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**EXPERIMENT DATA REPORT FOR
LOFT ANTICIPATED TRANSIENT WITH
MULTIPLE FAILURES EXPERIMENT L9-1 AND
SMALL BREAK EXPERIMENT L3-3**

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ABSTRACT

Selected, pertinent, and uninterpreted data from the first anticipated transient with multiple failures experiment (Experiment L9-1) and the sixth nuclear small break loss-of-coolant experiment (Experiment L3-3) conducted in the Loss-of-Fluid Test (LOFT) facility are presented. The LOFT facility is a 50-MW(t) pressurized water reactor (PWR) system with instruments that measure and provide data on the thermal-hydraulic conditions during a postulated loss-of-coolant accident. The operation of the LOFT system is typical of large [~ 1000 MW(e)], commercial PWR operations.

Experiment L9-1 simulated a loss-of-feedwater accident (anticipated transient) with delayed reactor scram and no auxiliary feedwater injection (multiple failures). The loss-of-feedwater accident led to a loss-of-coolant accident through the pressurizer power-operated relief valve. Experiment L3-3 consisted of two typical commercial PWR recovery scenarios for the loss-of-feedwater induced loss-of-coolant accident that did not include the emergency core cooling systems: (a) latching open the power-operated relief valve and (b) using feed and bleed after refilling the steam generator.

SUMMARY

Experiment L9-1/L3-3 was performed on April 15, 1981, as part of the Loss-of-Fluid Test (LOFT) Experimental Program conducted by EG&G Idaho, Inc., for the U.S. Nuclear Regulatory Commission. Experiment L9-1 is part of the LOFT Anticipated Transient with Multiple Failure Experiment Series L9. Experiment L3-3 is part of the LOFT Small Break Experiment Series L3.

For the performance of Experiment L9-1/L3-3, the pressurizer in the LOFT facility was configured with additional piping and a power-operated relief valve (PORV) scaled to be typical of a large [~ 1000 MW(e)] pressurized water reactor PORV (47.6 kg/h/MW of steam relief capacity at 16.18 MPa). This is referred to as the experiment PORV and was installed in parallel to the plant PORV. Experiment L9-1 was initiated by turning off the secondary coolant system main feedwater pump. The multiple failures that followed were the absence of steam generator auxiliary feedwater injection and delayed reactor scram. The scram occurred on indication of high pressure in the intact loop hot leg rather than low liquid level in the steam generator. After reactor scram, the steam generator steam control valve closed at $77.2^{+0.0}_{-0.2}$ s. The liquid level in the steam generator dropped below the range of the level measurement at 190^{+10}_{-20} s. Pressurizer spray valve cycling began prior to reactor scram at 30.0 ± 0.1 s and was terminated at 1246.0 ± 0.1 s.

When the experiment PORV pressure setpoint was reached at 1467.9 ± 0.1 s, the PORV began cycling and was allowed to cycle for ~ 1800 s. The

PORV was then held open, signifying the beginning of Experiment L3-3. The primary coolant pumps were manually tripped at the start of Experiment L3-3 and allowed to coast down. At ~ 25 s after pump coastdown was complete, the upper plenum reached saturation conditions. The experiment PORV was closed at 4849.7 ± 0.1 s and remained closed throughout the rest of the experiment. Steam generator refill took place between $5114.0^{+0.2}_{-0.0}$ and $5746.4^{+0.2}_{-0.0}$ s. Natural circulation was established in the primary coolant system at 5205^{+10}_{-5} s, during steam generator refill. Secondary system feed and bleed began with a bleed operation at $6712.2^{+0.2}_{-0.0}$ s. The experiment ended just before high-pressure injection system flow was injected into the primary coolant system.

During Experiment L9-1/L3-3, the emergency core coolant systems were not used.

Experiment L9-1/L3-3 was initiated from primary coolant system initial conditions of: hot leg temperature, 578 ± 2 K; cold leg temperature, 559 ± 1 K; hot leg pressure, 14.90 ± 0.10 MPa; and intact loop flow rate, 479.1 ± 2.6 kg/s. The preexperiment power level was 50 ± 1 MW, with a maximum linear heat generation rate of 50.8 ± 3.6 kW/m.

Experiment L9-1/L3-3 satisfied the specified objectives. This report presents data in the form of graphs in SI and British units. In conjunction with data obtained from direct measurement, chosen computed variables are included to facilitate the analysis of the system thermal-hydraulic behavior.

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ACRONYMS AND ABBREVIATIONS

ACC	Accumulator	LOCE	Loss-of-coolant experiment
BST	Blowdown suppression tank	LOFT	Loss-of-Fluid Test
BWST	Borated water storage tank	LPIS	Low-pressure injection system
DAVDS	Data acquisition and visual display system	PCP	Primary coolant pump
		PCS	Primary coolant system
DDT	Drag disc-turbine transducer	PORV	Power-operated relief valve
ECC	Emergency core cooling or coolant	PWR	Pressurized water reactor
ECCS	Emergency core cooling system	QOBV	Quick-opening blowdown valve
ESF	Engineered safety features	RV	Reactor vessel
FM	Frequency modulation	SCS	Secondary coolant system
HPIS	High-pressure injection system	SG	Steam generator
LOCA	Loss-of-coolant accident	XRO	Orifice

EXPERIMENT DATA REPORT FOR LOFT ANTICIPATED TRANSIENT WITH MULTIPLE FAILURES EXPERIMENT L9-1 AND SMALL BREAK EXPERIMENT L3-3

1. INTRODUCTION

This report presents selected, pertinent, and uninterpreted data from Experiment L9-1/L3-3, which was conducted in the Loss-of-Fluid Test (LOFT) facility on April 15, 1981. Experiment L9-1 was the first anticipated transient with multiple failures experiment performed at LOFT and simulated a loss-of-feedwater accident (anticipated transient) with delayed reactor scram and no auxiliary feedwater injection (multiple failures). The loss-of-feedwater accident led to a loss-of-coolant accident (LOCA) through the pressurizer power-operated relief valve (PORV). Experiment L3-3 was the sixth nuclear small break loss-of-coolant experiment (LOCE) performed in the LOFT facility and simulated a loss-of-feedwater induced LOCA recovery without the aid of emergency core coolant (ECC). The recovery methods used were (a) latching open the PORV and (b) using feed and bleed after refilling the steam generator.

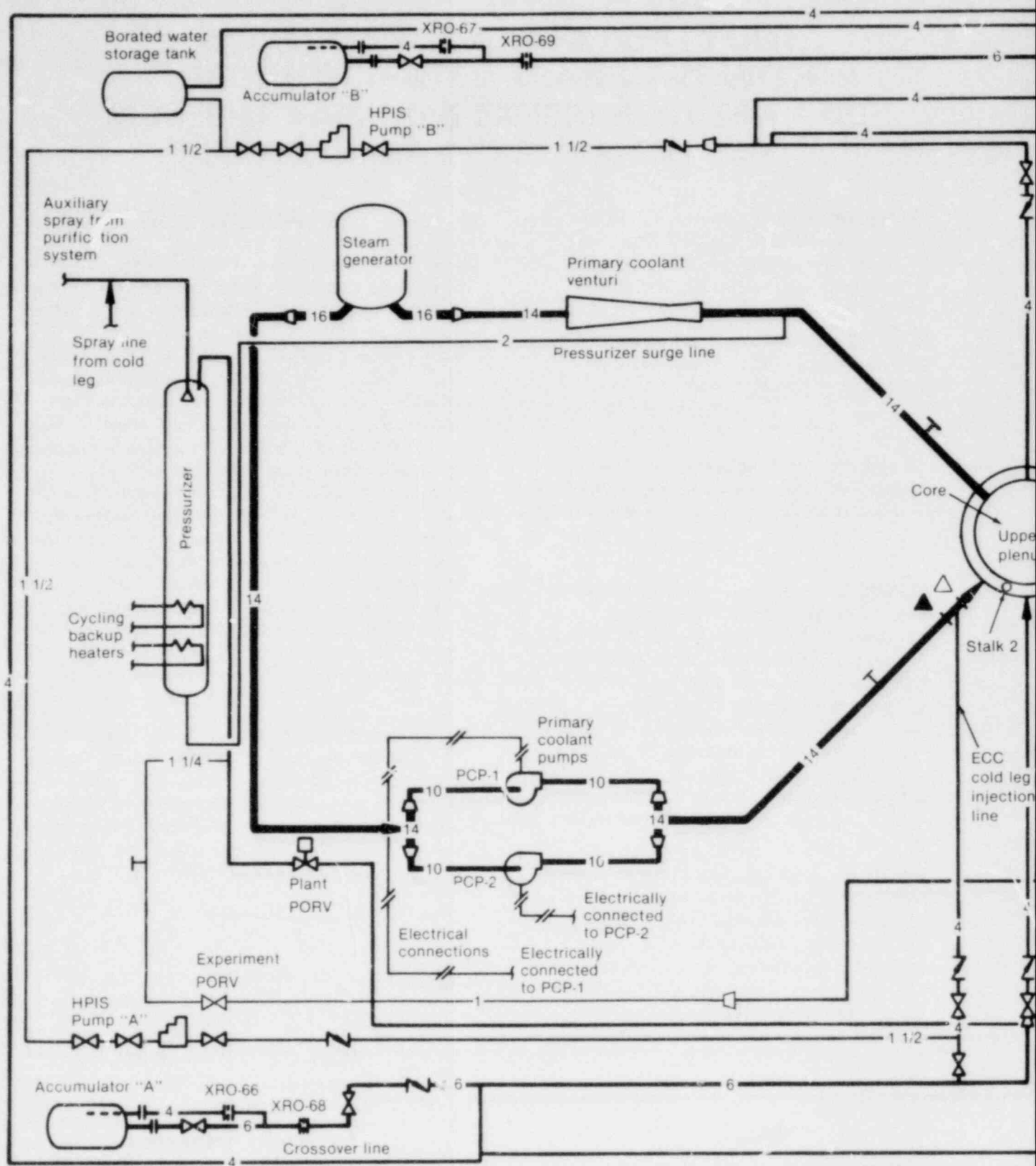
The LOFT facility is a 50-MW(t) pressurized water reactor (PWR) with instrumentation to measure and provide data on the thermal-hydraulic conditions throughout the system. Operation of the LOFT system is typical of large [~ 1000 MW(e)] commercial PWR operations. The LOFT facility consists of

1. A reactor vessel with a nuclear core (Core 1)
2. An intact loop with an active steam generator, pressurizer, and two primary coolant pumps connected in parallel
3. A broken loop with a simulated pump, simulated steam generator, and two quick-opening blowdown valve assemblies
4. A blowdown suppression system consisting of a header, suppression tank, and a spray system
5. An ECC injection system consisting of two low-pressure injection system (LPIS) pumps, two high-pressure injection system (HPIS) pumps, and two accumulators
6. A pressure relief pipeline from the top of the pressurizer to the suppression tank containing the experiment and plant PORVs in parallel.

Figure 1-1 presents the LOFT piping schematic. For additional information on the LOFT system, refer to Reference 1 and Appendixes A and B of this report.

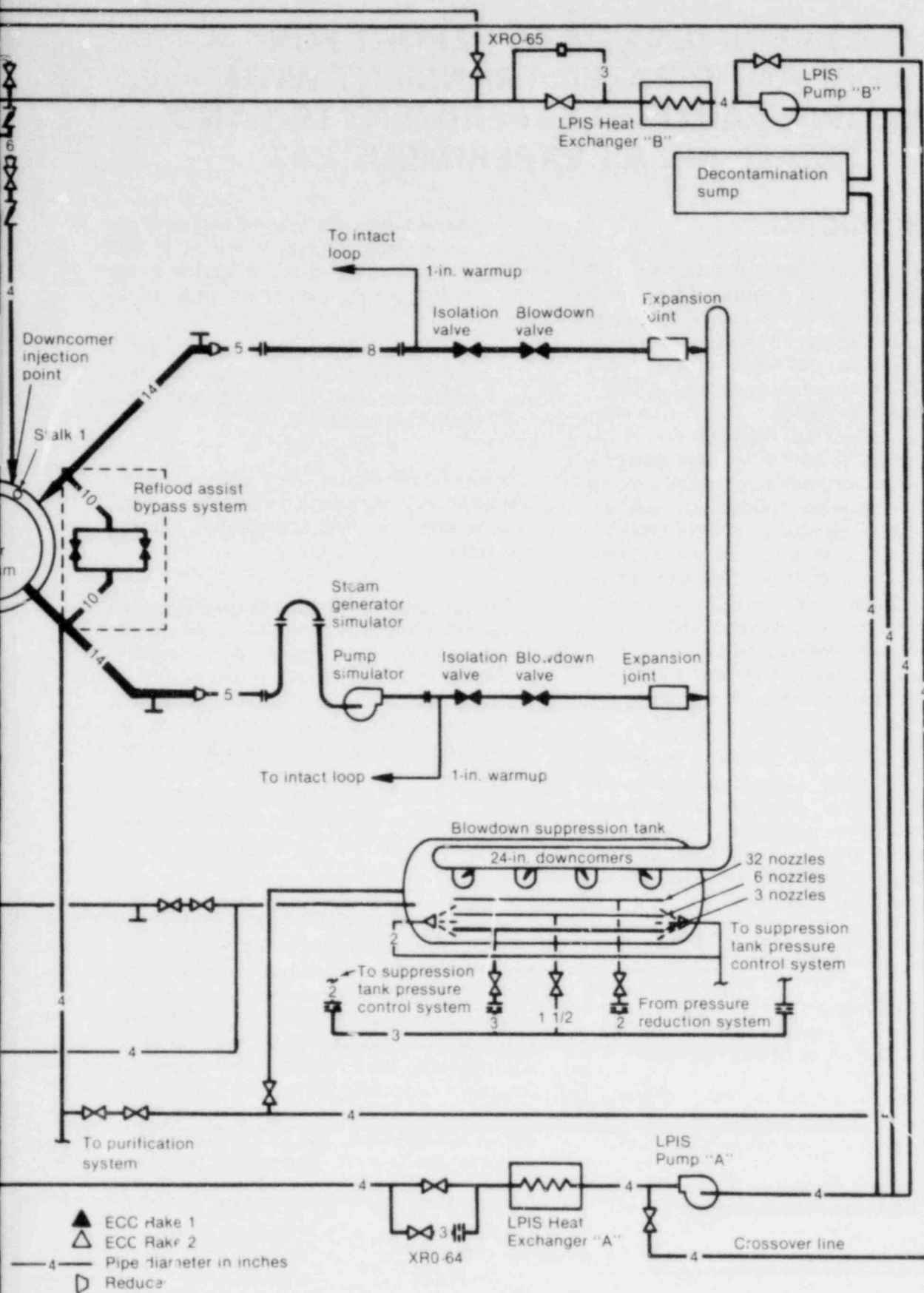
The data presented in this report are from 127 of the 693 instruments that provided data during Experiment L9-1/L3-3. Only the data considered pertinent to the understanding of this experiment are presented. The data are in an uninterpreted but readily usable form for use by the nuclear community in advance of detailed analysis and interpretation. The data, in the form of graphs in engineering units, have been analyzed only to the extent necessary to ensure that they are reasonable and consistent.

Sections 1.1, 1.2, and 1.3 state the LOFT Experimental Program objectives, the Experiment L9-1 objectives, and the Experiment Series L3 and Experiment L3-3 objectives, respectively. Section 2 summarizes the experimental procedures and initial conditions. Section 3 presents the data with supporting information for data interpretation. Appendix A describes the LOFT system configuration. Appendix B describes the LOFT instrumentation system, the methods of obtaining various measurements, and a list of instruments available for use in Experiment L9-1/L3-3. Appendix C summarizes the preexperimental calibrations and the methods used to verify the consistency and accuracy of the data.



INEL-L9-1/L3-3-1000

Figure 1-1. LOFT piping system



1.1 LOFT Experimental Program Objectives

The LOFT integral^a test facility was designed to simulate the major components of a four-loop, commercial PWR, thereby producing data on the thermal, hydraulic, nuclear, and structural processes expected to occur during a LOCA in a PWR. Reference 1 describes the LOFT facility in detail. The specific objectives of the LOFT Experimental Program are to

1. Provide data required to evaluate the adequacy of and to improve the analytical methods currently used to predict the response of large PWRs to postulated accident conditions, the performance of engineered safety features (ESF) with particular emphasis on emergency core coolant systems, and the quantitative margins of safety inherent in the performance of the ESF
2. Identify and investigate any unexpected event(s) or threshold(s) in the response of either the plant or the ESF and develop analytical techniques that adequately describe and account for the unexpected behavior(s)
3. Evaluate and develop methods to prepare, operate, and recover systems and plant for and from reactor accident conditions
4. Identify and investigate methods by which reactor safety can be enhanced, with emphasis on the interaction of the operator with the plant.

1.2 Experiment L9-1 Objectives

The major programmatic objective of Experiment L9-1 was to investigate a multiple failure accident scenario potentially more severe than the design basis analysis. The Experiment L9-1 specific objectives were to

a. The term "integral" is used to describe an experiment combining the nuclear, thermal, hydraulic, and structural processes occurring during a LOCA as distinguished from separate effects, nonnuclear, small-scale, and thermal-hydraulic experiments conducted for loss-of-plant analysis.

1. Evaluate uncertainties in predicted primary and secondary thermal-hydraulic response associated with steam generator dryout during delayed scram
2. Evaluate the adequacy of the PORV to provide overpressure protection in a loss-of-feedwater accident.

1.3 Experiment Series L3 and Experiment L3-3 Objectives

The LOFT Small Break Experiment Series L3 was designed to provide large-scale blowdown system data for a PWR small break transient. Parameters varied for the nuclear experiments in Experiment Series L3 include break size and location, primary coolant pump operation, and plant recovery procedures. The objectives of this experiment series pertaining to Experiment L3-3 were to

1. Determine the important plant thermal, hydraulic, operational, and neutronic phenomena during a variety of small break LOCEs in the LOFT facility, and to identify and explain unexpected behavior
2. Evaluate the effectiveness of current plant recovery methods for handling a small break LOCA
3. Determine the effectiveness of typical large PWR process instruments in providing accurate information on transient plant conditions
4. Provide data to develop and test the operational diagnostic and display system by operation of the system during each experiment.

The major programmatic objective of Experiment L3-3 was to evaluate the effectiveness of the PORV in mitigating the consequences of loss-of-feedwater accidents. The Experiment L3-3 specific objectives were to

1. Investigate uncertainties in system response during a PORV imposed small break with loss of secondary heat sink
2. Assess uncertainties in small break performance predictions identified in NUREG-0623²

3. Assess the effectiveness of steam generator refill on loss-of-feedwater accidents following reestablishment of auxiliary feedwater availability

4. Assess the relative magnitude of the change in reactor vessel mixture level as a result of

primary coolant system (PCS) shrink during steam generator refill

5. Contribute to the Nuclear Regulatory Commission relief and safety valve testing program by providing experimental data on PORV performance characteristics over a range of PORV inlet fluid conditions.

2. EXPERIMENTAL PROCEDURE AND INITIAL CONDITIONS

This section summarizes the experimental procedure and initial conditions recorded for the experiment.

2.1 Experimental Procedure

Initial reactor criticality occurred approximately 110 h prior to experiment initiation. The power level reached 50 ± 2 MW at 24 h prior to the experiment, and was maintained at that level until reactor scram during Experiment L9-1/L3-3. A plot of the power level versus time for the 110 h period prior to experiment initiation is given in Figure 2-1. During this time (a) measurements of power level were performed using a secondary calorimetric calculation, (b) the flow rate was set at 478.8 ± 6.3 kg/s, (c) adjustment of the secondary coolant system (SCS) was made to maintain the power level, and (d) the PCS boron concentration was adjusted to establish the specified reactor vessel inlet temperature of 556.8 ± 1.1 K and hot leg pressure of 14.95 ± 0.10 MPa.

Prior to initiating the experiment, a data acquisition and visual display system (DAVDS)³ calibration and a data integrity check were performed. During this period, the initial condition water samples were taken from the PCS, the SCS, and the blowdown suppression tank (BST). Just prior to experiment initiation, the purification lines were closed, BST recirculation pumps were turned on, HPIS and LPIS were inhibited and accumulators isolated to prevent automatic injection, and continuous steam generator blowdown flow was stopped. The broken loop warmup recirculation flow and heat tracing on the broken loop hot leg and pressurizer relief line were operated to keep fluid in the non-flowing pipe legs at the specified temperature.

The DAVDS was activated and started recording data ~7 min prior to the experiment. The experiment was initiated by turning off the main feedwater pump. The sequence of events for the experiment is provided in Table 2-1. Figure 2-2 shows the decay heat during the experiment, which was calculated using the American Nuclear Society Standard 5.1.⁴

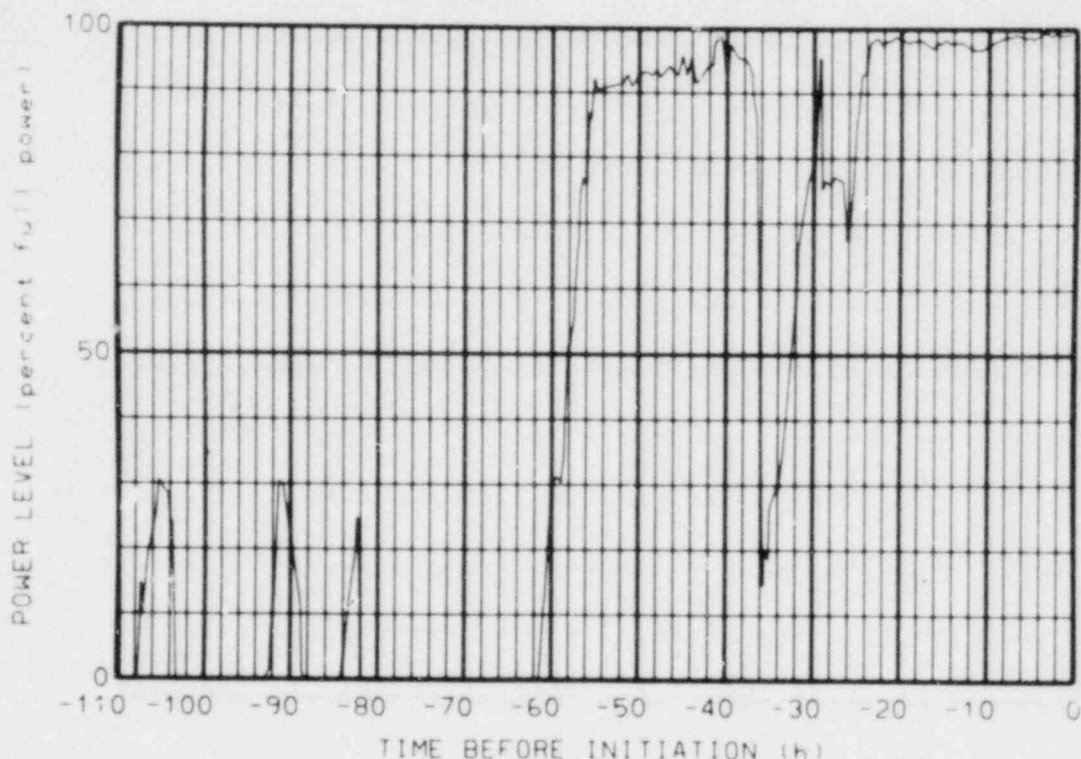


Figure 2-1. LOFT power history prior to Experiment L9-1/L3-3 initiation [full power = 50 MW(t)].

TABLE 2-1. SEQUENCE OF EVENTS FOR EXPERIMENT L9-1/L3-3

Event	Time after Experiment Initiation (s)
<u>Experiment L9-1</u>	
Main feed pump tripped off	0.0
Pressurizer spray valve cycling initiated	30.0 \pm 0.1
Reactor scrammed	65.4 \pm 0.2 - 0.0
Steam generator steam control valve closed	77.2 \pm 0.0 - 0.2
Steam generator liquid level reached bottom of indicating range (0.25 m above tube sheet)	190 \pm 10 - 20
Pressurizer liquid level reached top of indicating range (1.83 m above bottom)	1090 \pm 30
Pressurizer spray valve cycling ended	1246.0 \pm 0.1
Experiment PORV cycling initiated	1467.9 \pm 0.1
<u>Experiment L3-3</u>	
Experiment PORV held open	3269.9 \pm 0.1
Primary coolant pumps tripped off	3284.8 \pm 0.2 - 0.0
Primary coolant pump coastdown completed	3304.2 \pm 0.8 - 0.0
Upper plenum fluid reached saturation pressure	3329.4 \pm 0.2
Experiment PORV closed	4849.7 \pm 0.1
Steam generator secondary refill initiated	5114.6 \pm 0.2 - 0.0

TABLE 2-1. (continued)

Event	Time after Experiment Initiation (s)
<u>Experiment L3-3 (continued)</u>	
PCS natural circulation established	5205 \pm 10 - 5
Steam generator secondary refill completed	5746.4 \pm 0.2 - 0.0
Pressurizer liquid level reached bottom of indicating range (0.06 m above bottom)	5915 \pm 5
Steam generator secondary feed and bleed initiated	6712.2 \pm 0.2 - 0.0
Experiment completed (secondary feed and bleed ended) ^a	9517.4 \pm 0.2 - 0.0

a. The experiment was terminated just prior to ECC injection initiation.

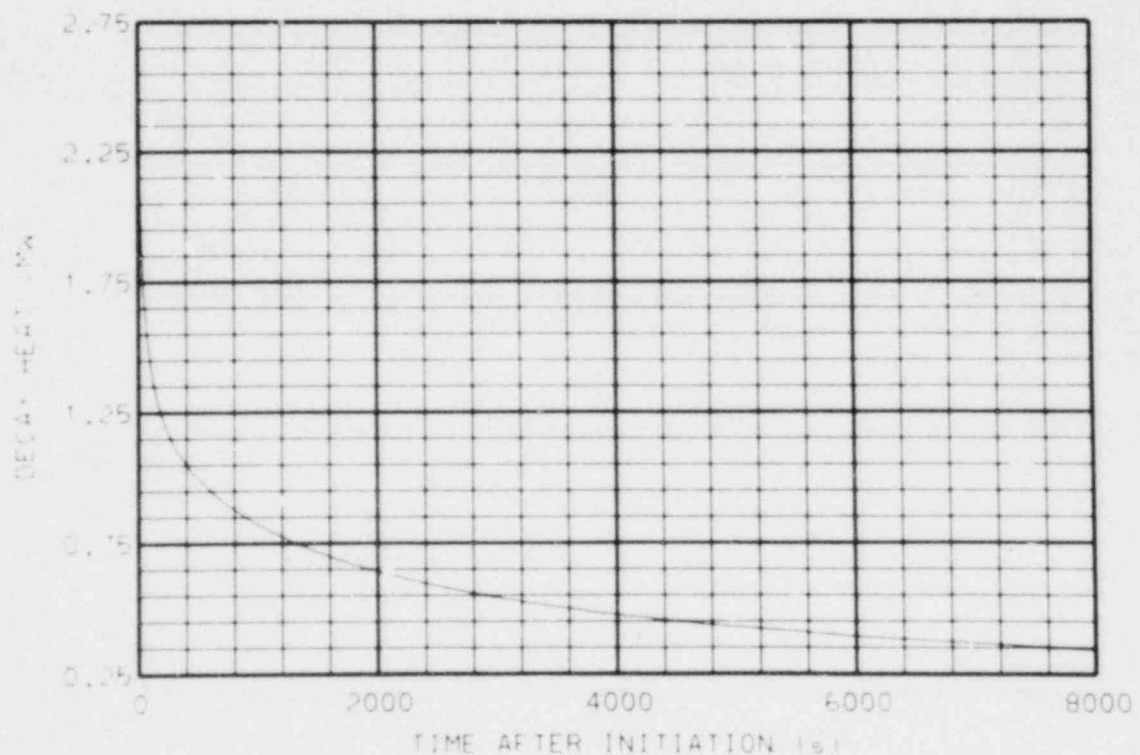


Figure 2-2. LOFT decay heat following Experiment L9-1/L3-3 initiation.

