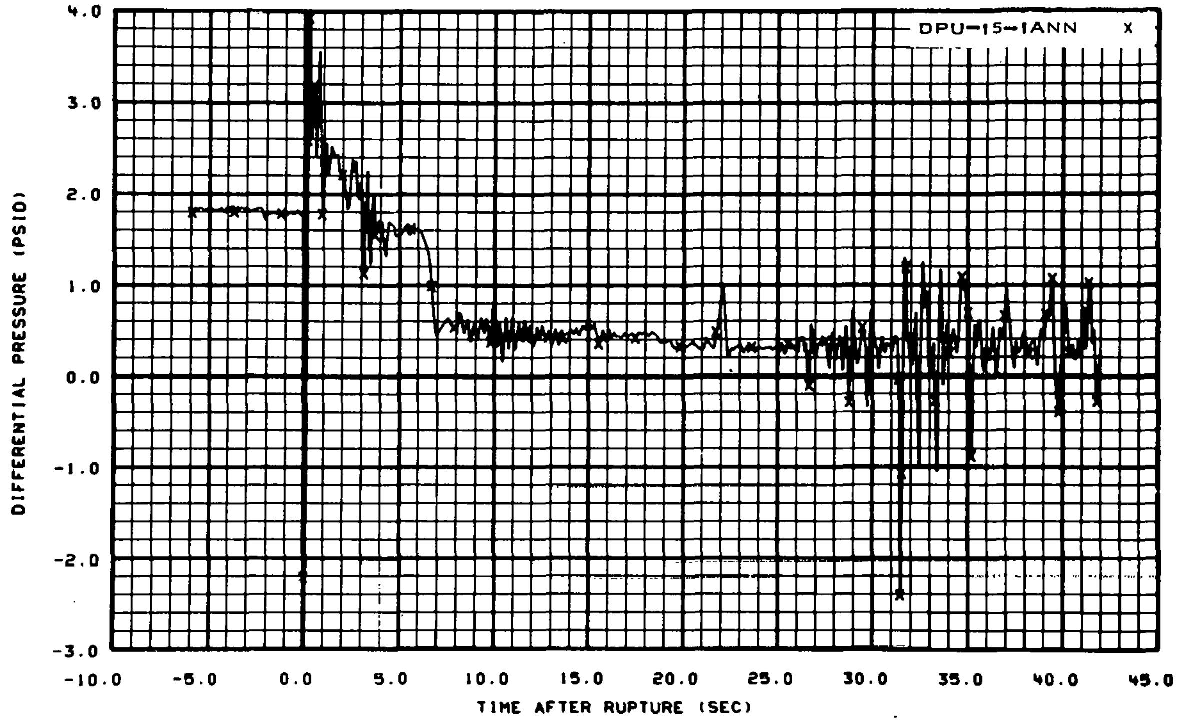

Fig. 87 Differential pressure in intact loop (Spool 15 to vessel inlet annulus).

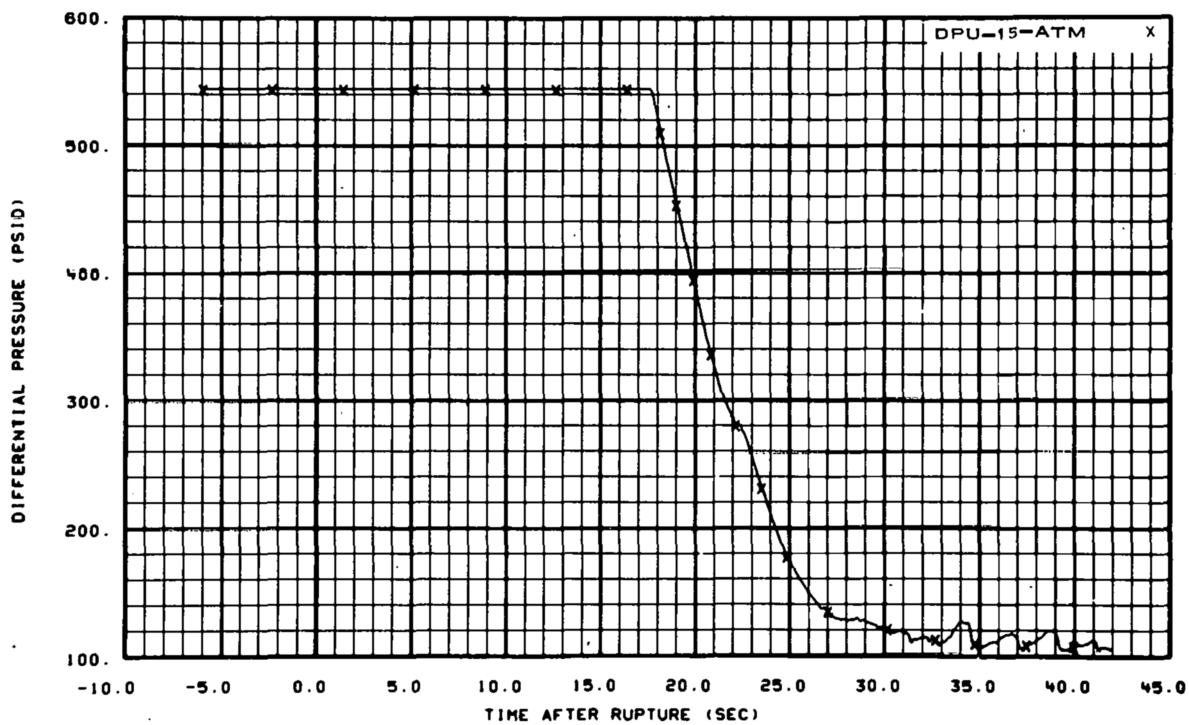

Fig. 88 Differential pressure in intact loop (Spool 15 to atmosphere).

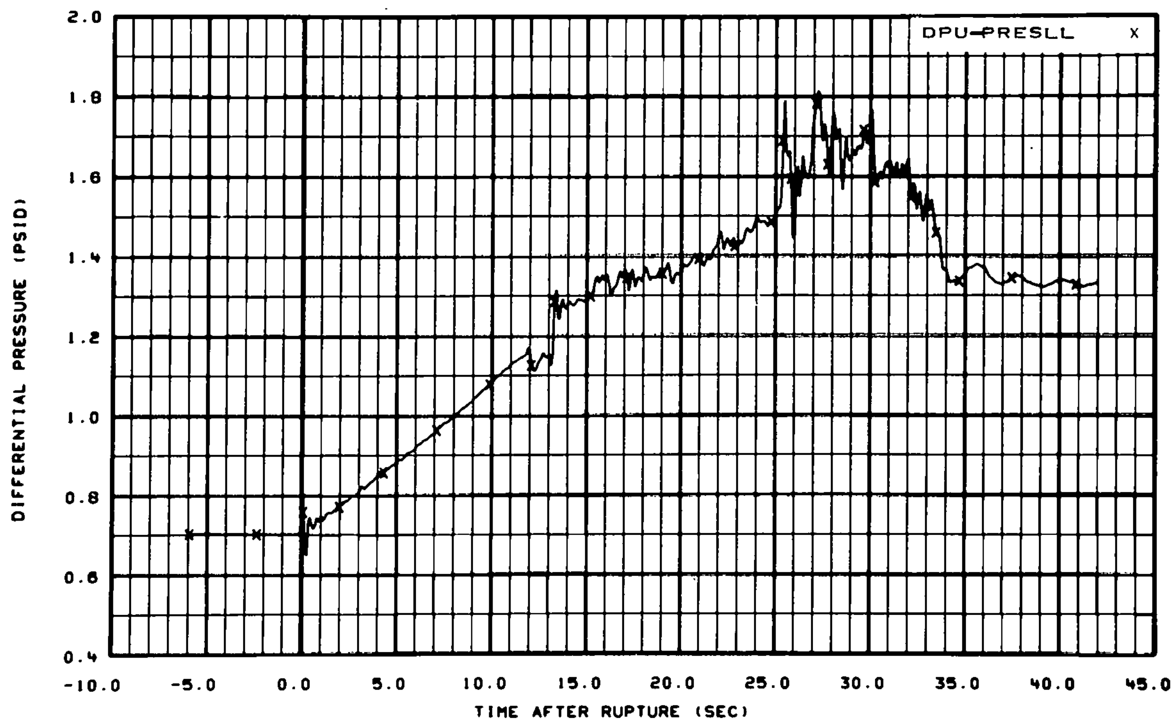

Fig. 89 Differential pressure in intact loop (pressurizer liquid level).

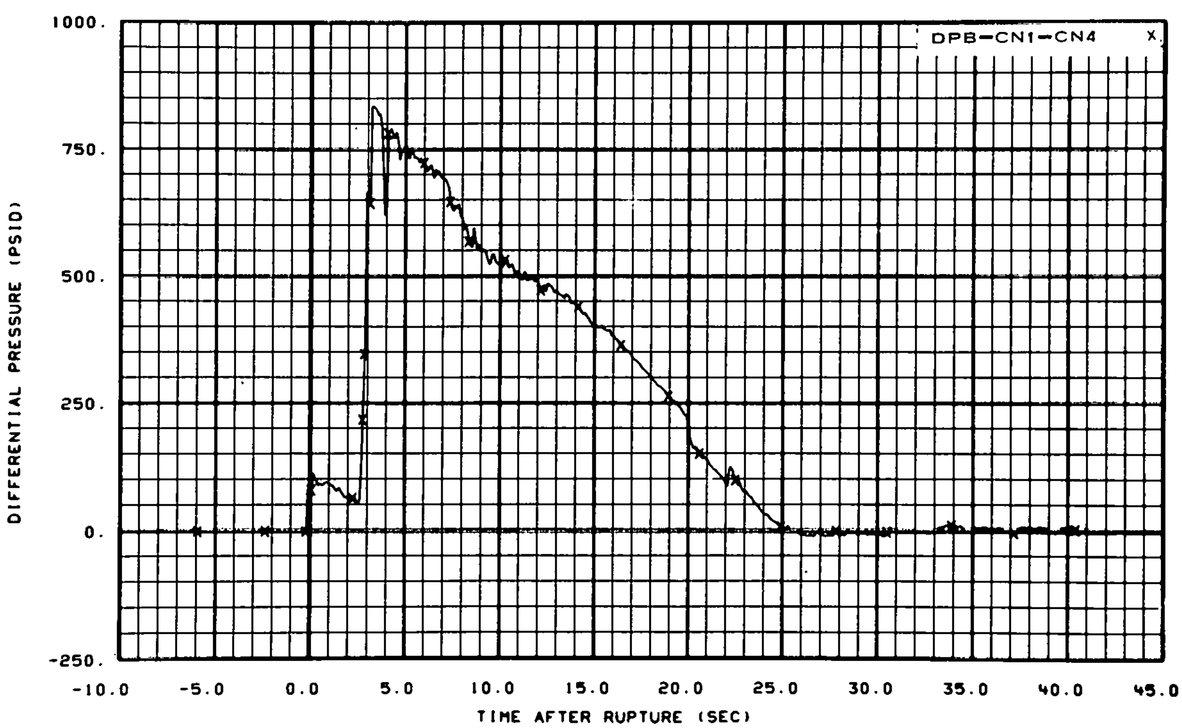

Fig. 90 Differential pressure in broken loop (vessel-side nozzel throat to divergent section).

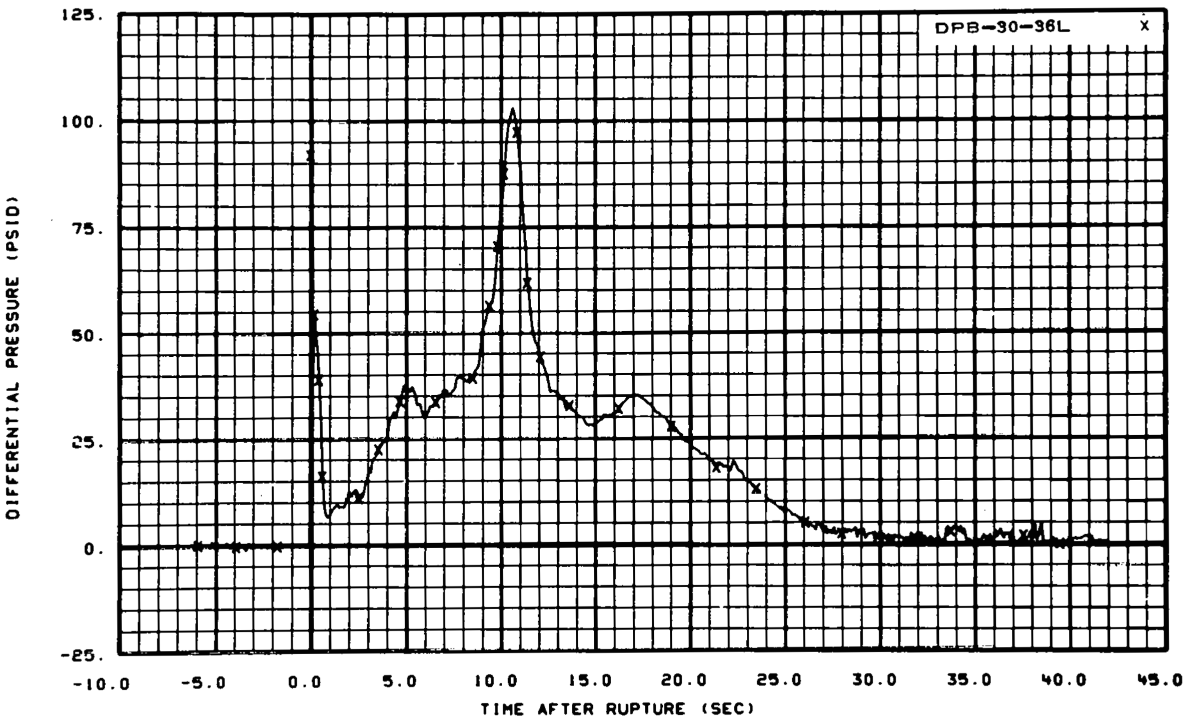

Fig. 91 Differential pressure in broken loop (Spool 30 to Spool 36L).

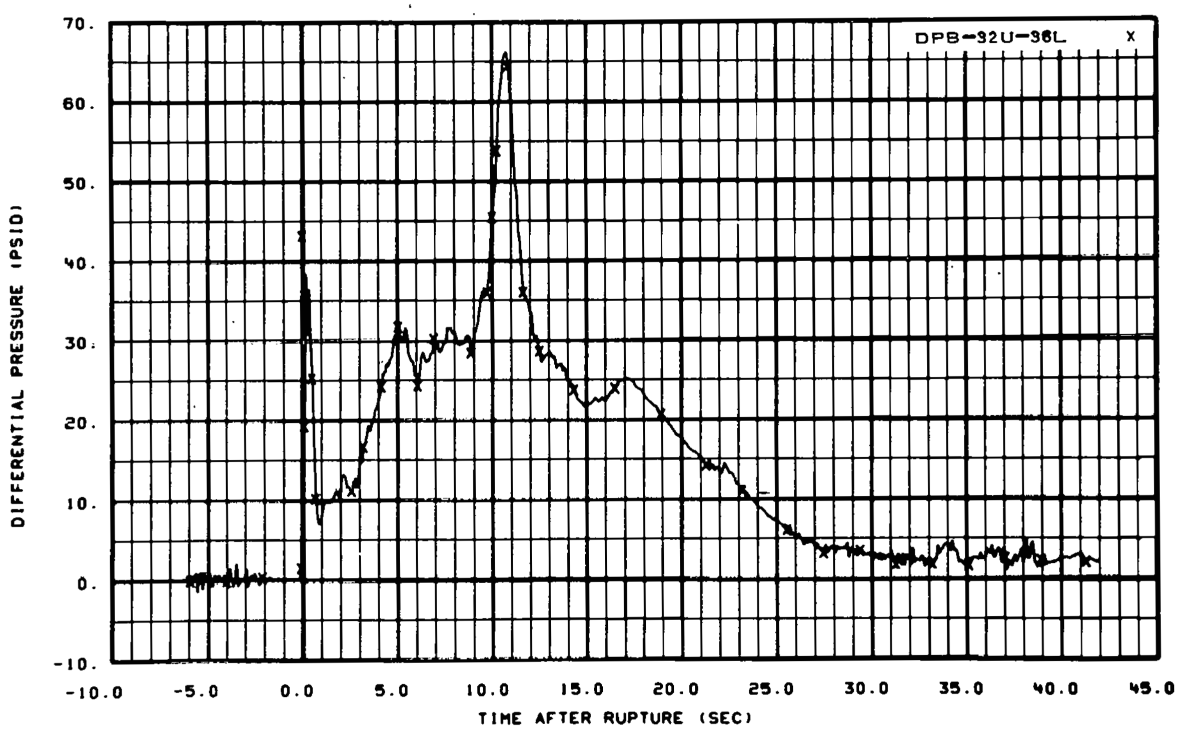

Fig. 92 Differential pressure in broken loop (Spool 32U to Spool 36L).

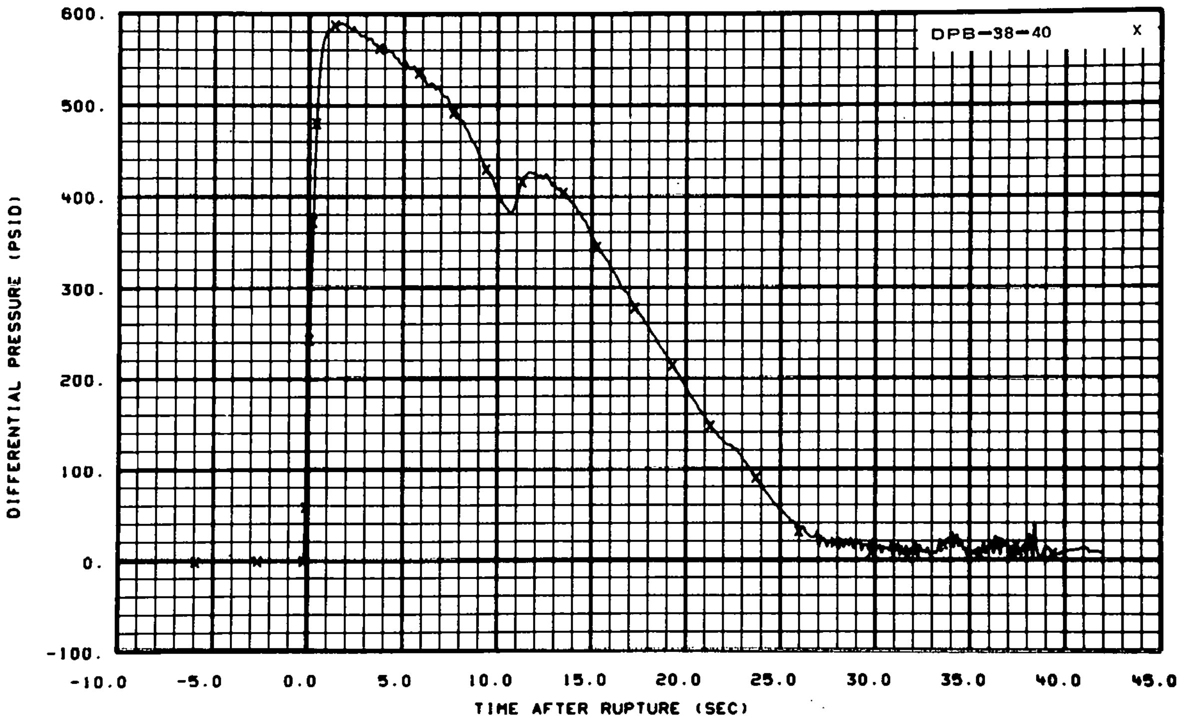

Fig. 93 Differential pressure in broken loop (Spool 38 to Spool 40).

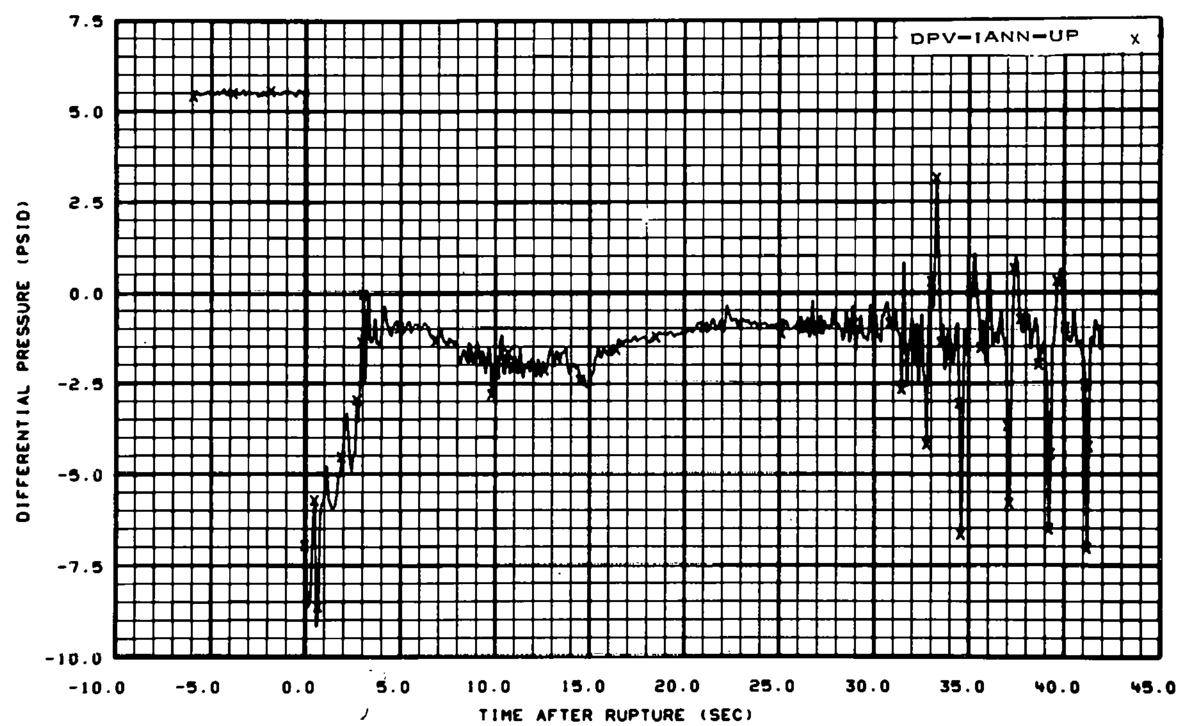

Fig. 94 Differential pressure in vessel (inlet annulus to upper plenum).

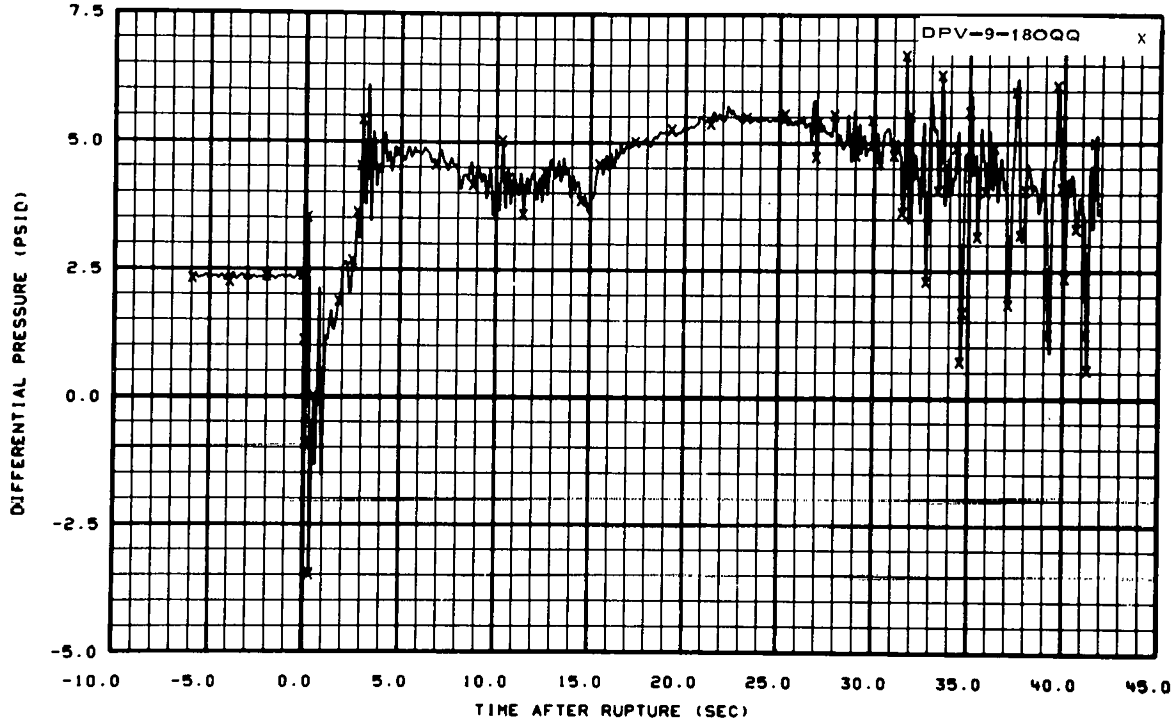

Fig. 95 Differential pressure in vessel (DPV-9-180QQ).

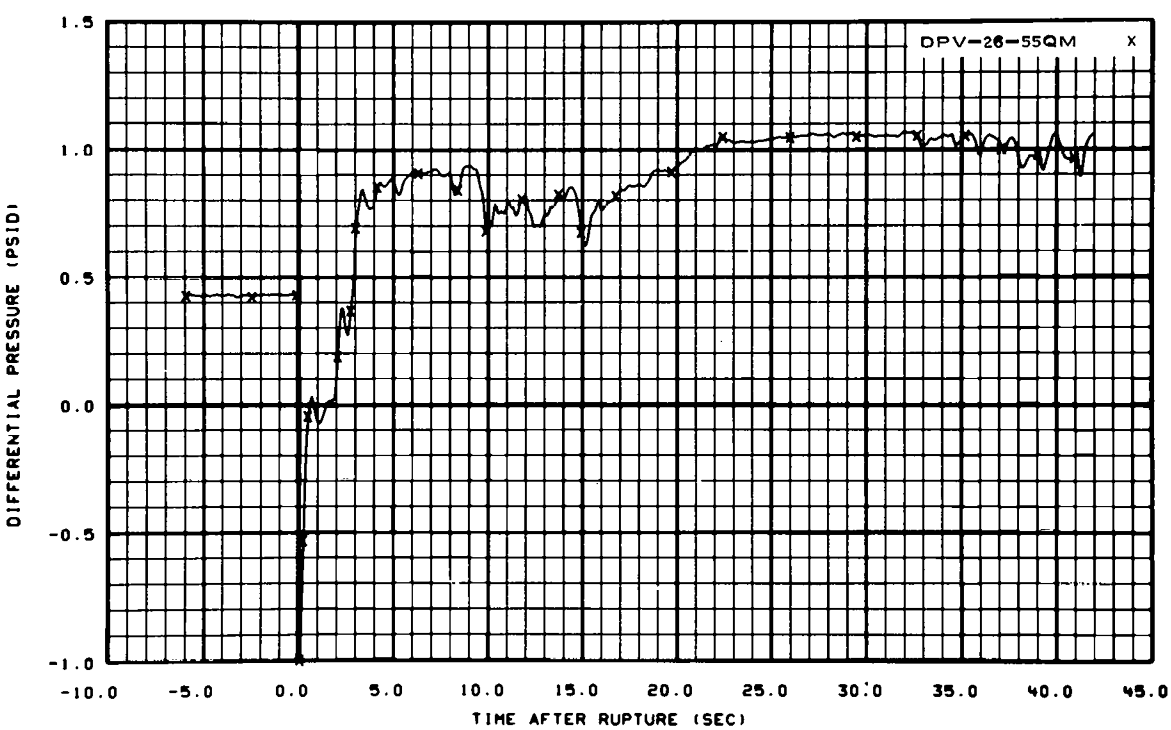

Fig. 96 Differential pressure in vessel (DPV-26-55QM).

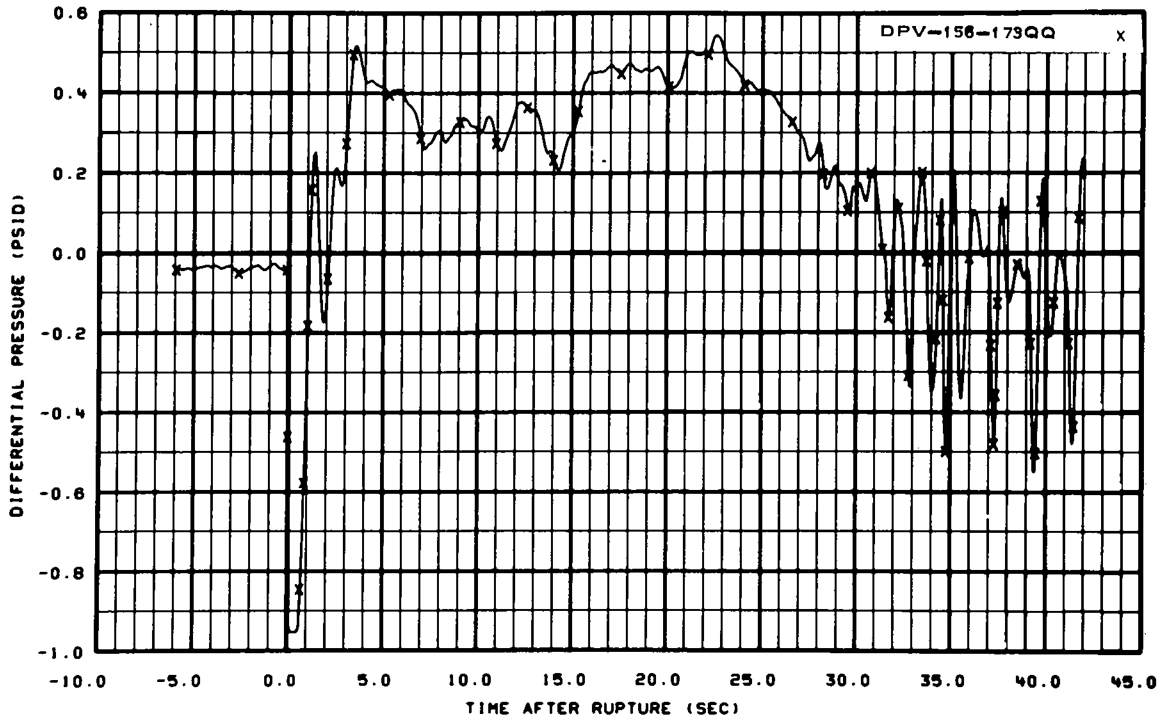

Fig. 97 Differential pressure in vessel (DPV-156-173QQ).

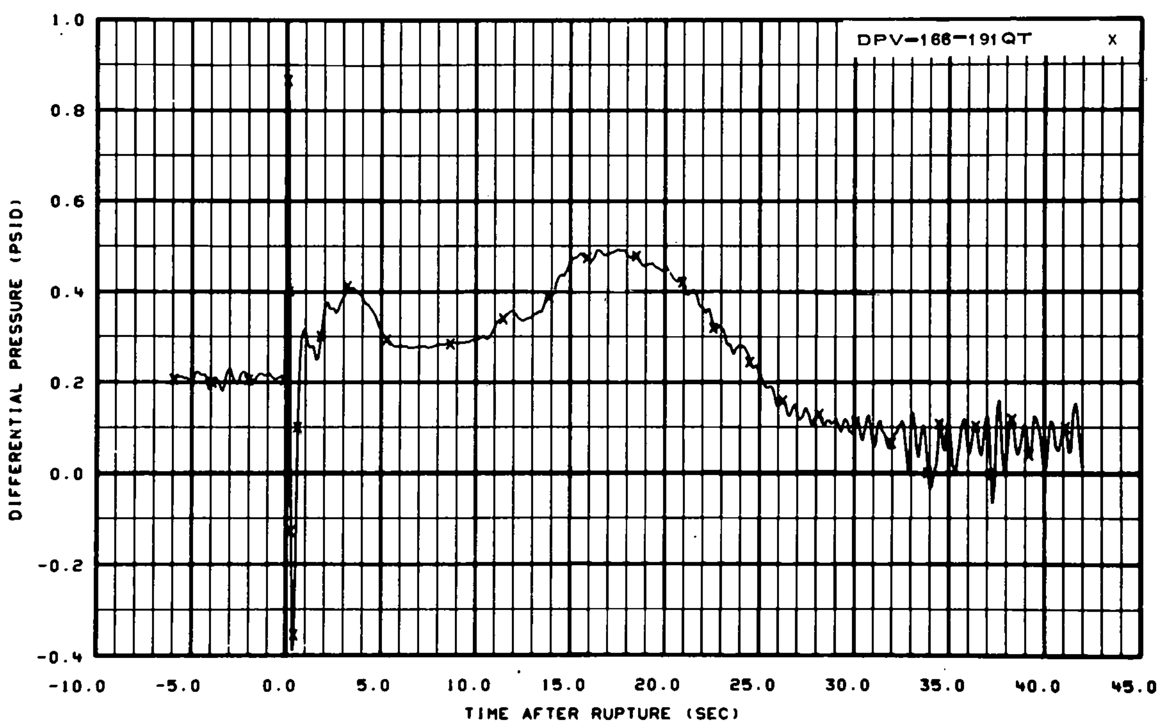

Fig. 98 Differential pressure in vessel (DPV-166-191QT).

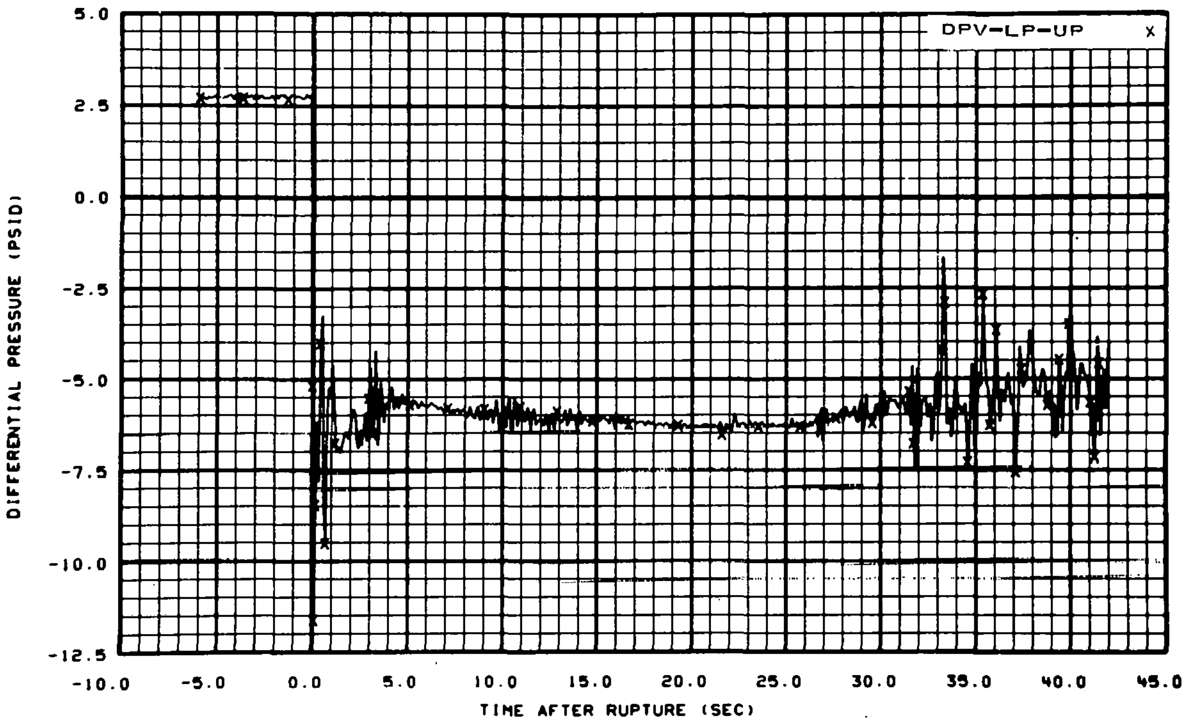

Fig. 99 Differential pressure in vessel (DPV-LP-UP).

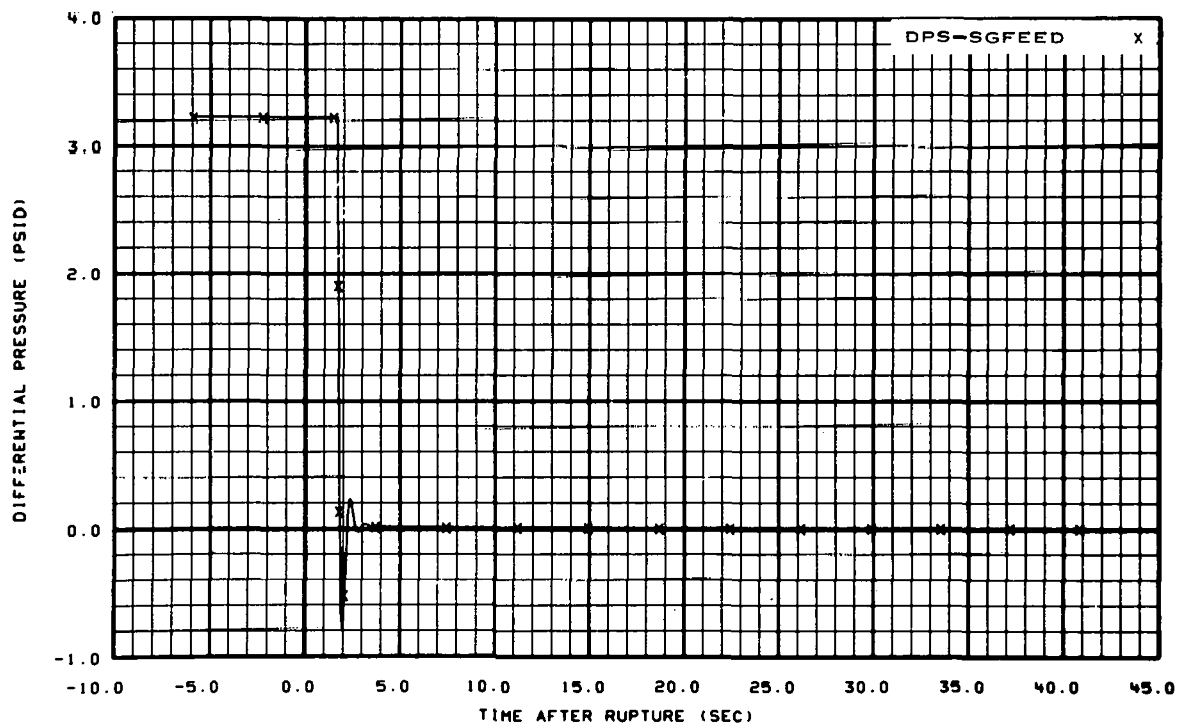

Fig. 100 Differential pressure across steam generator feedwater inlet.

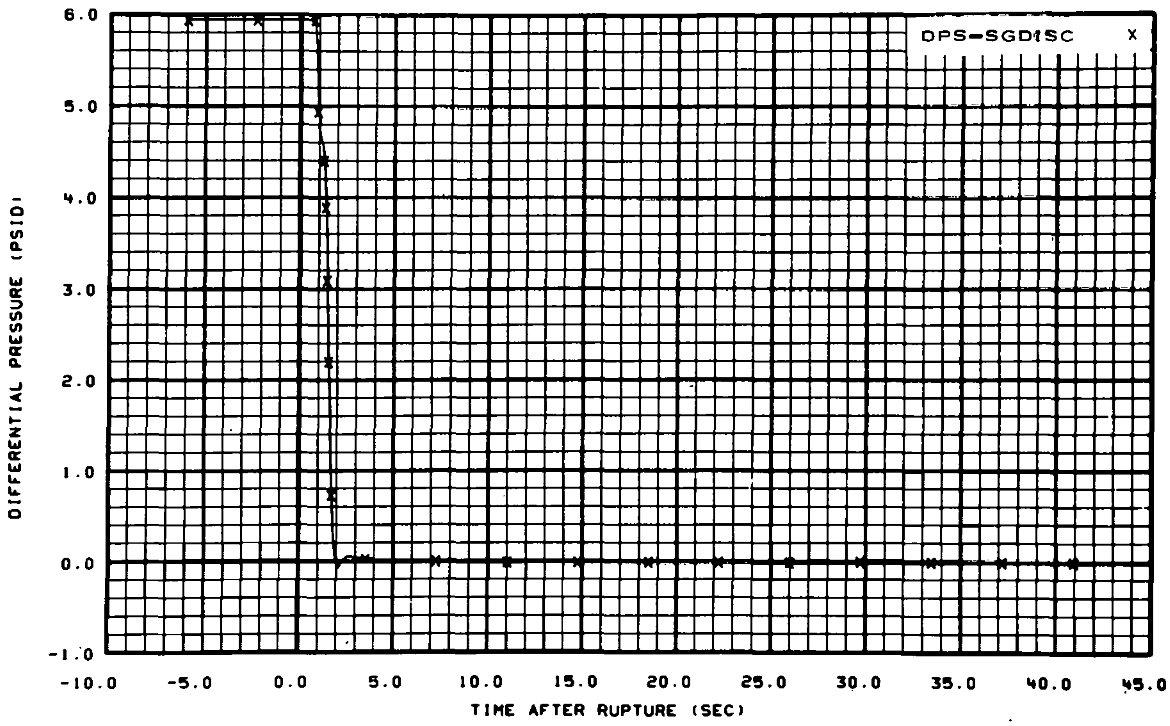

Fig. 101 Differential pressure across steam generator steam discharge.

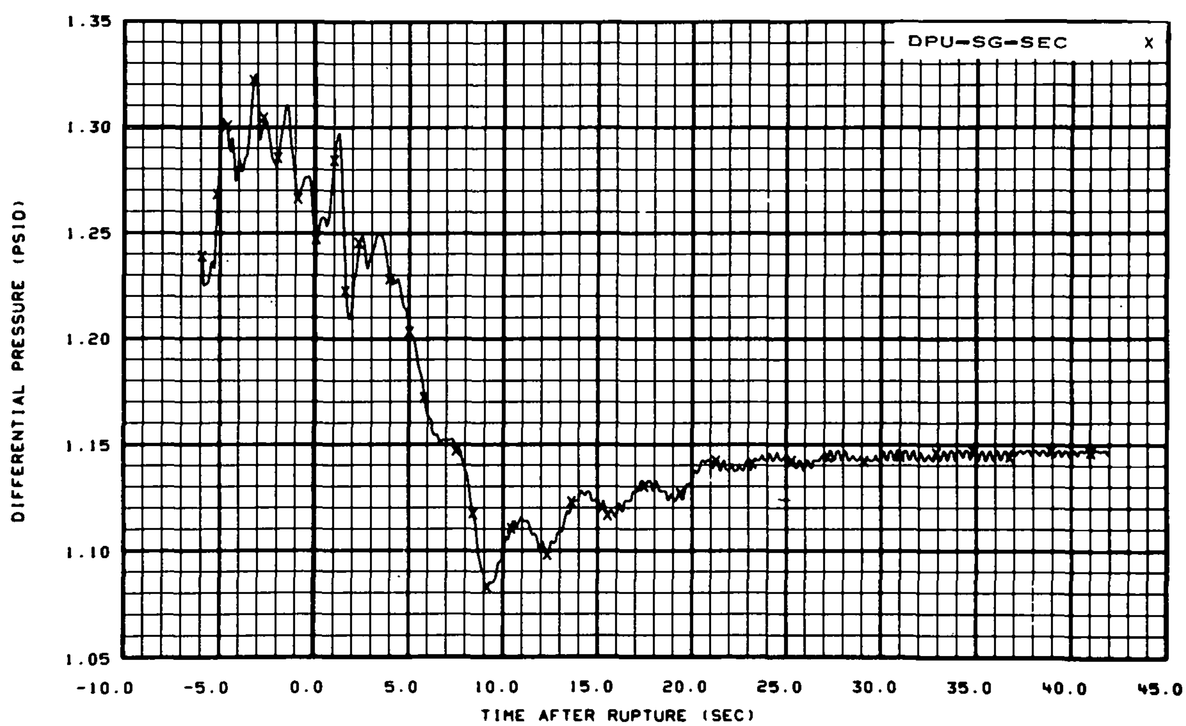

Fig. 102 Differential in steam generator secondary.

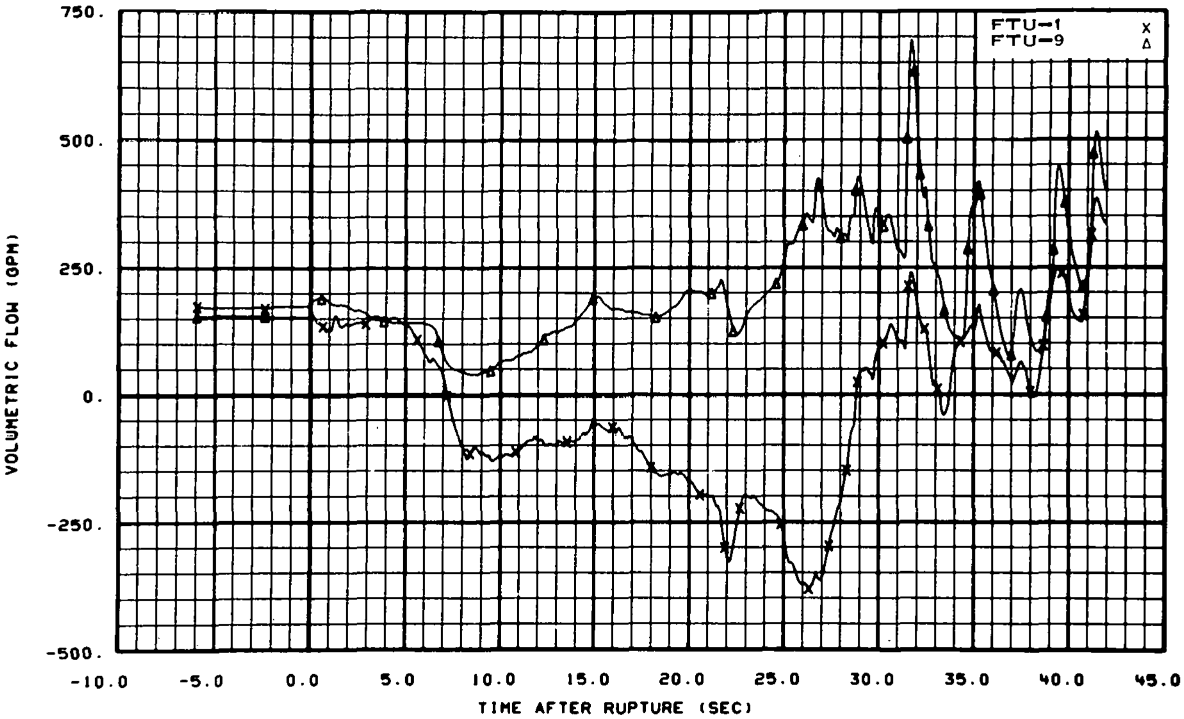

Fig. 103 Volumetric flow in intact loop (FTU-1, FTU-9).