In Experiment L9-1, the reactor scrammed on indication of high pressure in the intact loop hot leg approximately 65 s after the main feedwater pump was tripped. Auxiliary feedwater injection into the steam generator was prevented, as was scram on indication of low liquid level in the steam generator. The steam generator steam control valve started to close automatically on reactor scram and finished closing at $77.2^{+0.0}_{-0.2}$ s. The pressurizer spray valve cycled automatically at its close (15.16 MPa) and open (15.32 MPa) setpoints from 30.0 ± 0.1 s until it was closed by the operators at 1246.0 ± 0.1 s. Experiment PORV cycling starting at 1467.9 ± 0.1 s with close and open setpoints of 16.05 and 16.18 MPa, respectively.

Prior to initiating Experiment L3-3, the pressurizer heaters and broken loop hot leg heat tracing were turned off. Experiment L3-3 began when the experiment PORV was secured in the open position. The primary coolant pumps were tripped within 15 s, with pump coastdown lasting ~20 s. Saturation occurred in the upper plenum ~60 s after the beginning of Experiment L3-3 at 3329.4 ± 0.2 s. After closing the experiment PORV at 4849.7 ± 0.1 s, steam generator refill began at $5114.6^{+0.2}_{-0.0}$ s. Natural circulation was established during steam generator refill which was completed at $5746.4^{+0.2}_{-0.0}$ s. Alternating secondary coolant system bleed and feed operations began at $6712.2^{+0.2}_{-0.0}$ s. The experiment was complete at $9517.4^{+0.2}_{-0.0}$ s, just prior to injecting HPIS flow into the primary coolant system.

The BST pressure was not controlled because the back pressure was not expected to affect the blowdown. BST recirculation through the spray headers took place at full spray pump capacity throughout the transient to ensure that homogeneous temperatures would be maintained throughout the water volume in the BST.

The DAVDS recorded approximately 160 min of data after the main feed pump was tripped. An electrical calibration of the DAVDS was performed following the experiment.

2.2 Initial Conditions

The specified initial plant operating conditions (except for the linear heat generation rate) for Experiment L9-1/L3-3 are presented in Table 2-2, along with the values measured immediately prior to experiment initiation. Table 2-3 gives the linear heat generation rate versus core height for three locations within the LOFT core prior to experiment initiation. The data for Table 2-3 were obtained from the traversing in-core probe system.

Table 2-4 gives the measured fluid temperatures of the PCS immediately prior to experiment initiation.

Table 2-5 specifies the required water chemistry for the PCS, the BST, and the SCS. In addition, the results of the water chemistry analyses are presented for preexperiment conditions in these systems, and for postexperiment conditions in the BST.

TABLE 2-2. INITIAL CONDITIONS FOR EXPERIMENT L9-1/L3-3

Parameter	Specified Value	Measured Value
<u>Primary Coolant System</u>		
Mass flow (kg/s)	478.8 ± 6.3	479.3 ± 4.5
Hot leg pressure (MPa)	14.95 ± 0.10	14.90 ± 0.28
Cold leg temperature (K) ^a	556.8 ± 1.1	559 ± 1
Hot leg temperature (K)	--	578 ± 2
Boron concentration (ppm)	As required to maintain temperature	631 ± 5
<u>Reactor Vessel</u>		
Power level (MW)	50 ± 1	50 ± 1
Maximum linear heat generation rate (kW/m)	--	50.8 ± 3.6
Control rod position (above full-in position) (m)	1.372 ± 0.013	1.376 ± 0.010
<u>Pressurizer</u>		
Steam volume (m ³)	--	0.43 ± 0.05
Liquid volume (m ³)	--	0.50 ± 0.05
Liquid temperature (K)	--	614.9 ± 1.3
Pressure (MPa)	14.95 ± 0.10	14.93 ± 0.25
Liquid level (m) ^a	1.02 ± 0.05	0.92 ± 0.10
<u>Broken Loop</u>		
Cold leg temperature near reactor vessel (K)	557 ± 17	557.6 ± 2.6
Hot leg temperature near reactor vessel (K)	557 ± 17	563.3 ± 2.6
<u>Steam Generator Secondary Side</u>		
Liquid level (m) ^{a,b}	0.25 ± 0.05	0.14 ± 0.06
Liquid temperature (K)	--	545 ± 1
Pressure (MPa)	--	5.67 ± 0.08
Mass flow (kg/s)	--	27 ± 1

TABLE 2-2. (continued)

Parameter	Specified Value	Measured Value
<u>Suppression Tank</u>		
Liquid level (m) ^a	1.27 ± 0.05	1.33 ± 0.10
Liquid volume (m ³)	--	31.2 ± 3.2
Gas volume (m ³)	--	53.8 ± 3.2
Liquid temperature (K)	350.9 to 374.5	358.0 ± 0.6
Pressure (gas space)(MPa)	0.085 to 0.146	0.136 ± 0.004

a. Out of specification, but did not impair results.

b. The liquid level is defined as 0.0 at 2.95 m above the top of the tube sheet.

TABLE 2-3. LINEAR HEAT GENERATION RATE PRIOR TO EXPERIMENT L9-1/L3-3
(Reading Uncertainty $\pm 7.6\%$)

Height Above Core Bottom (m)	Linear Heat Generation Rate for Core Position (kW/m)		
	1C7	5H8	5M3
0.152	11.53	19.61	19.60
0.292	23.55	38.36	38.39
0.394	26.84	42.53	43.08
0.456	25.73	40.76	41.28
0.503	26.67	43.44	43.48
0.546	29.42	46.61	47.21
0.648	31.22	47.59	48.15
0.749	30.82	46.71	47.26
0.846	27.85	42.21	42.70
0.886	24.66	39.07	39.57
0.953	26.89	40.75	41.23
1.054	24.43	37.02	37.46
1.181	20.22	30.65	31.01
1.257	16.15	24.48	24.77
1.299	13.47	20.41	20.65
1.359	11.86	17.97	18.19
1.511	5.03	9.11	8.55
1.613	2.70	4.88	4.59
1.664	1.85	3.77	3.54

TABLE 2-4. PRIMARY COOLANT TEMPERATURES AT EXPERIMENT INITIATION

Location	Detector	Temperature (K)
Intact loop hot leg (near vessel)	TE-PC-002B	578.7 \pm 3.1
Intact loop steam generator outlet	TE-SG-002	556.0 \pm 2.7
Intact loop cold leg (near vessel)	TE-PC-005	558.8 \pm 3.1
Reactor vessel downcomer:		
Instrument Stalk 1	TE-1ST-001	556.9 \pm 2.8
Instrument Stalk 2	TE-2ST-001	558.4 \pm 2.8
Reactor vessel lower plenum	TE-1LP-001	558.3 \pm 2.7
Reactor vessel upper plenum	TE-1UP-001	583.8 \pm 2.9
	TE-4UP-001	571.9 \pm 2.8
	TE-5UP-001	587.4 \pm 2.9
Broken loop hot leg (near vessel)	TE-BL-002B	563.3 \pm 2.6
Broken loop cold leg (near vessel)	TE-BL-001B	557.6 \pm 2.6
Intact loop pressurizer (from saturation pressure)	PE-PC-004	614.9 \pm 1.3

TABLE 2-5. WATER CHEMISTRY RESULTS FOR EXPERIMENT L9-1/L3-3

Parameter	Primary Coolant System		Blowdown Suppression Tank			Secondary Coolant System	
	Specified	Preexperiment ^a	Specified	Preexperiment	Postexperiment	Specified	Preexperiment
pH (each at 298 K)	4.2 to 10.5	5.90	4.2 to 10.5	4.74	4.85	9.0 to 10.2	9.5
Conductivity ($\mu\text{mho}/\text{cm}^3$) (each at 298 K)	60 maximum	3.7	60 maximum	11.7	11.32	2 maximum ^b	1.6
Total gas (cm^3/kg)	100 maximum	47	--	--	--	--	--
Dissolved oxygen (ppm)	--	--	--	--	--	0.005 maximum	0.02
Chloride (ppm)	0.15 maximum	< 0.1	0.15 maximum	< 0.1	< 0.1	0.15 maximum	< 0.1
Undissolved solids (ppm)	1.0 maximum	< 0.5	1.0 maximum	< 0.5	< 0.5	1.0 maximum	37.3
Boron (ppm)	--	631	> 3050	3644	3464	--	--
Fluoride (ppm)	0.1 maximum	0.06	0.1 maximum	0.06	< 0.02	--	--
Hydrogen (cm^3/kg) ^c	10 to 60	22	--	--	--	--	--
Total gross activity ($\mu\text{Ci}/\text{mL}$)	375 maximum	0.03	--	--	3.9×10^{-5}	--	--
Gross beta and gamma ($\mu\text{Ci}/\text{mL}$)	--	0.03	--	--	3.9×10^{-5}	--	--
^{131}I ($\mu\text{Ci}/\text{mL}$)	0.37 maximum	0.0	--	--	0.0	9×10^{-4} maximum	0.0
^{135}I ($\mu\text{Ci}/\text{mL}$)	0.76 maximum	0.0	--	--	0.0	--	0.0

a. Sample taken upstream of the primary coolant system ion exchanger.

b. Cation conductivity.

c. Prior to depressurization.

3. DATA PRESENTATION

This section of the report contains selected, pertinent, and uninterpreted thermal-hydraulic and nuclear data from LOFT Experiment L9-1/L3-3. The experimental data have been divided into two categories, "Qualified" and "Failed." The "Qualified" designation was applied to measurements that have been found to be within the uncertainty of the instrument. All the data presented in this report are "Qualified." The plot captions contain applicable restrictive statements if the data are invalid or questionable over a portion of the recorded time span. All "Qualified" data, including "Qualified" data not presented, are available from the Nuclear Regulatory Commission, Reactor Safety Research data bank. The checks on data consistency and instrument performance are discussed in detail in Appendix C. Any information concerning calibration data may be received by contacting the LOFT Data Analysis Branch Manager.

The data were processed and are presented in graphical form in SI and British units with accompanying tic marks also included. Most of the data were collected at a rate of five samples per second. Plots were reduced to 2000 or fewer points for ease of plotting. This was accomplished by dividing the time span into 1000 or fewer constant increments and plotting only the minimum and maximum values in each increment. The resulting plot looks identical to a plot produced by plotting every point because of the finite resolution of the plotting device.

Uncertainties for experimental measurements and computed variables are of the form $\pm\sqrt{(B)^2 + (M \times RD/100)^2}$, where B is the bias (offset) uncertainty, RD is the percentage-of-reading uncertainty, and M is the measurement reading at a particular time. The uncertainties supplied on the plots were calculated for M equal to the maximum data value to ensure that the uncertainties are conservative. Uncertainties for process instruments are of the form $\pm RG/100$, where RG is a percentage-of-range uncertainty. B, RD, and RG are calculated at the 95% confidence level. Uncertainty values are presented in Table B-2 of Appendix B and on each plot.

Uncertainty bands on selected measurements are presented for ease in code comparison. The uncertainties are fixed values calculated at the

upper range of the recorded data so as to be conservative. On certain plots, the uncertainty band may exceed a physical limit, such as a density below zero. This is a result of the plotting software and does not represent a real phenomenon.

The design ranges of the instruments are also presented on each plot. Computed variables are calculated from several measurements and thus do not have a design range.

Table 3-1 lists the Experiment L9-1/L3-3 measurements presented in this report and gives the detector location and the figure numbers. In addition, this table contains a "Comments" column which gives information pertaining to the qualification of the data. A list of instruments available for Experiment L9-1/L3-3 is included in Table B-2.

Table 3-2 lists the variables that were computed from the measurements and geometrical constants. This table also gives the equations used to compute these variables, the figure number, and comments which reflect on the usefulness of the data.

The data are divided into seven major sections with the individual plots in each section being presented in alphanumeric order to facilitate comparison and location of desired variables. These data sections include:

1. Experiment L9-1/L3-3 Measured Variables, Short-Term Plots (-50 to 200 s), Figures 3S-1 through 3S-22.
2. Experiment L9-1/L3-3 Measured Variables, Experiment L9-1 Plots (-400 to 3600 s), Figures 3B-1 through 3B-19.
3. Experiment L9-1/L3-3 Measured Variables, Experiment L3-3 Plots (3 000 to 10 000 s), Figures 3M-1 through 3M-33.
4. Experiment L9-1/L3-3 Measured Variables, Long-Term Plots (0 to 10 000 s), Figures 3L-1 through 3L-59.
5. Experiment L9-1/L3-3 Computed Variables, Figures 3C-1 through 3C-25.
6. Experiment L9-1/L3-3 Variables with Uncertainty Bands, Figures 3U-1 through 3U-11.

TABLE 3-1. MEASURED VARIABLES FOR EXPERIMENT L9-1/L3-3

Variable, System, and Detector	Location	Figure Number	Comments
VALVE OPENING			
<u>Secondary Coolant System</u>			
CV-P004-008	Main feedwater control valve.	3S-1	Qualified.
CV-P004-010	Main steam control valve.	3S-2	Qualified.
CV-P004-091	Main feedwater bypass valve.	3M-1	Qualified.
CHORDAL DENSITY			
<u>Broken Loop</u>			
DE-BL-001A	Cold leg at drag disc turbine transducer (DTT) flange. Beam A is 14°, 21 min from Beam B [clockwise (CW) looking toward reactor vessel (RV)].	3L-1	Qualified after reactor scram, anomalous spikes at approximately 6000 and 6500 s.
DE-BL-001B	Cold leg at DTT flange. Beam B through centerline of pipe 45° from vertical [counterclockwise (CCW) looking toward RV].	3L-2	Qualified after reactor scram, several anomalous spikes.
DE-BL-001C	Cold leg at DTT flange. Beam C is 22°, 7 min from Beam B (CCW looking toward RV).	3L-3	Qualified after reactor scram, several anomalous spikes.
DE-BL-002A	Hot leg at DTT flange. Beam A is 14°, 21 min from Beam B (CCW looking toward RV).	3L-4	Qualified after reactor scram.
DE-BL-002B	Hot leg at DTT flange. Beam B through centerline of pipe 45° from vertical (CW looking toward RV).	3L-5	Qualified after reactor scram.

TABLE 3-1. (continued)

Variable, System, and Detector	Location	Figure Number	Comments
CHORDAL DENSITY (continued)			
<u>Broken Loop</u> (continued)			
DE-BL-002C	Hot leg at DTT flange. Beam C is 22°, 7 min from Beam B (CW looking toward RV).	3L-6	Qualified after reactor scram.
<u>Intact Loop</u>			
DE-PC-S03A	Pressurizer relief line. Chordal density upstream of experiment power- operated relief valve (PORV).	3B-1 3M-2 3L-7	Qualified.
DE-PC-S03B	Pressurizer relief line. Chordal density upstream of experiment PORV.	3B-2 3M-3 3L-8	Qualified, spikes from 1529 to 1560 s.
DE-PC-001A	Cold leg at DTT flange. Beam A is 14°, 21 min from Beam B (CW looking away from RV).	3M-4 3L-9	Qualified after reactor scram.
DE-PC-001B	Cold leg at DTT flange. Beam B through centerline of pipe 45° from vertical (CCW looking away from RV).	3M-5 3L-10 3U-1	Qualified after reactor scram.
DE-PC-001C	Cold leg at DTT flange. Beam C is 22°, 7 min from Beam B (CCW looking away from RV).	3M-6 3L-11	Qualified after reactor scram.
DE-PC-002A	Hot leg at DTT flange. Beam A is 14°, 21 min from Beam B (CW looking away from RV).	3M-7 3L-12	Qualified after reactor scram, several anomalous spikes.

TABLE 3-1. (continued)

Variable, System, and Detector	Location	Figure Number	Comments
CHORDAL DENSITY (continued)			
<u>Intact Loop</u> (continued)			
DE-PC-002B	Hot leg at DT ^r flange. Beam B through centerline of pipe 45° from vertical (CCW looking away from RV).	3M-8 3L-13	Qualified after reactor scram.
DE-PC-002C	Hot leg at DTT flange. Beam C is 22°, 7 min from Beam B (CCW looking away from RV).	3M-9 3L-14	Qualified after reactor scram. anomalous spikes at 2000 s.
DE-PC-003A	Below steam generator (SG) at DTT flange. Beam A is 14°, 21 min from Beam B.	3M-10 3L-15	Qualified after reactor scram.
DE-PC-003C	Below SG at DTT flange. Beam C is 22°, 7 min from Beam B.	3M-11 3L-16	Qualified after reactor scram.
FLUID VELOCITY			
<u>Intact Loop</u>			
FE-PC-S02	Pressurizer relief line. Upstream of experiment PORV.	3B-3 3M-12	Qualified.
FE-PC-002A	Hot leg DTT flange at bottom of pipe.	3B-4 3L-17 3U-2	Qualified to 6000 s.
FE-PC-002B	Hot leg DTT flange at middle of pipe.	3B-4	Qualified to 6000 s.
FE-PC-002C	Hot leg DTT flange at top of pipe.	3B-4	Qualified to 6000 s.

TABLE 3-1. (continued)

Variable, System, and Detector	Location	Figure Number	Comments
FLOW RATE			
<u>Secondary Coolant System</u>			
FT-P004-012	Inlet to air-cooled condenser inlet header.	3S-3 3M-13	Qualified, magnitude uncertain due to instrument drift.
FT-P004-091	Main feedwater control valve bypass flow piping.	3M-14	Qualified after 5000 s, only indicates presence or absence of flow, flow magnitude is not correct.
<u>Intact Loop</u>			
FT-P139-27-2	Hot leg venturi flowmeter (bottom of pipe).	3L-18	Qualified to primary coolant pump trip.
LIQUID LEVEL			
<u>Secondary Coolant System</u>			
LT-P004-008A	SG (narrow range).	3S-4	Qualified, not density compen- sated ^a , oscilla- tions at approxi- mately 5000 s are not indicative of real level.
LT-P004-008B	SG (wide range).	3S-4 3L-19 3U-3	Qualified after 0 s, not density compensated ^a , oscillations at approximately 5000 s are not indicative of real level.
LT-P004-042	Condensate receiver, 1.83 m south of condensate receiver centerline.	3S-5 3L-20	Qualified, magni- tude uncertain.

TABLE 3-1. (continued)

Variable, System, and Detector	Location	Figure Number	Comments
LIQUID LEVEL (continued)			
<u>Blowdown Sup- pression Tank</u>			
LT-P138-033	Blowdown suppression tank (BST) level on north end of tank.	3L-21	Qualified, not density com- pensated. ^a
LT-P138-058	BST level on south end of tank.	3L-22	Qualified, not density com- pensated. ^a
MOMENTUM FLUX			
<u>Intact Loop</u>			
ME-PC-S02	Pressurizer relief line. Upstream of experiment PORV.	3B-5 3M-15	Qualified from 1575 to 4000 s.
ME-PC-002A	Hot leg DTT rake at bottom of pipe.	3B-6	Qualified to pump trip.
ME-PC-002B	Hot leg DTT rake at middle of pipe.	3B-7	Qualified to pump trip.
ME-PC-002C	Hot leg DTT rake at top of pipe.	3B-8	Qualified to pump trip.
NEUTRON DETECTION			
<u>Reactor Vessel</u>			
NE-2H8-26	Neutron detector in Fuel Assembly 2.	3S-6	Qualified, good to reactor scram.

TABLE 3-1. (continued)

Variable, System, and Detector	Location	Figure Number	Comments
ELECTRICAL CURRENT			
<u>Intact Loop</u>			
PCP-1-I-RMS	Primary Coolant Pump (PCP) 1.	3S-7	Qualified to pump trip.
PCP-2-I-RMS	PCP-2.	3S-7	Qualified to pump trip.
ELECTRICAL VOLTAGE			
<u>Intact Loop</u>			
PCP-1-V-RMS	PCP-1.	3S-8	Qualified to pump trip.
PCP-2-V-RMS	PCP-2.	3S-8	Qualified to pump trip.
DIFFERENTIAL PRESSURE			
<u>Intact Loop</u>			
PdE-PC-S03	Pressurizer relief line across experiment PORV.	3M-16	Qualified after PORV latched open.
PdE-PC-001	Cold leg across PCPs.	3L-23 3U-4	Qualified.
PdE-PC-002	Across SG.	3L-24	Qualified.
PdE-PC-003	Hot leg piping, RV to SG inlet.	3M-17	Qualified.
PdE-PC-005	Cold leg piping, PCPs to RV nozzle.	3M-18	Qualified.

TABLE 3-1. (continued)

Variable, System, and Detector	Location	Figure Number	Comments
DIFFERENTIAL PRESSURE (continued)			
<u>Intact Loop</u> (continued)			
PdE-PC-008	Across pressurizer surge line.	3B-9 3M-19	Qualified.
PdE-PC-009	Across PCP-1.	3B-10 3L-25	Qualified.
PdE-PC-010	Across PCP-2.	3B-10 3L-25	Qualified.
PdE-PC-017B	Pitot tube next to bottom of emergency core coolant (ECC) Rake 1 (facing PCP).	3M-20	Qualified.
PdE-PC-018B	Pitot tube at bottom of ECC Rake 1 (facing PCP).	3M-21	Qualified.
PdE-PC-027	SG outlet to pump suction (lowest point).	3M-22	Qualified.
PdE-PC-028	Pump suction (lowest point) to PCP-2 inlet.	3M-23	Qualified.
PdT-P139-030	Across RV just beyond intact loop inlet and out- let nozzles.	3L-26	Qualified.
PRESSURE			
<u>Broken Loop</u>			
PE-BL-001	Cold leg at DTT flange.	3L-27	Qualified.
PE-BL-002	Hot leg at DTT flange.	3L-27	Qualified.

TABLE 3-1. (continued)

Variable, System, and Detector	Location	Figure Number	Comments
PRESSURE (continued)			
<u>Intact Loop</u>			
PE-PC-S06	Pressurizer relief line upstream of DTT.	3S-9 3B-11 3M-24 3L-28 3U-5	Qualified.
PE-PC-S07	Pressurizer relief line downstream of experiment PORV.	3B-12 3M-25 3L-29	Qualified.
PE-PC-001	Cold leg at DTT flange.	3S-10 3L-30	Qualified.
PE-PC-002	Hot leg at DTT flange.	3S-10 3L-30	Qualified.
PE-PC-004	Pressurizer vapor space.	3S-11 3B-13 3M-26 3L-31	Qualified.
PE-PC-005	Reference pressure between SG outlet and PCP inlet.	3L-32	Qualified.
PE-PC-006	Reference pressure between SG outlet and PCP inlet.	3L-32	Qualified.
<u>Secondary Coolant System</u>			
PE-SGS-001	SG dome pressure.	3S-12 3B-14 3M-27 3L-33 3U-6	Qualified.

TABLE 3-1. (continued)

<u>Variable, System, and Detector</u>	<u>Location</u>	<u>Figure Number</u>	<u>Comments</u>
PRESSURE (continued)			
<u>Blowdown Sup- pression System</u>			
PE-SV-016	BST across from Down- comer 1, 230° from top vertical (CW looking north).	3L-34	Qualified.
PE-SV-060	BST top above Downcomer 1.	3L-34	Qualified.
<u>Reactor Vessel</u>			
PE-1ST-001A	Downcomer Stalk 1, 0.62 m above RV bottom.	3L-35	Qualified.
PE-1UP-001A	Above Fuel Assembly 1 upper end box.	3S-13	Qualified.
PE-1UP-001A1	Above Fuel Assembly 1 upper end box.	3L-36	Qualified.
PE-2ST-001A	Downcomer Stalk 2, 0.62 m above RV bottom.	3L-35	Qualified.
<u>Secondary Coolant System</u>			
PT-P004-010A	In 10-in. line from SG.	3L-33	Qualified.
<u>Intact Loop</u>			
PT-P139-002	Hot leg at venturi on bottom.	3L-37	Qualified.
PT-P139-05-1	Pressurizer, 1.88 m above bottom (vapor space).	3L-31	Qualified.

TABLE 3-1. (continued)

Variable, System, and Detector	Location	Figure Number	Comments
PUMP SPEED			
<u>Intact Loop</u>			
RPE-PC-001	PCP-1.	3M-28 3U-7	Qualified.
RPE-PC-002	PCP-2.	3M-28	Qualified.
REACTIVITY			
<u>Reactor Vessel</u>			
RE-T-77-1A2	Power range, Channel A level.	3S-14	Qualified.
RE-T-77-2A2	Power range, Channel B level.	3S-14	Qualified.
TEMPERATURE			
<u>Broken Loop</u>			
TE-BL-001B	Cold leg DTT flange at middle of pipe.	3L-38	Qualified.
TE-BL-002B	Hot leg DTT flange at middle of pipe.	3L-39	Qualified.
<u>Intact Loop</u>			
TE-PC-S04	Pressurizer relief line in DTT spool piece.	3B-15 3M-29	Qualified.
TE-PC-S05	Pressurizer relief line downstream of experiment PORV.	3B-16 3M-30 3L-40	Qualified.
TE-PC-002A	Hot leg DTT flange at bottom of pipe.	3L-41 3U-8	Qualified.

TABLE 3-1. (continued)

Variable, System, and Detector	Location	Figure Number	Comments
TEMPERATURE (continued)			
<u>Intact Loop (continued)</u>			
TE-PC-002B	Hot leg DTT flange at middle of pipe.	3S-15 3L-41 3L-42	Qualified.
TE-PC-002C	Hot leg DTT flange at top of pipe.	3L-41	Qualified.
TE-PC-005	Next to bottom of ECC Rake 1 (between PdE-FC-013 and PdE-PC-017).	3S-16 3U-9	Qualified.
TE-P139-019	Pressurizer vapor space, 0.86 m above heater rods.	3S-17 3B-17 3M-31 3L-43	Qualified.
TE-P139-020	Pressurizer liquid volume, 0.36 m above heater rods.	3S-17 3B-17 3M-31 3L-43	Qualified.
TE-P139-32-1	Hot leg.	3L-42	Qualified, response limited.
TE-SG-002	SG outlet.	3S-18 3B-18 3M-32 3L-44	Qualified.
<u>Secondary Coolant System</u>			
TE-SG-004	SG secondary side down- comer, 2.12 m above top of tube sheet.	3S-19 3B-19 3M-33 3L-45	Qualified.

TABLE 3-1. (continued)

<u>Variable, System, and Detector</u>	<u>Location</u>	<u>Figure Number</u>	<u>Comments</u>
TEMPERATURE (continued)			
<u>Secondary Coolant System (continued)</u>			
TE-SG-005	SG secondary side down- comer, 2.92 m above top of tube sheet.	3S-19 3B-19 3M-33 3L-45	Qualified.
<u>Blowdown Suppression System</u>			
TE-SV-001	BST, 0.3 m north of Down- comer 1, 0.53 m east of tank centerline, 2.72 m from tank bottom.	3L-46	Qualified, anomalous spike at approximately 7000 s.
TE-SV-004	BST, 0.3 m north of Down- comer 1, 0.53 m east of tank centerline, 1.45 m from tank bottom.	3L-47	Qualified.
TE-SV-006	BST, 0.3 m north of Down- comer 1, 0.53 m east of tank centerline, 0.37 m from tank bottom.	3L-48	Qualified.
TE-SV-007	BST, 0.3 m north of Down- comer 3, 0.53 m east of tank centerline, 2.72 m from tank bottom.	3L-46	Qualified.
TE-SV-010	BST, 0.3 m north of Down- comer 3, 0.53 m east of tank centerline, 1.45 m from tank bottom.	3L-47	Qualified.

TABLE 3-1. (continued)

Variable, System, and Detector	Location	Figure Number	Comments
TEMPERATURE (continued)			
<u>Blowdown Suppression System (continued)</u>			
TE-SV-011	BST, 0.3 m north of Down- comer 3, 0.53 m east of tank centerline, 0.99 m from tank bottom.	3L-49	Qualified.
TE-SV-012	BST, 0.3 m north of Down- comer 3, 0.53 m east of tank centerline, 0.37 m from tank bottom.	3L-48	Qualified.
<u>Reactor Vessel</u>			
TE-1F7-015	Fuel Assembly 1, Row F, Column 7, 0.38 m above bottom of fuel rod.	3L-50	Qualified.
TE-1F7-021	Fuel Assembly 1, Row F, Column 7, 0.53 m above bottom of fuel rod.	3L-50	Qualified.
TE-1F7-026	Fuel Assembly 1, Row F, Column 7, 0.66 m above bottom of fuel rod.	3L-50	Qualified.
TE-1F7-030	Fuel Assembly 1, Row F, Column 7, 0.76 m above bottom of fuel rod.	3L-50	Qualified.
TE-1LP-001	Fuel Assembly 1, lower end box.	3L-51	Qualified.
TE-1ST-005	Downcomer Stalk 1, 2.37 m from RV bottom.	3L-52	Qualified.

TABLE 3-1. (continued)

Variable, System, and Detector	Location	Figure Number	Comments
TEMPERATURE (continued)			
<u>Reactor Vessel (continued)</u>			
TE-1ST-013	Downcomer Stalk 1, 0.24 m from RV bottom.	3L-52	Qualified.
TE-1UP-001	Fuel Assembly 1, upper end box.	3L-53	Qualified.
TE-2G14-011	Cladding on Fuel Assembly 2, Row G, Column 14 at 0.28 m above bottom of fuel rod.	3L-54	Qualified.
TE-2G14-030	Cladding on Fuel Assembly 2, Row G, Column 14 at 0.76 m above bottom of fuel rod.	3L-54	Qualified.
TE-2G14-045	Cladding on Fuel Assembly 2, Row G, Column 14 at 1.14 m above bottom of fuel rod.	3L-54	Qualified.
TE-2ST-005	Downcomer Stalk 2, 2.37 m from RV bottom.	3L-55	Qualified.
TE-2ST-013	Downcomer Stalk 2, 0.24 m from RV bottom.	3L-55	Qualified.
TE-3UP-003	Fuel Assembly 3, support column above RV nozzle.	3L-56	Qualified.
TE-3UP-008	Liquid level transducer above Fuel Assembly 3.	3L-56	Qualified.
TE-3UP-010	Liquid level transducer above Fuel Assembly 3.	3L-56	Qualified.

TABLE 3-1. (continued)

Variable, System, and Detector	Location	Figure Number	Comments
TEMPERATURE (continued)			
Reactor Vessel (continued)			
TE-3UP-015	Liquid level transducer above Fuel Assembly 3.	3L-56	Qualified.
TE-4LP-001	Fuel Assembly 4, lower end box.	3L-51	Qualified.
TE-4UP-001	Fuel Assembly 4, upper end box.	3L-53	Qualified.
TE-5F9-011	Cladding on Fuel Assembly 5, Row F, Column 9 at 0.28 m above bottom of fuel rod.	3L-57 3U-10	Qualified.
TE-5F9-030	Cladding on Fuel Assembly 5, Row F, Column 9 at 0.76 m above bottom of fuel rod.	3L-57	Qualified.
TE-5F9-045	Cladding on Fuel Assembly 5, Row F, Column 9 at 1.14 m above bottom of fuel rod.	3L-57	Qualified.
TE-5F9-062	Cladding on Fuel Assembly 5, Row F, Column 9 at 1.57 m above bottom of fuel rod.	3L-57 3U-11	Qualified.
TE-5H5-002	Cladding on Fuel Assembly 5, Row H, Column 5 at 0.05 m above bottom of fuel rod.	3S-20 3L-58	Qualified.

TABLE 3-1. (continued)

Variable, System, and Detector	Location	Figure Number	Comments
TEMPERATURE (continued)			
<u>Reactor Vessel</u> (continued)			
TE-5H5-015	Cladding on Fuel Assembly 5, Row H, Column 5 at 0.38 m above bottom of fuel rod.	3S-20 3L-58	Qualified.
TE-5H5-034.5	Cladding on Fuel Assembly 5, Row H, Column 5 at 0.88 m above bottom of fuel rod.	3S-20 3L-58	Qualified.
TE-5LP-002	Fuel Assembly 5, lower end box.	3S-21 3L-51	Qualified.
TE-5L8-011	Guide tube for Fuel Assembly 5, Row L, Column 8 at 0.28 m above bottom of guide tube.	3S-22 3L-59	Qualified.
TE-5L8-024	Guide tube for Fuel Assembly 5, Row L, Column 8 at 0.61 m above bottom of guide tube.	3S-22 3L-59	Qualified.
TE-5L8-039	Guide tube for Fuel Assembly 5, Row L, Column 8 at 0.99 m above bottom of guide tube.	3S-22 3L-59	Qualified.
TE-5UP-001	Fuel Assembly 5, upper end box.	3S-21 3L-53	Qualified.
<u>Intact Loop</u>			
TT-P139-032	Hot leg primary coolant, Channel A.	3L-42	Qualified, response limited.

a. For density corrected liquid levels see LTD-PC04-008B, -P139-033, and -058 in Table 3-2.

TABLE 3-2. COMPUTED VARIABLES FOR EXPERIMENT L9-1/L3-3

Variable, Location, and Detector	Units	Uncertainty	Calculation Method	Figure	Comments
DENSITY, AVERAGE			Except where the density distribution reduces to an average directly, the following method is used to determine the average density:		The individual beam densities were filtered with a 4-Hz filter prior to being used in the average calculation.
Broken Loop Cold Leg					
$\left. \begin{array}{l} \text{DE-BL-1A } (\rho_A) \\ \text{DE-BL-1B } (\rho_B) \\ \text{DE-BL-1C } (\rho_C) \end{array} \right\} \text{DE-BL-105}$	Mg/m ³	±0.13	1. A calculated density profile is determined from an assumed distribution which has been "fit" to each beam measurement. These are optimized as shown below.	3C-12	Qualified after reactor scram, several anomalous spikes.
Broken Loop Hot Leg			2. The least squares curve fits are compared to determine the optimum assumed density profile to fit the data.		
$\left. \begin{array}{l} \text{DE-BL-2A } (\rho_A) \\ \text{DE-BL-2B } (\rho_B) \\ \text{DE-BL-2C } (\rho_C) \end{array} \right\} \text{DE-BL-205}$	Mg/m ³	±0.17	3. The best profile is area averaged to give average density by	3C-13	Qualified after reactor scram.
Intact Loop Cold Leg			$\bar{\rho} = 1/A \int \rho(r) dA$ <p>where</p> <p>A = cross-sectional area of the pipe</p> <p>$\rho(r)$ = chordal profile.</p>	3C-14	Qualified after reactor scram.
Intact Loop Hot Leg			The assumed profiles are as follows:		
$\left. \begin{array}{l} \text{DE-PC-2A } (\rho_A) \\ \text{DE-PC-2B } (\rho_B) \\ \text{DE-PC-2C } (\rho_C) \end{array} \right\} \text{DE-PC-205}$	Mg/m ³	±0.17	1. For homogeneous flow, the average results directly in	3C-15	Qualified after reactor scram, several anomalous spikes.
			$\bar{\rho} = \frac{(\rho_A + \rho_B + \rho_C)}{3}$ <p>where</p> <p>$\rho_A, \rho_B,$ = density along gamma densitometer beam and ρ_C lines A, B, and C.</p>		
			2. For tilted stratified flow,		
			$\rho(r) = \rho_l - \frac{\rho_l - \rho_g}{1 + \exp[-4a(x-b)]}$ <p>where</p> <p>a and b = two adjustable parameters</p> <p>ρ_g and ρ_l = gas and liquid densities</p>		

TABLE 3-2. (continued)

Variable, Location, and Detector	Units	Uncertainty	Calculation Method	Figure	Comments
DENSITY, AVERAGE (continued)			<p>x = position in maximum density gradient direction.</p> <p>3. For annular distribution,</p> $\rho(r) = \begin{cases} \rho_c & \text{for } r < R - D \\ \rho_l & \text{for } r > R - D \end{cases}$ <p>where</p> <p>R = pipe radius</p> <p>ρ_l = density of liquid shell</p> <p>ρ_c = density of vapor core</p> <p>D = thickness of liquid shell</p> <p>ρ_c and D are two adjustable parameters and are iteratively adjusted to fit the data.</p> <p>4. Eccentric annular is the same as annular, except that the core region may be vertically displaced from the pipe center.</p> <p>5. Default calculation. If the above distributions do not represent the data, the density is calculated by a beam length weighted average of the chordal average density readings, ρ_i:</p> $\rho = 0.34485 \rho_A + 0.40034 \rho_B + 0.25481 \rho_C$		
LIQUID LEVEL			The individual conductivity probes are designed to output increasing voltage with increasing fluid void fraction. The bubble plot symbols correspond to the following probe output voltage ranges:		
Downcomer and Lower Plenum					
LE-1ST-1 and -2	cm	--a		3C-24	Qualified.

TABLE 3-2. (continued)

Variable, Location, and Detector	Units	Uncertainty	Calculation Method	Figure	Comments
LIQUID LEVEL (continued)					
<u>Upper Plenum</u>					
LE-3UP-1	cm	±0.3	Symbol Voltage Range (x) 0-2 (o) 2-8 () 8-10	3C-25	Qualified.
<p>The levels are measured from the bottom of the reactor vessel.</p> <p>Because the plots cover a long time period, short-term phenomena tend to be obscured.</p>					
<u>Intact Loop Seal</u>					
PdE-PC-27 } PE-PC-5 } LEPdE-PC-27 TE-PC-4 }	m	±0.10	$\Delta P = \rho_R g H - \rho_A g L - \rho_V (H - L)$	3C-16	Qualified after pump coastdown.
PdE-PC-28 } PE-PC-5 } LEPdE-PC-28 TE-PC-4 }	m	±0.09	where ΔP = the differential pressure measured (Pa) ρ_R = the liquid density in the reference leg (kg/m ³) g = the gravitational acceleration of 9.8 m/s ² H = the liquid height of the reference leg (m) (leg is assumed to be full)	3C-17	Qualified after pump coastdown.
<u>Pressurizer</u>					
PdT-P139-6 } PE-PC-4 } LEPdE-P139-6 TE-P139-19 } TE-P139-20 }	m	±0.06	$\rho_A = \rho'_L$ liquid density in the pipe or vessel (kg/m ³) ρ_V = the vapor density in the pipe or vessel (kg/m ³) L = the liquid level to be calculated (m).	3C-1 3C-3 3C-18	Qualified, drift below 0.0 m after 6000 s caused by transmission line flashing.
PdT-P139-7 } PE-PC-4 } LEPdE-P139-7 TE-P139-19 } TE-P139-20 }	m	±0.06		3C-22	Qualified, drift below 0.0 m after 6000 s caused by transmission line flashing.
<p>Using the liquid temperature from the TE measurement or the system pressure from the PE, depending on whether the liquid being measured is subcooled or saturated, respectively, the steam tables were consulted to give the specific volume of the liquid which, in turn, provided the ρ_A value.</p>					

TABLE 3-2. (continued)

Variable, Location, and Detector	Units	Uncertainty	Calculation Method	Figure	Comments
LIQUID LEVEL (continued)			Using the system pressure, again the steam tables were consulted to get the ρ_v value.		
DENSITY COMPENSATED LIQUID LEVEL			The measured liquid level was generated using the steady state assumption that fluid densities are not changing in time. To convert the indicated level to the actual liquid level, a density compensation must be made. The ΔP measured by the transducer was calculated from the following pressure balance:		
Steam Generator					
LT-P004-008B } LTD-P004-008B in PE-S65-001 }	m	± 0.08	$\Delta P = \rho_l g H - \rho_{ls} g l - \rho_{vs} g (H - l)$	3C-2 3C-19 3C-23	Qualified after 0 s, oscillations at approximately 5000 s are not indicative of real level.
Blowdown Suppression Tank			where		
LT-P138-33 } LTD-P138-33 PE-SV-17 }	m	± 0.06	ΔP = the differential pressure measured (Pa)	3C-4 3C-20	Qualified.
LT-P138-58 } LTD-P138-58 PE-SV-17 }	m	± 0.06	ρ_R = the liquid density in the reference leg (kg/m^3)		
			g = the gravitational acceleration of 9.8 m/s^2	3C-4 3C-20	Qualified.
			H = the liquid height of the reference leg (m) (leg is assumed to be full)		
			ρ_{ls} = steady state liquid density (kg/m^3)		
			ρ_{vs} = steady state vapor density (kg/m^3)		
			l = indicated liquid level (m).		
			The actual liquid level was calculated by rearranging the above equation and substituting in the ΔP and liquid and vapor densities:		
			$L = (\Delta P + \rho_v g H - \rho_R g H) / (\rho_v g - \rho_l g)$		
			where		
			ρ_l = actual liquid density (kg/m^3)		
			ρ_v = actual vapor density (kg/m^3)		
			L = actual liquid level (m).		

TABLE 3-2. (continued)

Variable, Location, and Detector	Units	Uncertainty	Calculation Method	Figure	Comments
DENSITY COMPENSATED LIQUID LEVEL (continued)			Actual densities were obtained from saturated steam tables using a pressure measurement in the pressurizer and steam generator and a temperature measurement in the blowdown suppression tank.		
MASS FLOW RATE					
Pressurizer Relief Line Spool Piece					
ME-PC-S02 } FE-PC-S02 } FR-PC-S203	kg/s	±0.2	FR-PC-S203 was calculated using drag screen and turbine meter data. The momentum flux was forced to zero when its value was 0.1 Mg/m ² s ² or less. The following equation was then applied with the exception that the flow rate was set at zero flow when the turbine meter indicated a fluid velocity of less than 0.06096 m/s. $\text{Flow rate (kg/s)} = \left[\frac{\text{Momentum Flux (Mg/m}^2\text{s}^2\text{)}}{\text{Fluid Velocity (m/s)}} \right] * [\text{Flow area (m}^2\text{)}] * [1000 \text{ (kg/Mg)}].$	3C-9	Qualified from 1550 to 6000 s.
DE-PC-S03A } DE-PC-S03B } FE-PC-S02 } FR-PC-S231	kg/s	±0.2	FR-PC-S231 was calculated using densitometer and turbine meter data. The two densitometer beams were averaged and the electronic spike in DE-PC-S03B was removed. The following equation was then applied: $\text{Flow rate (kg/s)} = [\text{Density (Mg/m}^3\text{)}] * [\text{Fluid velocity (m/s)}] * [\text{Flow area (m}^2\text{)}] * [1000 \text{ (kg/Mg)}].$	3C-6 3C-7 3C-8 3C-10	Qualified to 6000 s.
DE-PC-S03A } DE-PC-S03B } ME-PC-S02 } FR-PC-S232	kg/s	±0.2	FR-PC-S232 was calculated using densitometer and drag screen data. As above, the two densitometer beams were averaged and the electronic spike was removed from DE-PC-S03B. The momentum flux was forced to zero when its value was <0.1 Mg/m ² s ² . The following equation was then applied: $\text{Flow rate (kg/s)} = (\text{sign of Momentum Flux}) * [\text{Momentum Flux}] * [\text{Flow area (m}^2\text{)}] * [1000 \text{ (kg/Mg)}].$	3C-11	Qualified from 1575 to 4900 s.

TABLE 3-2. (continued)

Variable, Location, and Detector	Units	Uncertainty	Calculation Method	Figure	Comments
MASS FLOW RATE (continued)			$\frac{\sqrt{[\text{Momentum Flux (Mg/m}\cdot\text{s}^2)]}}{\sqrt{[\text{Density (Mg/m}^3)]}} \cdot$ $[\text{Flow area (m}^2)] \cdot [1000 \text{ (kg/Mg)}].$		
FLUID SUBCOOLING			Pressurizer relief line flow area = 0.0006818 m ² .		
Upper Plenum			The subcooling is defined as $T_{\text{sat}} - T$. The saturation temperature was calculated from an average pressure reading from PE-1UP-1A and PE-1UP-1A1 using the following curve fits of steam table data:		
TE-5UP-1 through TE-5UP-7 PE-1UP-1A PE-1UP-1A1	SC-5UP-102	K	± 6 ± 6 ± 6 ± 6		
			1. For $P < 1.4 \text{ MPa}$, $T_{\text{sat}} = 348.225 + 290.13P - 399.543P^2 + 298.730P^3 - 84.196P^4$	3C-5 3C-21	Qualified.
			2. For $1.4 \text{ MPa} \leq P \leq 12 \text{ MPa}$, $T_{\text{sat}} = 419.024 + 42.6705P - 5.63957P^2 + 0.433108P^3 - 0.0130329P^4$		
			3. For $P > 12 \text{ MPa}$, $T_{\text{sat}} = 508.252 + 8.84806P - 0.114572P^2$		
			The measured temperature is an average of TE-5UP-1 through TE-5UP-7.		
a. The uncertainty in each conductivity probe for (a) LE-1ST-1 is $\pm 4.5\%$ of range, (b) LE-1ST-2 is $\pm 7.1\%$ of range, and (c) LE-3UP-1 is $\pm 2.9\%$ of range. All conductivity probes have a response time of 340 ms.					

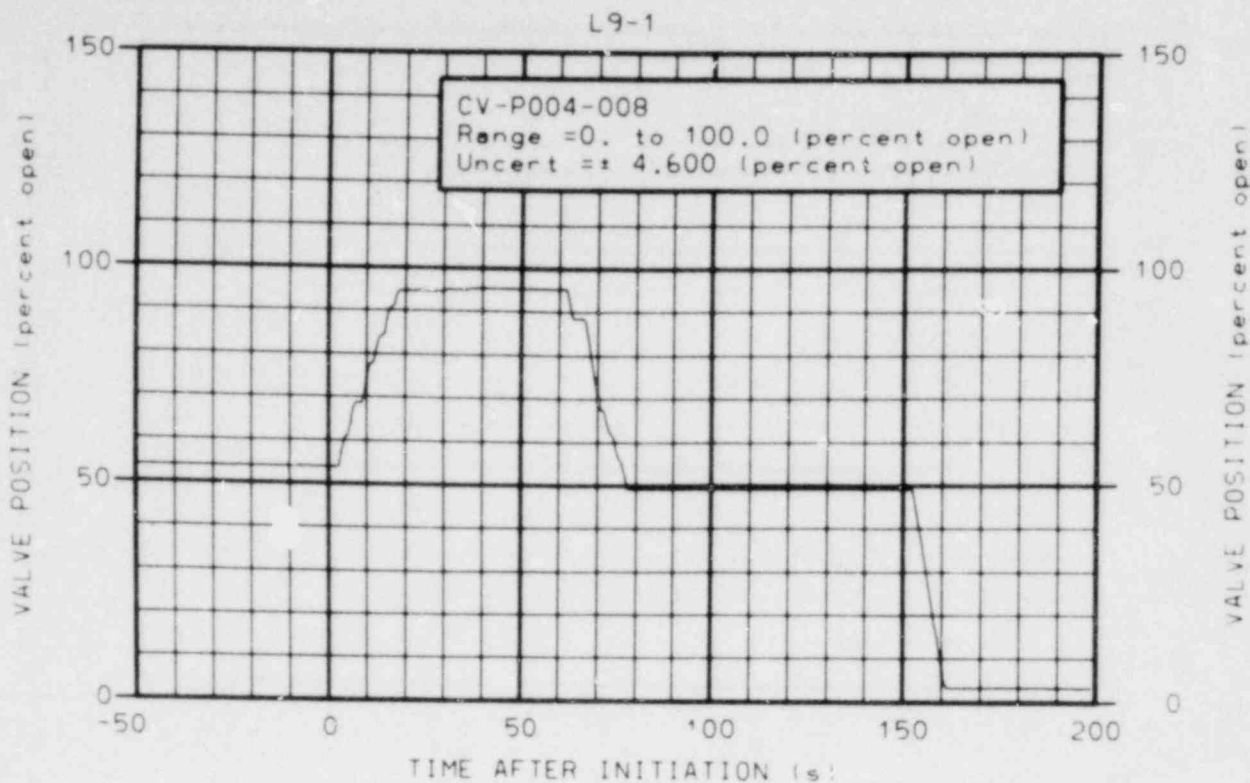


Figure 3S-1. Valve position for secondary coolant system feedwater control valve (CV-P004-008).

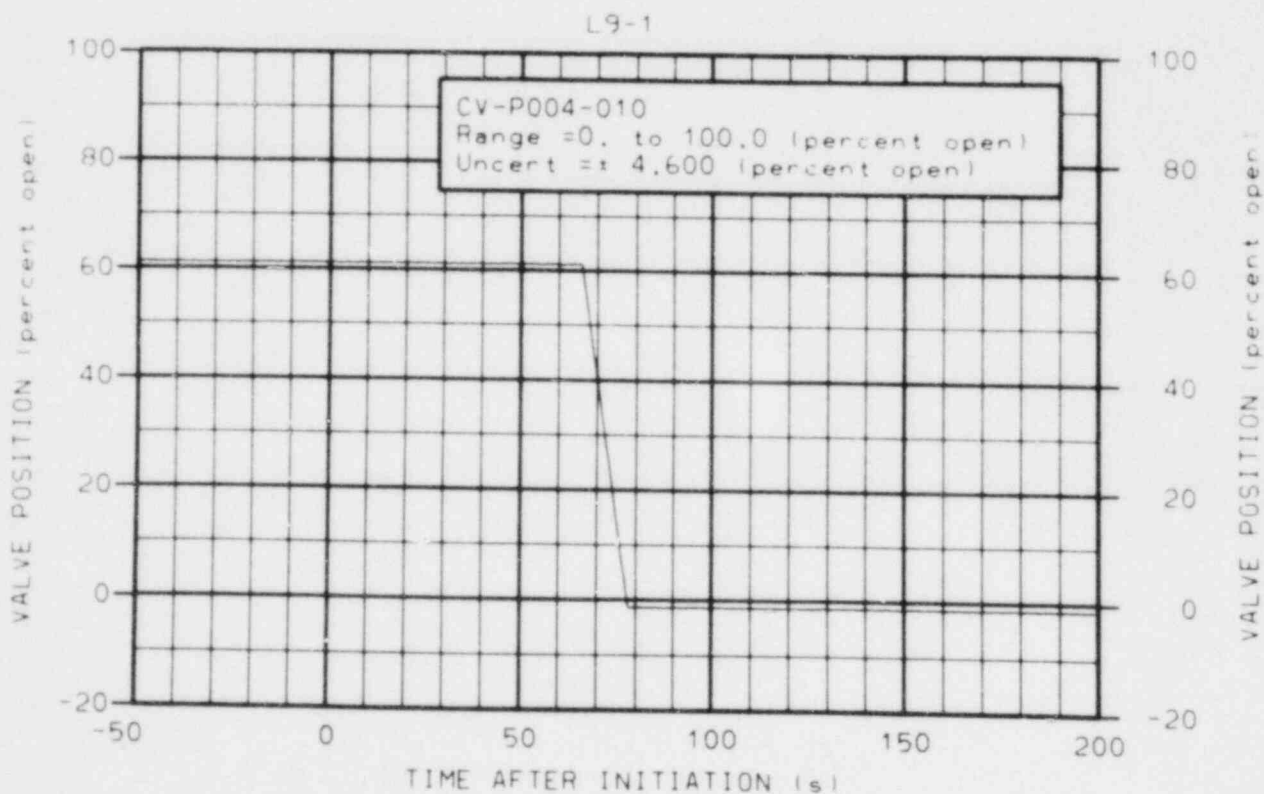


Figure 3S-2. Valve position for secondary coolant system steam flow control valve (CV-P004-010).