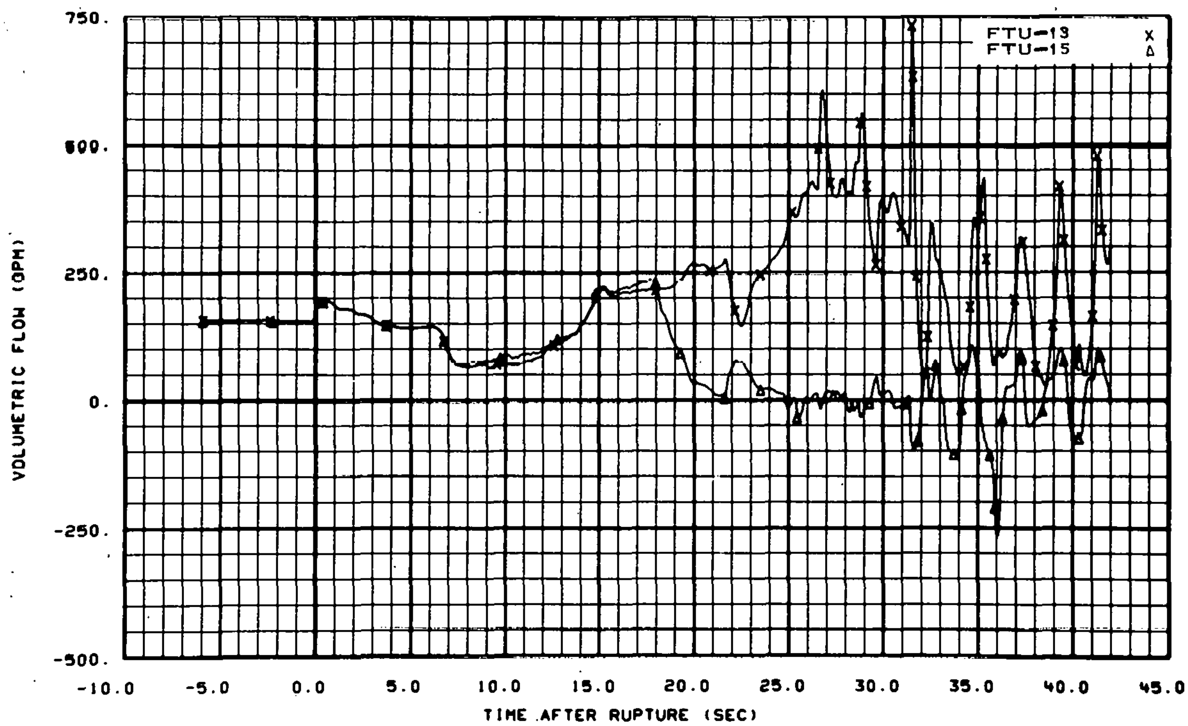

Fig. 104 Volumetric flow in intact loop (FTU-13, FTU-15).

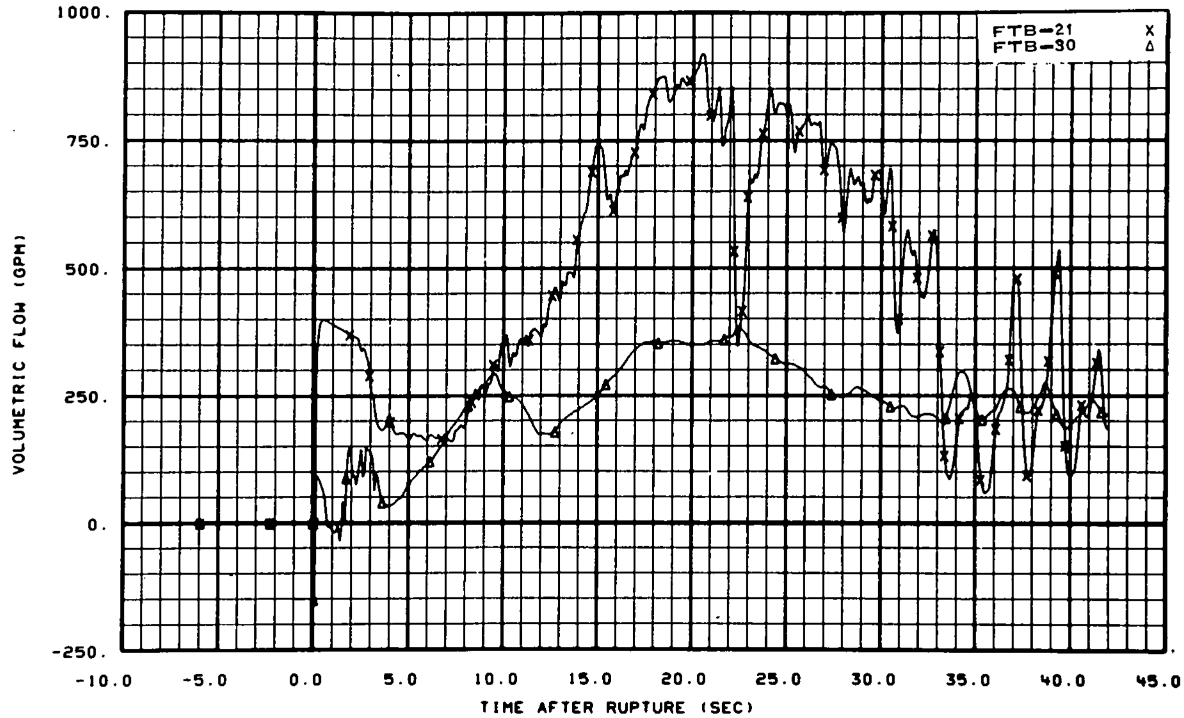

Fig. 105 Volumetric flow in broken loop (FTB-21, FTB-30).

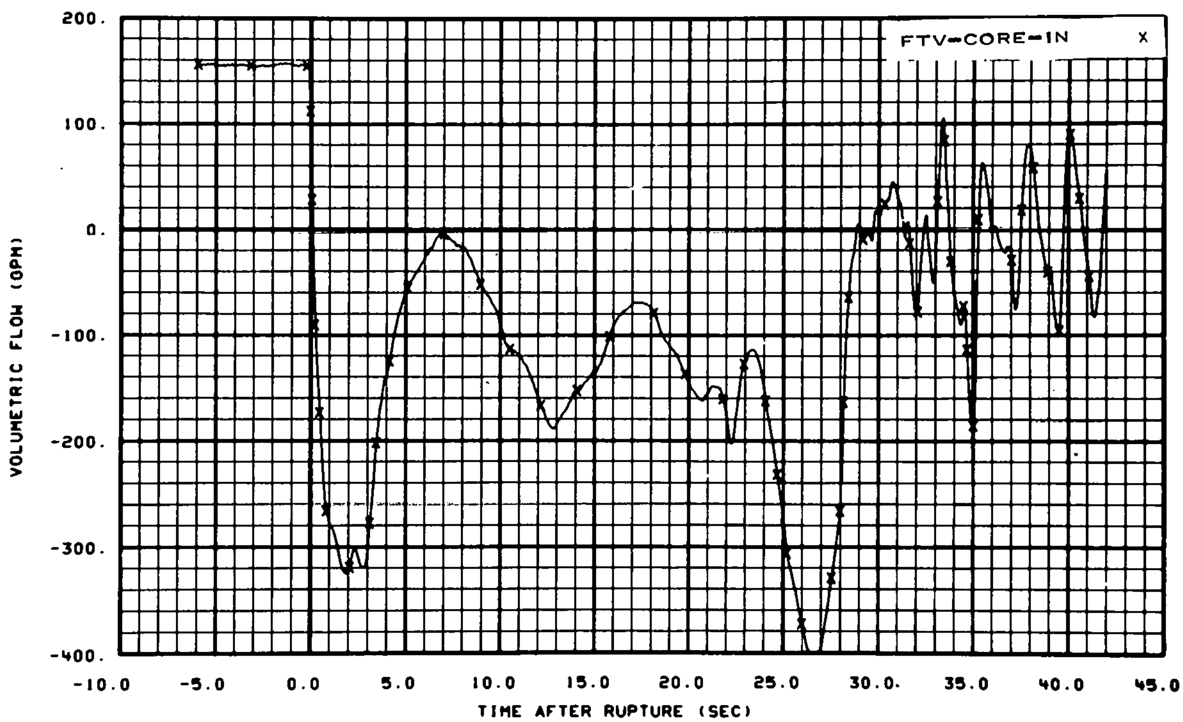

Fig. 106 Volumetric flow in core entrance.

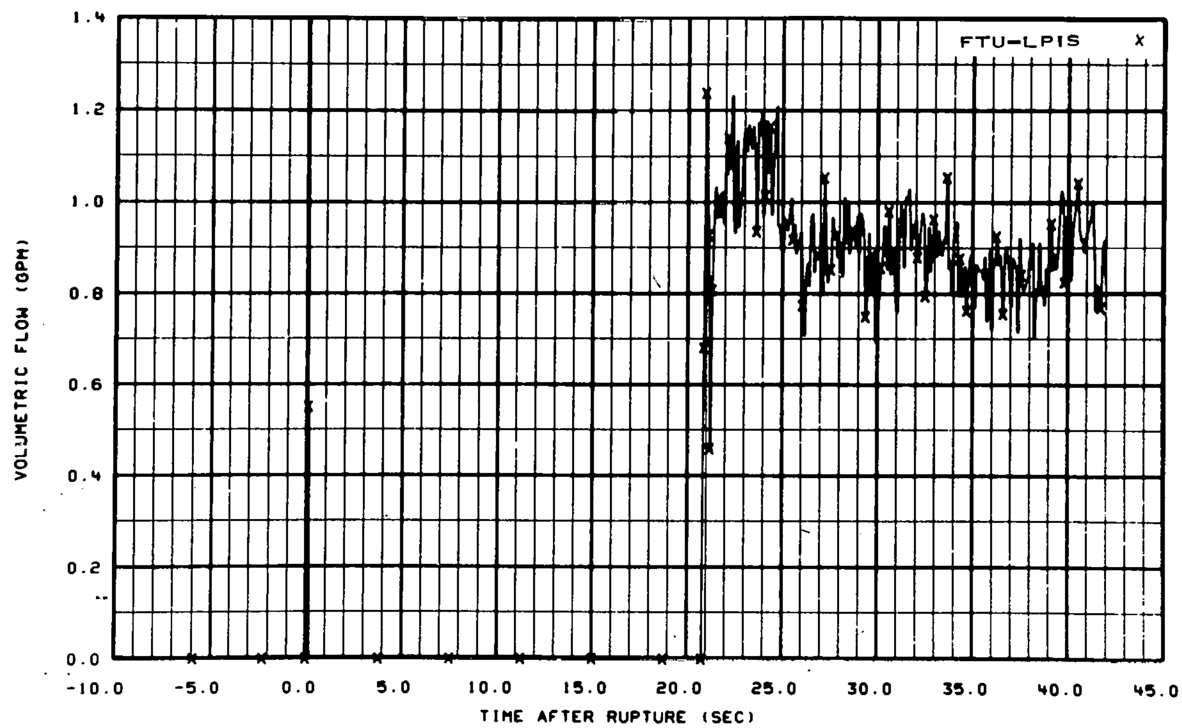

Fig. 107 Volumetric flow in low-pressure injection line (intact loop).

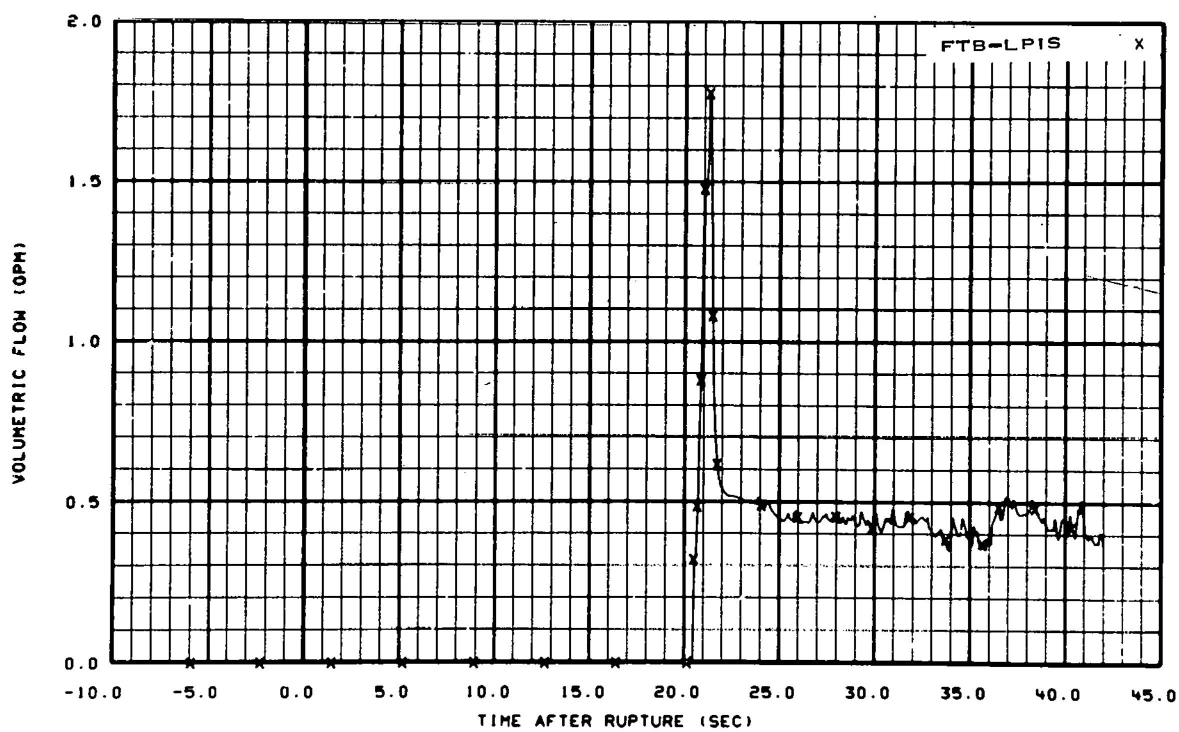

Fig. 108 Volumetric flow in low-pressure injection line (broken loop).

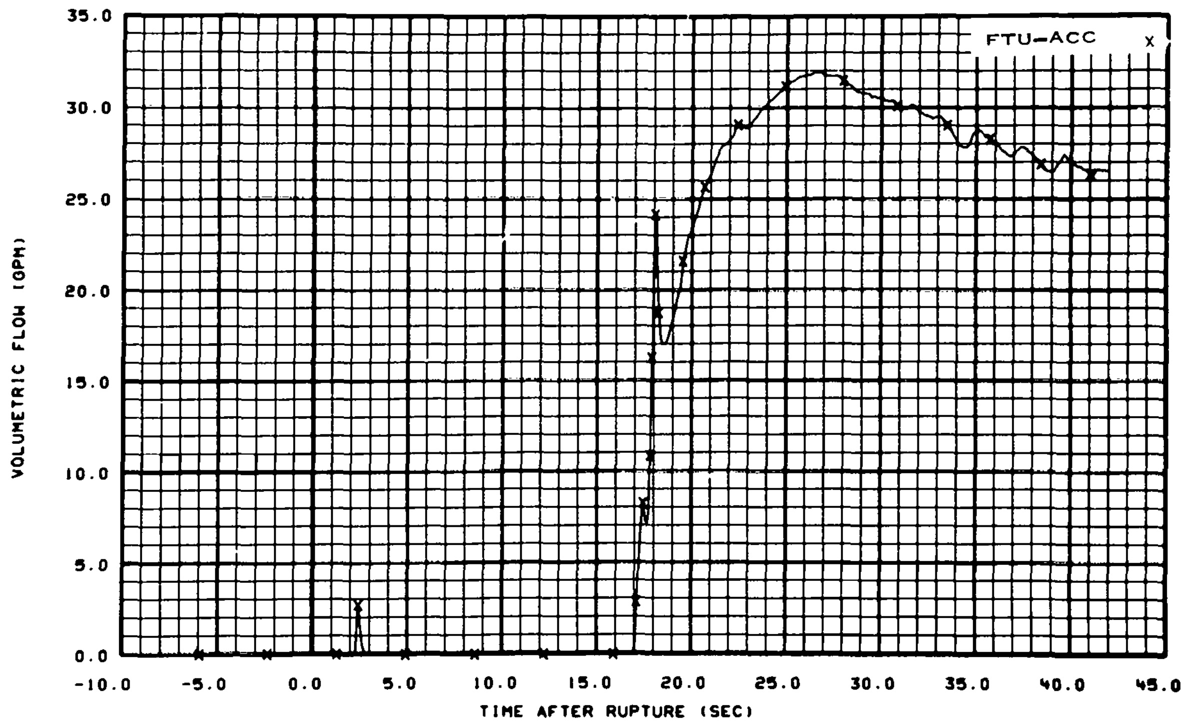

Fig. 109 Volumetric flow in accumulator discharge line (intact loop).

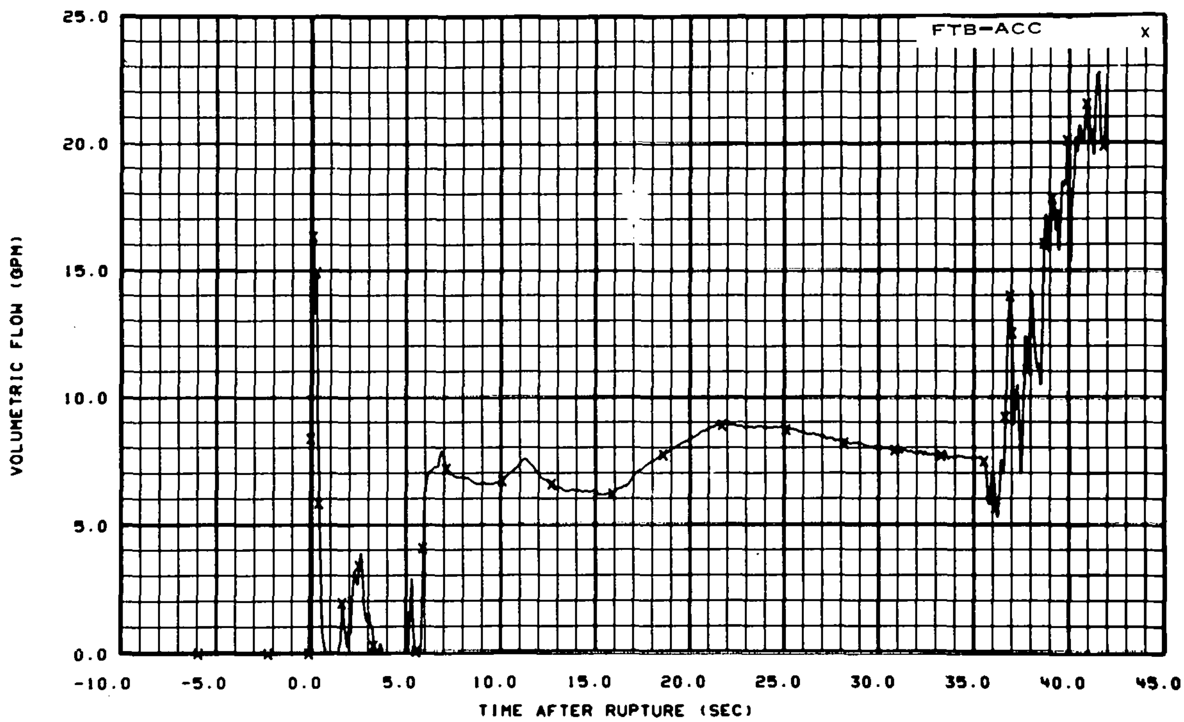

Fig. 110 Volumetric flow in accumulator discharge line (broken loop).

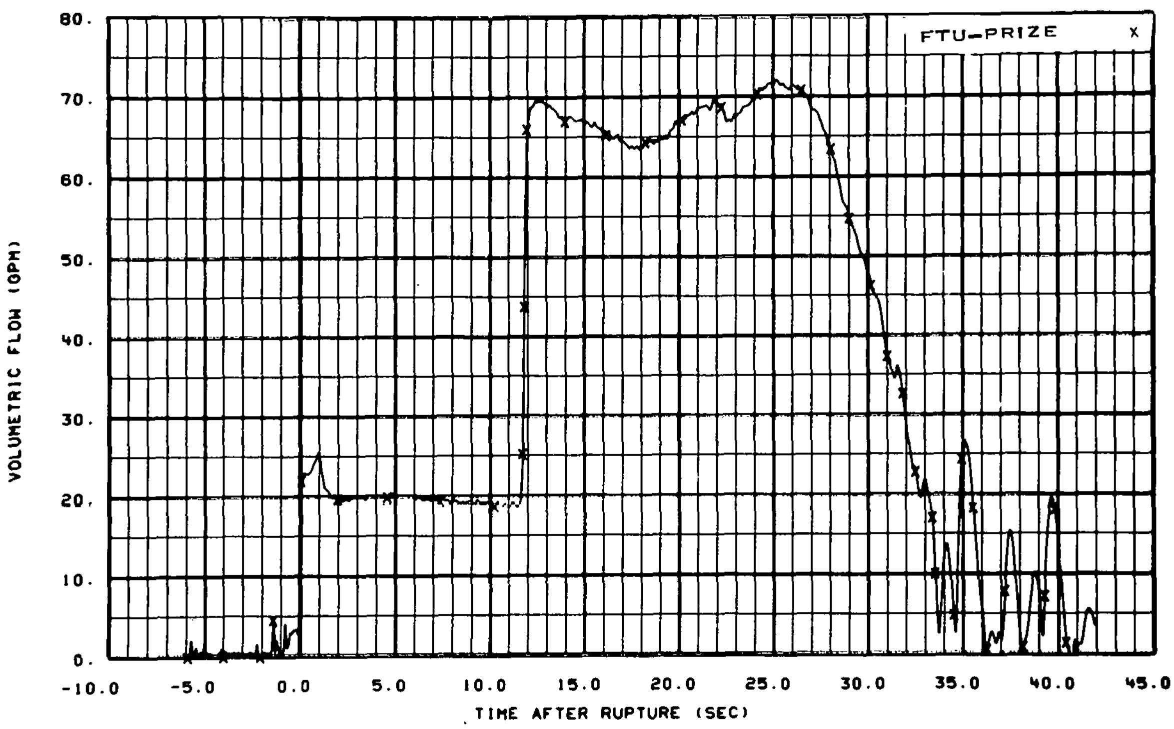

Fig. 111 Volumetric flow in pressurizer surge line.

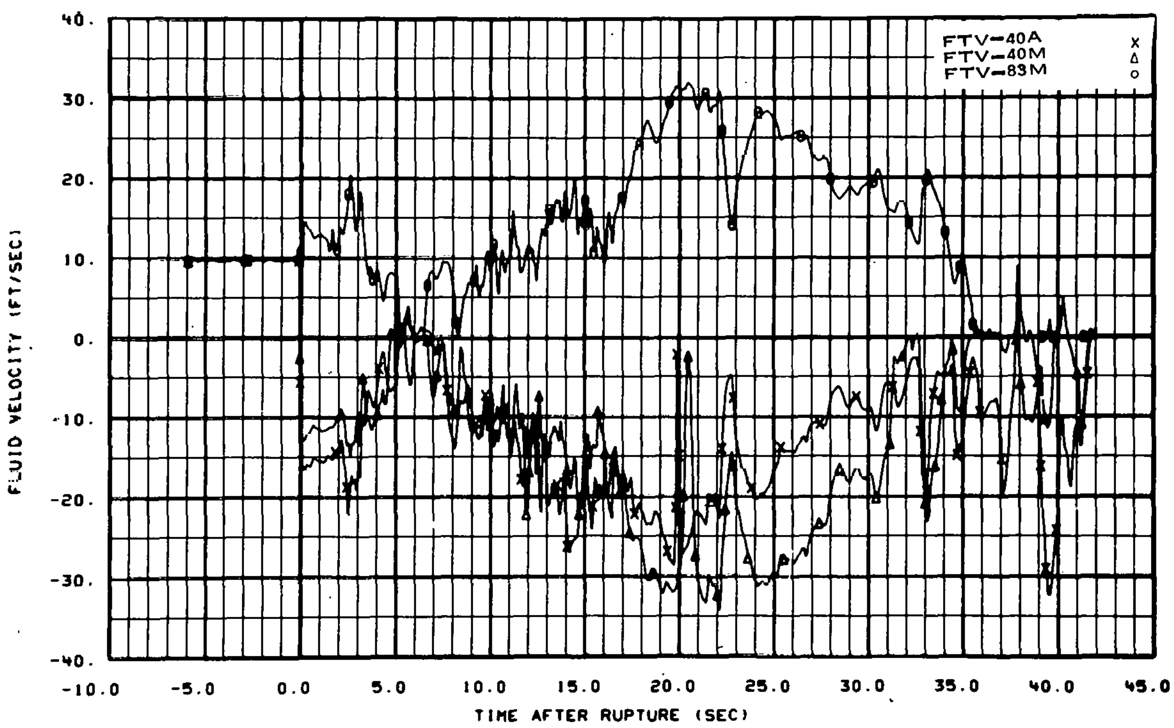

Fig. 112 Fluid velocity in vessel.

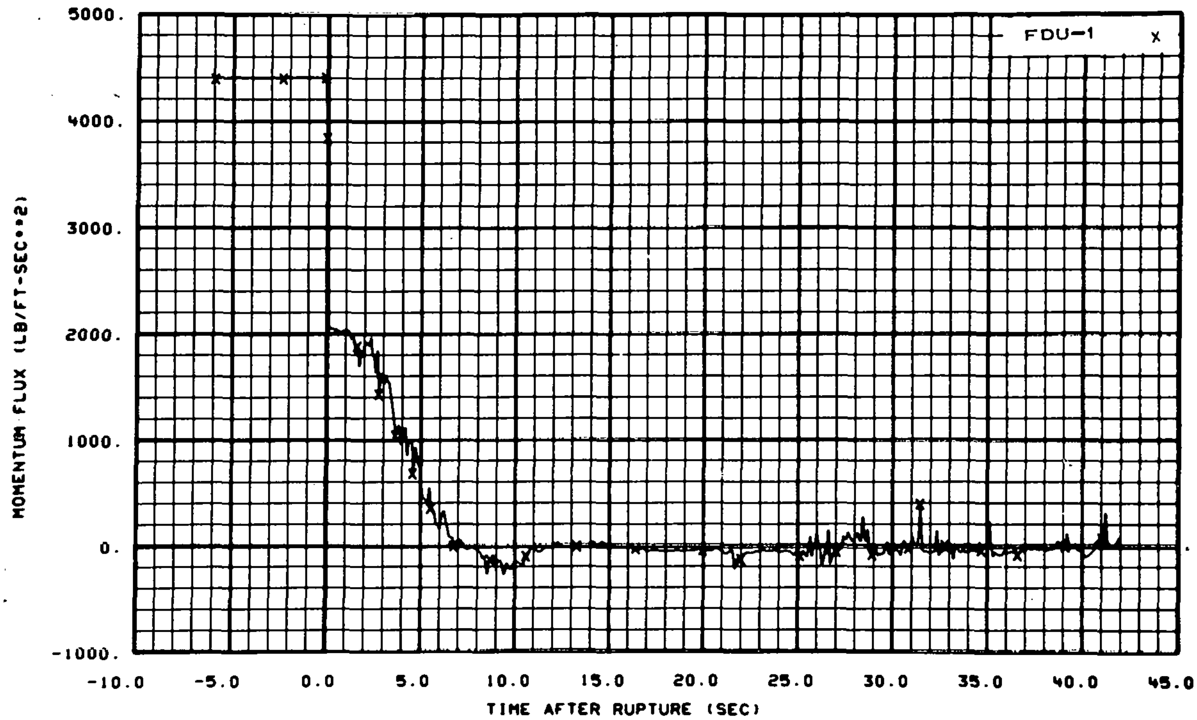

Fig. 113 Momentum flux in intact loop (Spool 1).

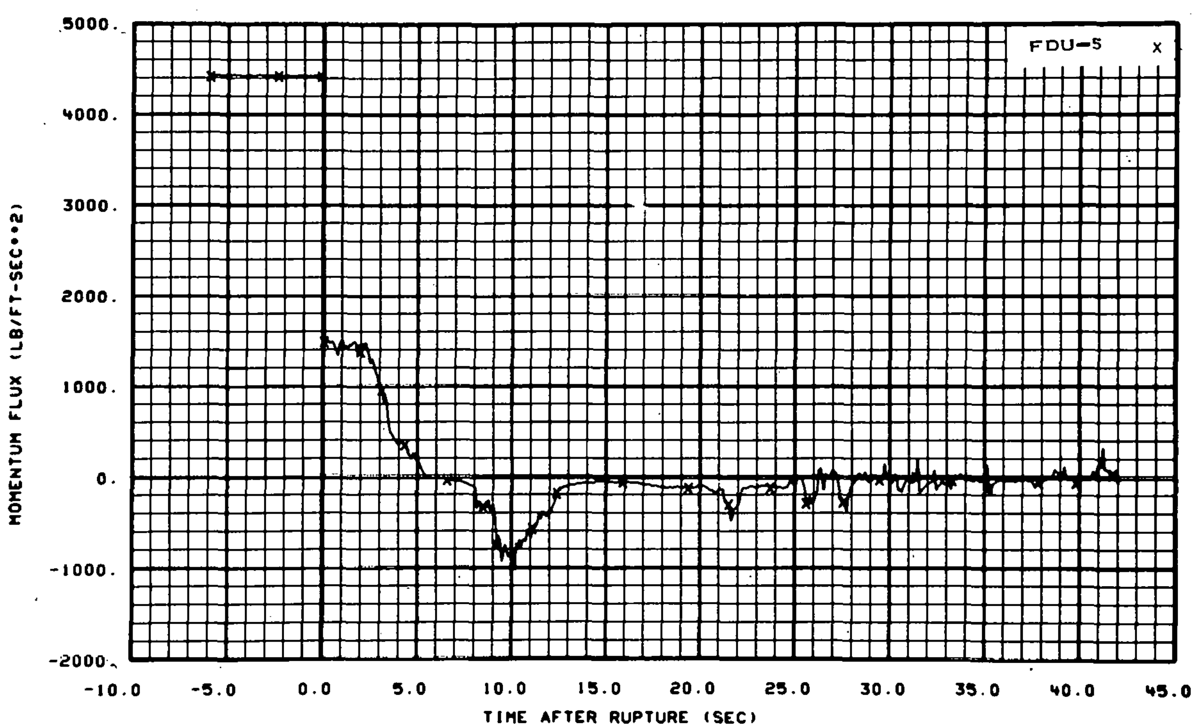

Fig. 114 Momentum flux in intact loop (Spool 5).

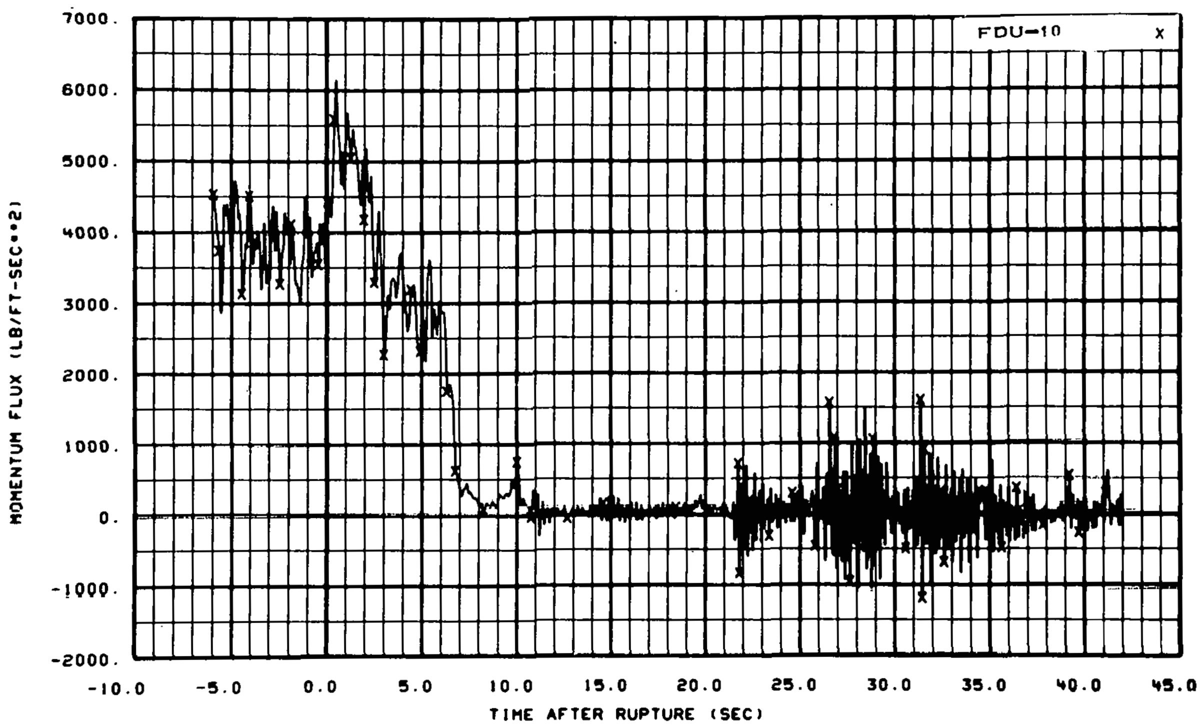

Fig. 115 Momentum flux in intact loop (Spool 10).

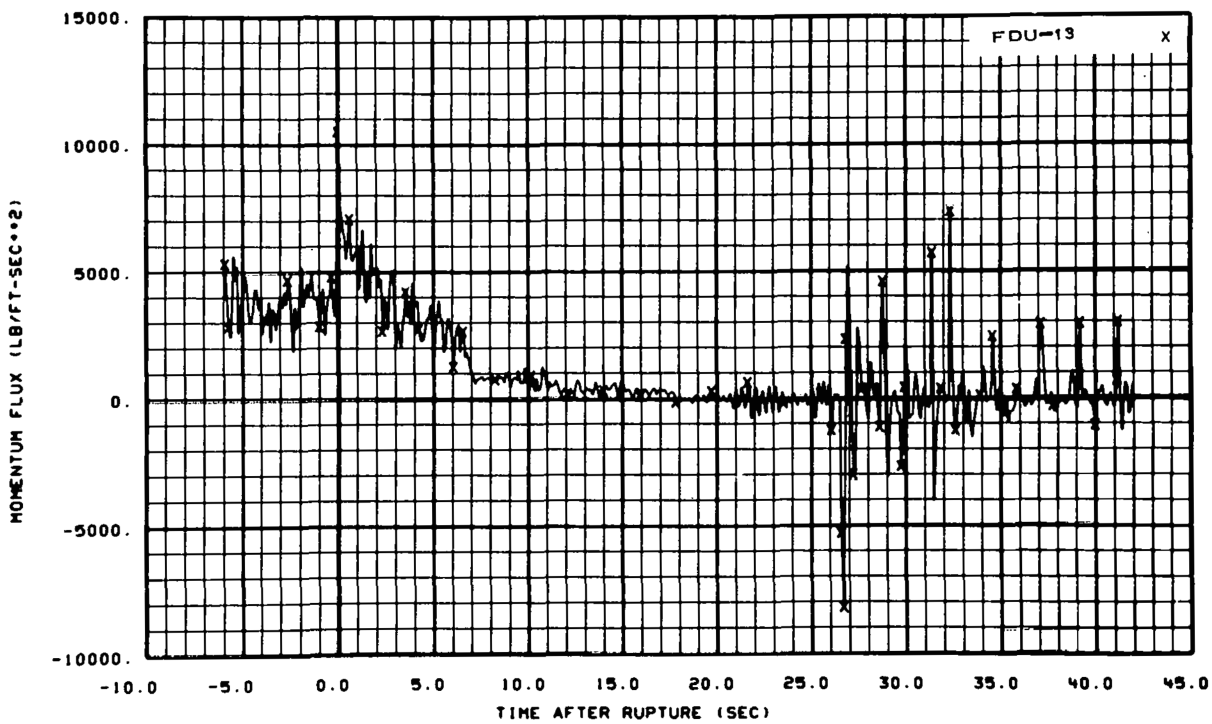

Fig. 116 Momentum flux in intact loop (Spool 13).

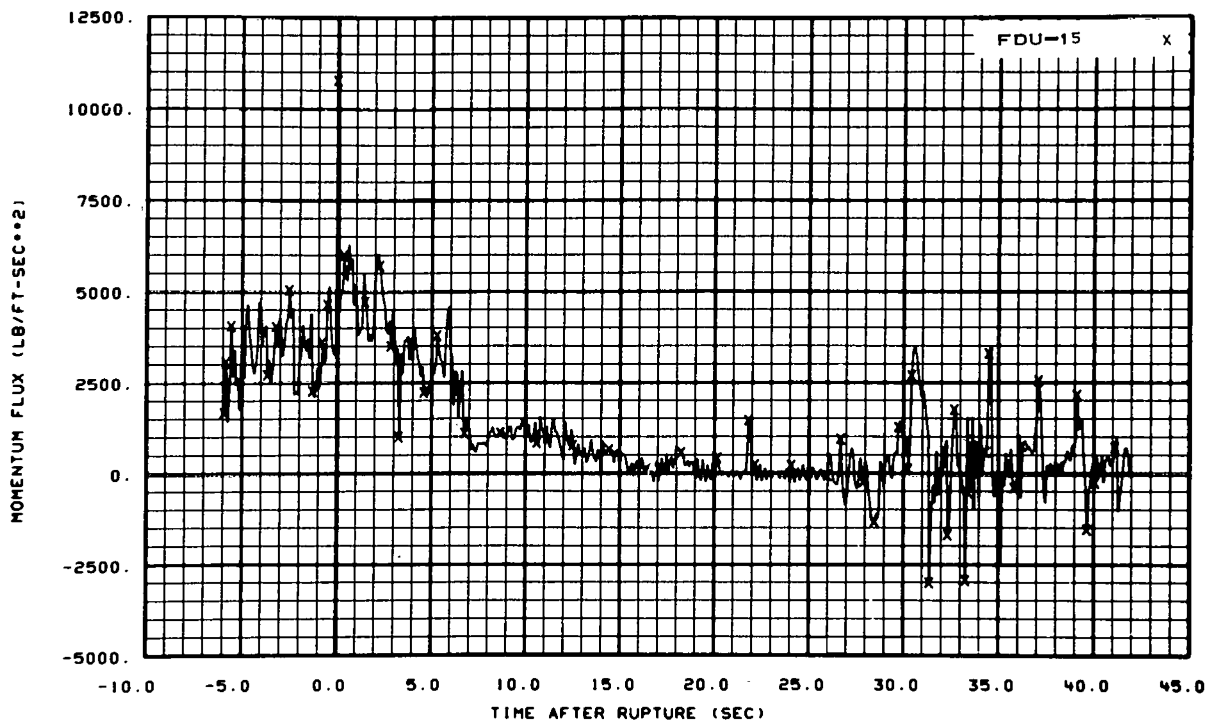

Fig. 117 Momentum flux in intact loop (Spool 15).

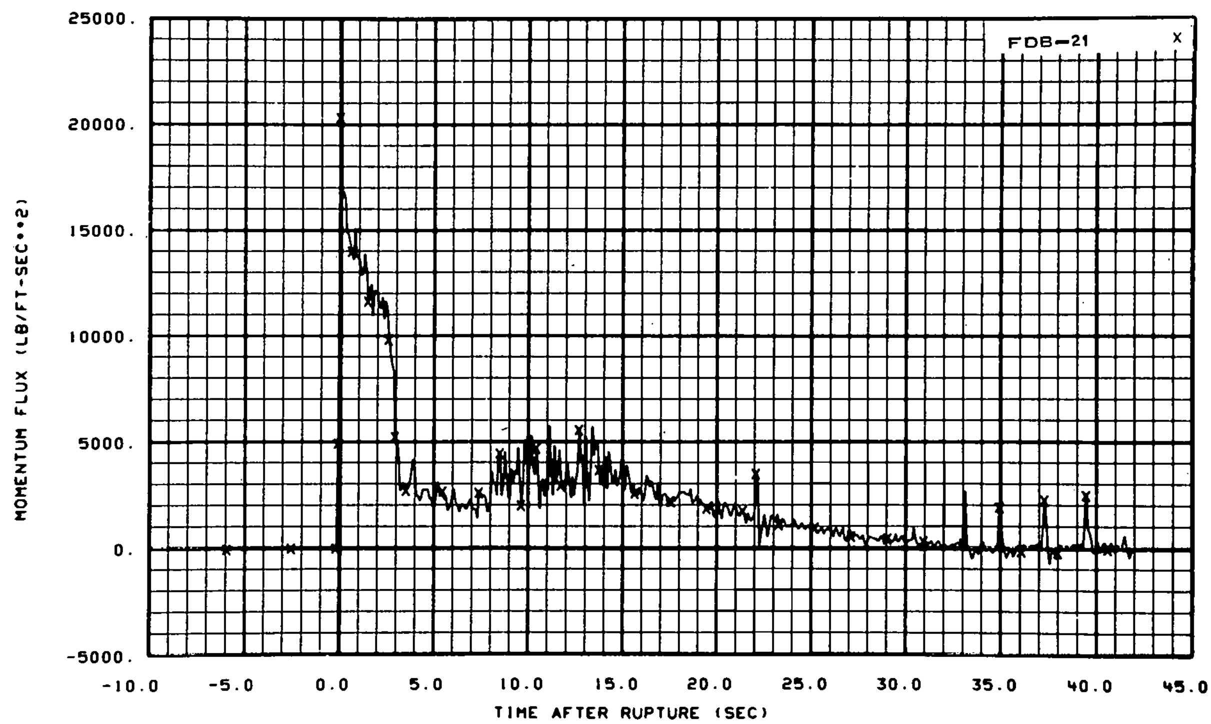

Fig. 118 Momentum flux in intact loop (Spool 21).

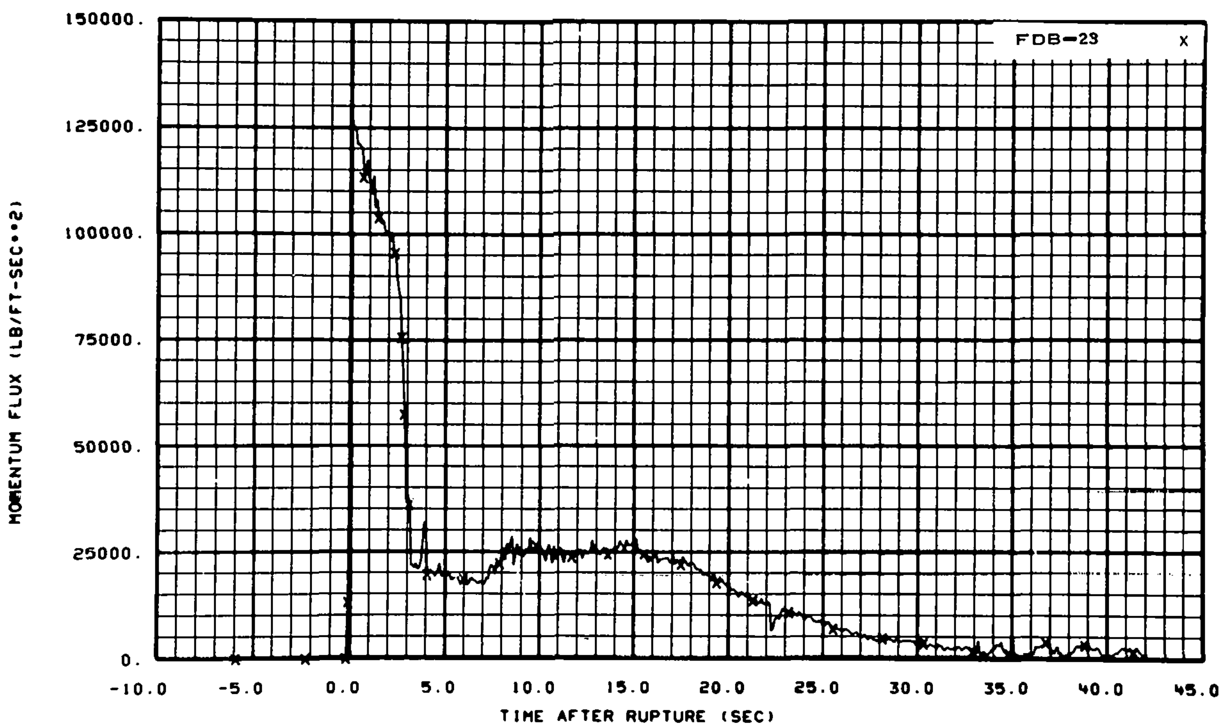

Fig. 119 Momentum flux in broken loop (Spool 23).