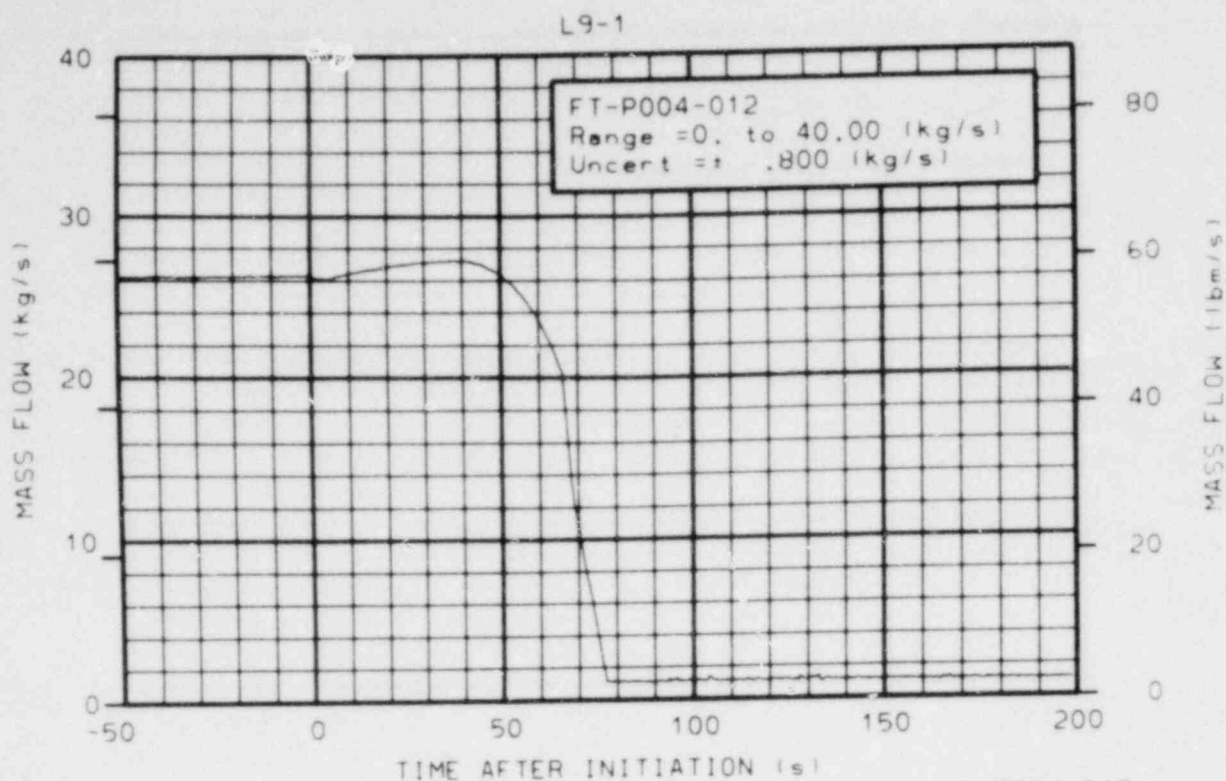


Figure 3S-3. Steam flow rate at condenser inlet (FT-P004-012) (qualified magnitude uncertain due to instrument drift).

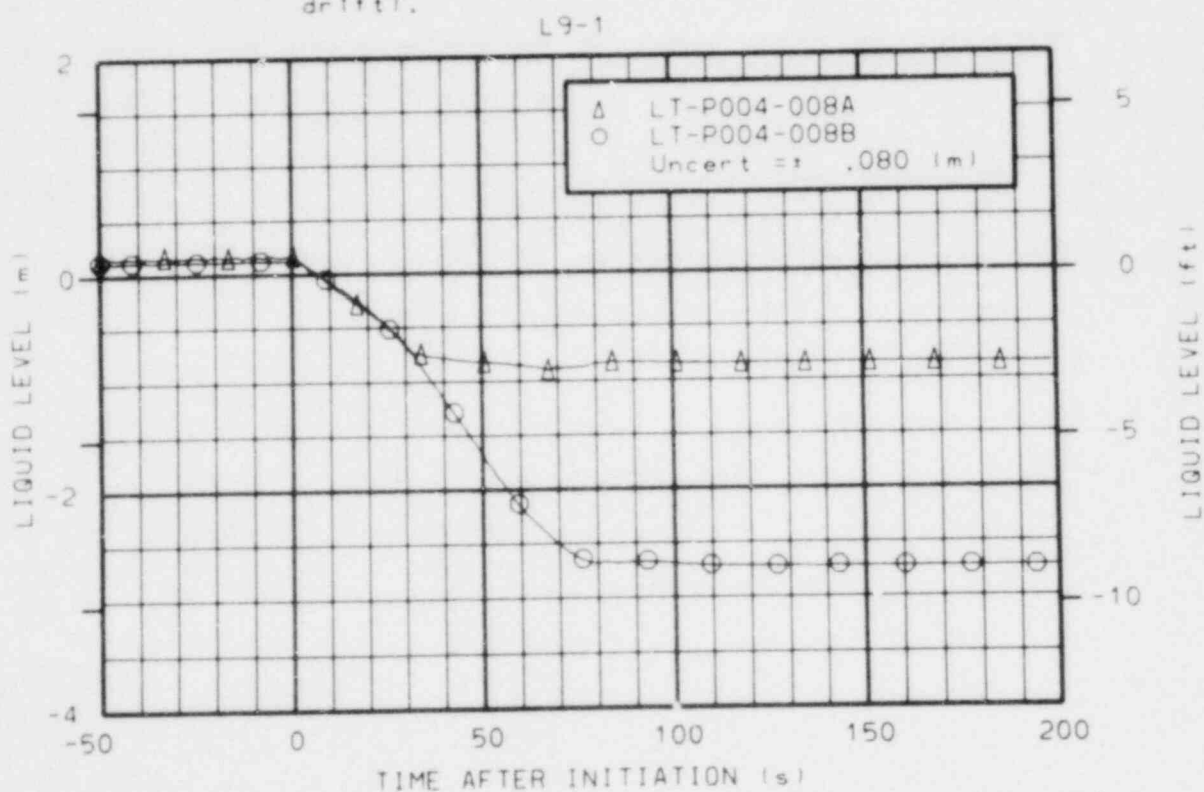


Figure 3S-4. Liquid level in steam generator secondary side, narrow (-1.0 to 1.5 m) and wide (-3.700 to 1.500 m) ranges respectively (LT-P004-008A and -008B) (qualified, not density compensated, oscillations at approximately 5000 s are not indicative of real level, LT-P004-008B, only after 0 s).

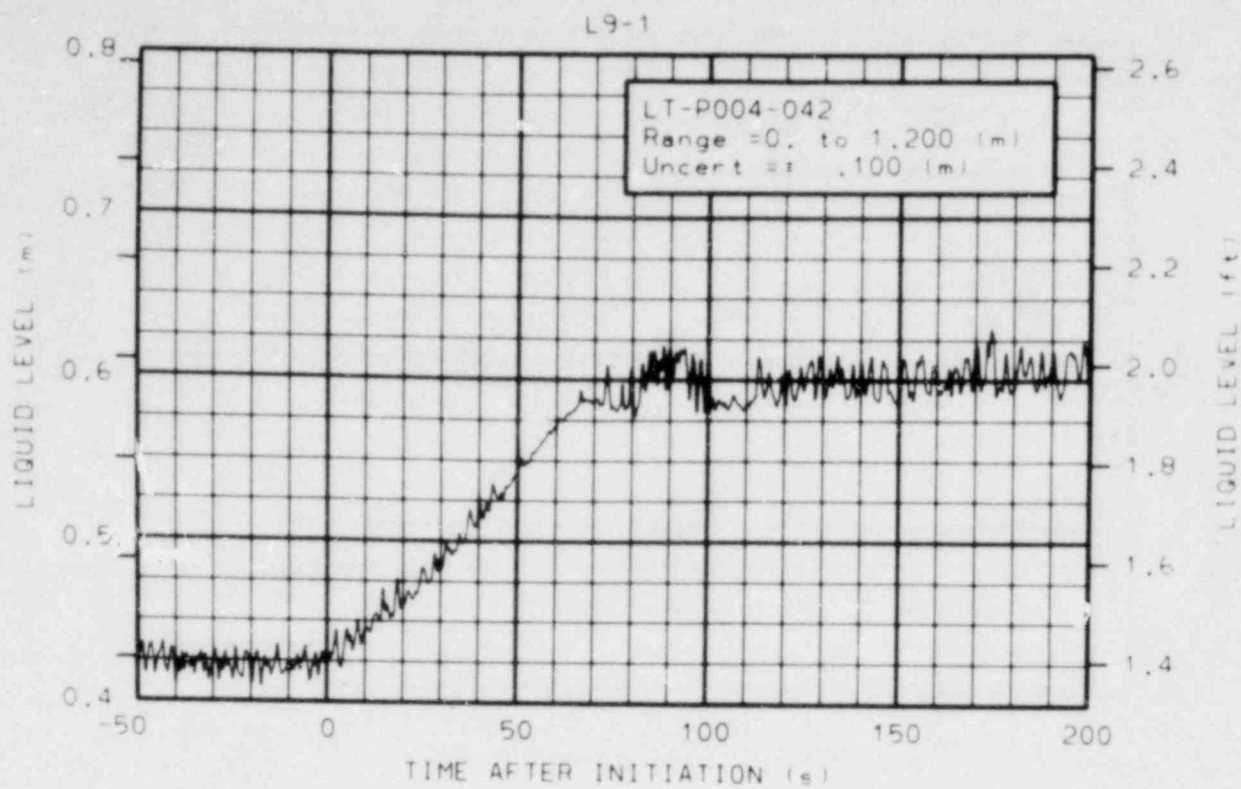


Figure 3S-5. Liquid level in condensate receiver at centerline (LT-P004-042) (qualified, magnitude uncertain).

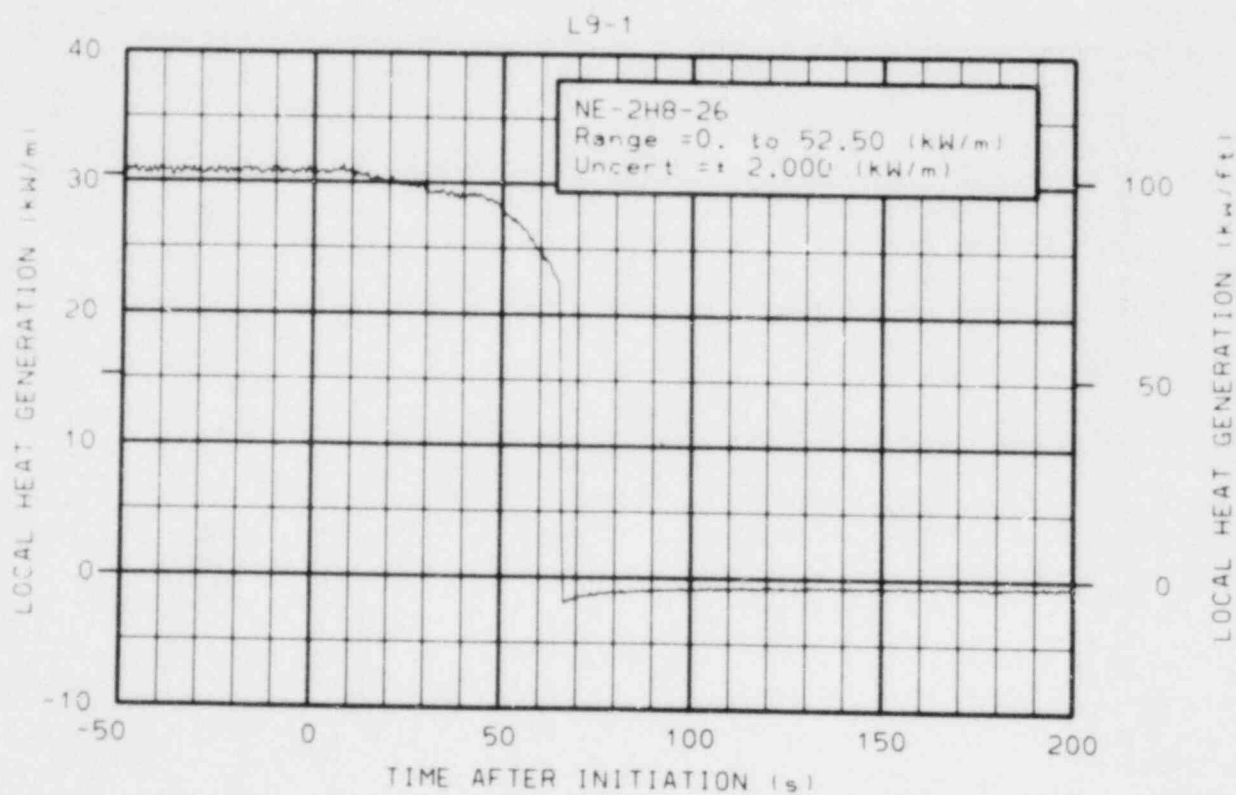


Figure 3S-6. Local heat generation rate for Fuel Assembly 2 (NE-2H8-26) (qualified, good to reactor scram).

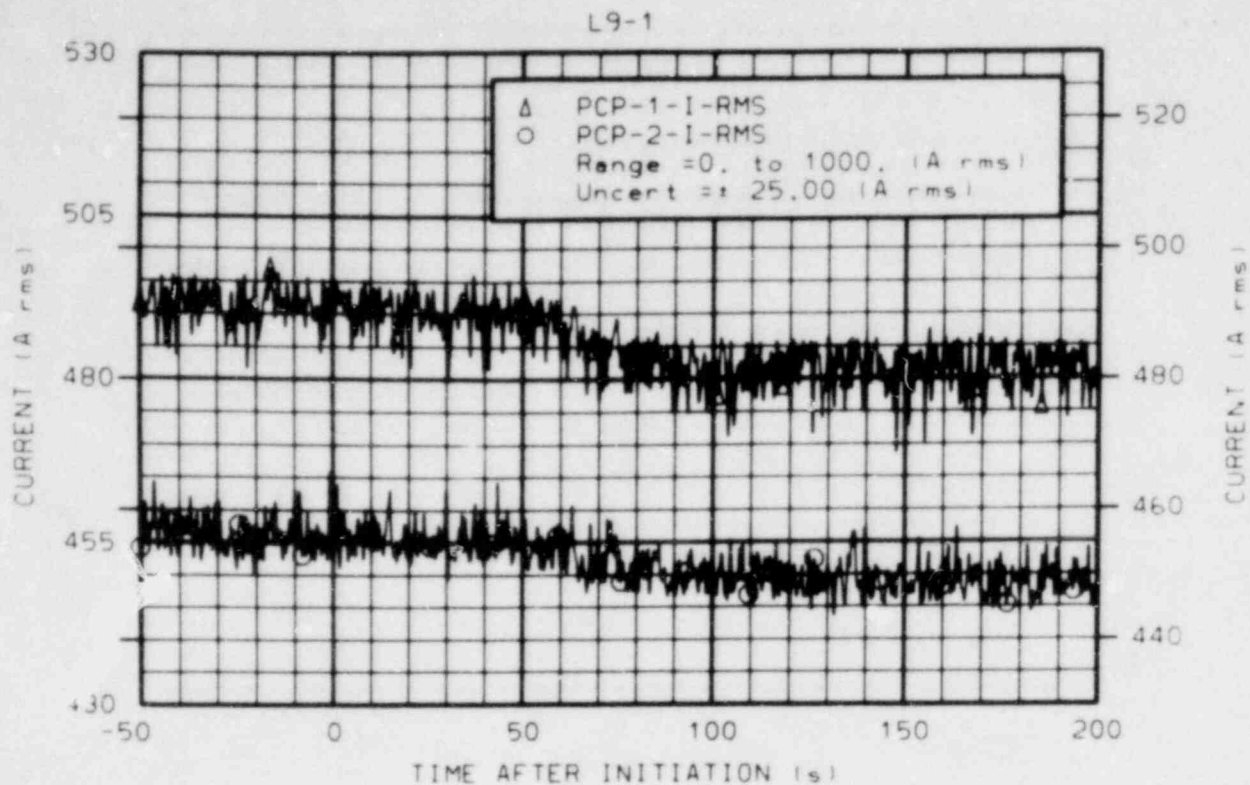


Figure 3S-7. Electrical current for primary coolant Pumps 1 and 2 (PCP-1-I-RMS and -2-I-RMS) (qualified to pump trip).

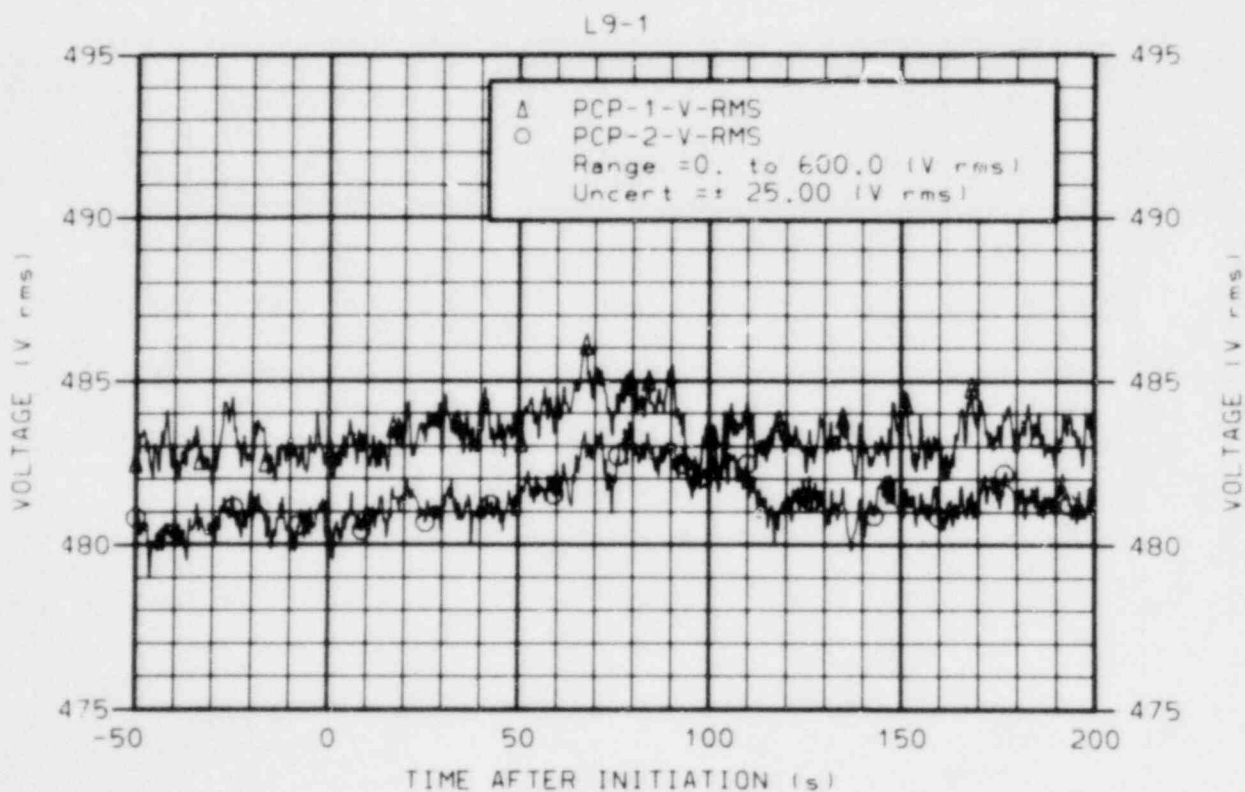


Figure 3S-8. Electrical voltage for primary coolant Pumps 1 and 2 (PCP-1-V-RMS and -2-V-RMS) (qualified to pump trip).

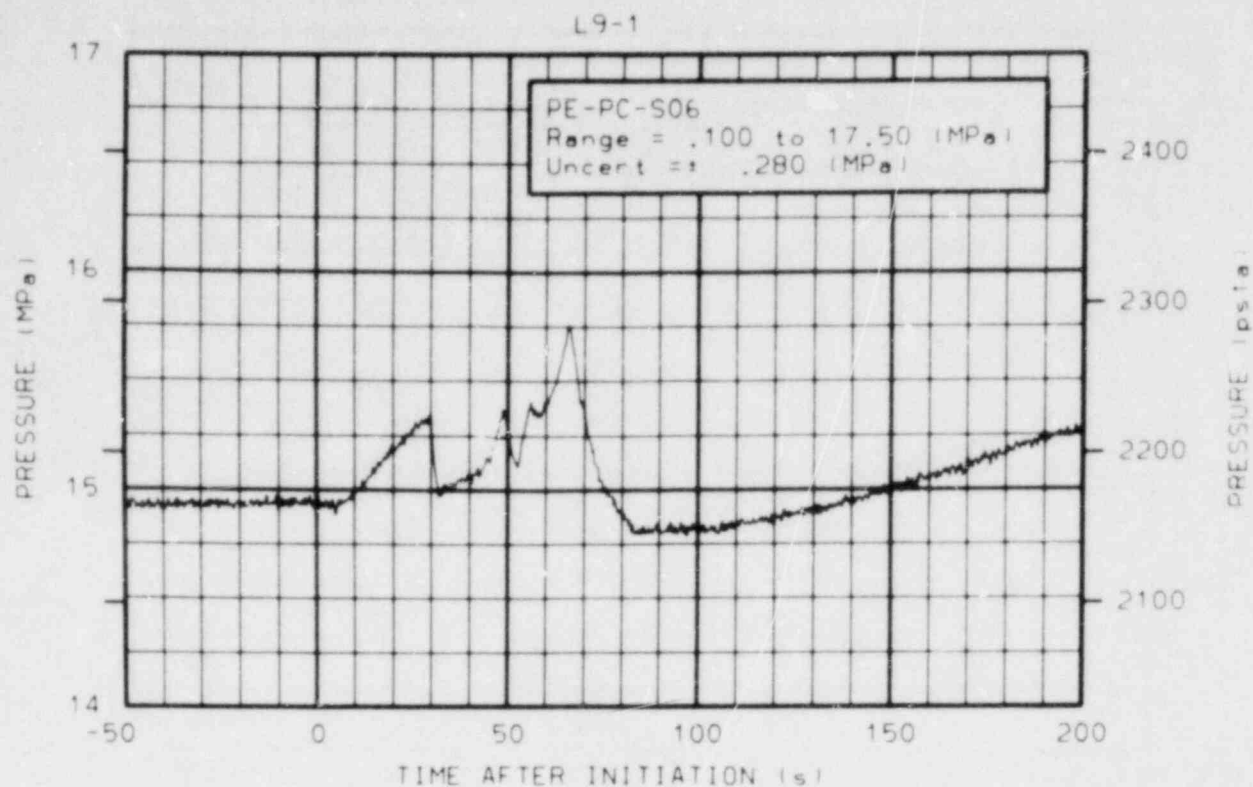


Figure 3S-9. Pressure in intact loop pressurizer relief line upstream of DTT (PE-PC-S06).

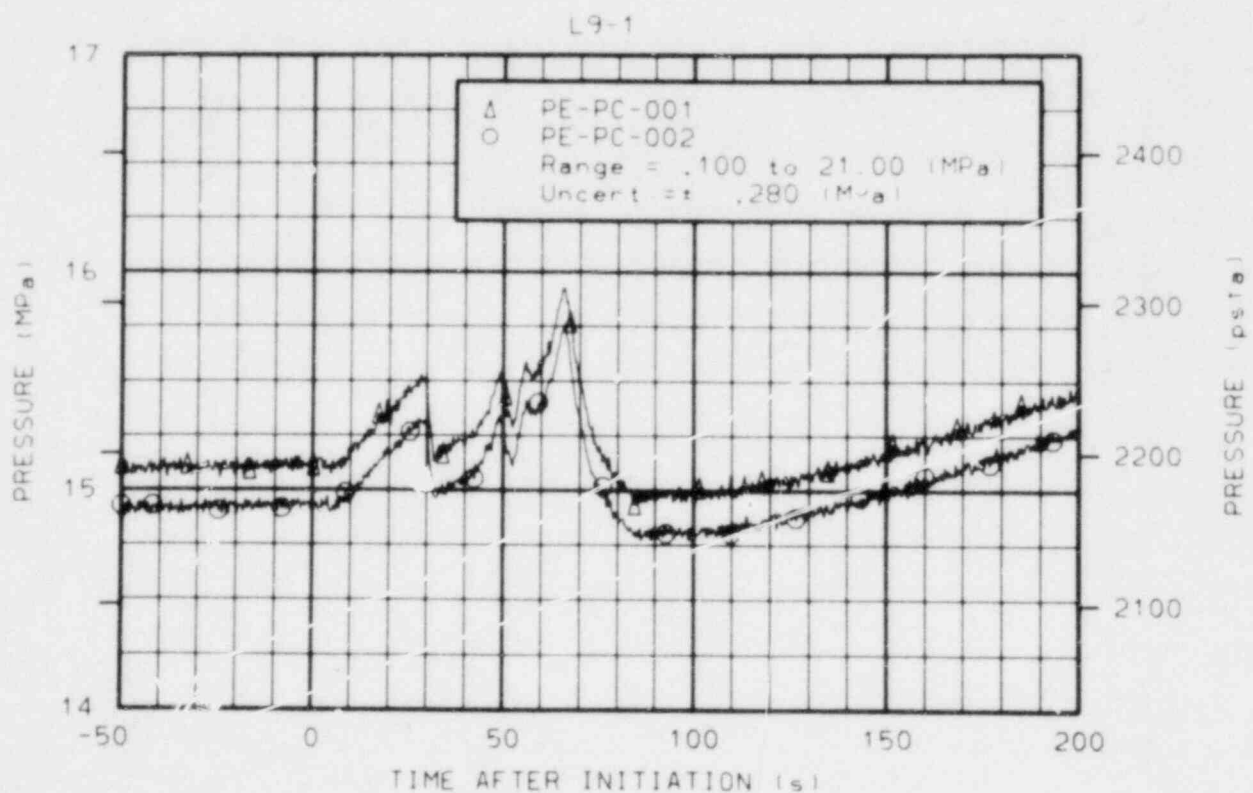


Figure 3S-10. Pressure in intact loop cold and hot legs (PE-PC-001 and -002).