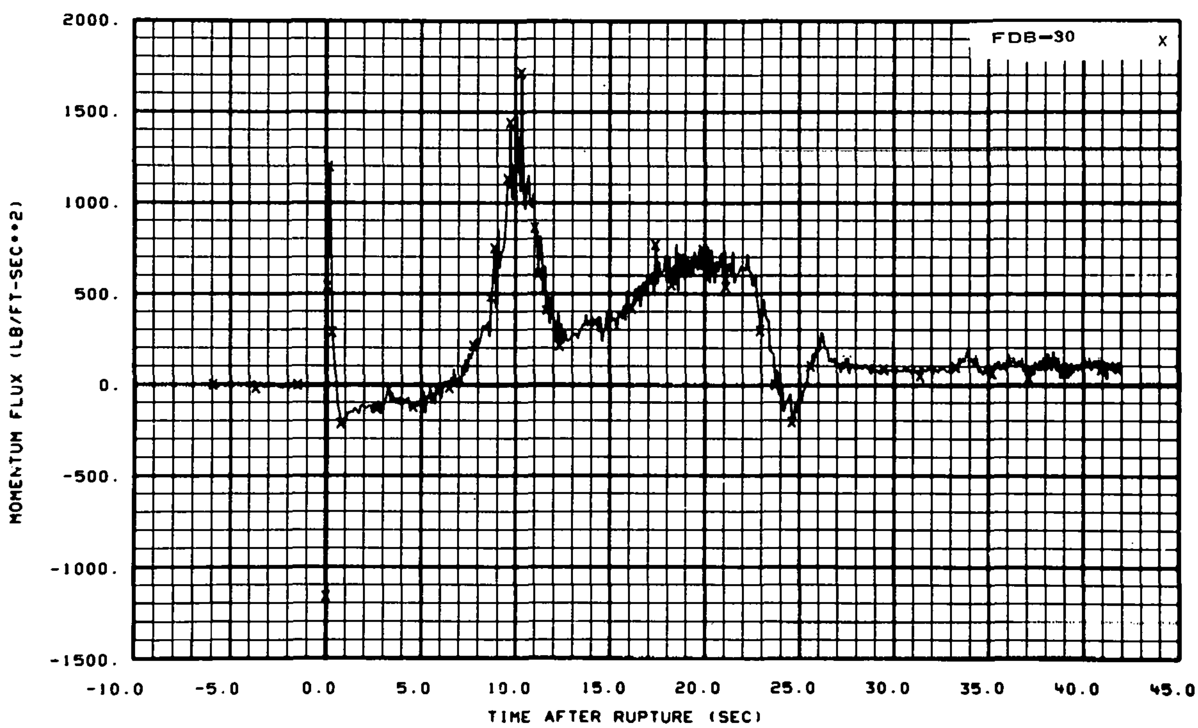

Fig. 120 Momentum flux in broken loop (Spool 30).

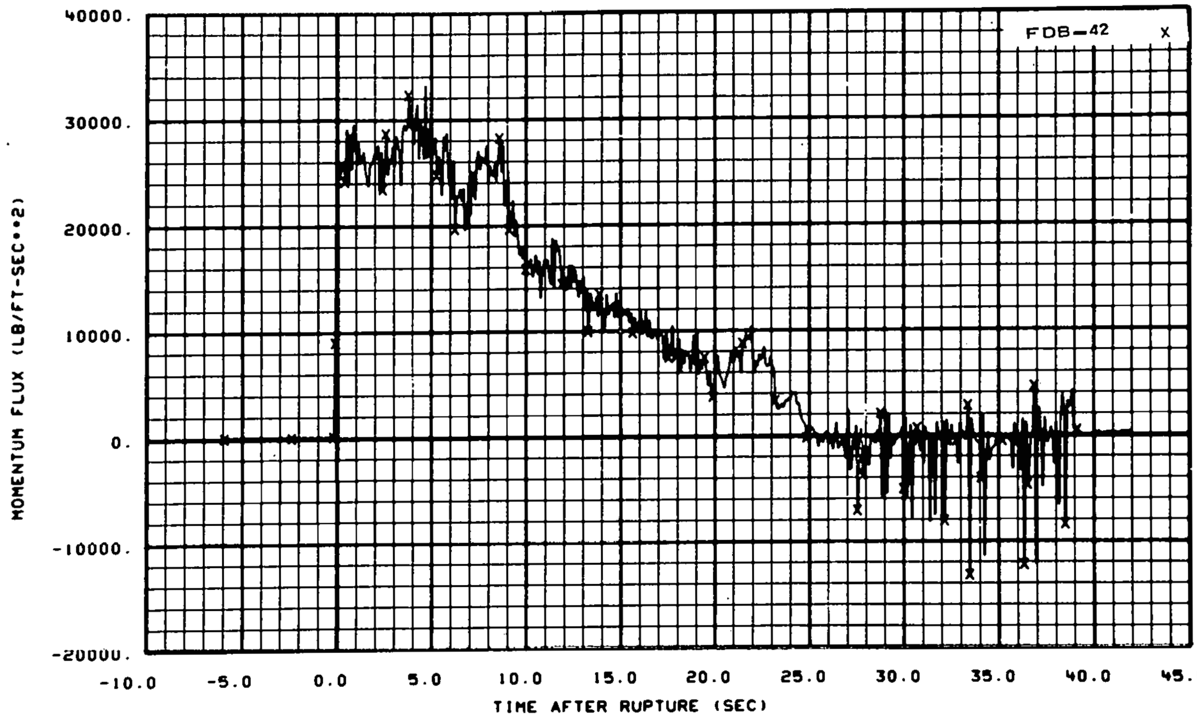

Fig. 121 Momentum flux in broken loop (Spool 42).

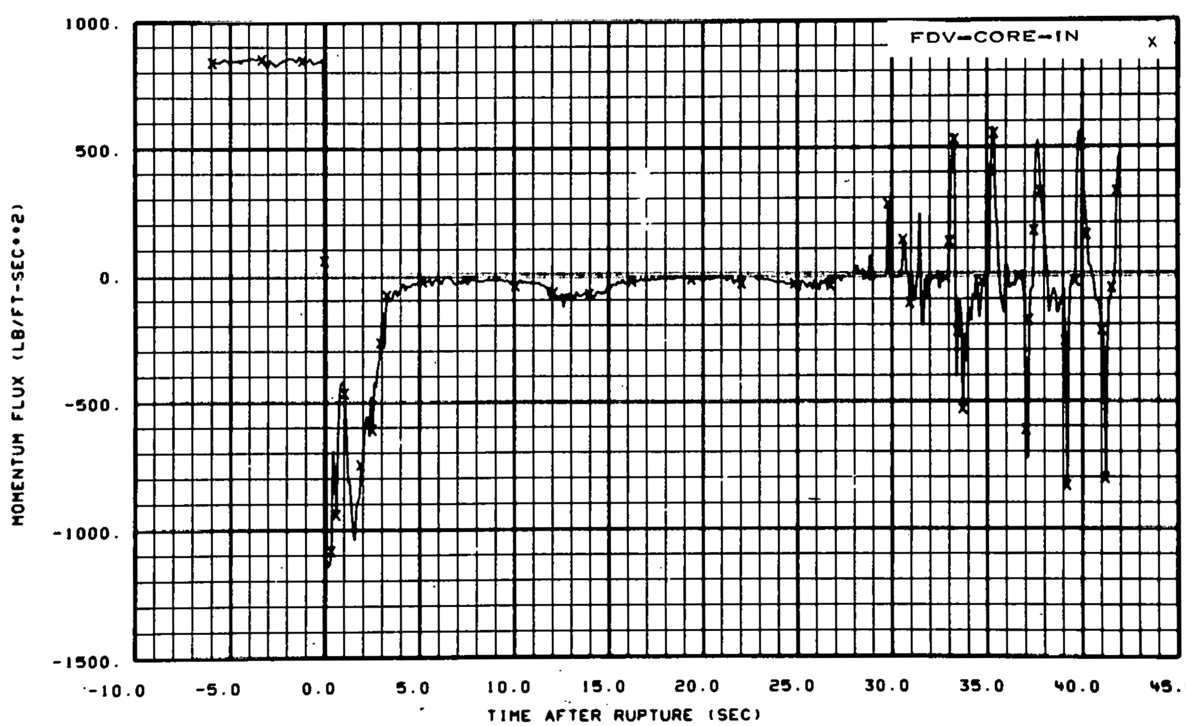

Fig. 122 Momentum flux in core entrance.

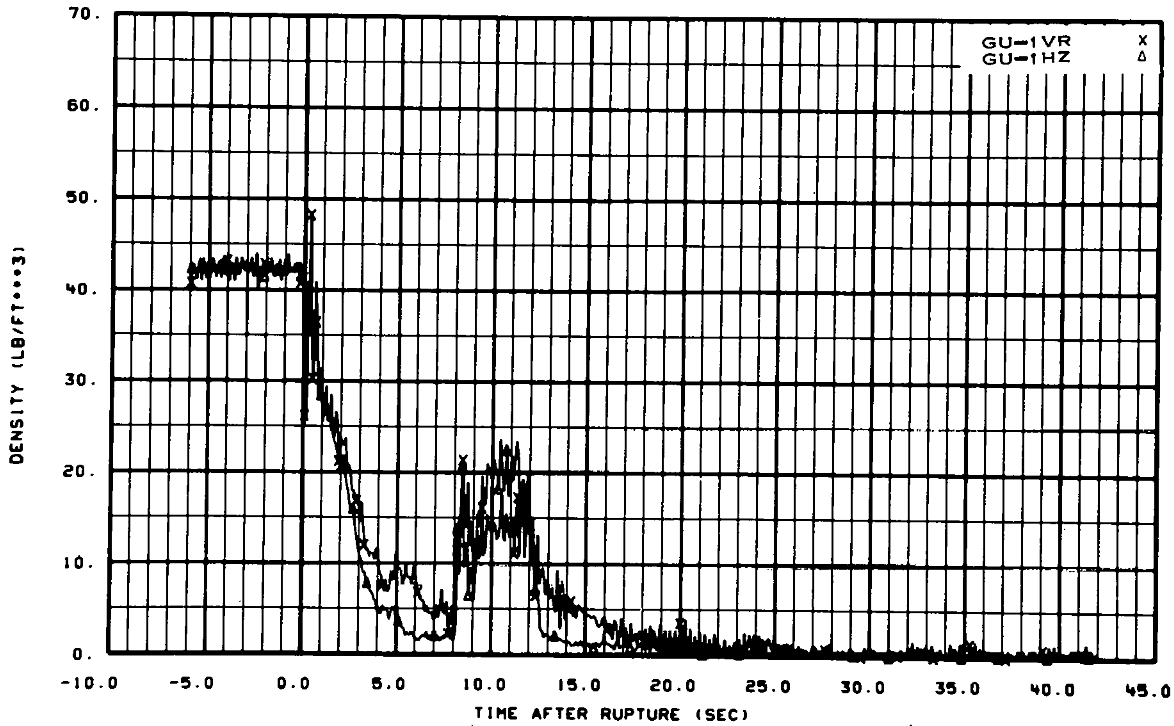

Fig. 123 Density in intact loop (GU-1VR, GU-1HZ).

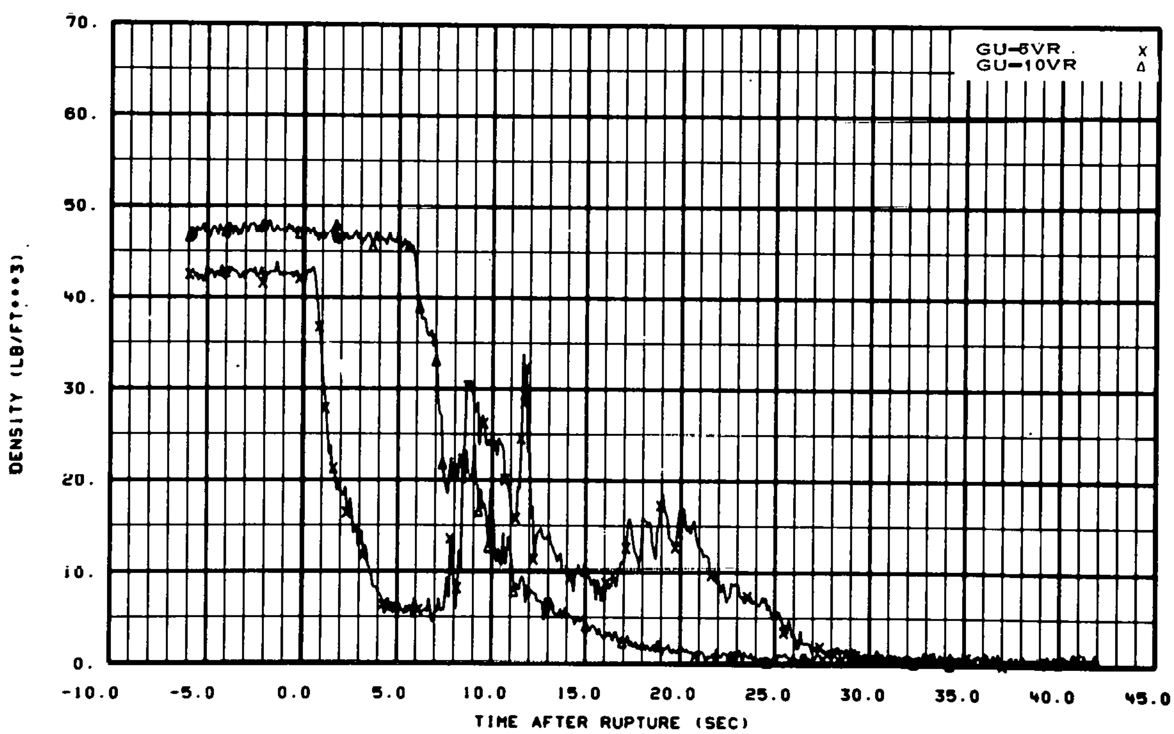

Fig. 124 Density in intact loop (GU-5VR, GU-10VR).

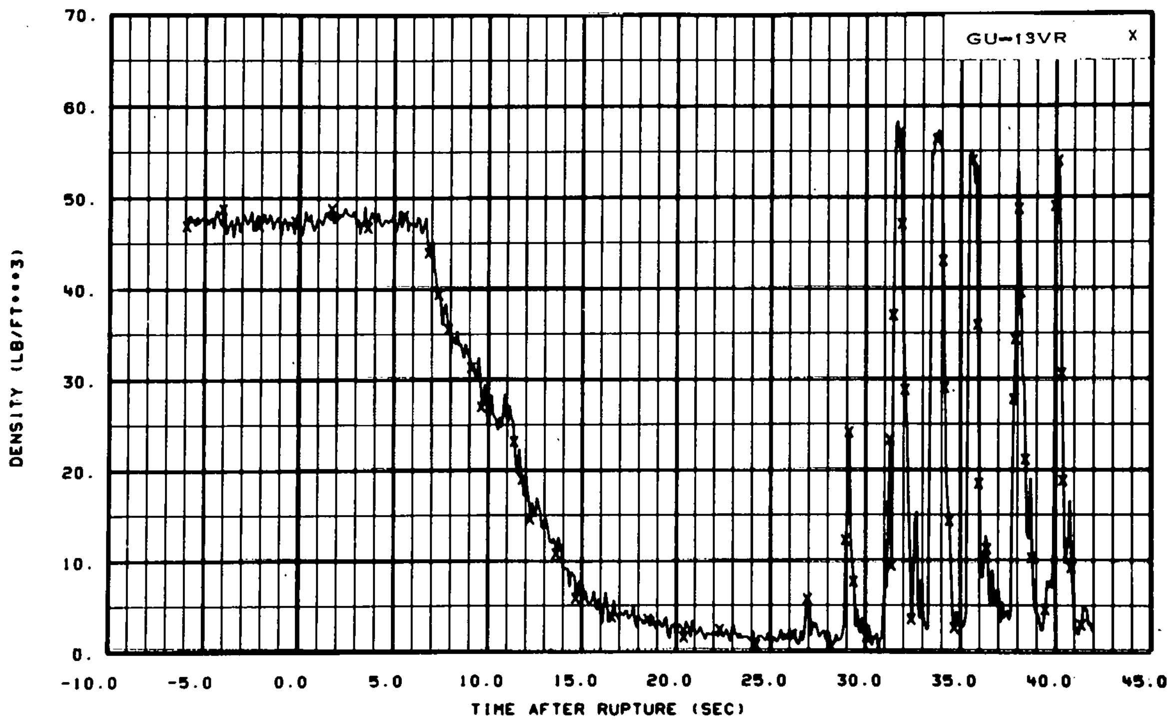

Fig. 125 Density in intact loop (GU-13VR).

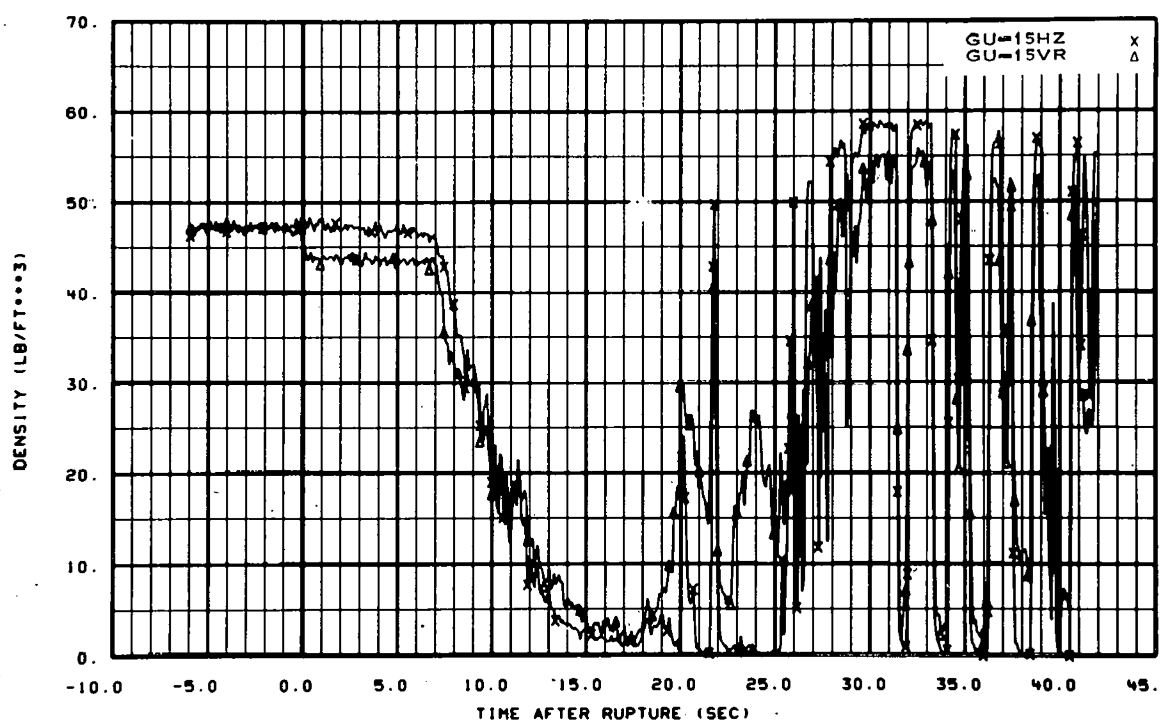

Fig. 126 Density in intact loop (CU-15HZ, GU-15VR).

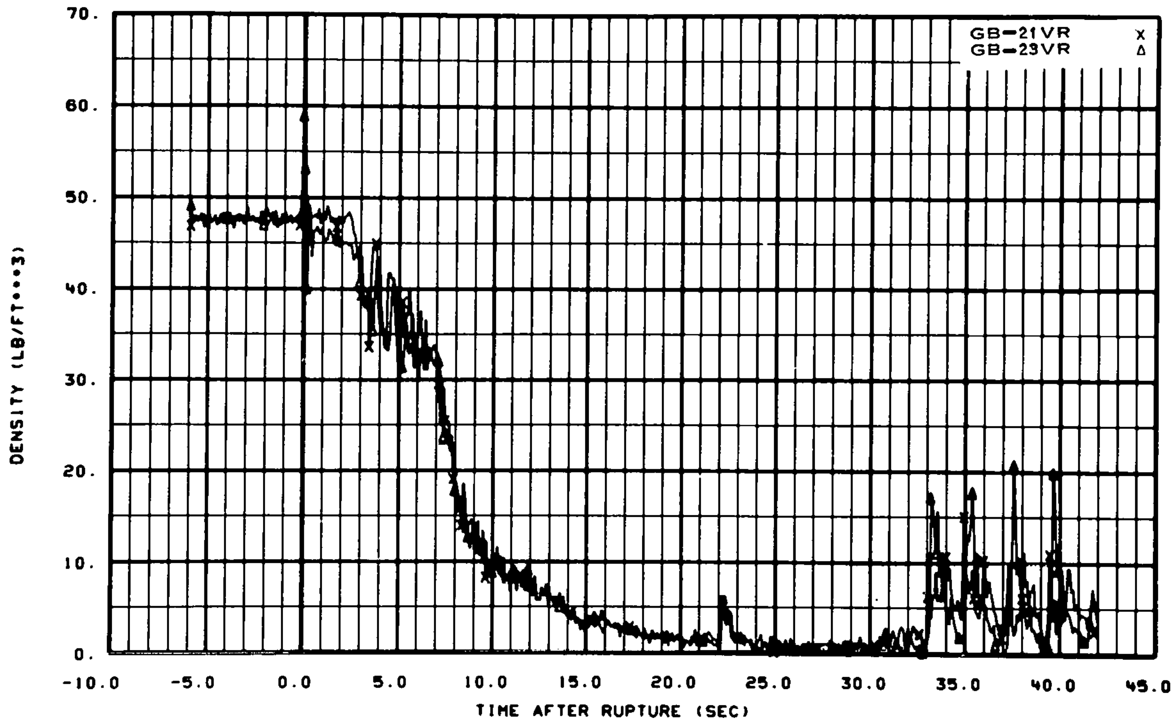

Fig. 127 Density in broken loop (GB-21VR, GB-23VR).

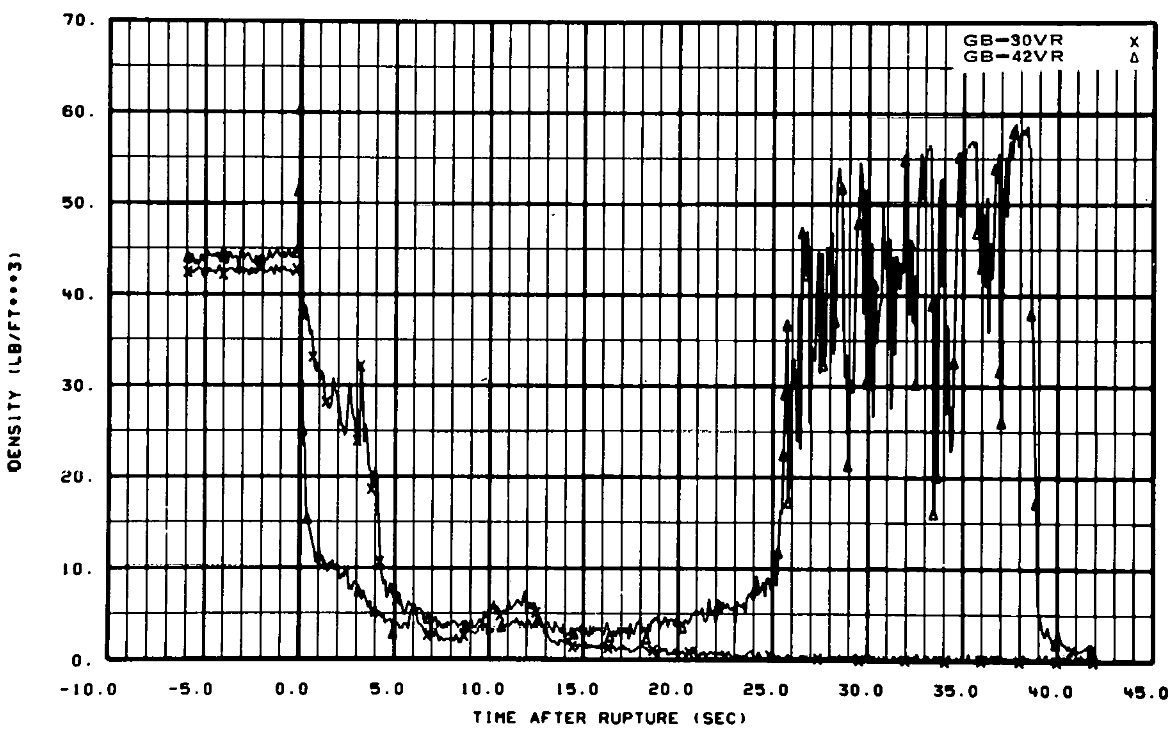

Fig. 128 Density in broken loop (GB-30VR, GB-42VR).

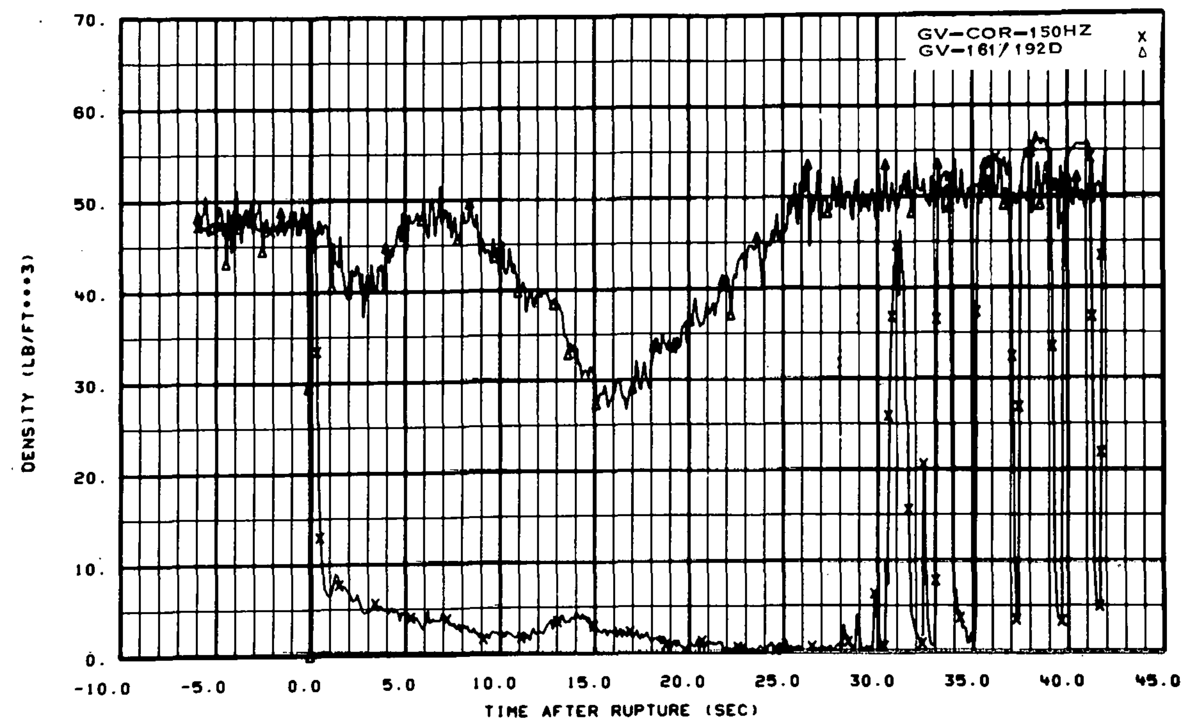

Fig. 129 Density in vessel (GV-COR-150HZ, GV-161/192).

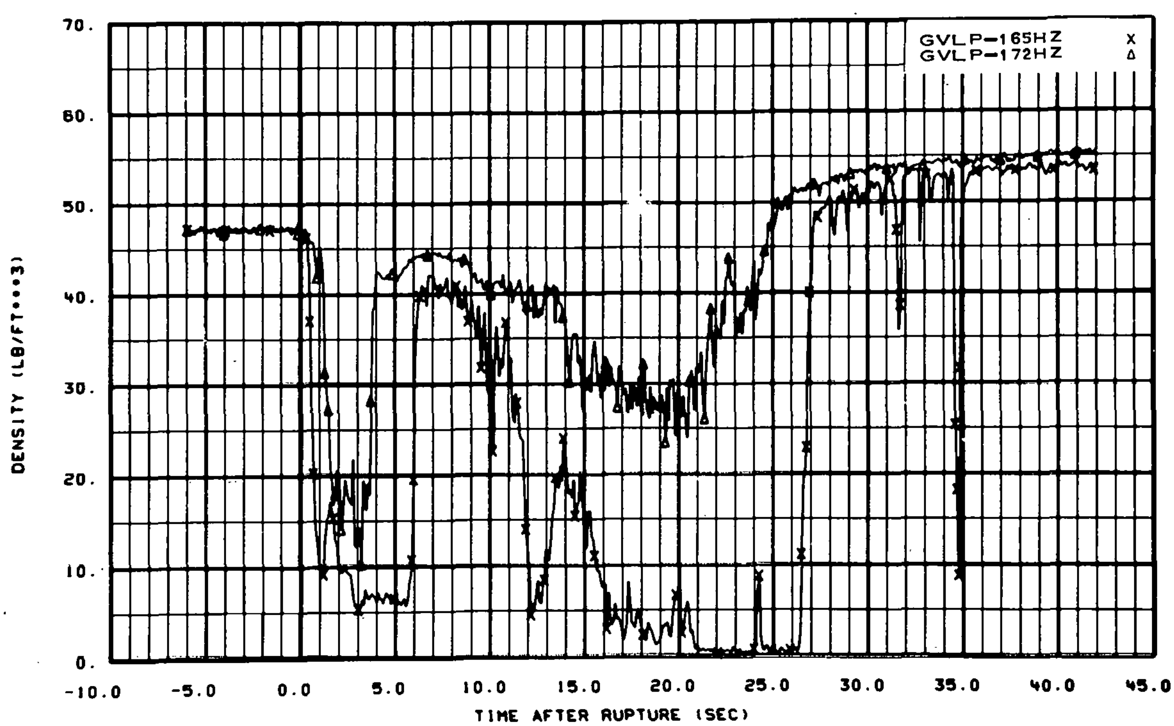

Fig. 130 Density in vessel (GVLP-165HZ, GVLP-172HZ)

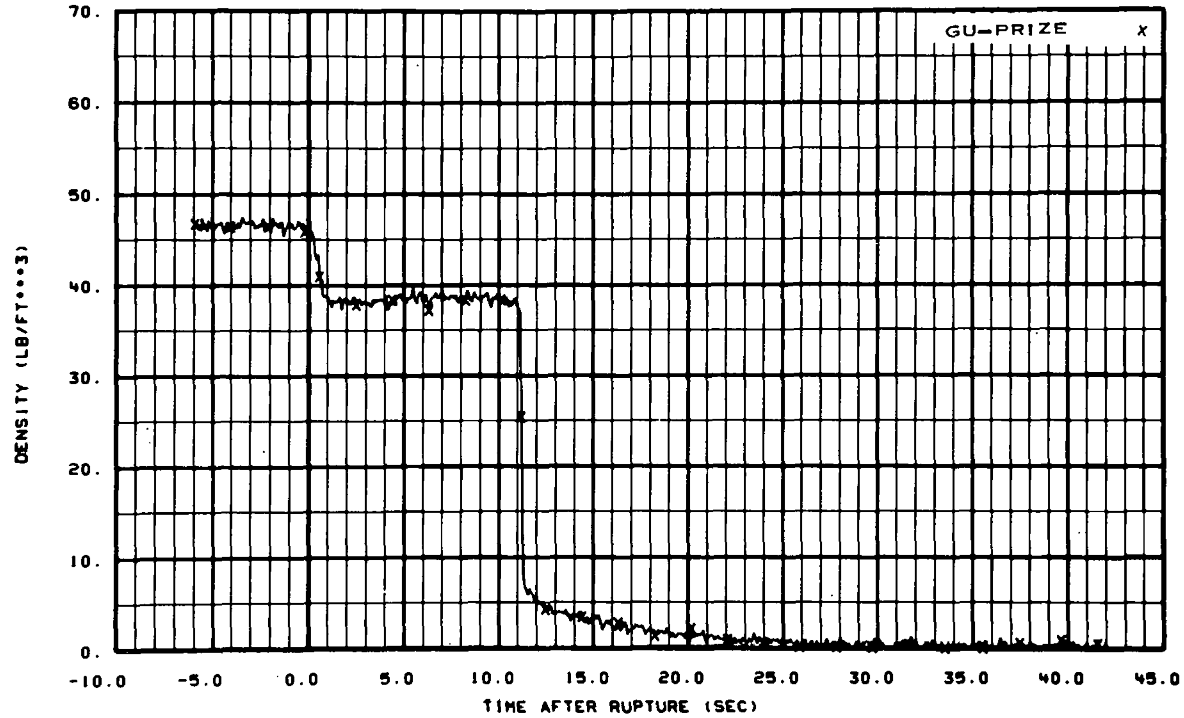

Fig. 131 Density in pressurizer.

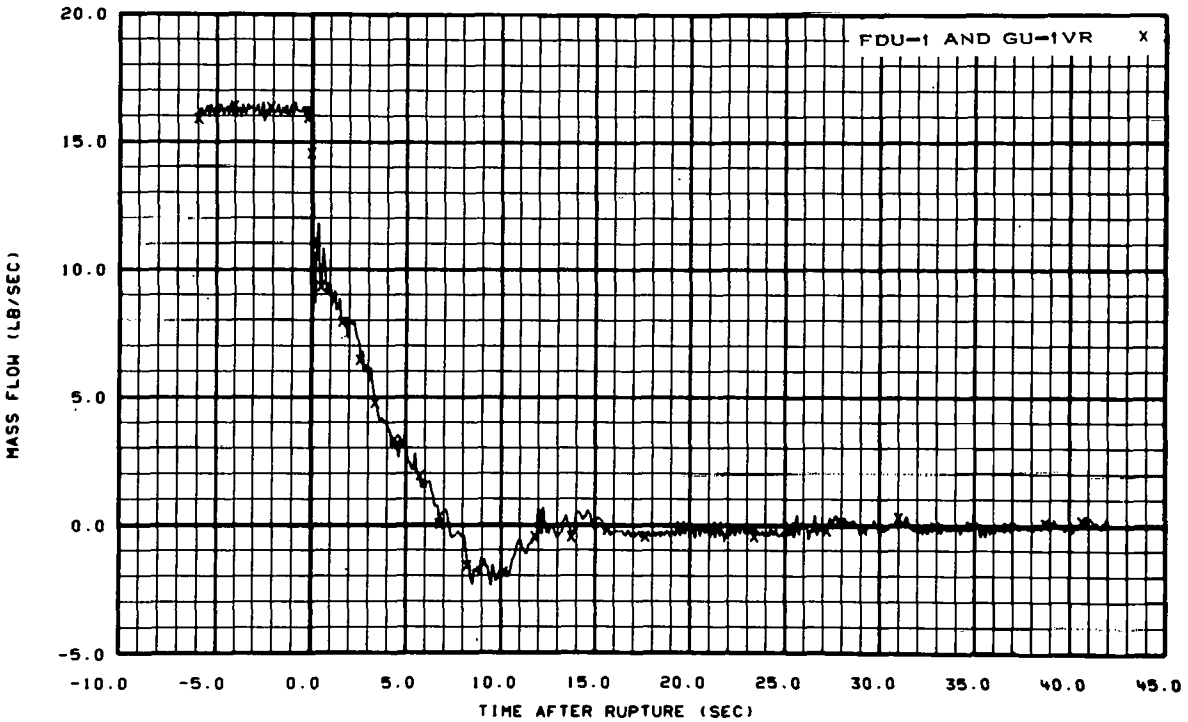

Fig. 132 Mass flow in intact loop (FDU-1 and GU-1VR).

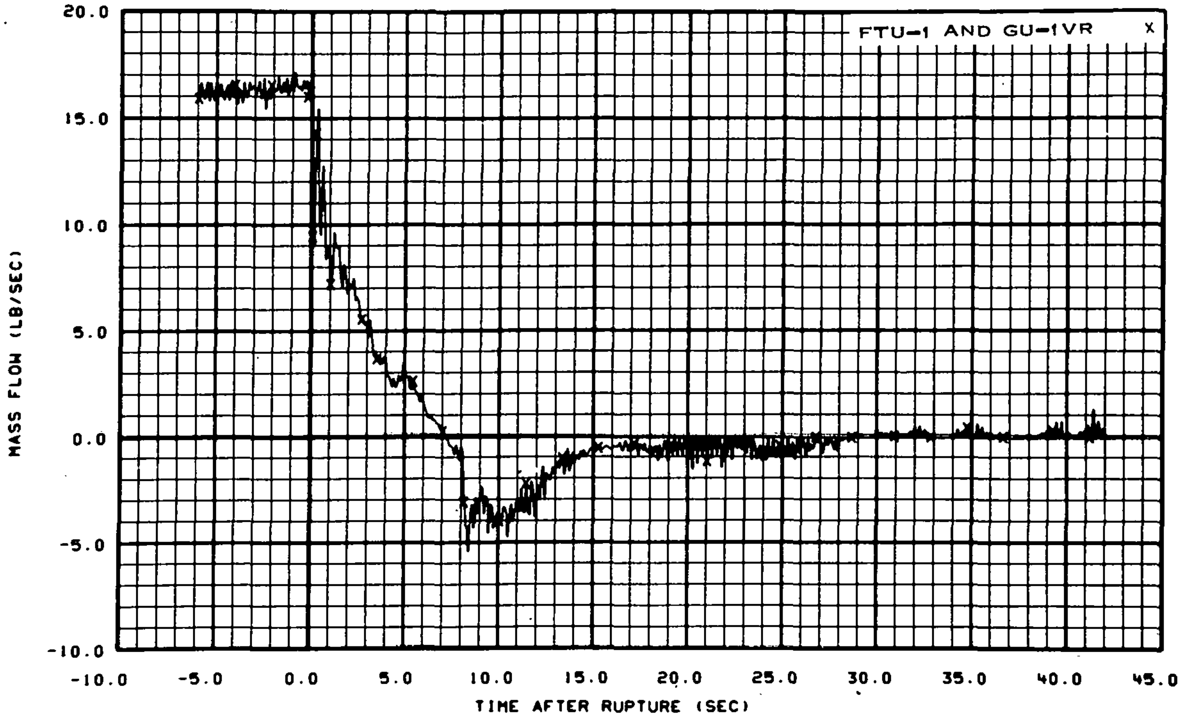

Fig. 133 Mass flow in intact loop (FTU-1 and GU-1VR).

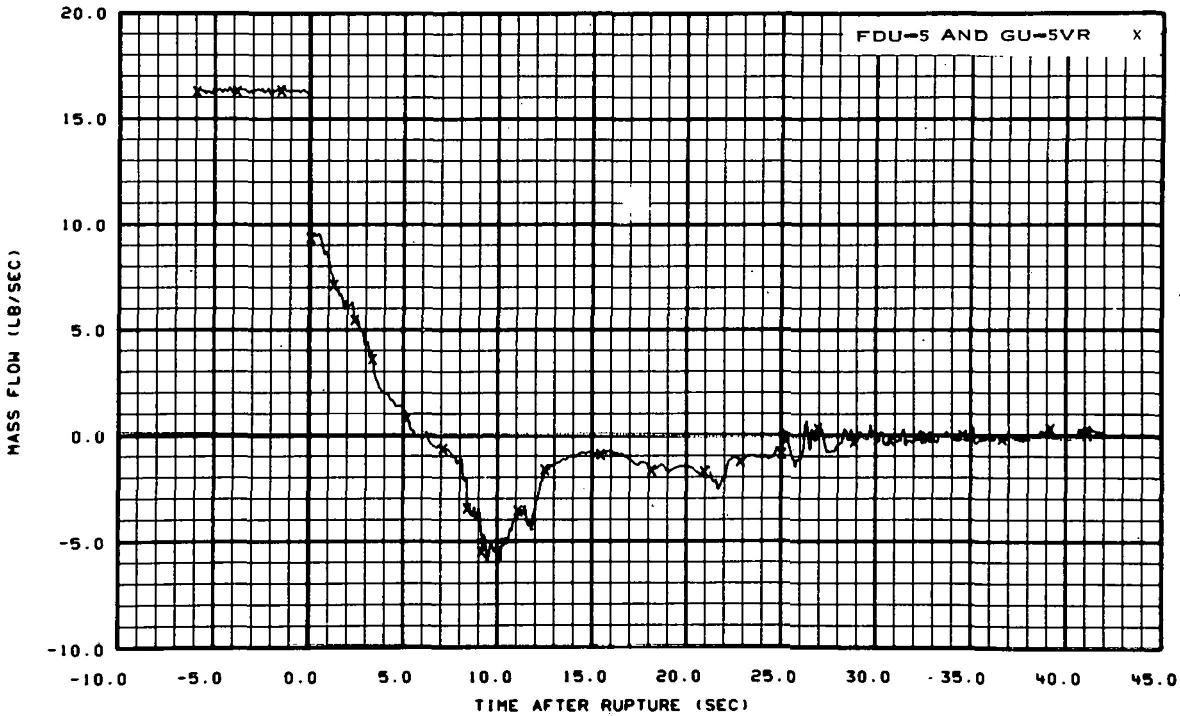

Fig. 134 Mass flow in intact loop (FDU-5 and GU-5VR).

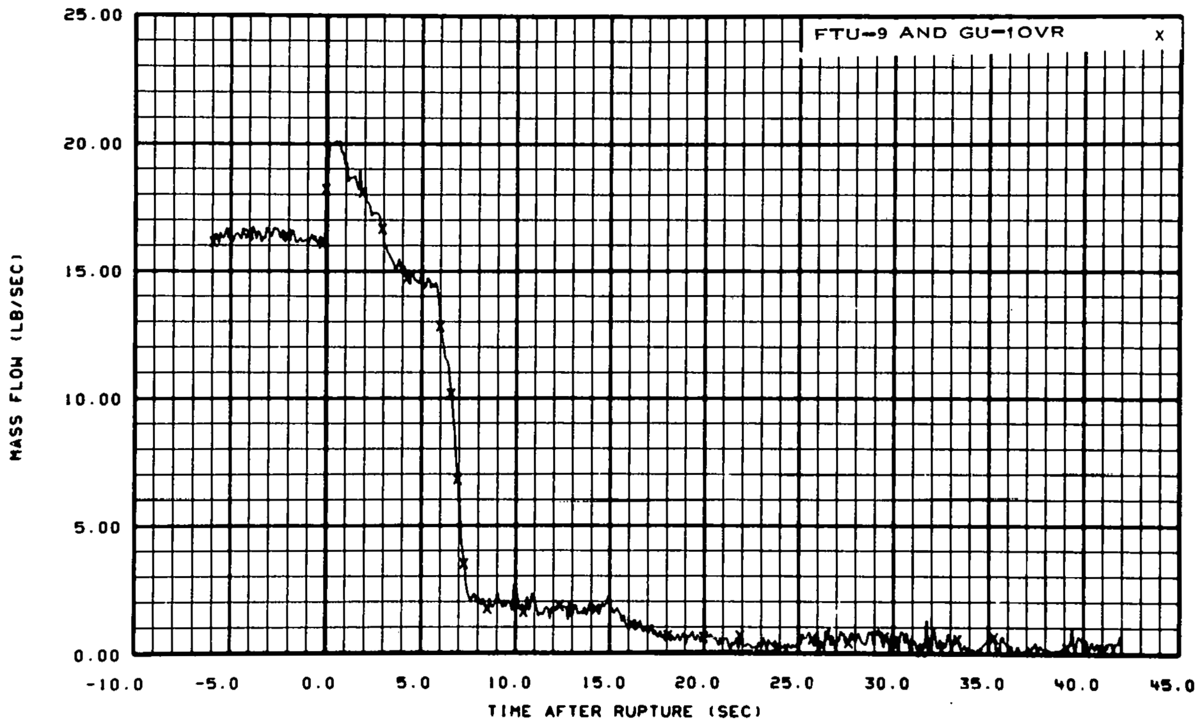

Fig. 135 Mass flow in intact loop (FTU-9 and GU-10VR).