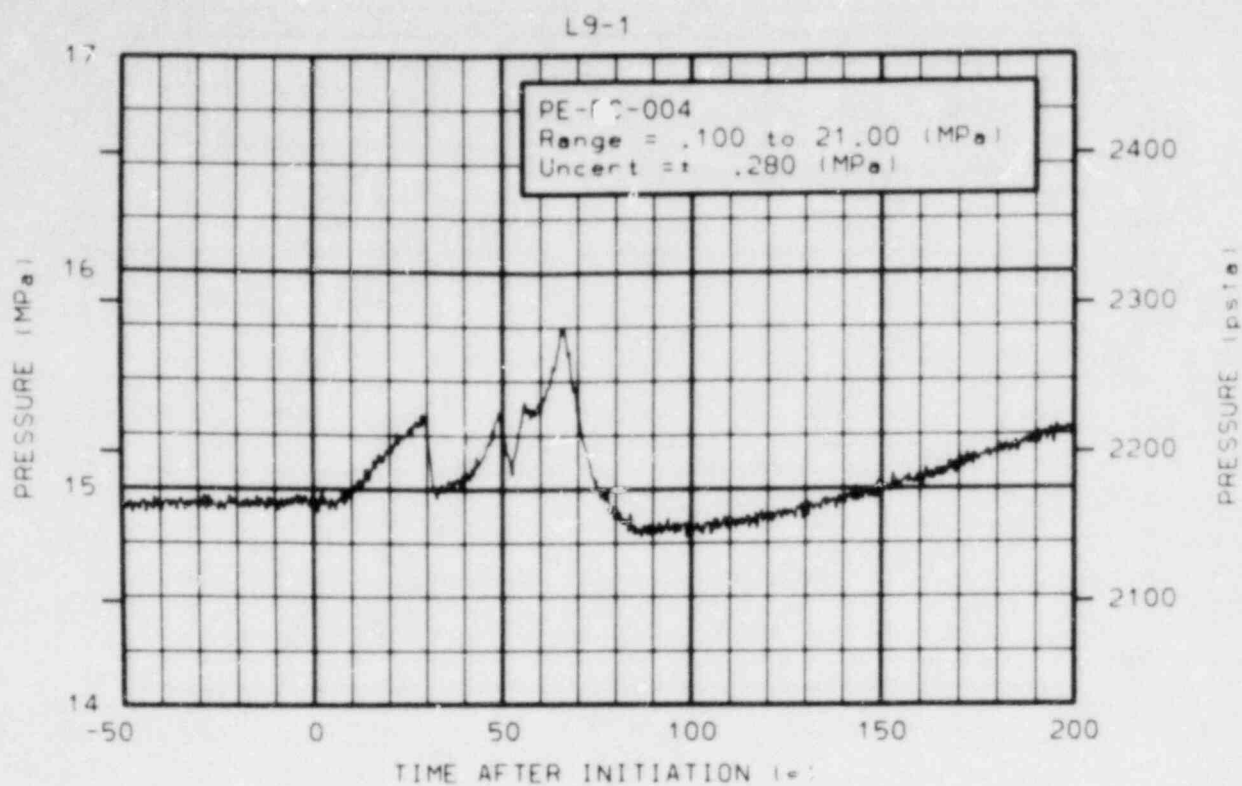


Figure 3S-11. Pressure in pressurizer (PE-PC-004).

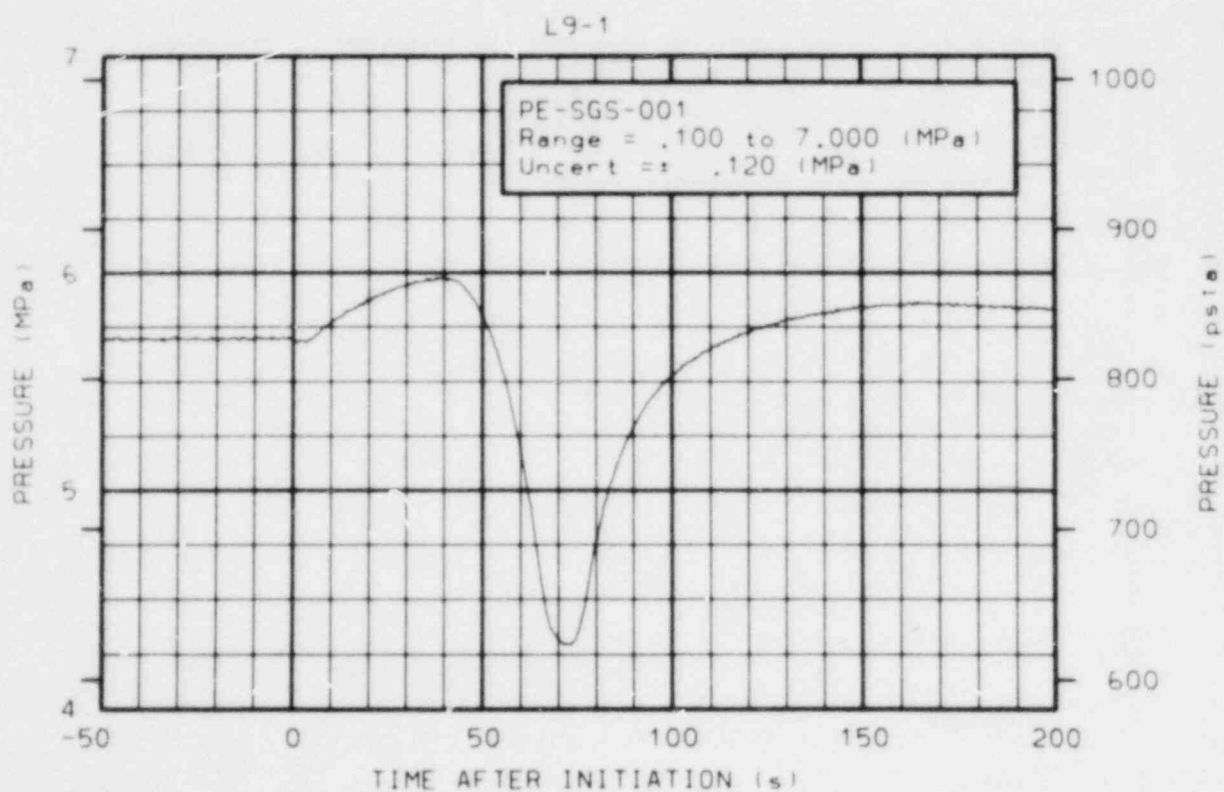


Figure 3S-12. Pressure in steam generator dome (PE-SGS-001).

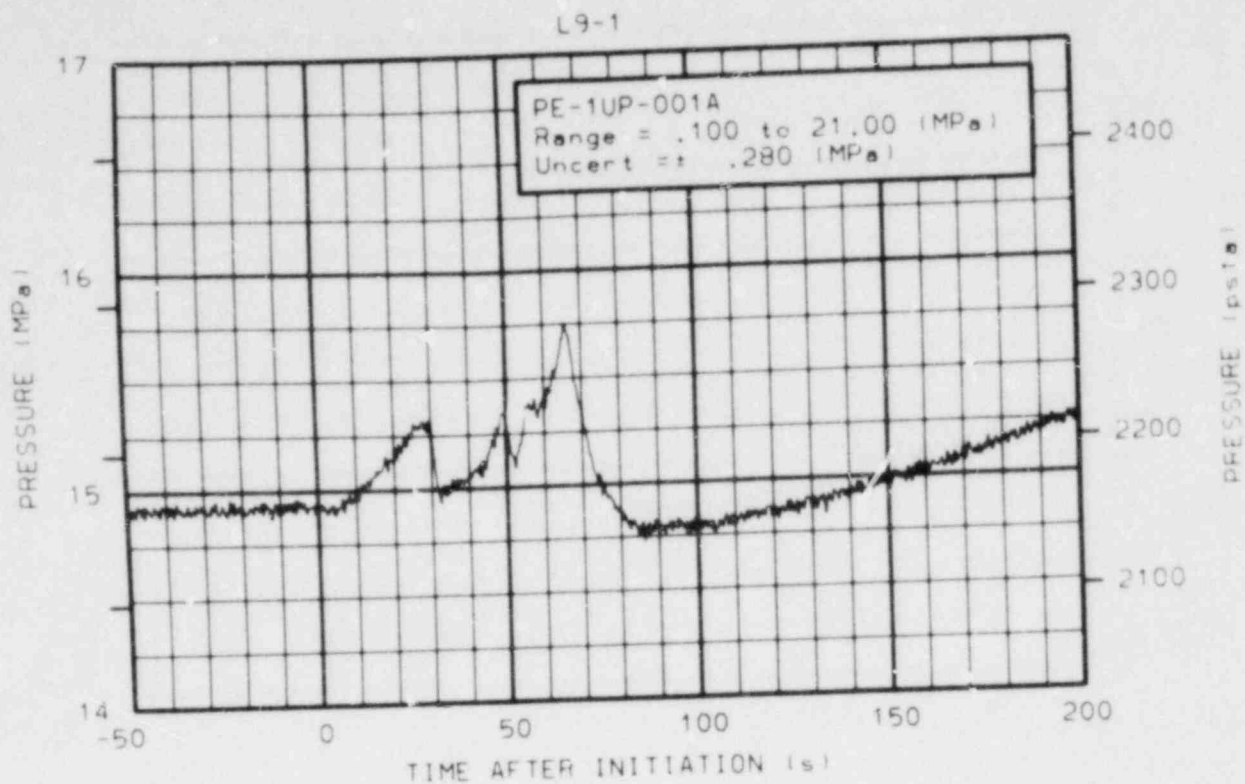


Figure 3S-13. Pressure in reactor vessel above upper end box of Fuel Assembly 1 (PE-1UP-001A).

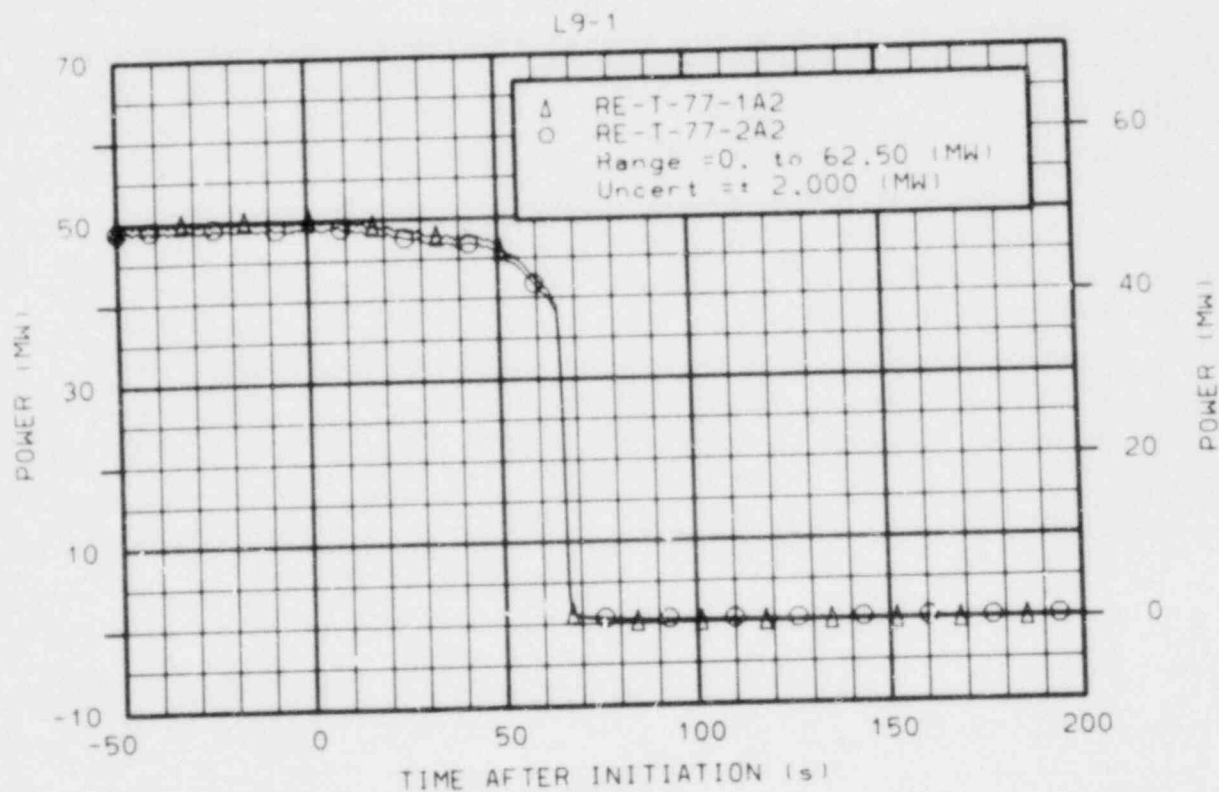


Figure 3S-14. Local average power, Channels A and B (RE-T-77-1A2 and -2A2).

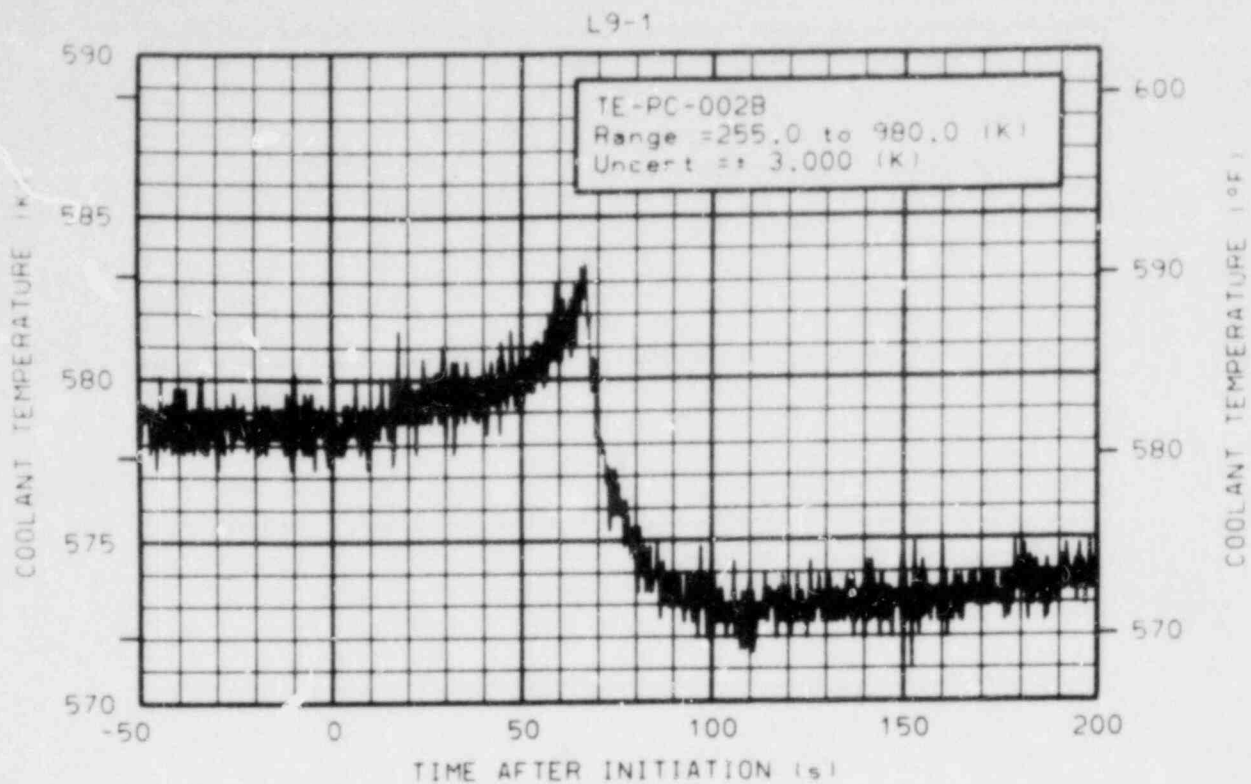


Figure 3S-15. Coolant temperature in intact loop hot leg (TE-PC-002B).

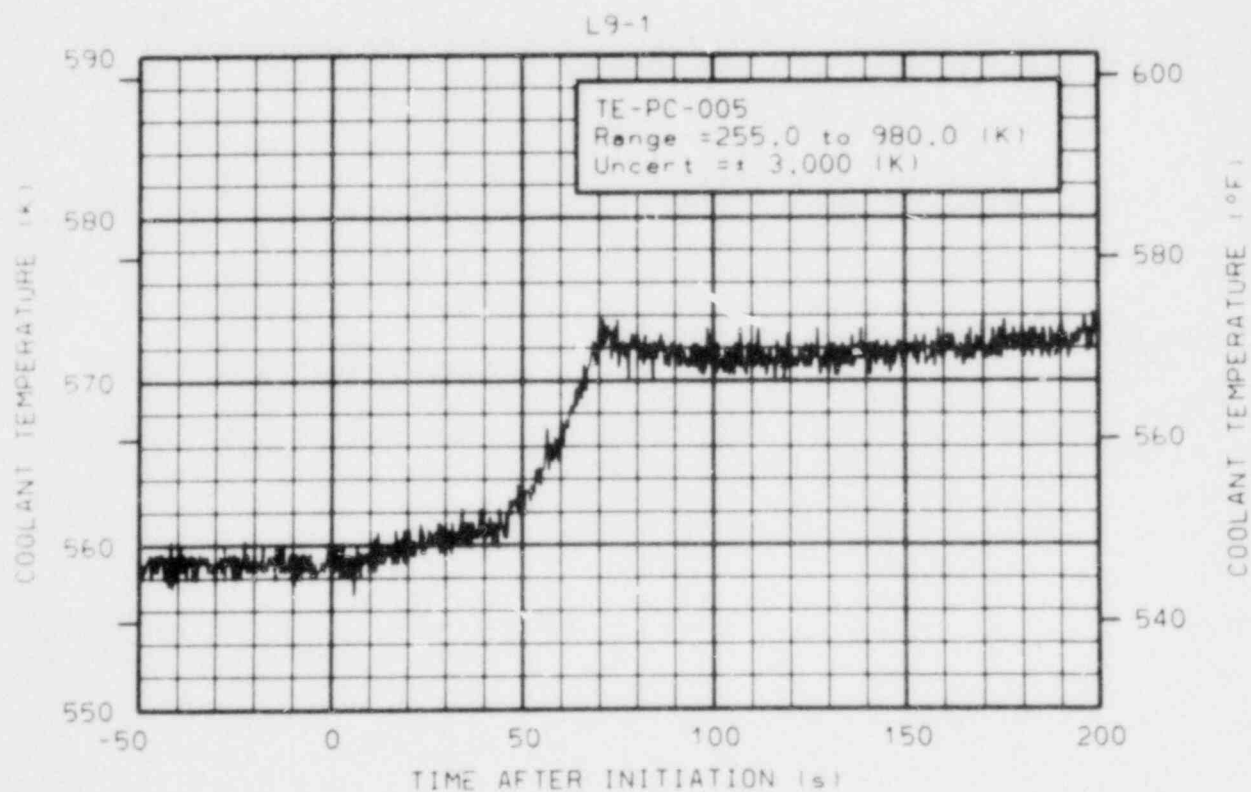


Figure 3S-16. Coolant temperature in intact loop cold leg next to bottom of ECC Rake 1 (TE-PC-005).

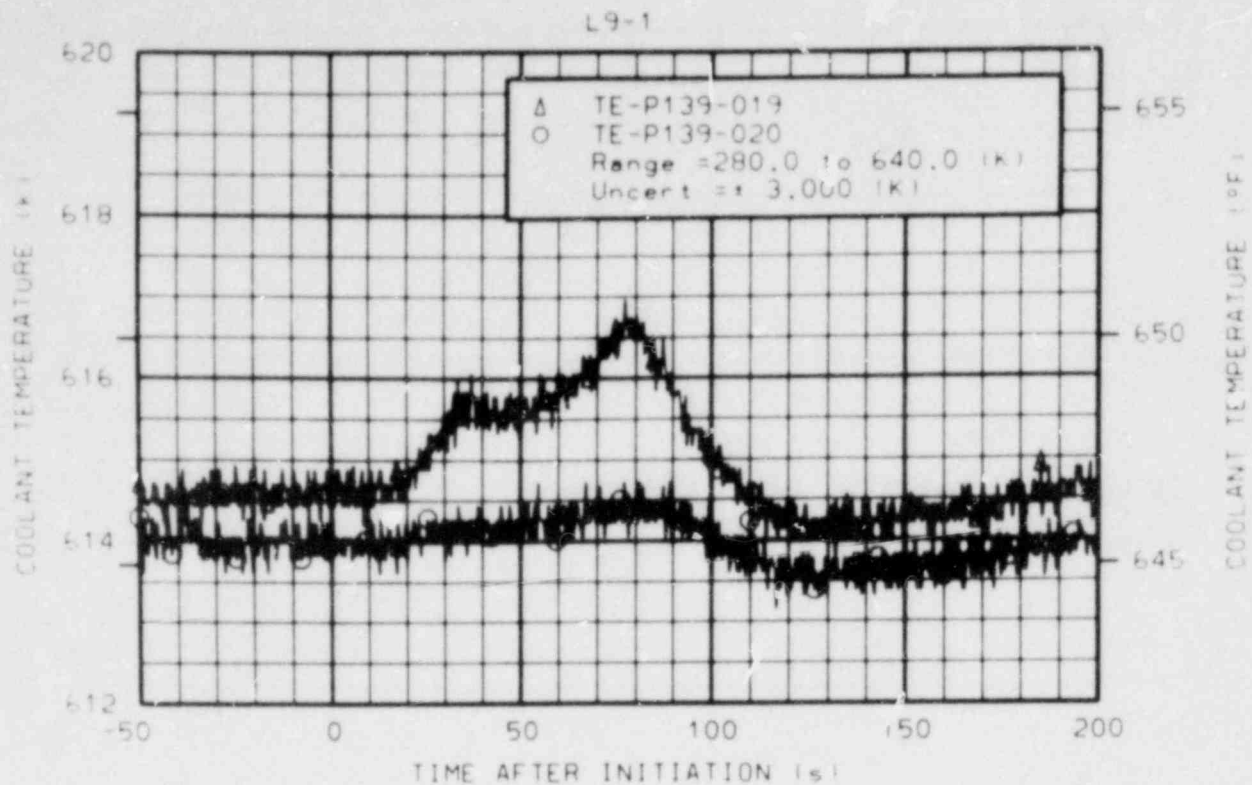


Figure 3S-17. Coolant temperature in intact loop pressurizer vapor and liquid space (TE-P139-019 and -020).

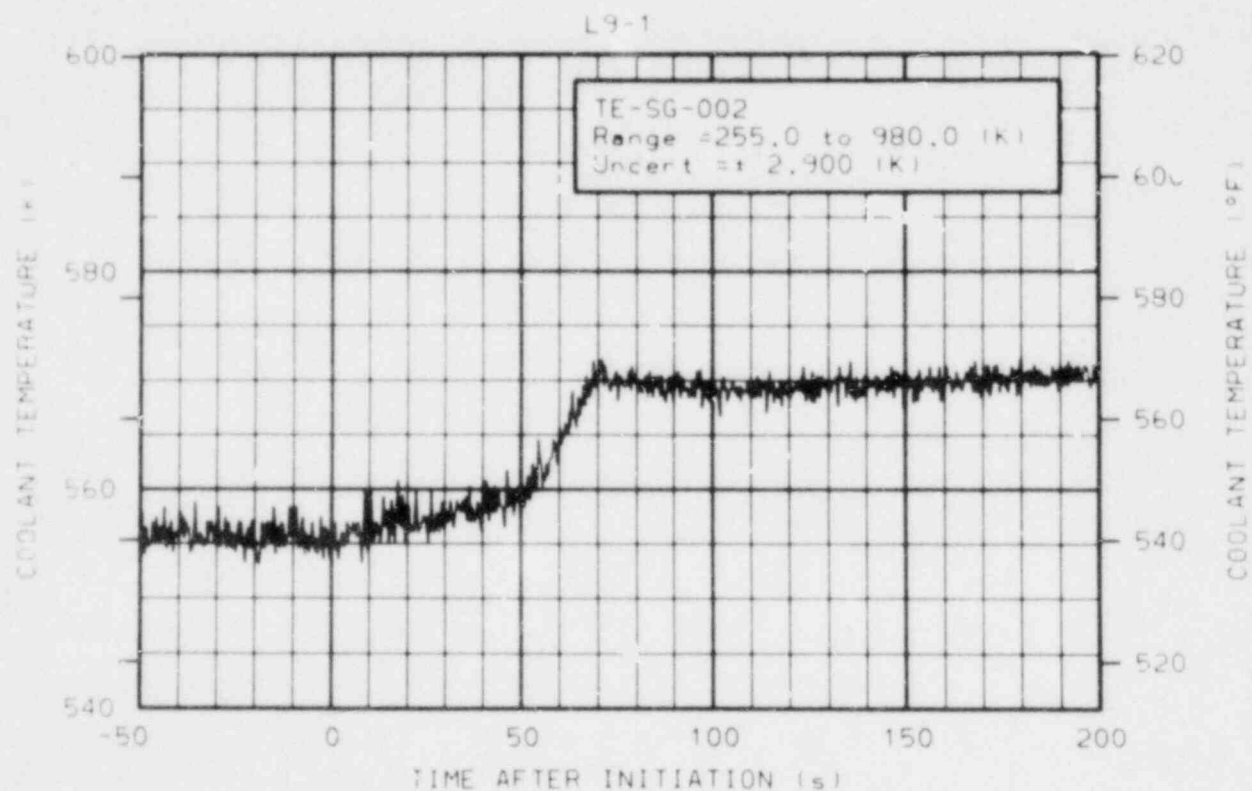


Figure 3S-18. Coolant temperature in intact loop steam generator outlet plenum (TE-SG-002).

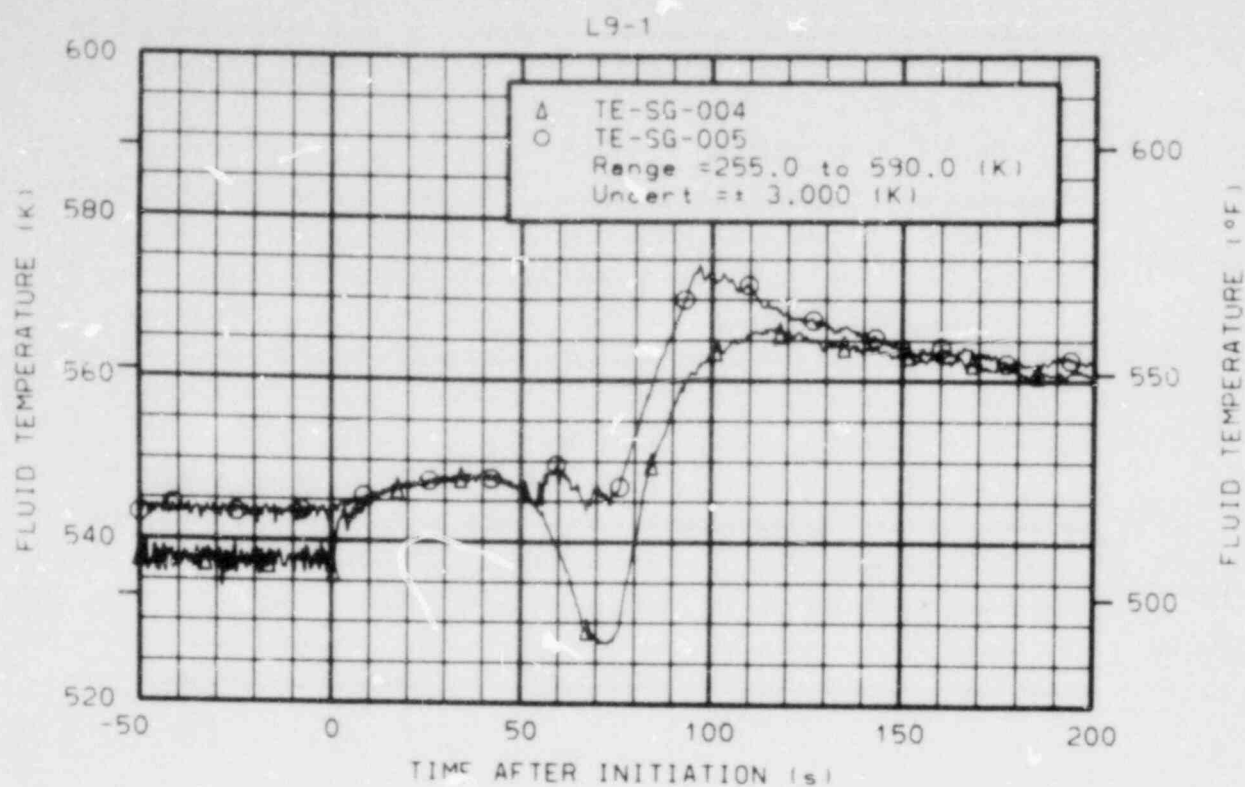


Figure 3S-19. Fluid temperature in steam generator secondary side downcomer at 2.12 and 2.92 m above top of tube sheet (TE-SG-004 and -005).