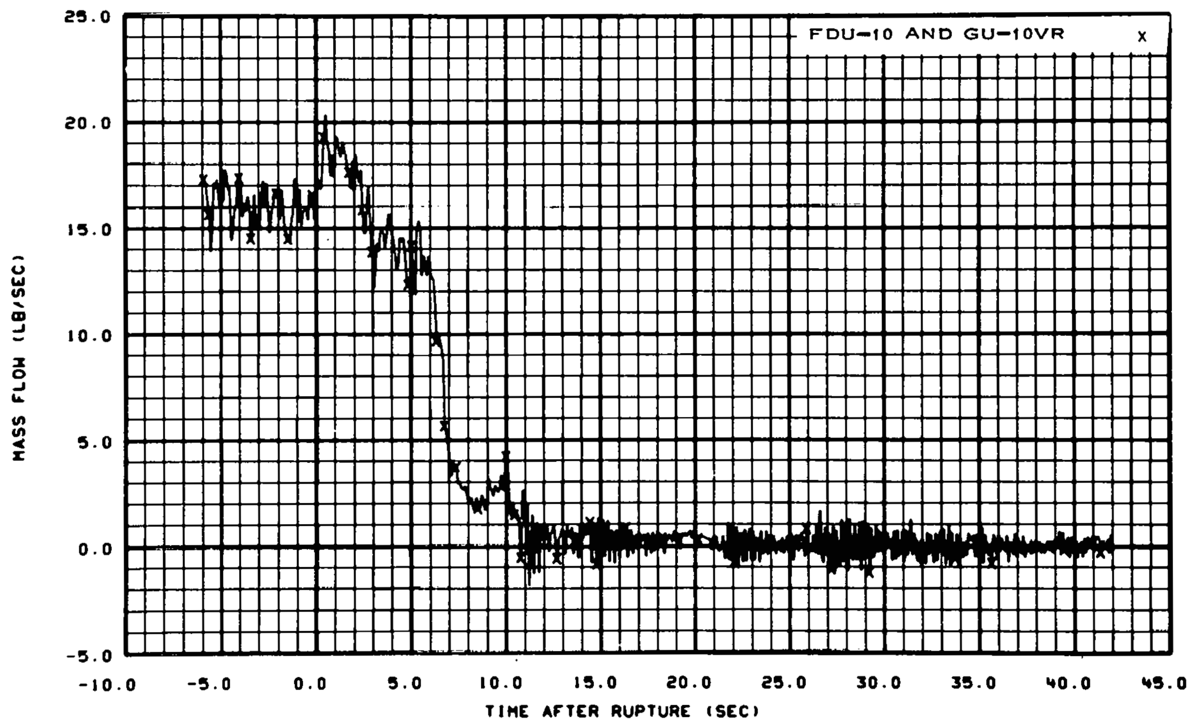

Fig. 136 Mass flow in intact loop (FDU-10 and GU-10VR).

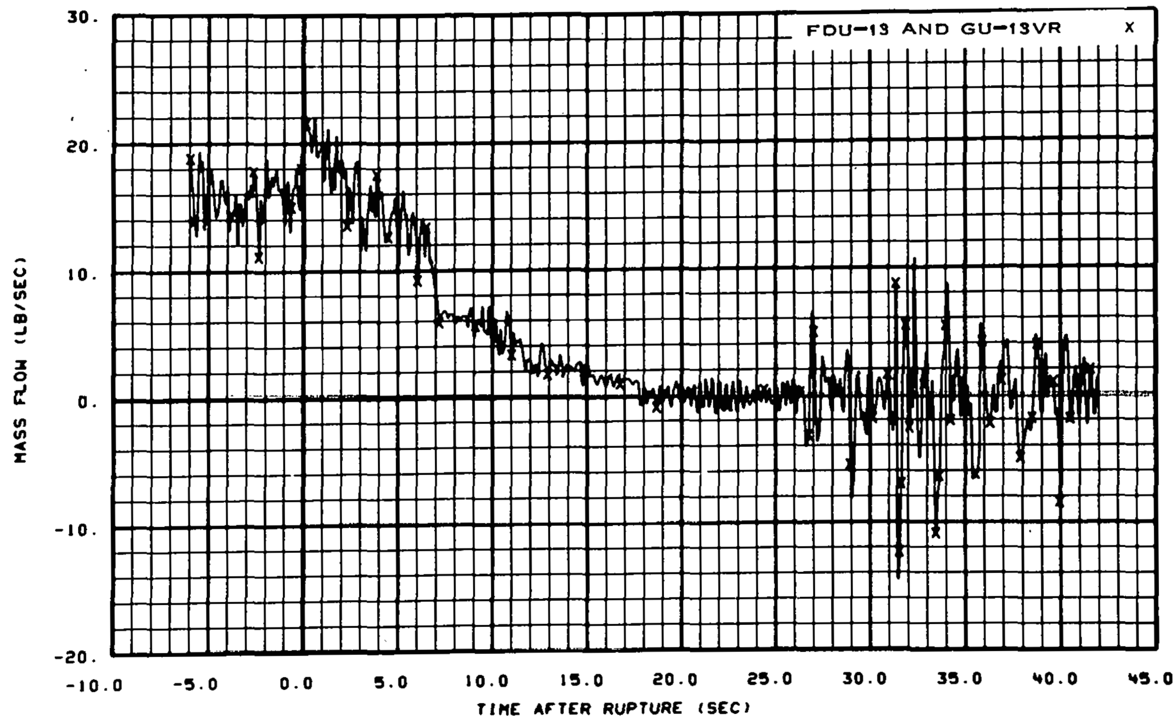

Fig. 137 Mass flow in intact loop (FDU-13 and GU-13VR).

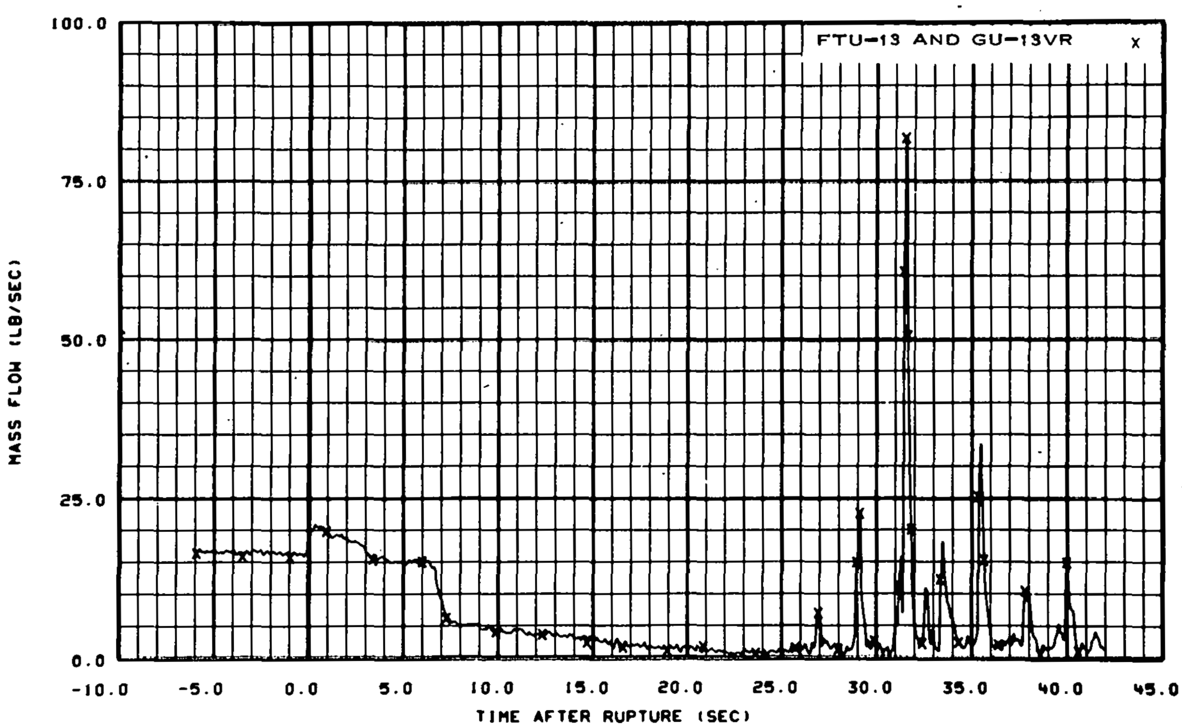

Fig. 138 Mass flow in intact loop (FTU-13 and GU-13VR).

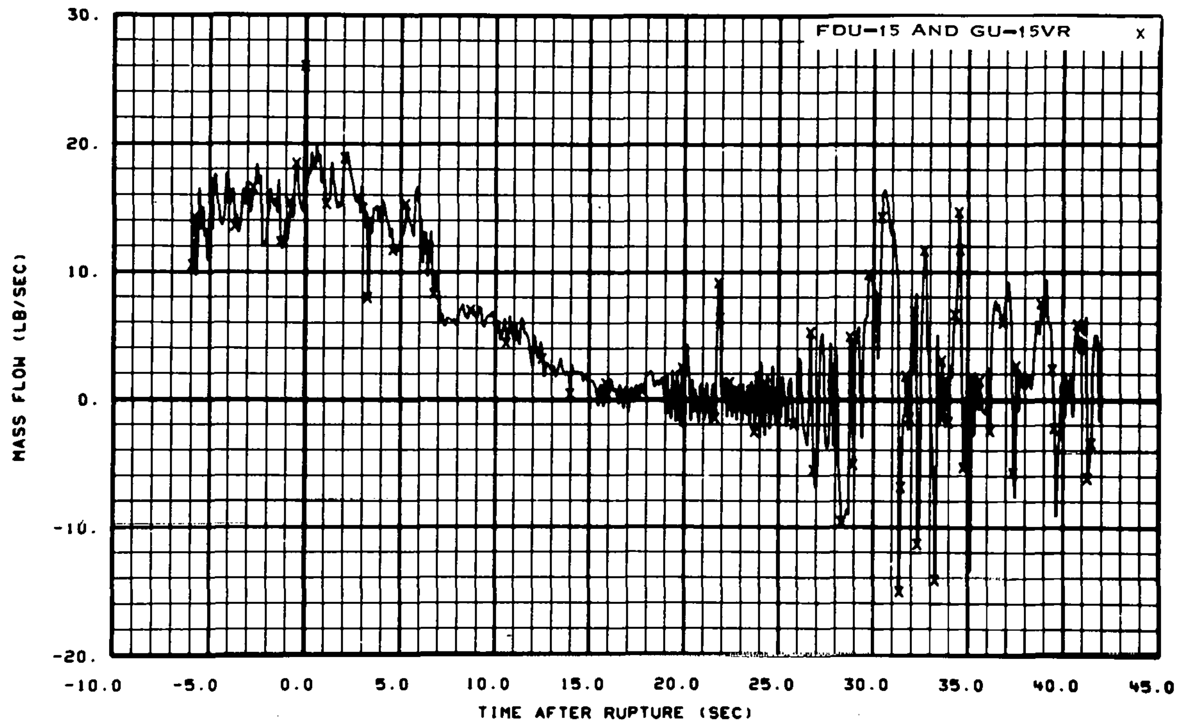

Fig. 139 Mass flow in intact loop (FDU-15 and GU-15VR).

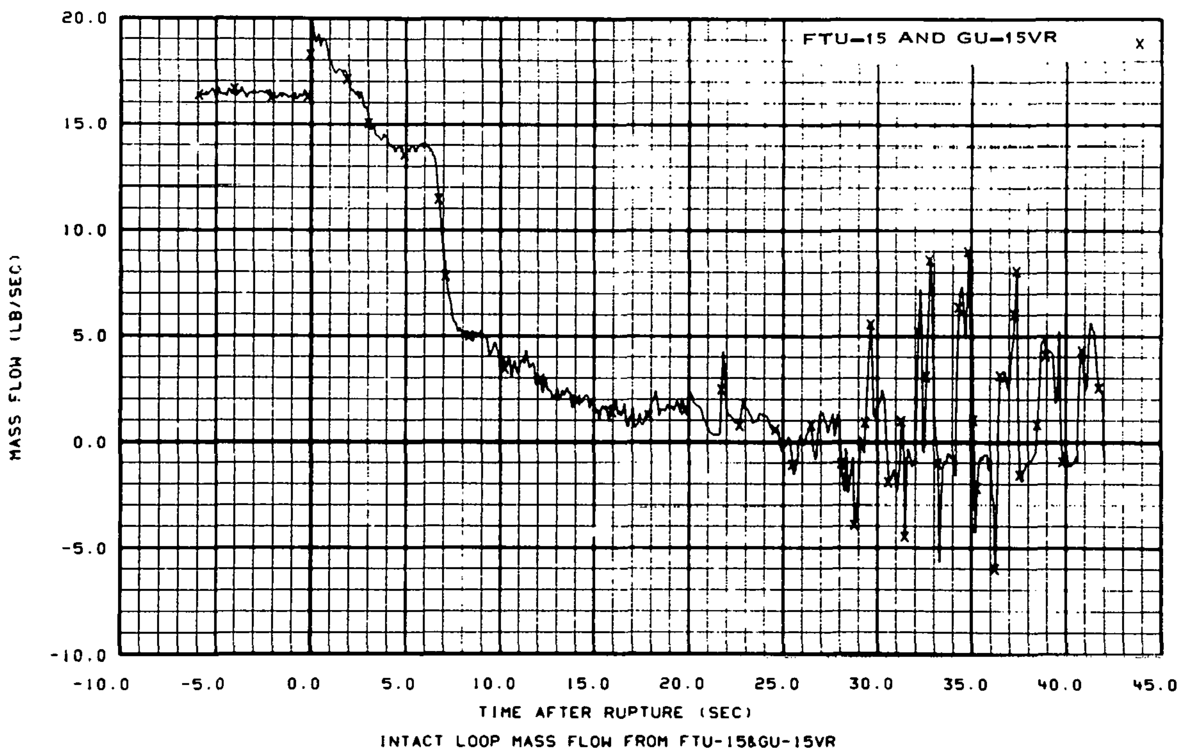

Fig. 140 Mass flow in intact loop (FTU-15 and GU-15VR).

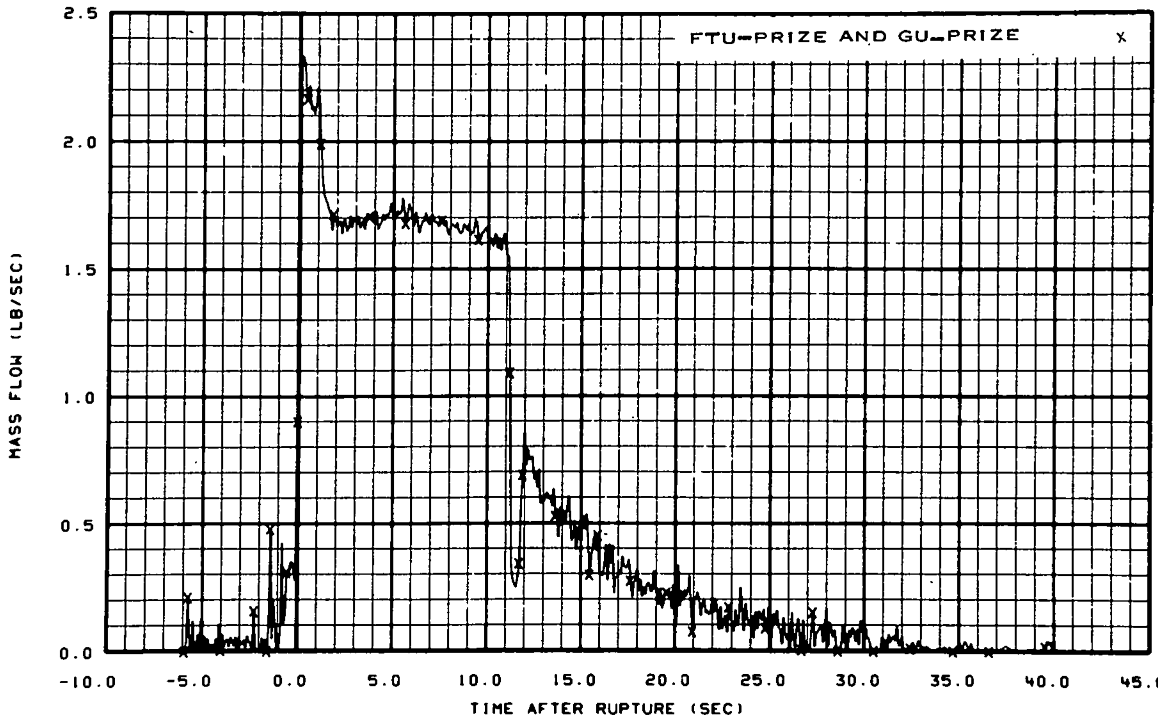

Fig. 141 Mass flow in pressurizer surge line (FTU-PRIZE and GU-PRIZE).

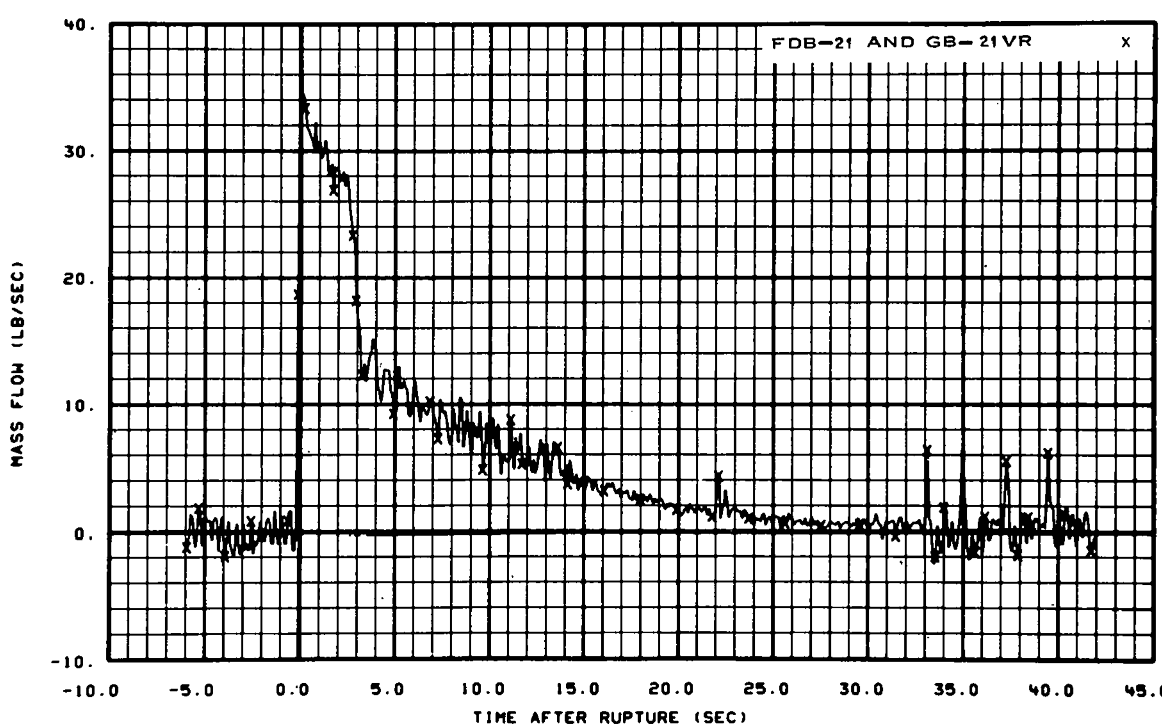

Fig. 142 Mass flow in broken loop (FDB-21 and GB-21VR).

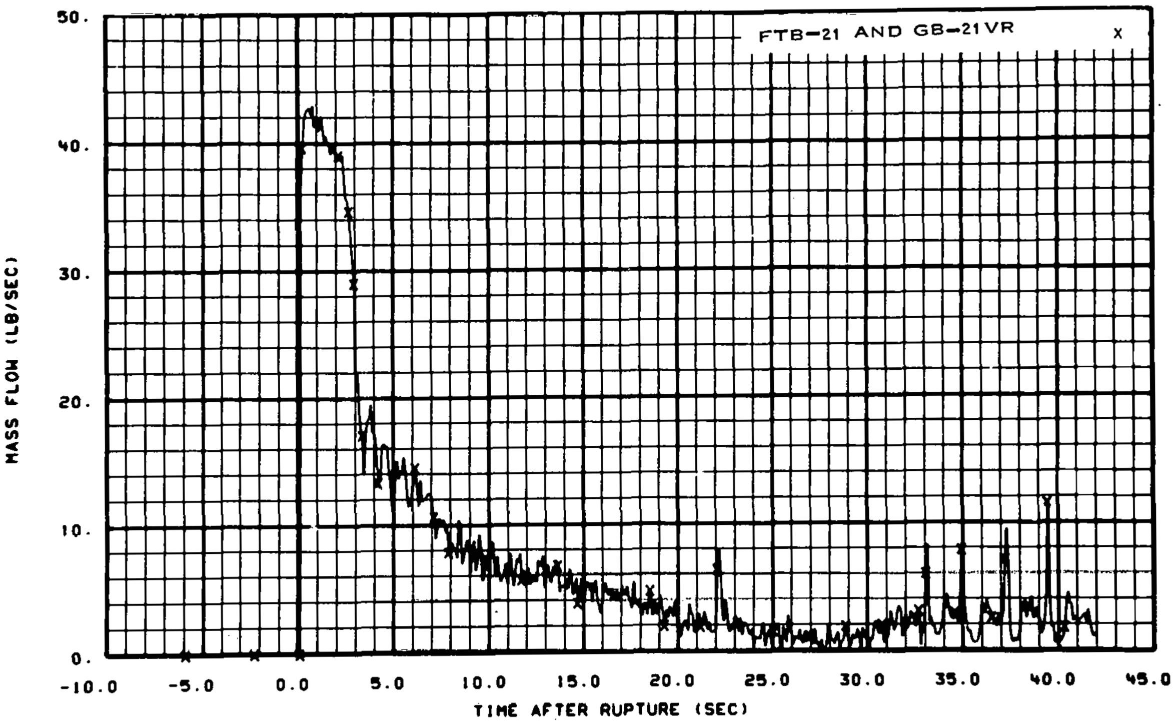

Fig. 143 Mass flow in broken loop (FTB-21 and GB-21VR).

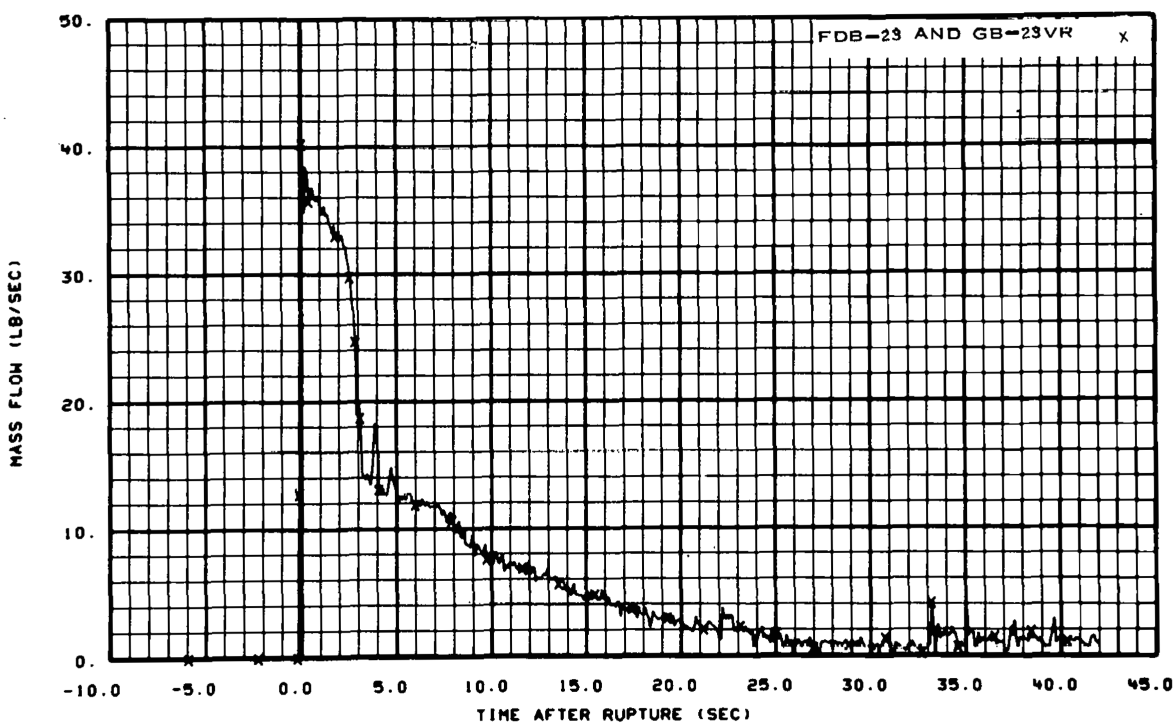

Fig. 144 Mass flow in broken loop (FDB-23 and GB-23VR).