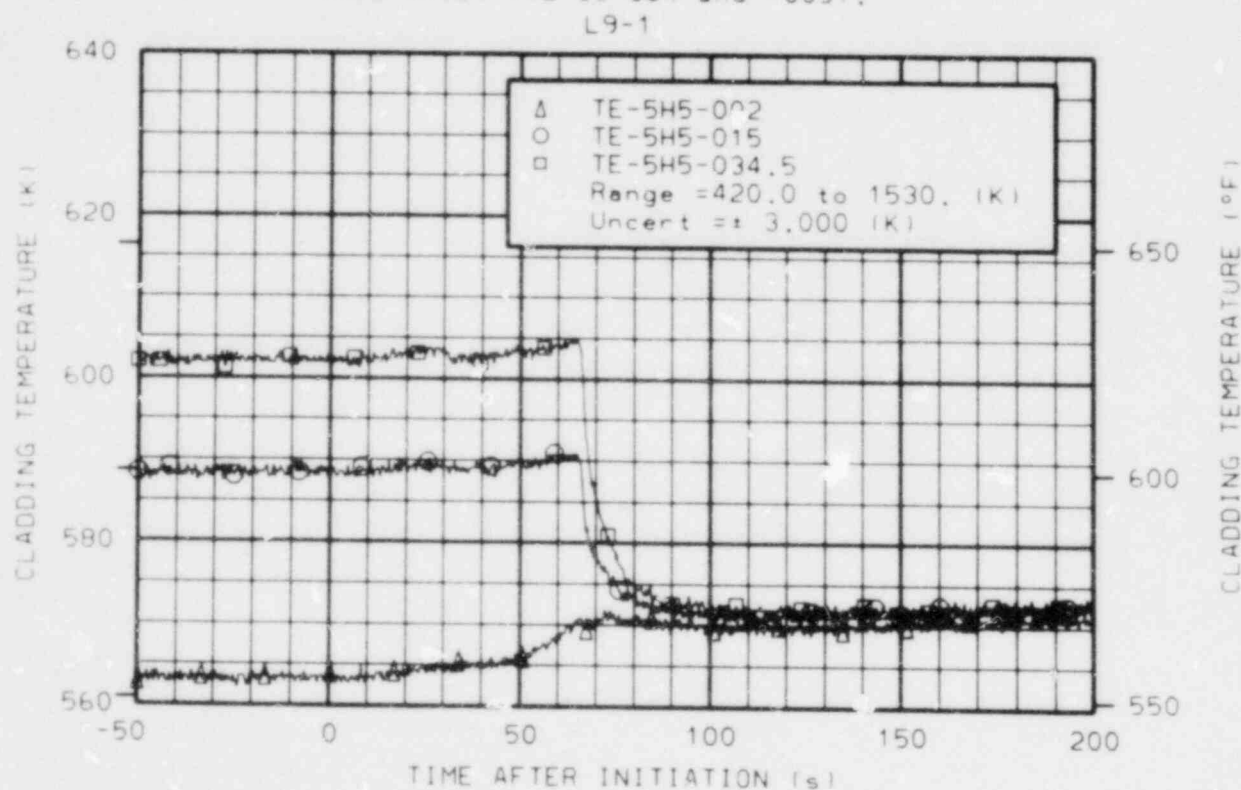


Figure 3S-20. Cladding temperature in reactor vessel at Fuel Assembly 5, Row H, Column 5 at 0.05, 0.38, and 0.88 m above bottom of fuel rod (TE-5H5-002, -015, and -034.5).

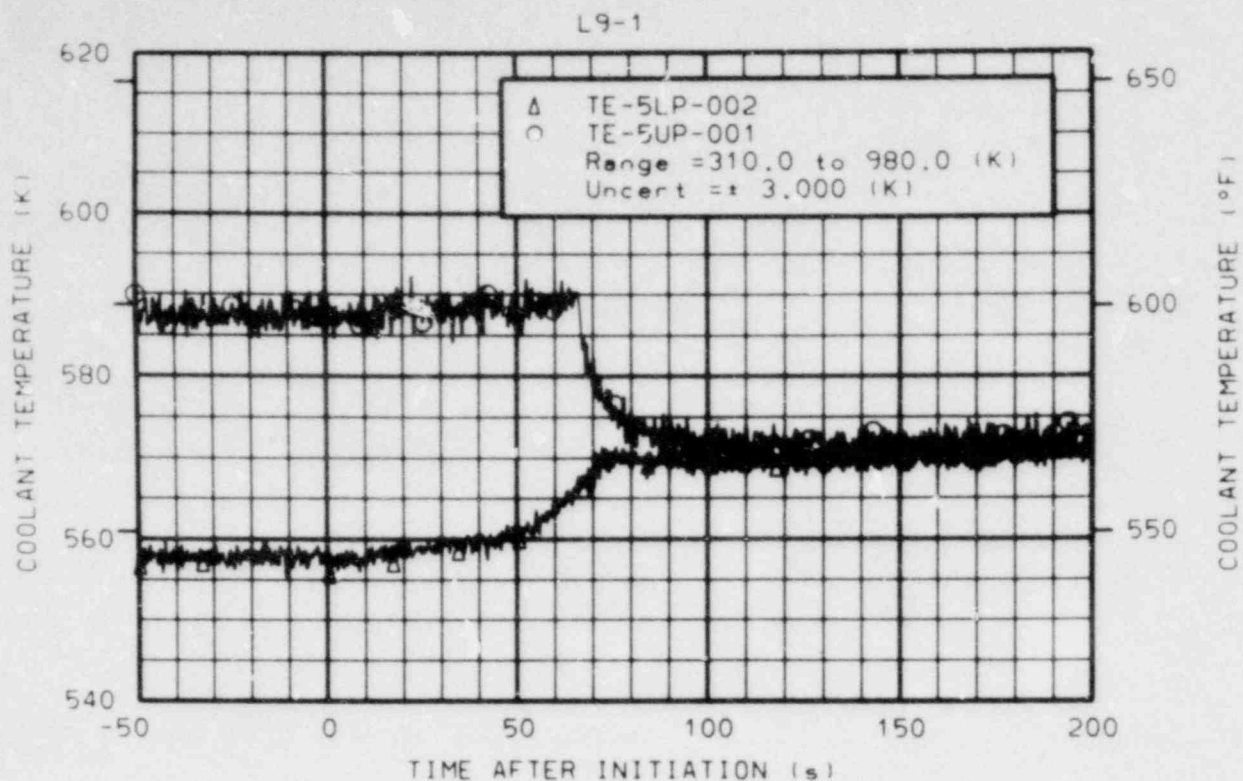


Figure 3S-21. Coolant temperature in reactor vessel at lower and upper end boxes of Fuel Assembly 5 (TE-5LP-002 and -5UP-001).

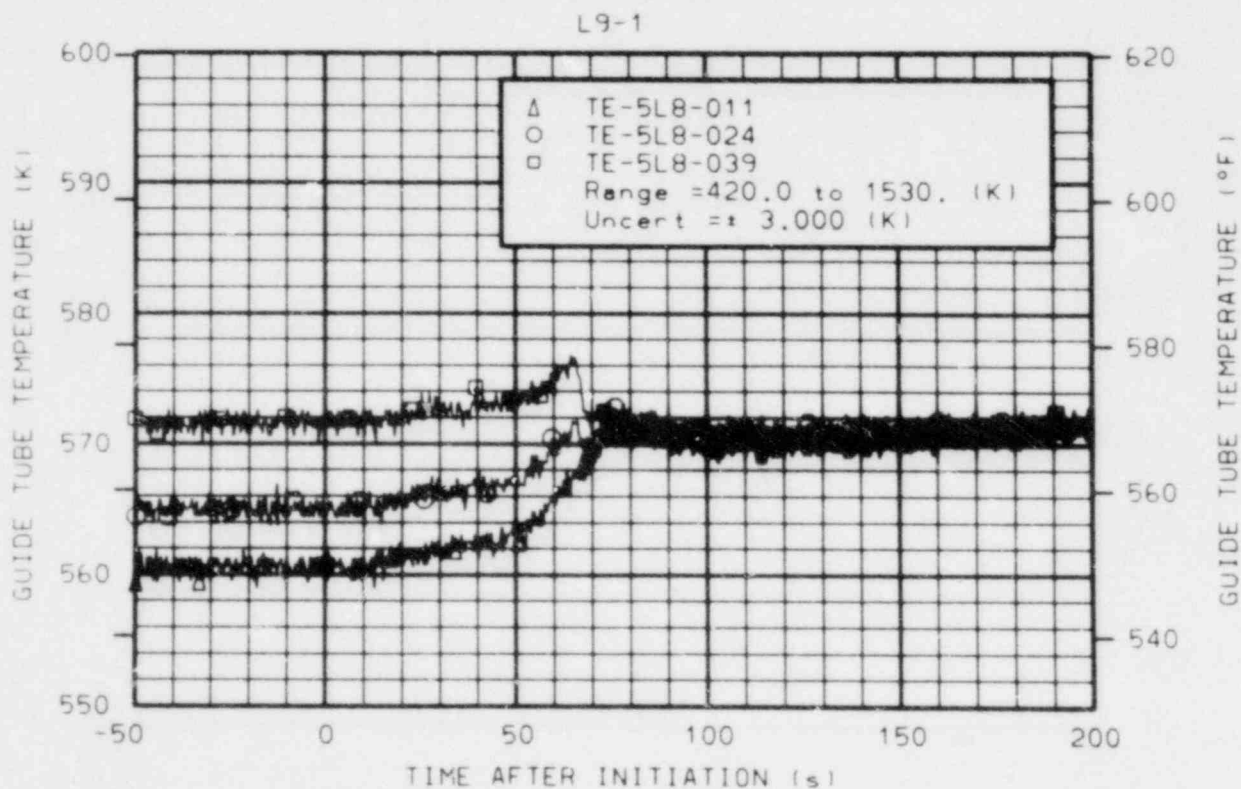


Figure 3S-22. Guide tube temperature in reactor vessel at Fuel Assembly 5, Row L, Column 8 at 0.28, 0.41, and 0.99 m above bottom of guide tube (TE-5L8-011, -024, and -039).

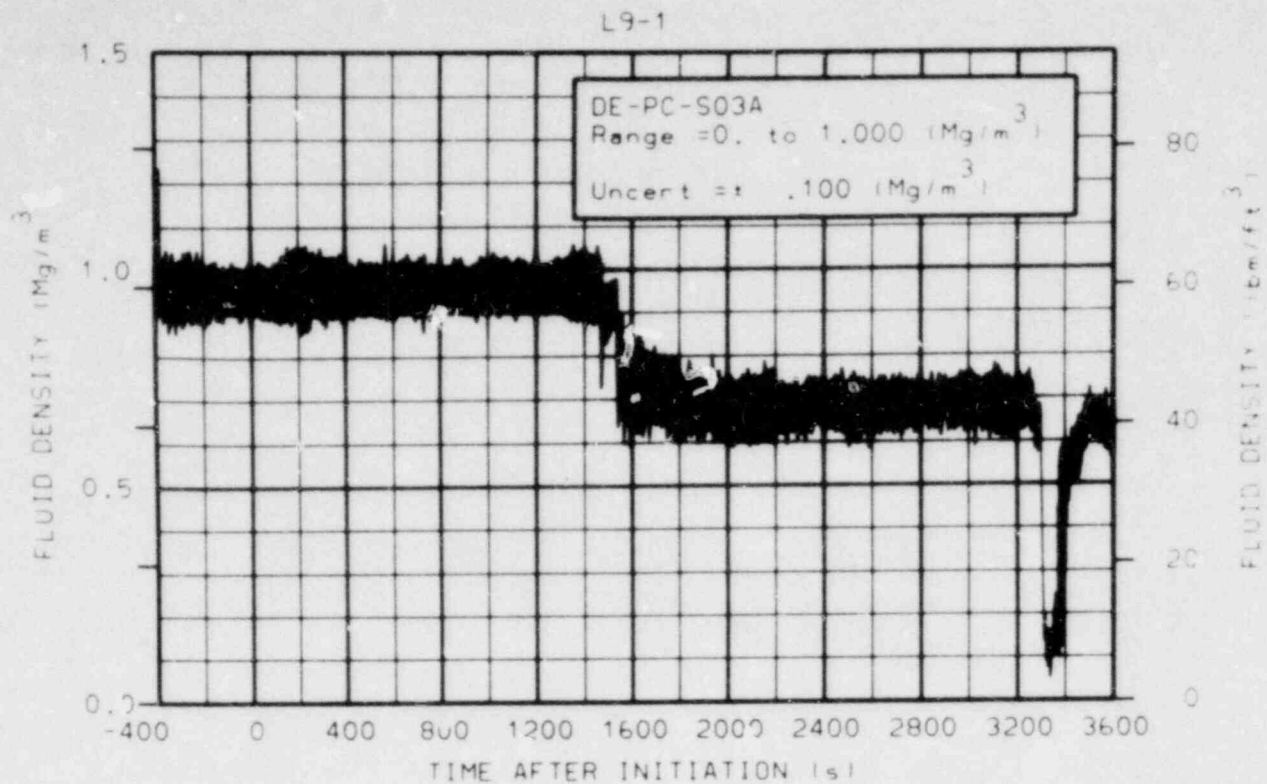


Figure 3B-1. Fluid density in intact loop pressurizer relief line upstream of experiment PORV, chordal density (DE-PC-S03A).

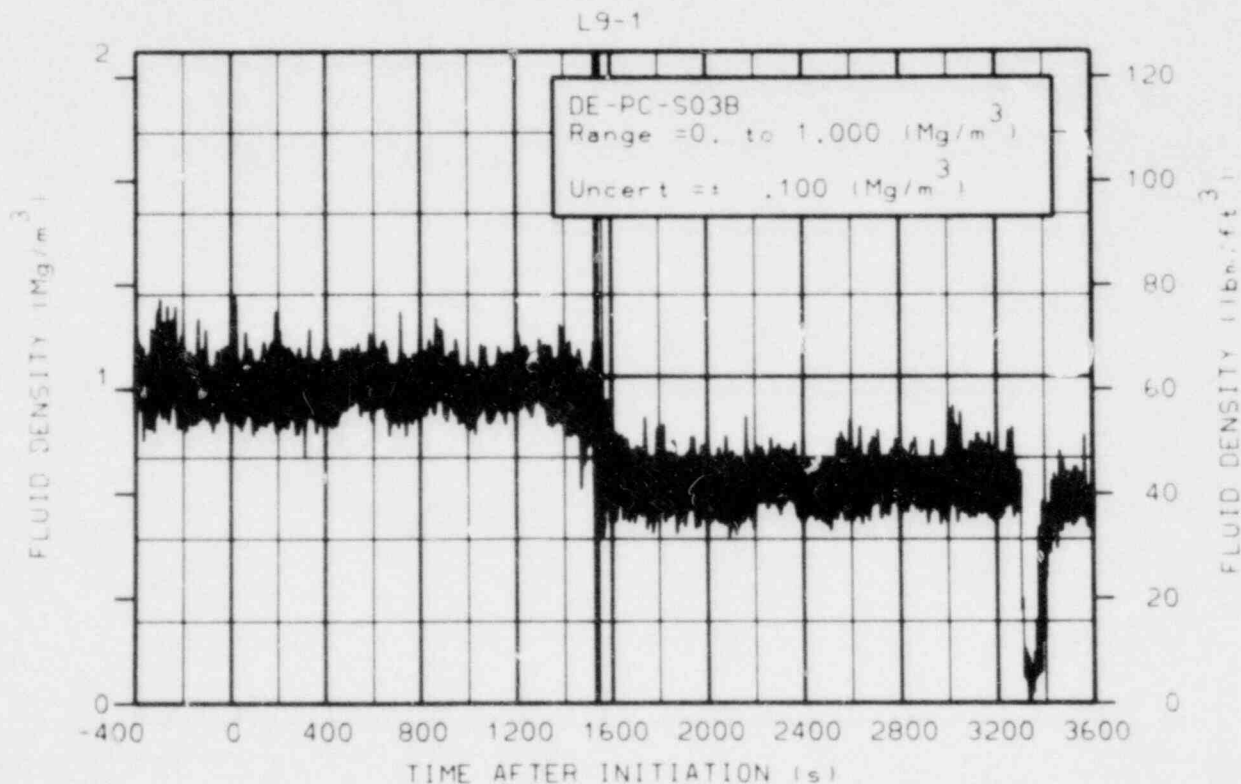


Figure 3B-2. Fluid density in intact loop pressurizer relief line upstream of experiment PORV, chordal density (DE-PC-S03B) (qualified, spikes from 1529 to 1560 s).

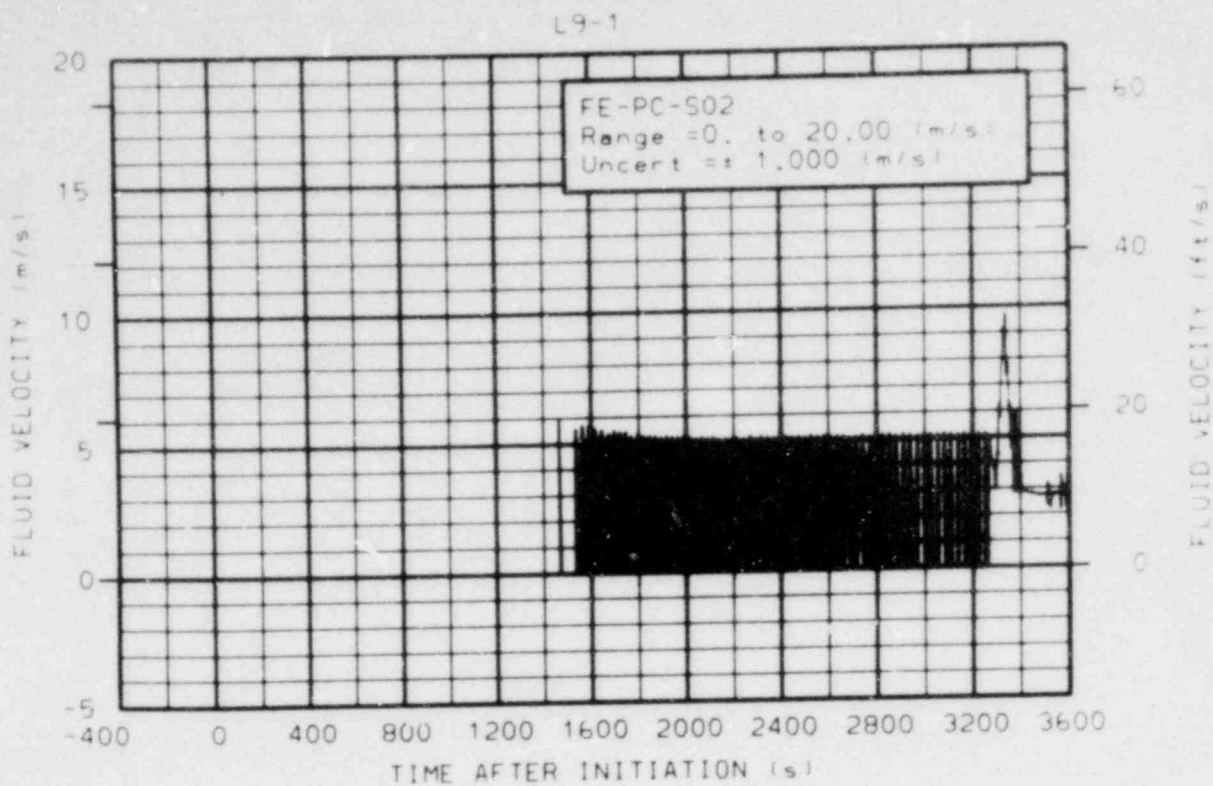


Figure 3B-3. Fluid velocity in intact loop pressurizer relief line upstream of experiment PORV (FE-PC-S02).

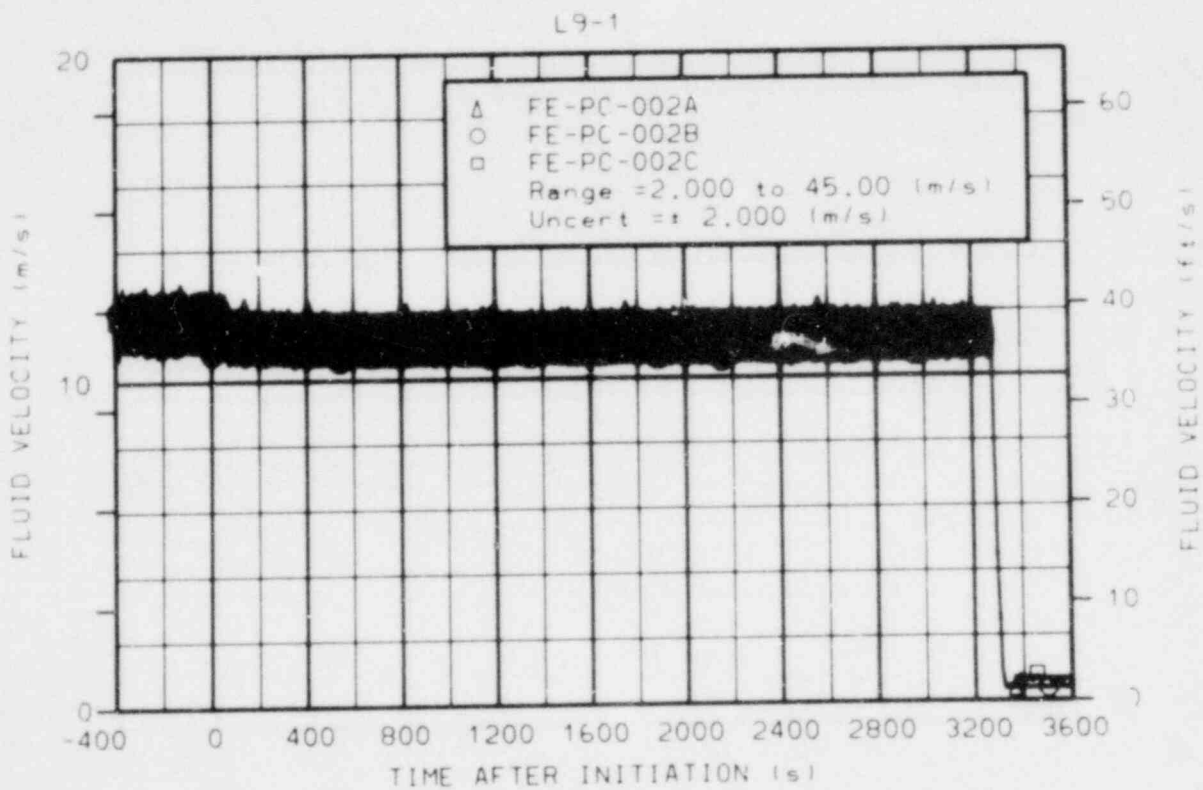


Figure 3B-4. Fluid velocity in intact loop hot leg DTT rake at bottom, middle, and top of pipe (FE-PC-002A, -002B, and -002C) (qualified to 6000 s).

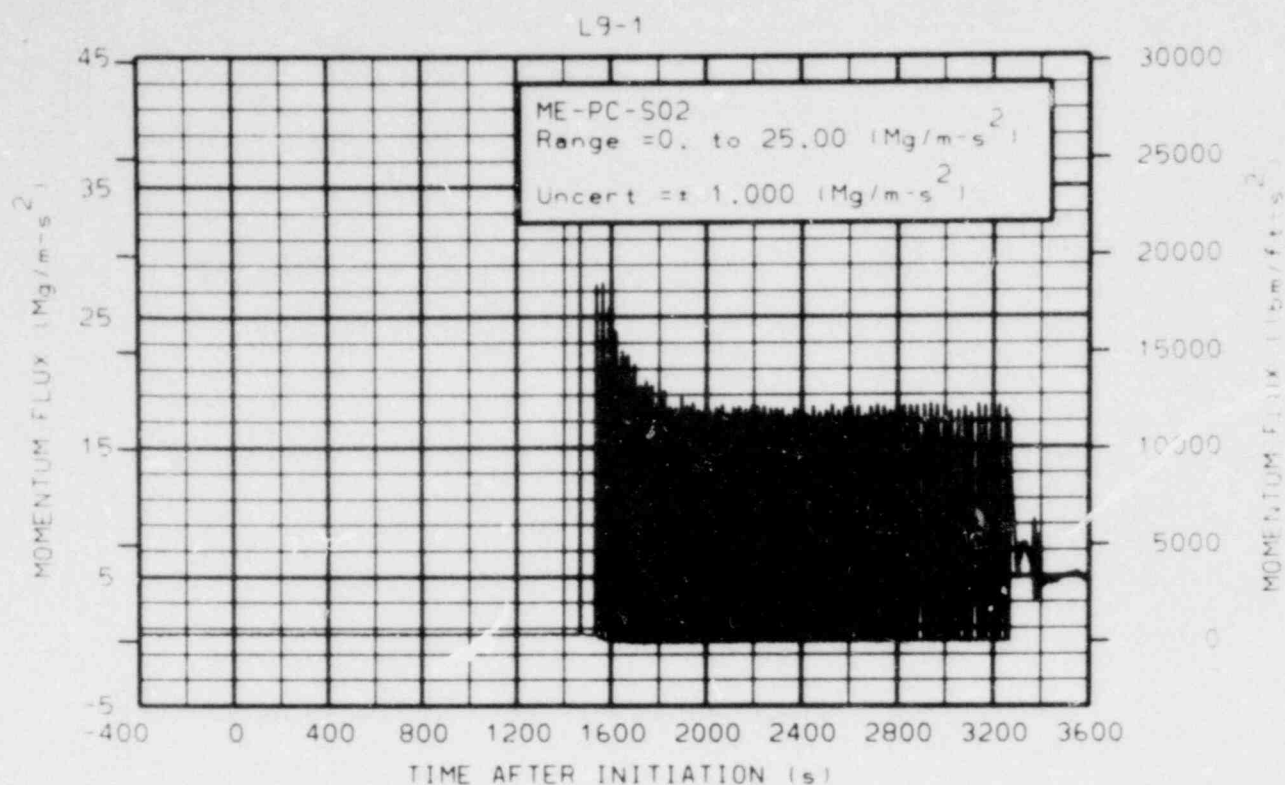


Figure 3B-5. Momentum flux in intact loop pressurizer relief line upstream of experiment PORV (ME-PC-S02) (qualified from 1575 to 4900 s).

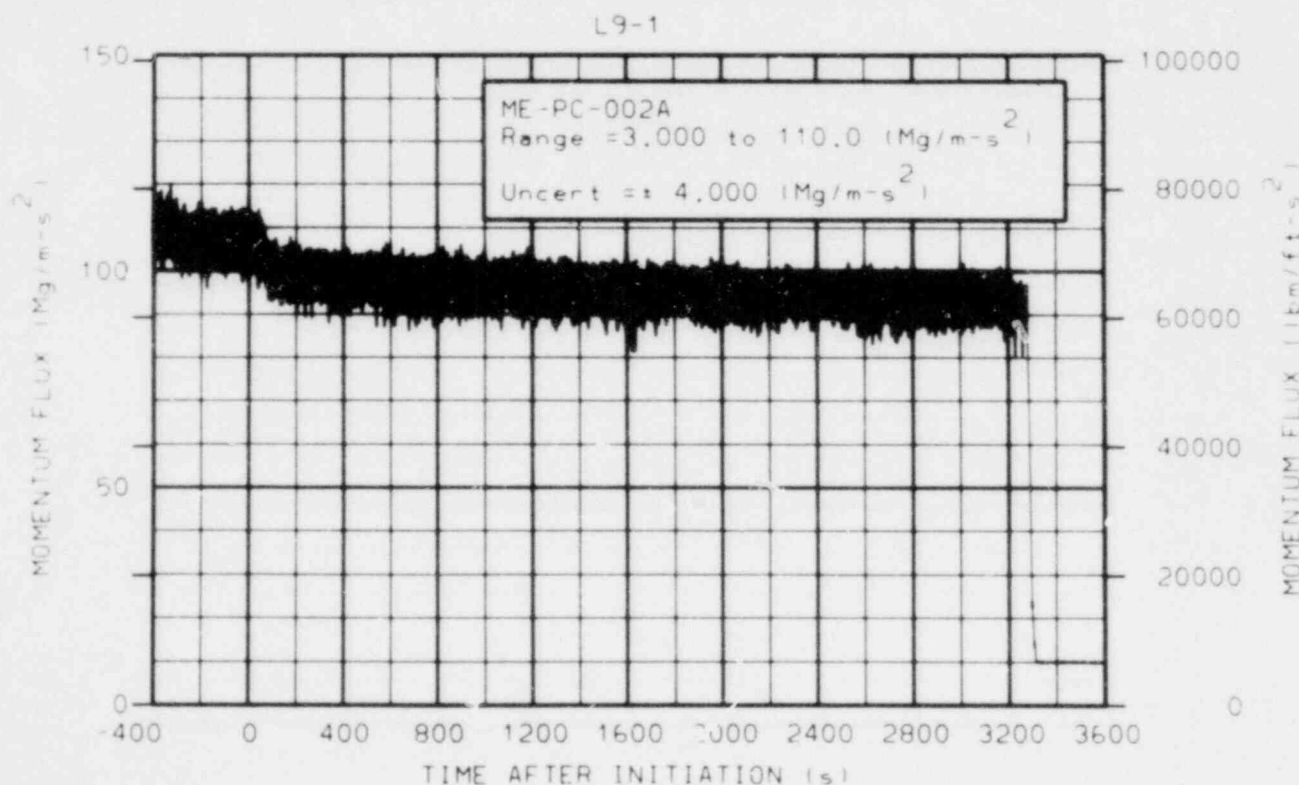


Figure 3B-6. Momentum flux in intact loop hot leg DTT rake at bottom of pipe (ME-PC-002A) (qualified to pump trip).

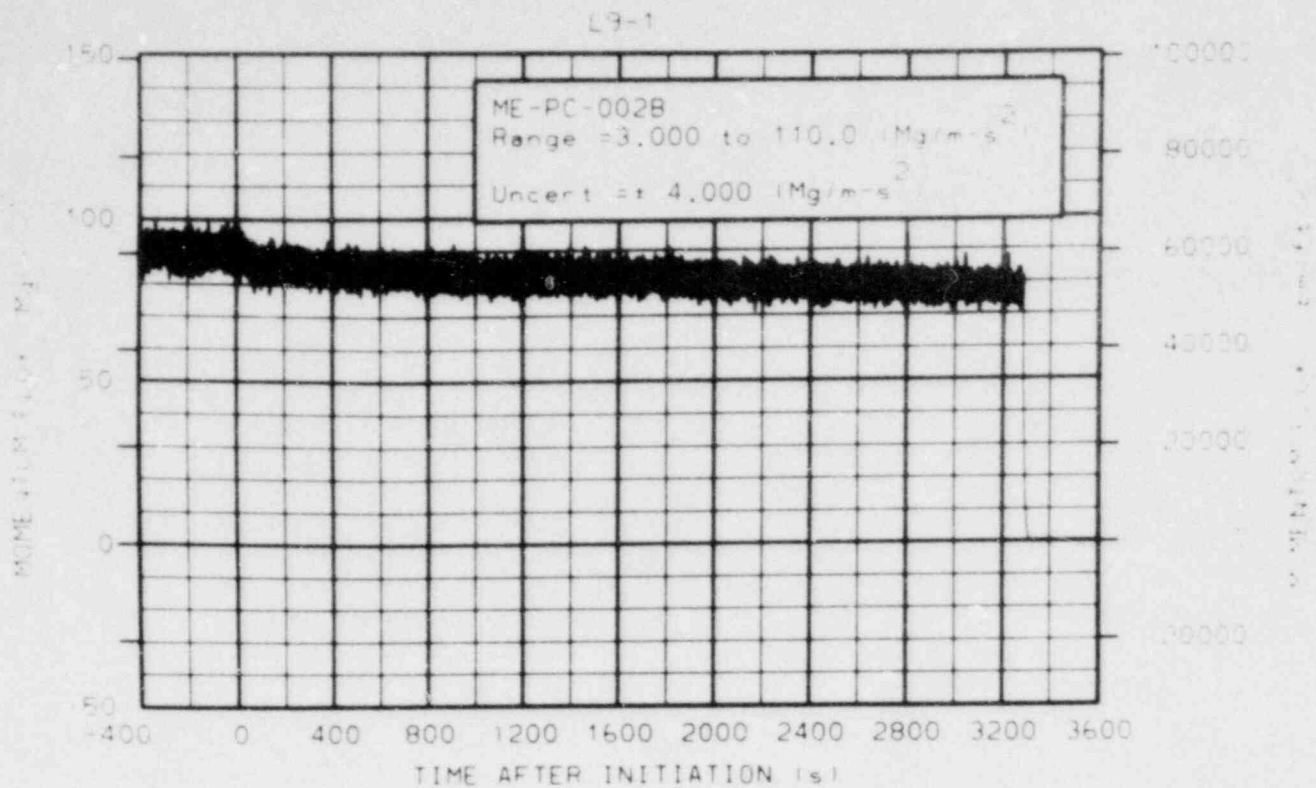


Figure 3B-7. Momentum flux in intact loop hot leg DTT rake at middle of pipe (ME-PC-002B) (qualified to pump trip).

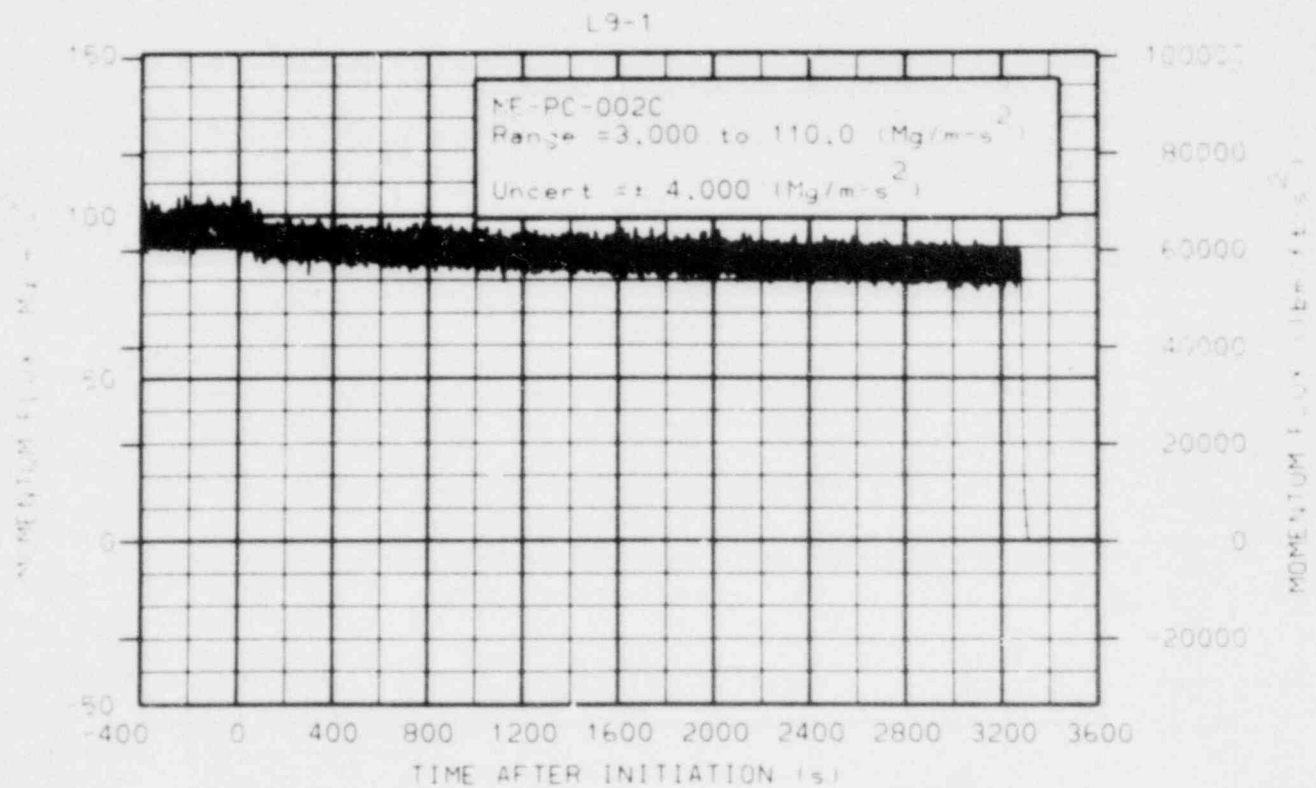


Figure 3B-8. Momentum flux in intact loop hot leg DTT rake at top of pipe (ME-PC-002C) (qualified to pump trip).

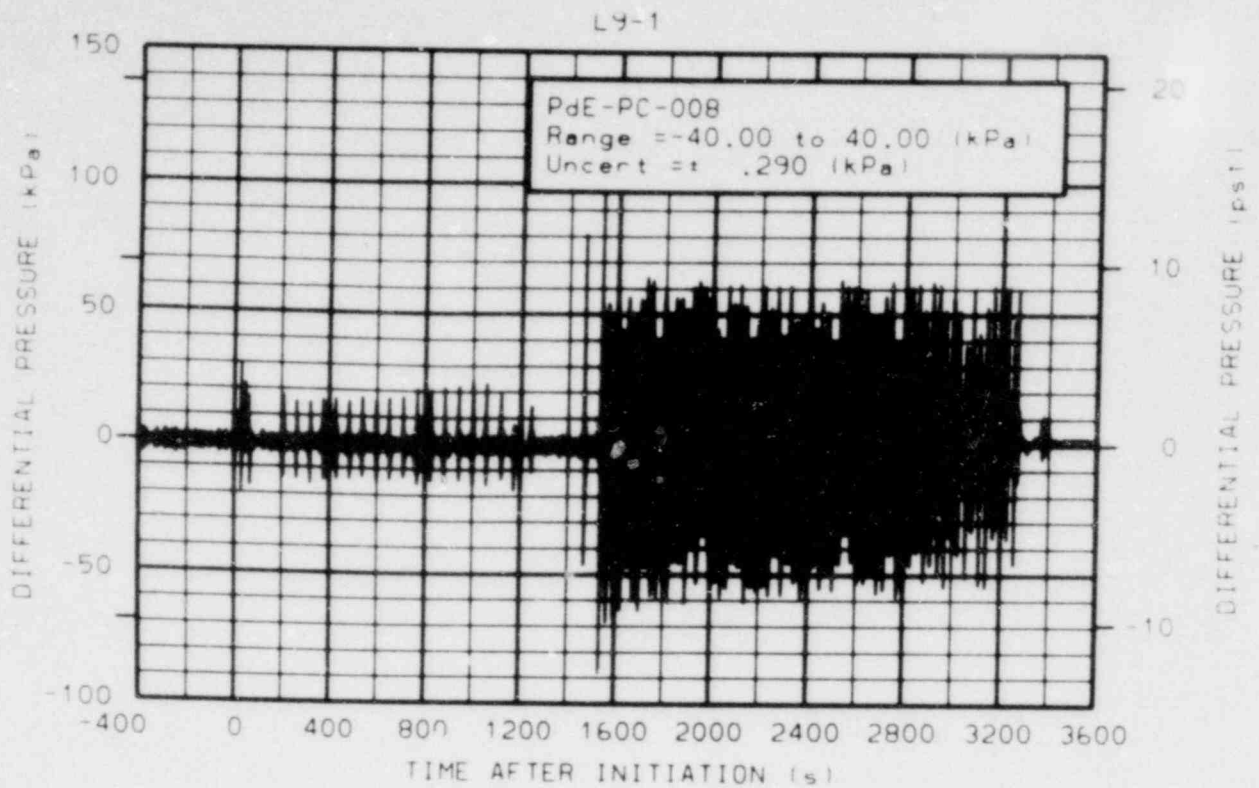


Figure 3B-9. Differential pressure in intact loop across pressurizer surge line (PdE-PC-008).

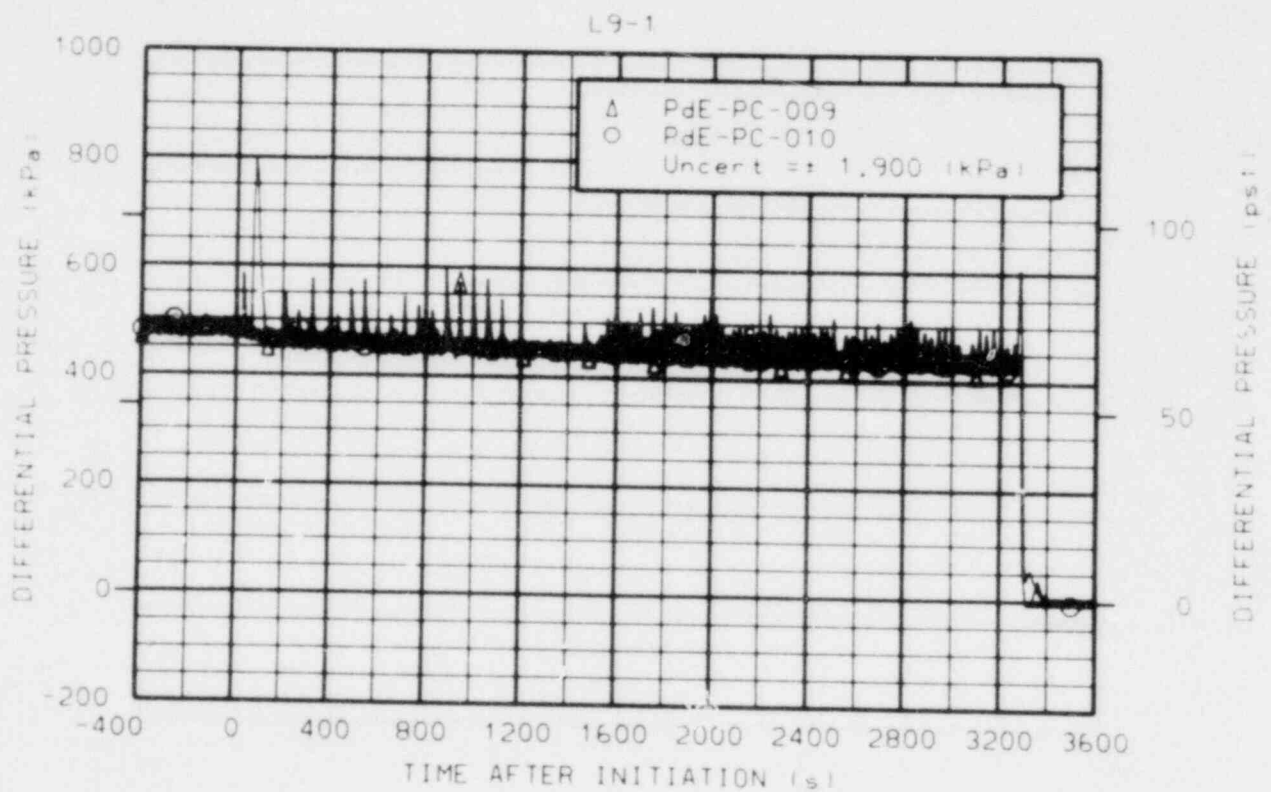


Figure 3B-10. Differential pressure in intact loop across primary coolant Pumps 1 and 2 (PdE-PC-009 and -010) Ranges -700 to 700 kPa and -1400 to 1400 kPa, respectively.

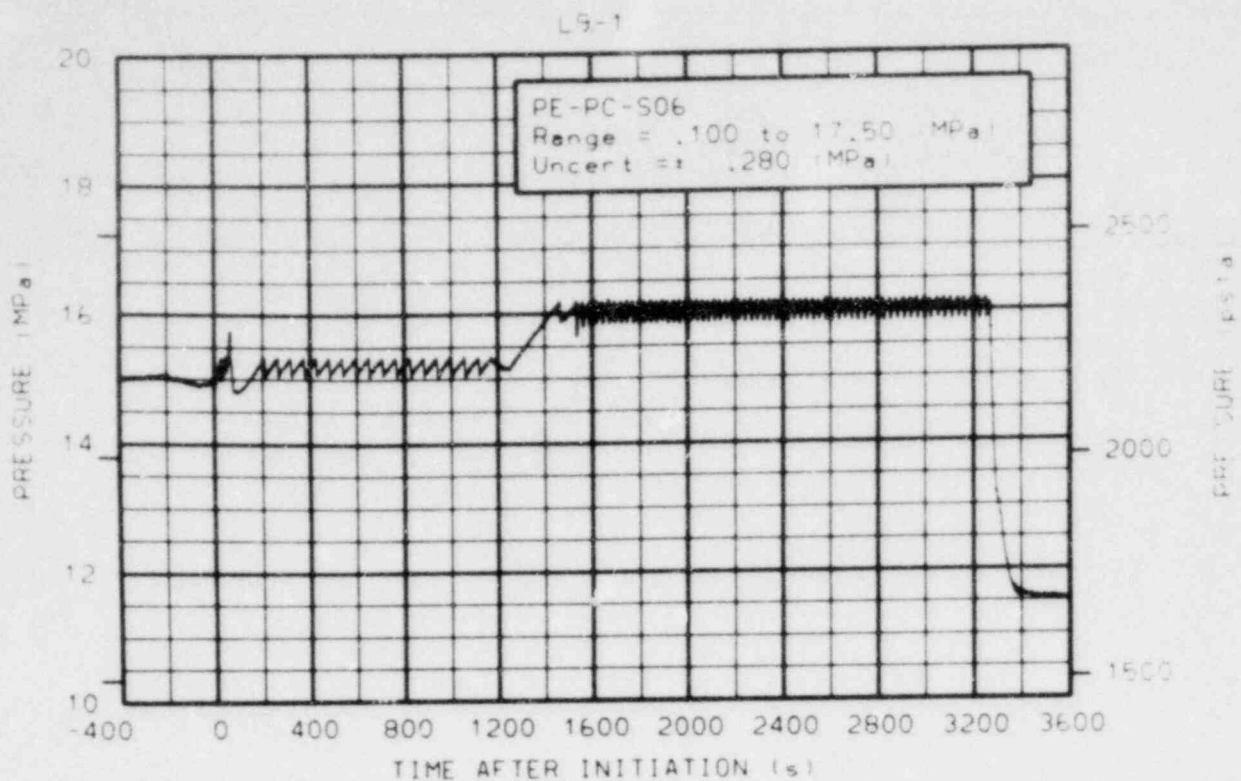


Figure 3B-11. Pressure in intact loop pressurizer relief line upstream of DTT (PE-PC-S06).

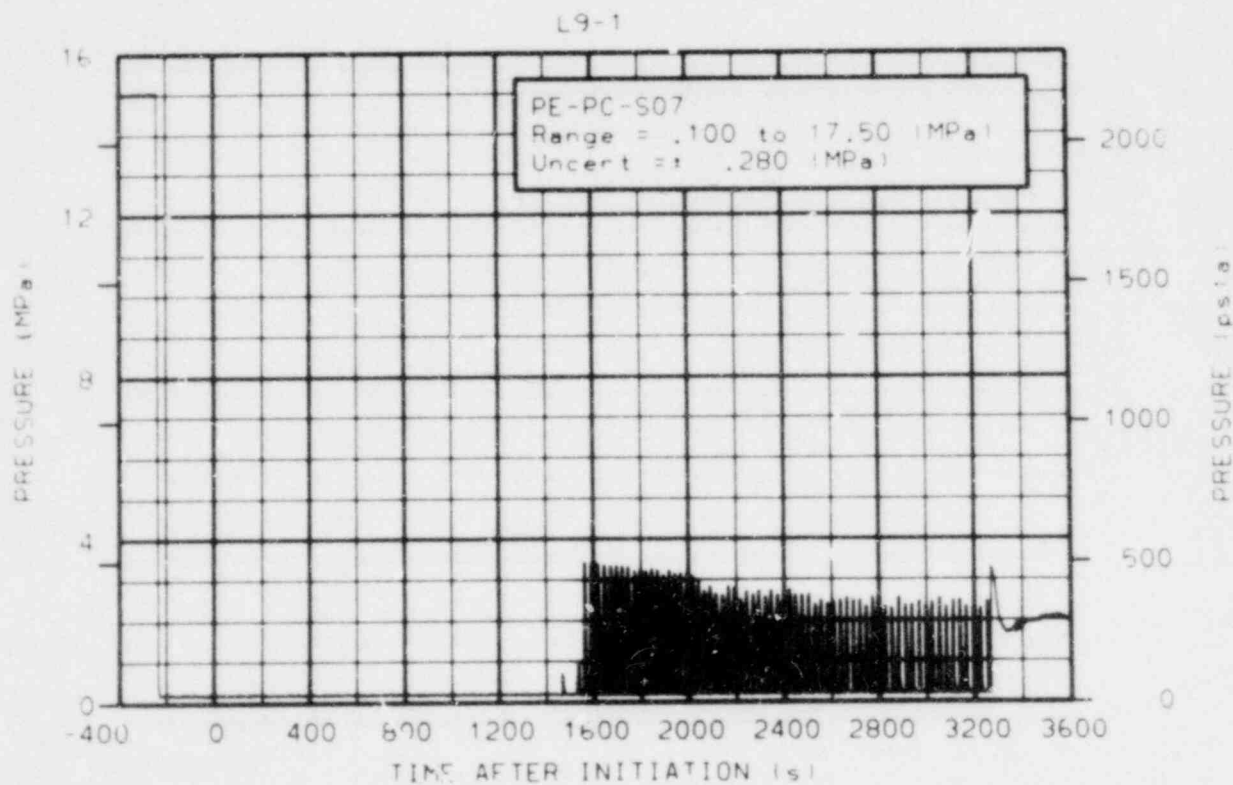


Figure 3B-12. Pressure in intact loop pressurizer relief line downstream of experiment PORV (PE-PC-S07).

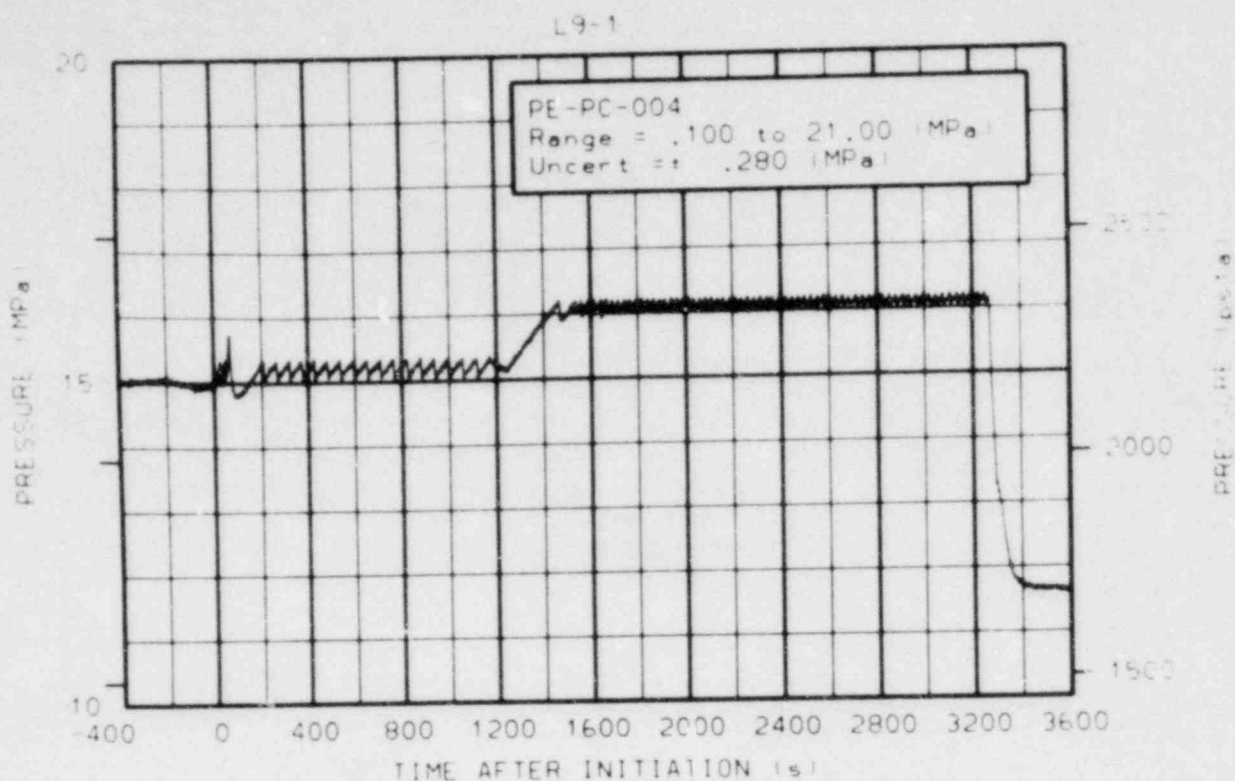


Figure 3B-13. Pressure in pressurizer (PE-PC-004).