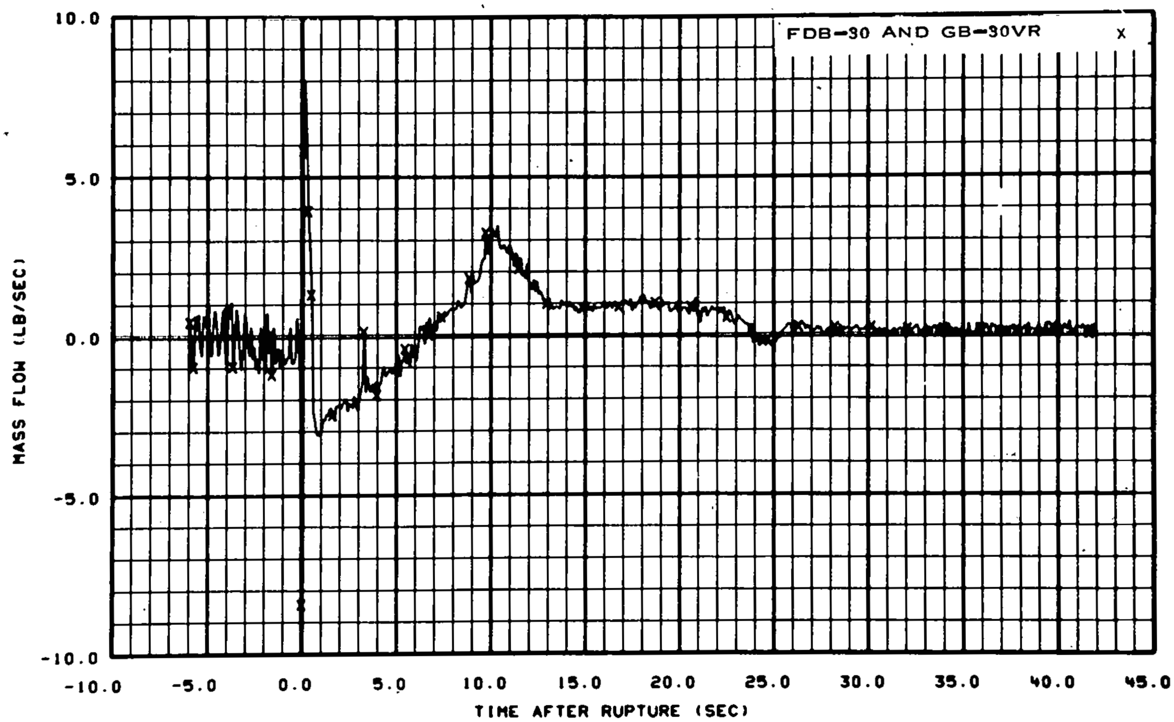

Fig. 145 Mass flow in broken loop (FDB-30 and GB-30VR).

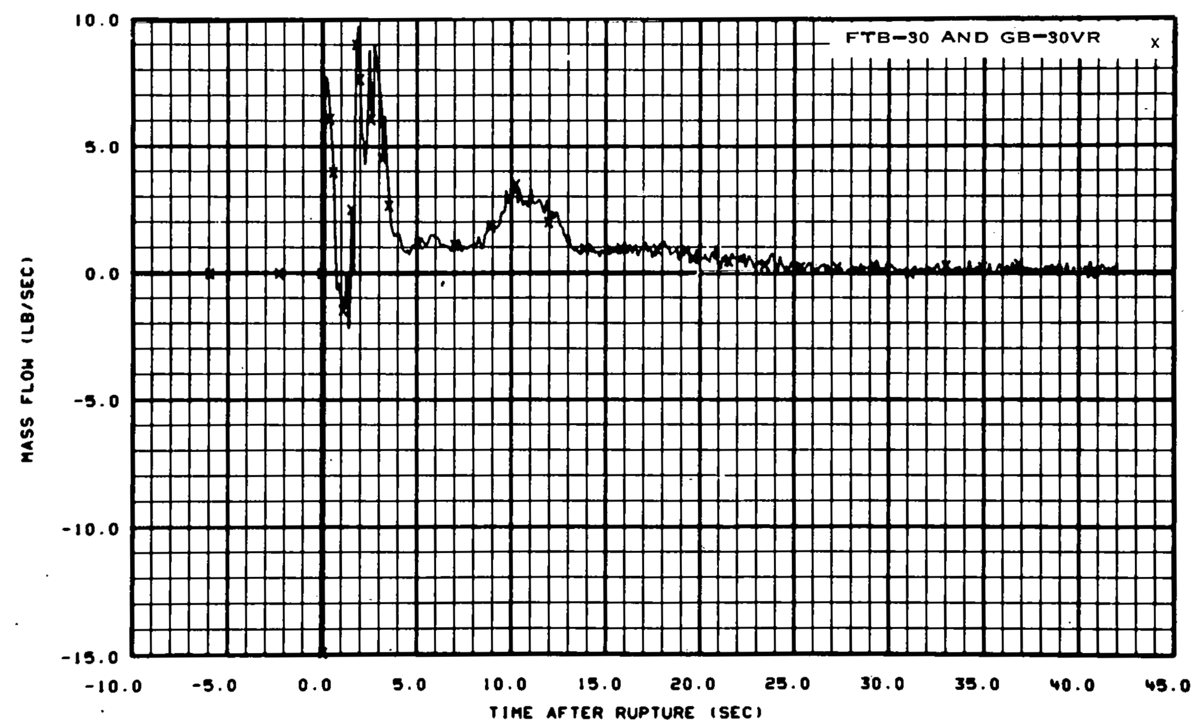

Fig. 146 Mass flow in broken loop (FTB-30 and GB-30VR).

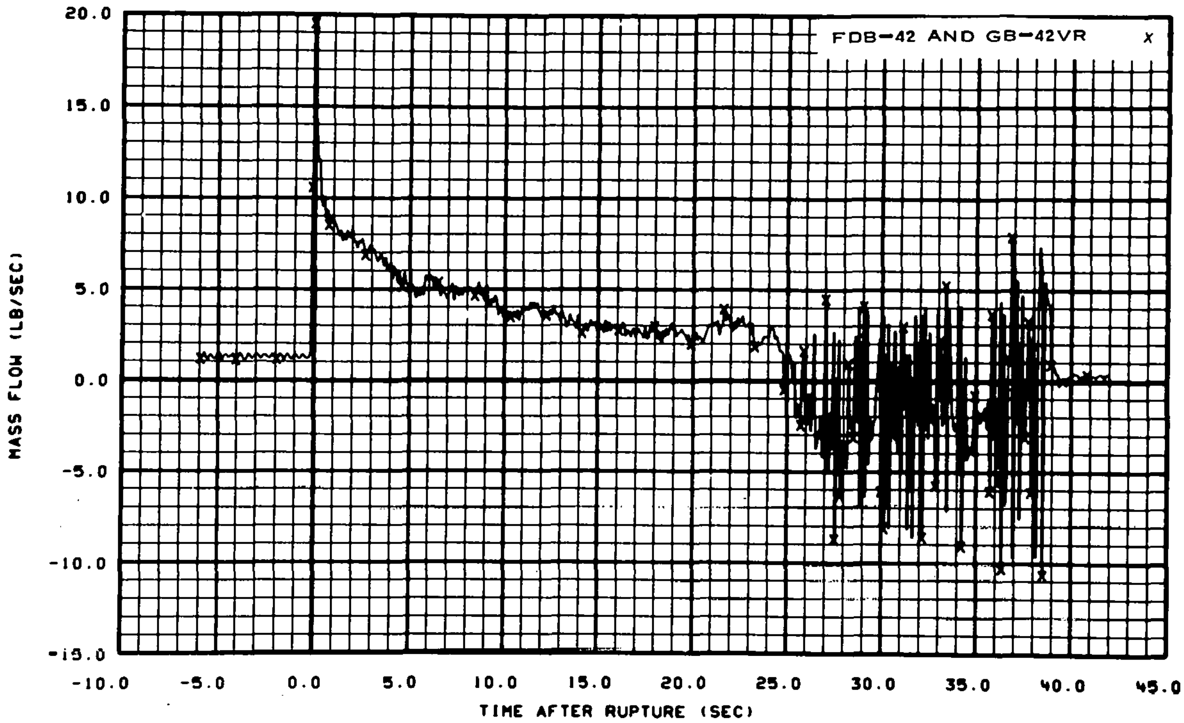

Fig. 147 Mass flow in broken loop (FDB-42 and GB-42VR).

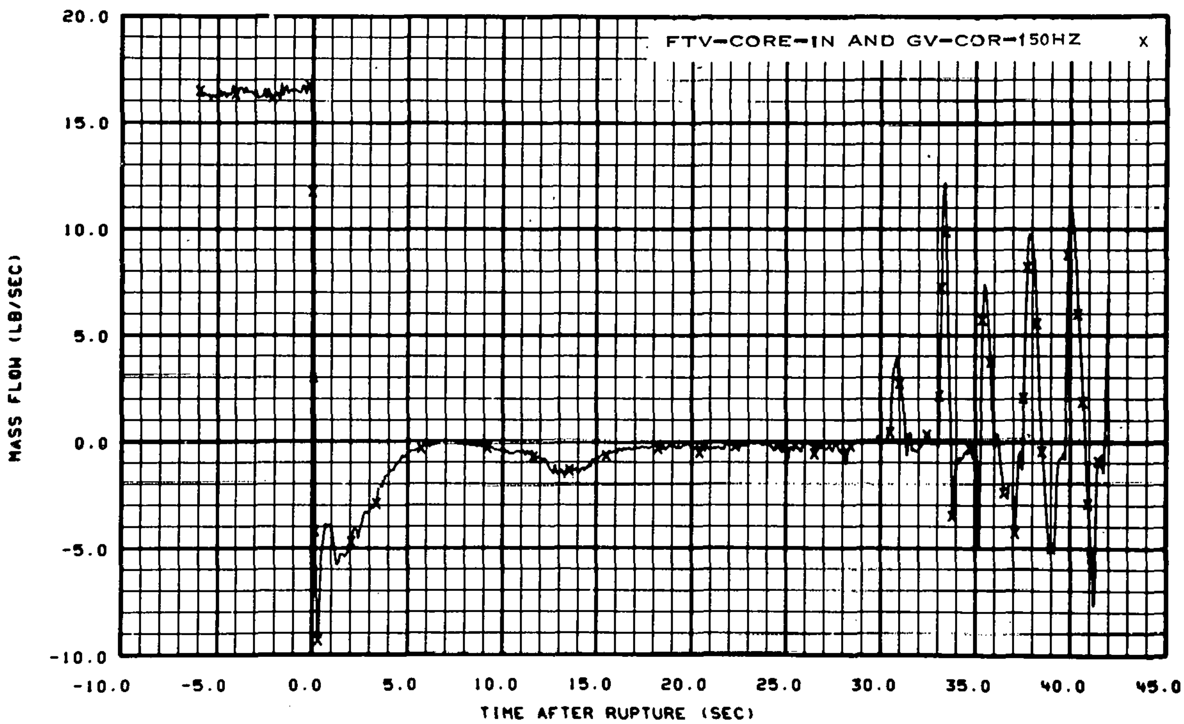

Fig. 148 Mass flow in vessel (FTV-CORE-IN and GV-COR-150HZ).

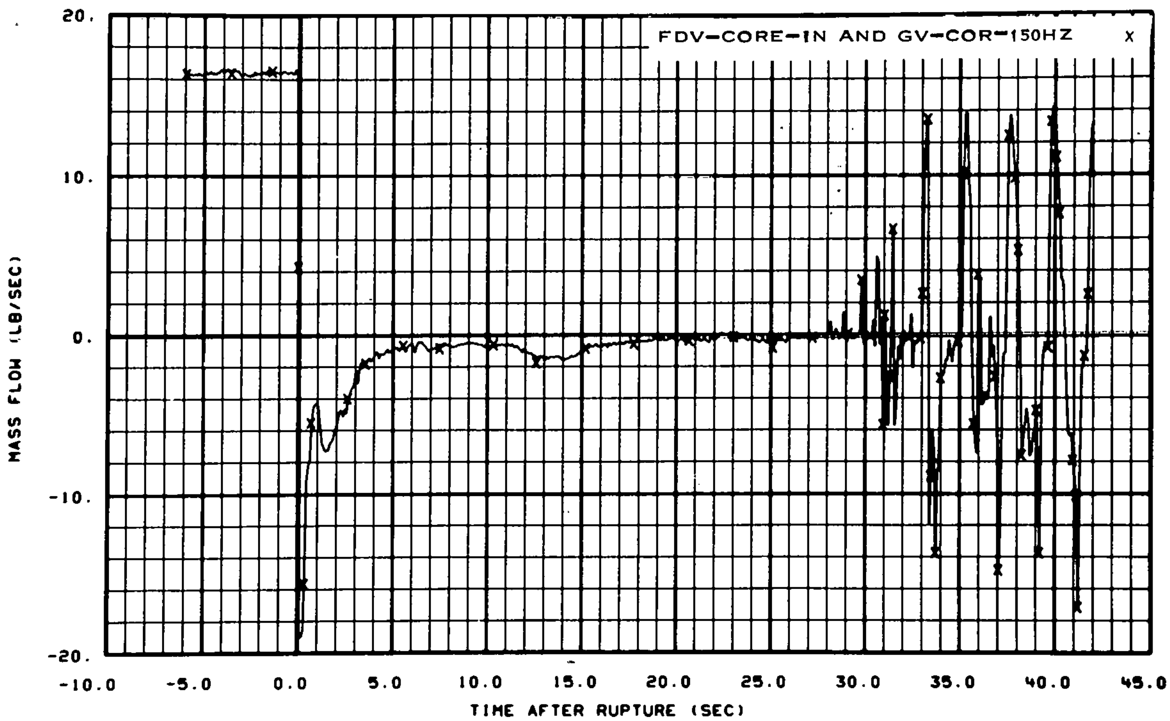

Fig. 149 Mass flow in vessel (FDV-CORE-IN and GV-COR-150HZ).

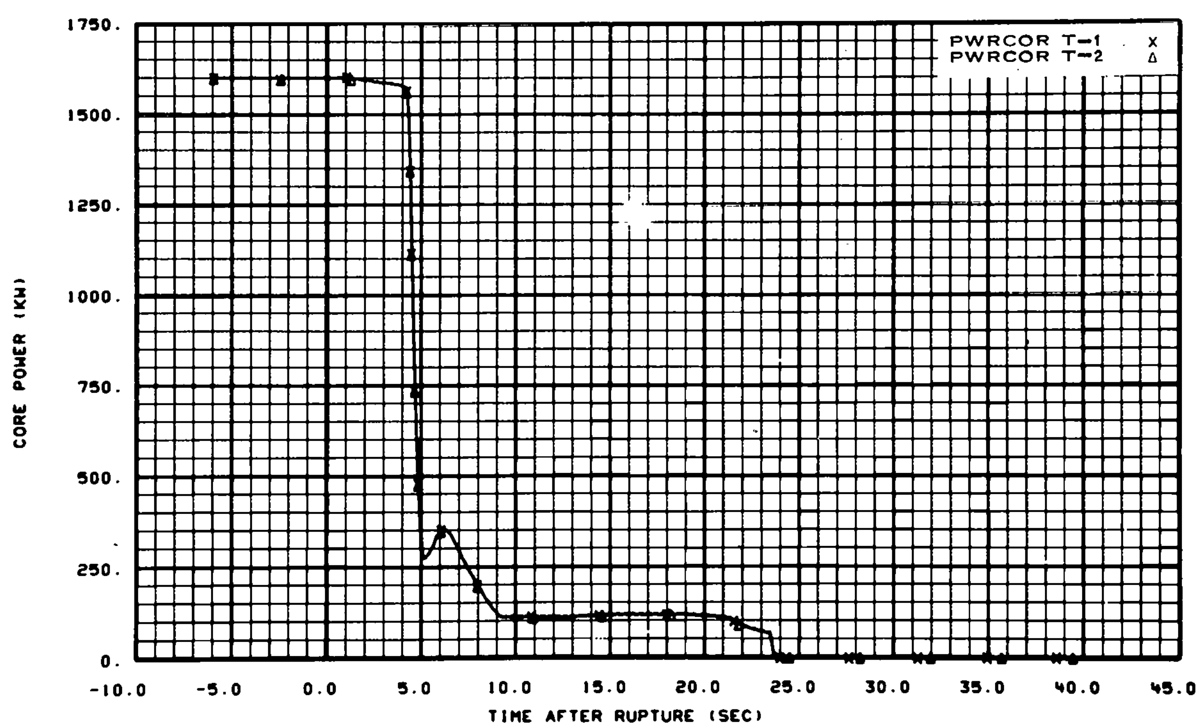

Fig. 150 Core heater pin total power.

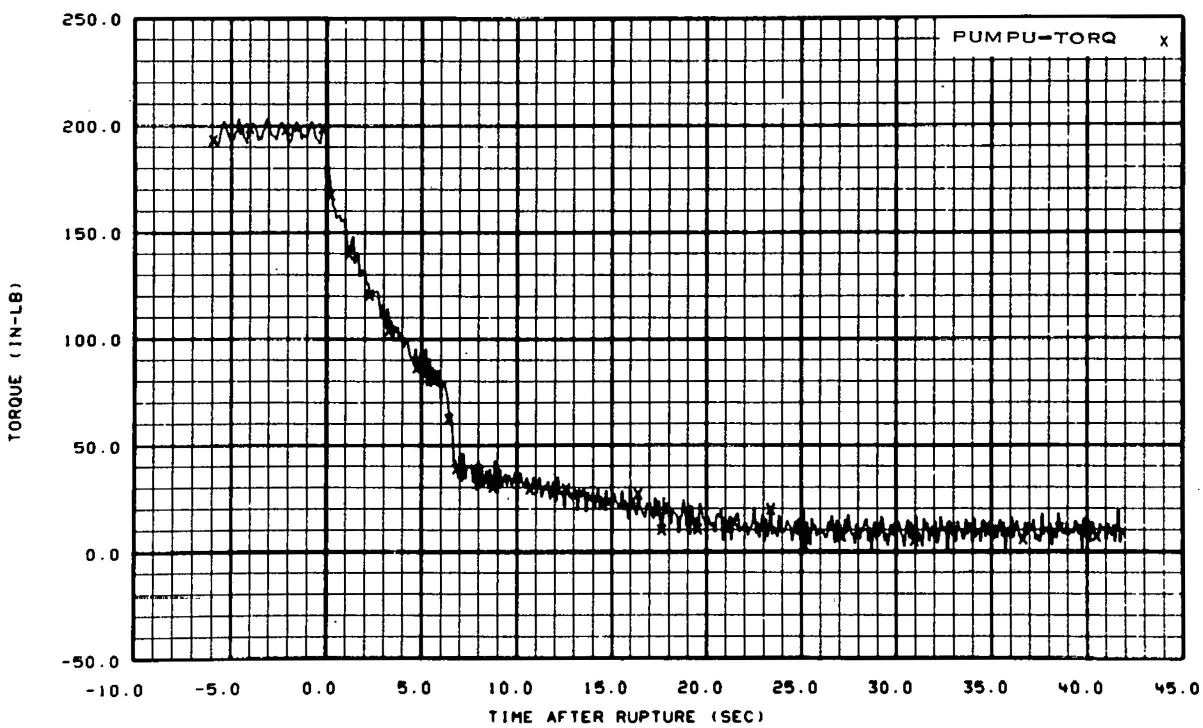

Fig. 151 Primary pump torque.

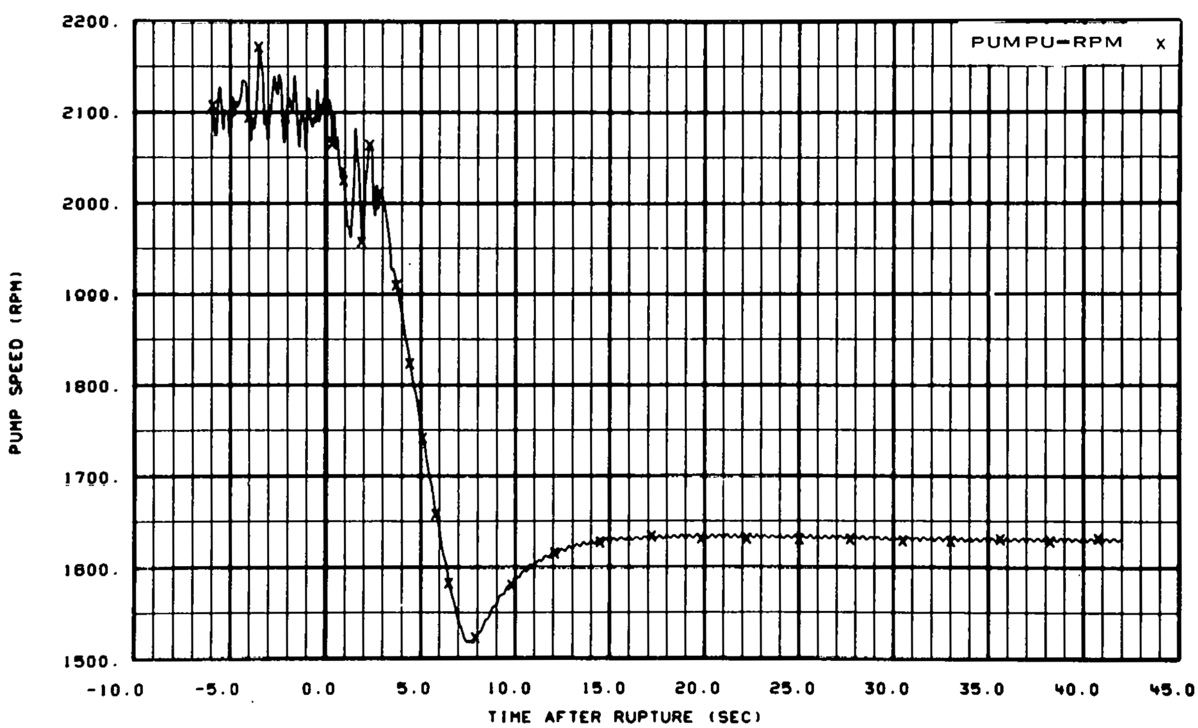

Fig. 152 Primary pump speed.

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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