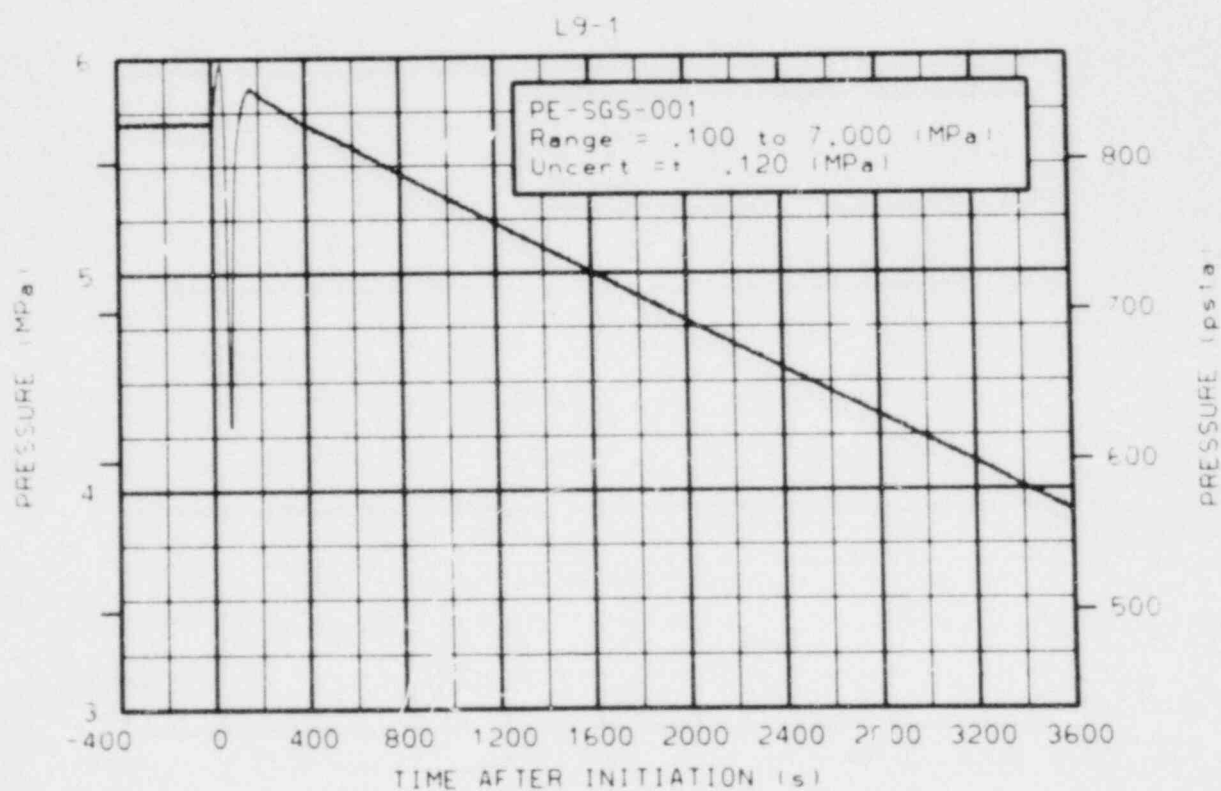


Figure 3B-14. Pressure in steam generator dome (PE-SGS-001).

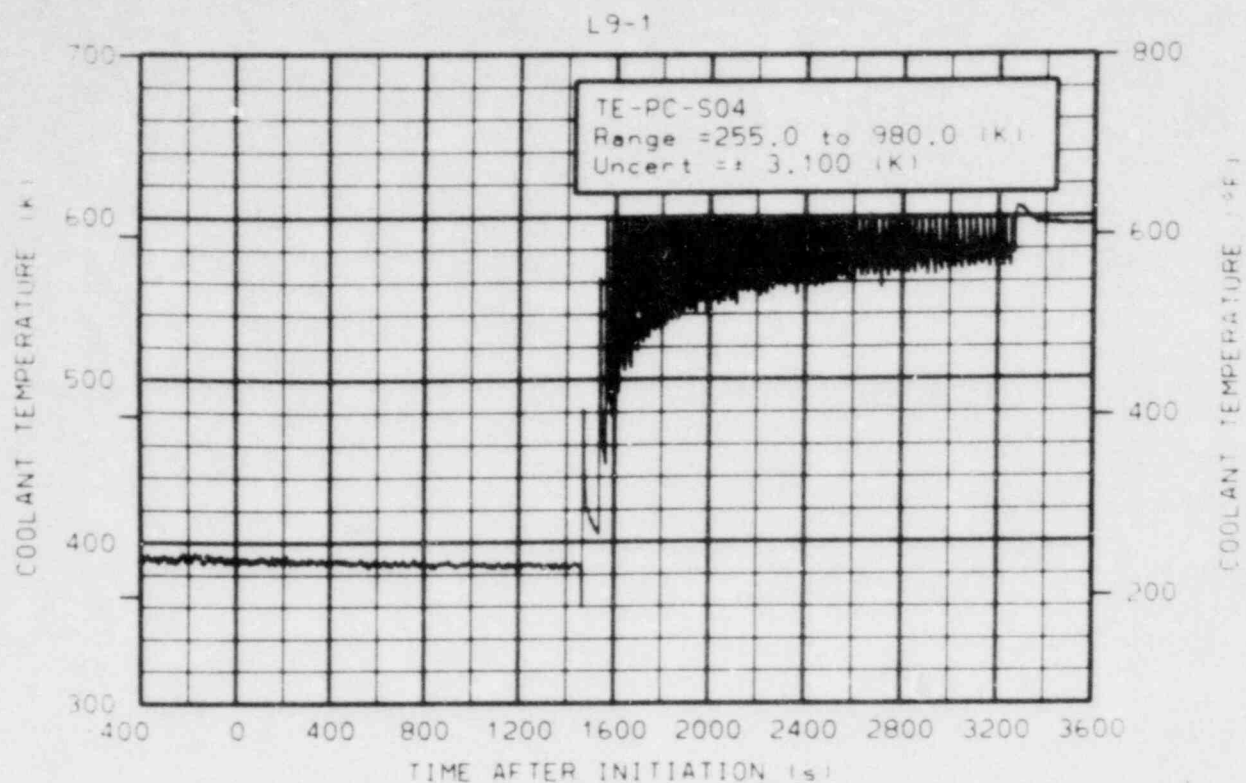


Figure 3B-15. Coolant temperature in intact loop pressurizer relief line at DTI in spool piece (TE-PC-S04).

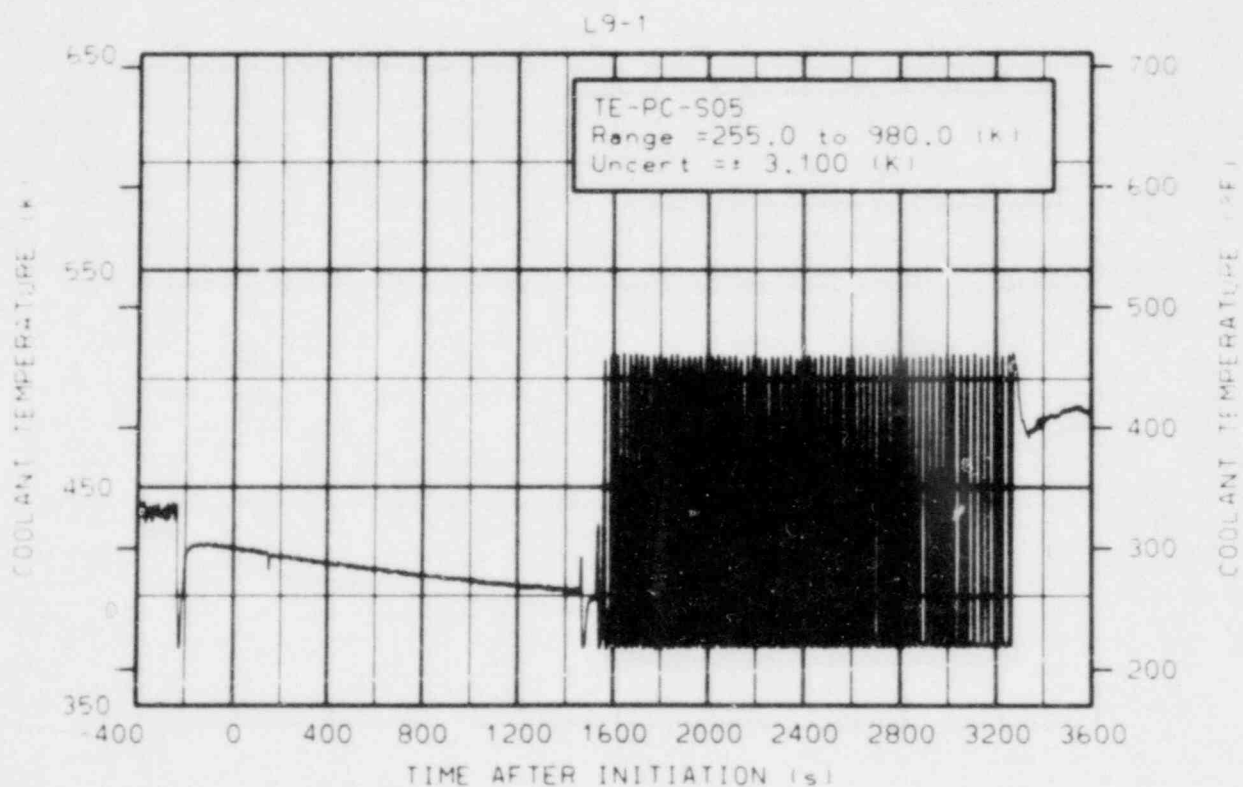


Figure 3B-16. Coolant temperature in intact loop pressurizer relief line downstream of experiment PORV (TE-PC-S05).

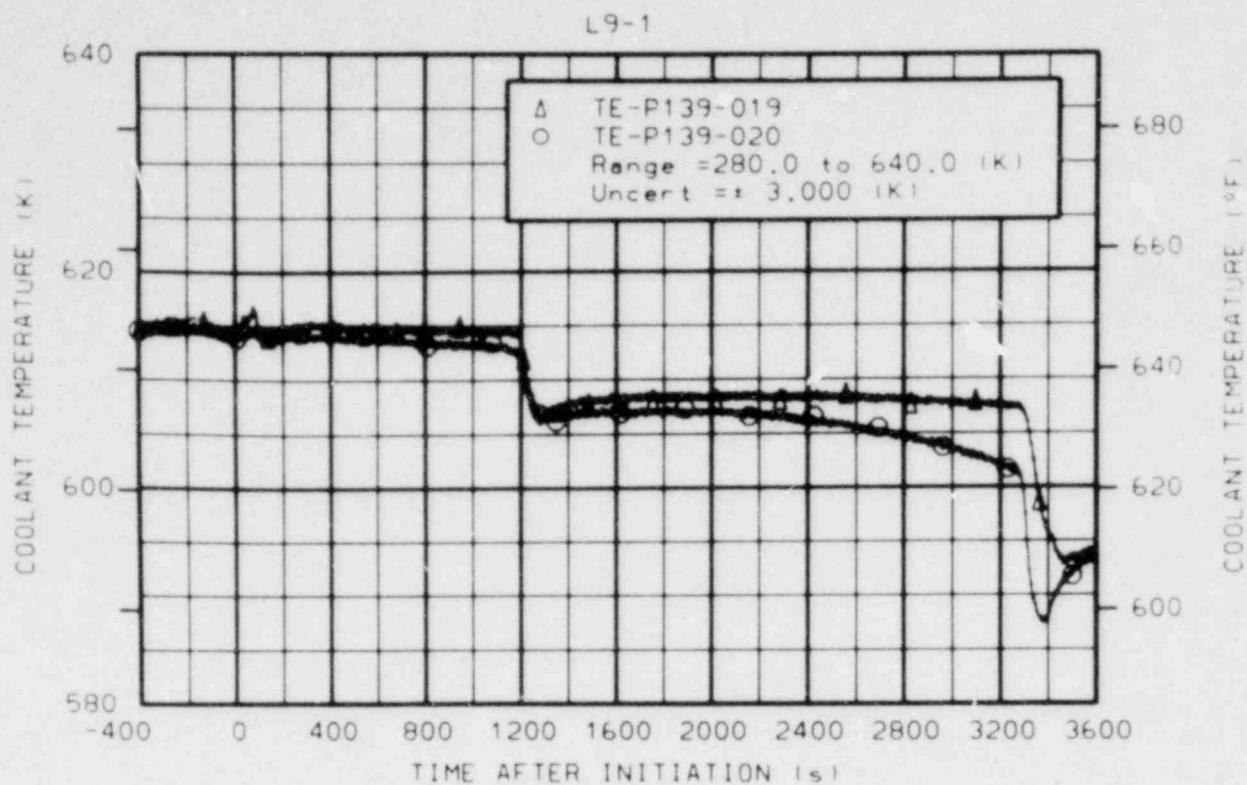


Figure 3B-17. Coolant temperature in intact loop pressurizer vapor and liquid space (TE-P139-019 and -020).

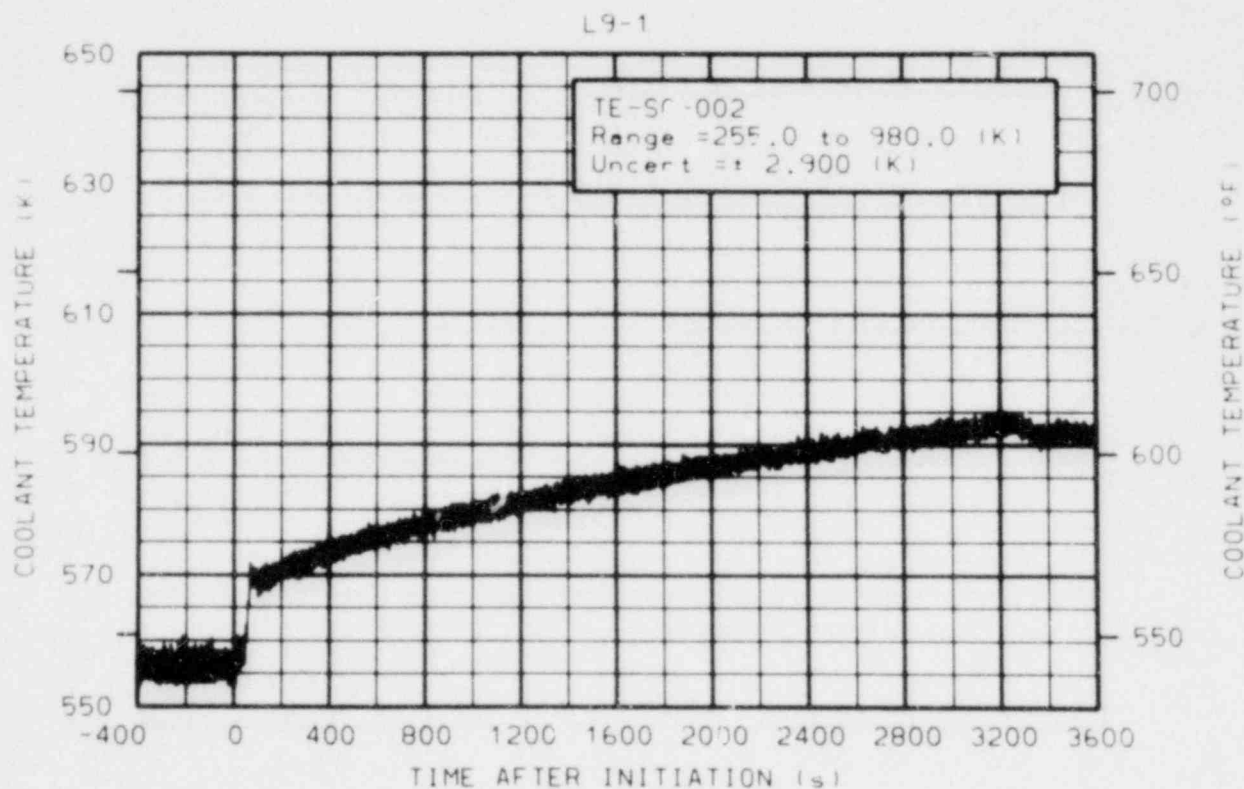


Figure 3B-18. Coolant temperature in intact loop steam generator outlet plenum (TE-SG-002).

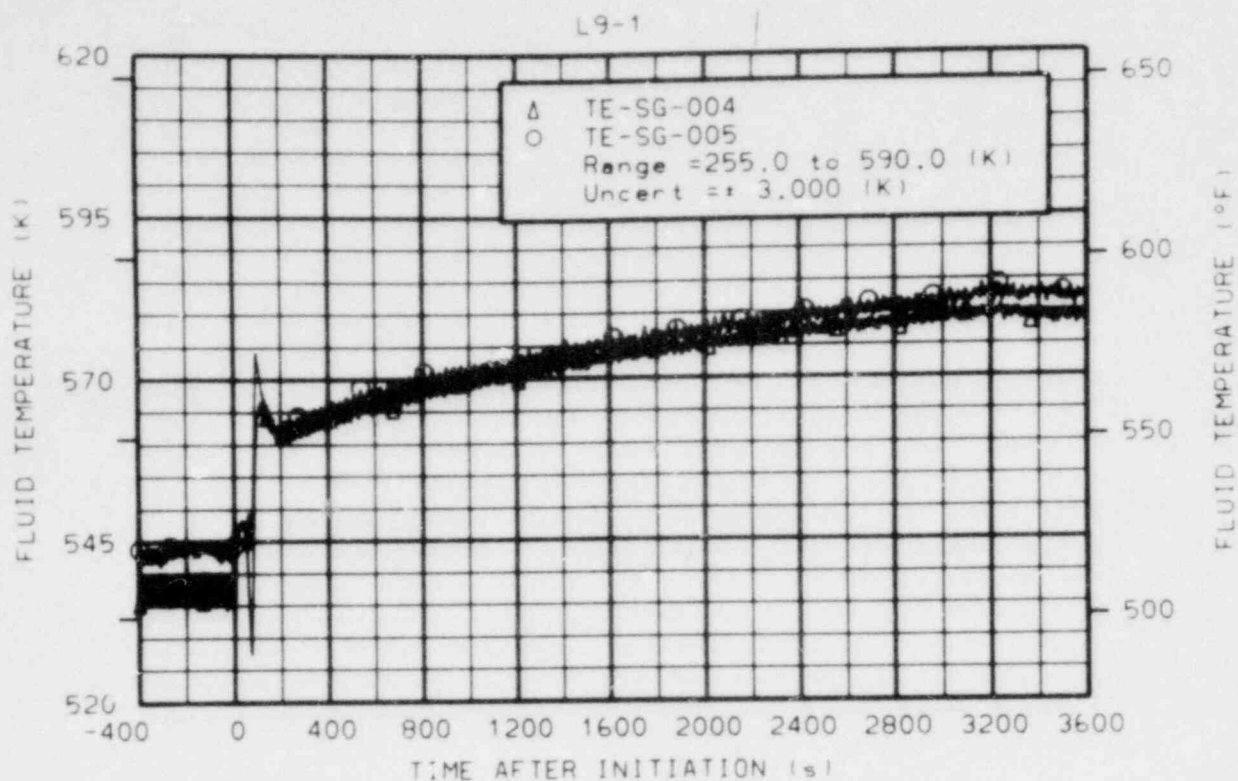


Figure 3B-19. Fluid temperature in steam generator secondary side downcomer at 2.12 and 2.92 m above top of tube sheet (TE-SG-004 and -005).

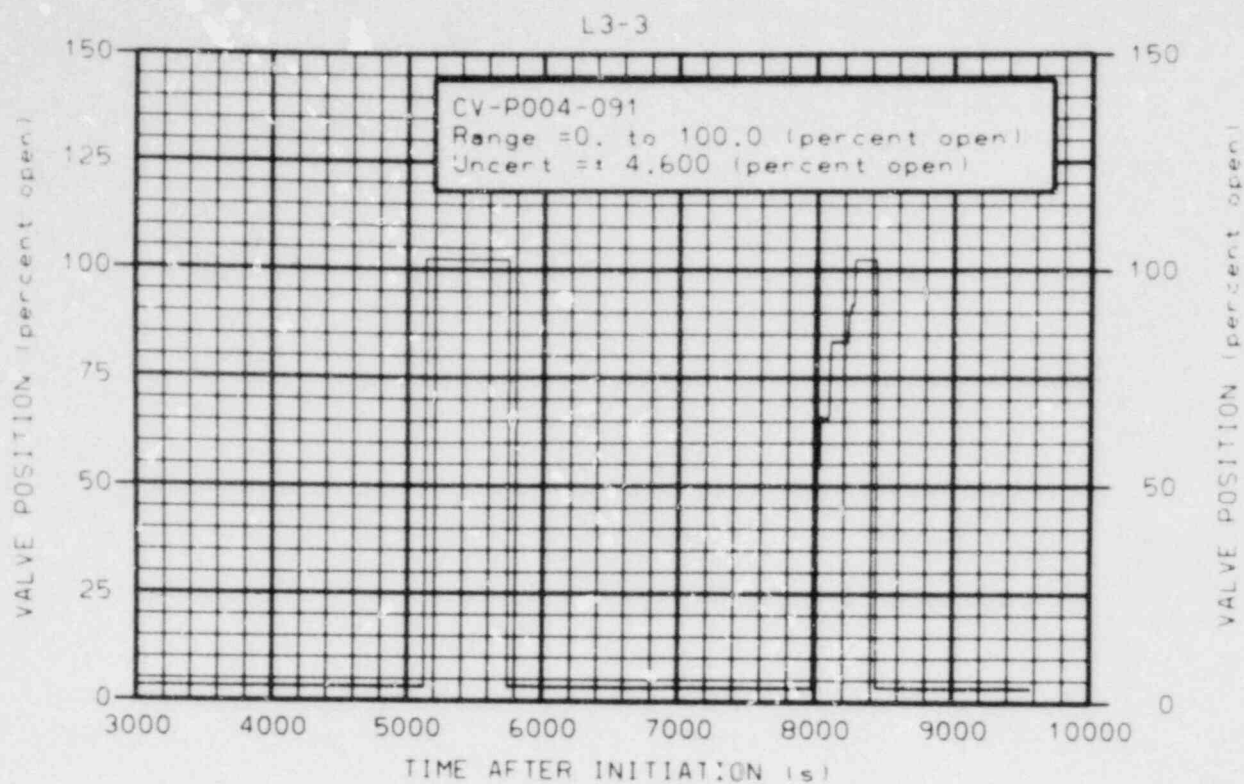


Figure 3M-1. Valve position for secondary coolant system feedwater bypass valve (CV-P004-091).

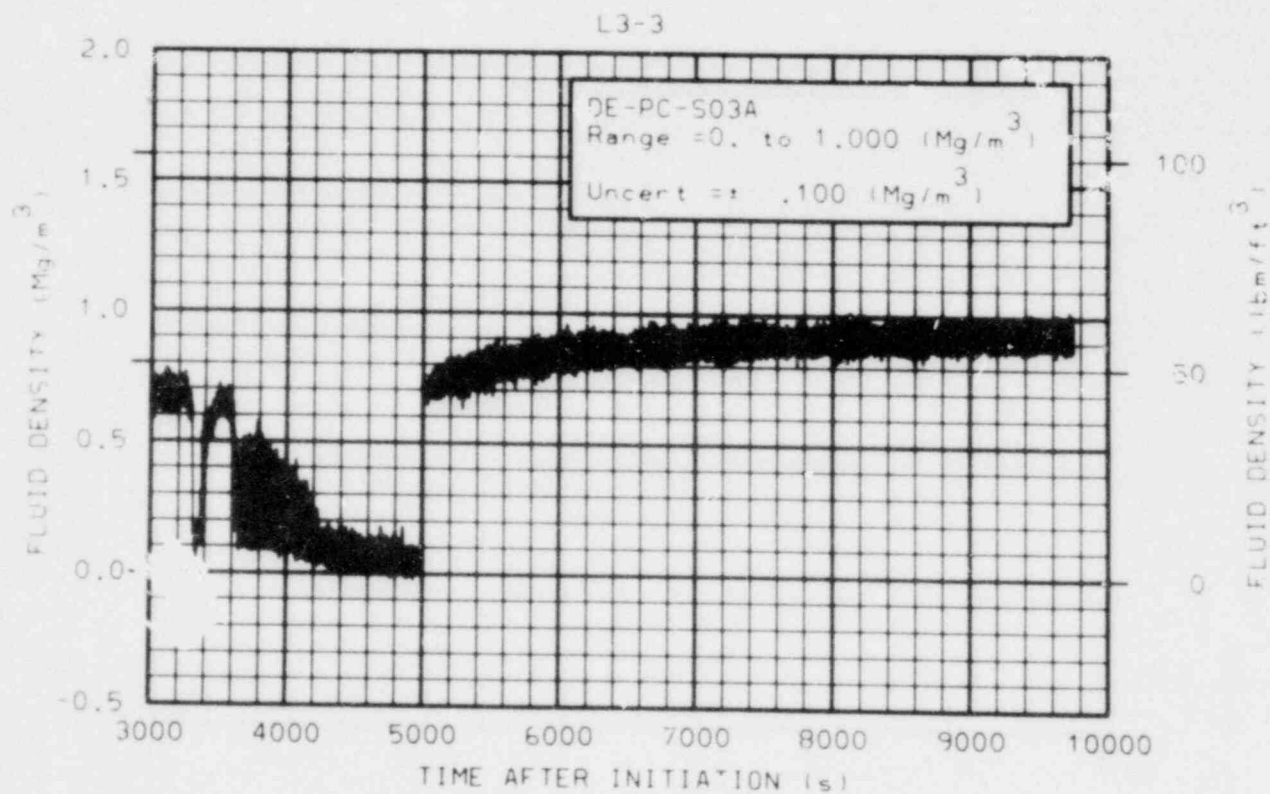


Figure 3M-2. Fluid density in intact loop pressurizer relief line upstream of experiment PORV, chordal density (IDE-PC-S03A).

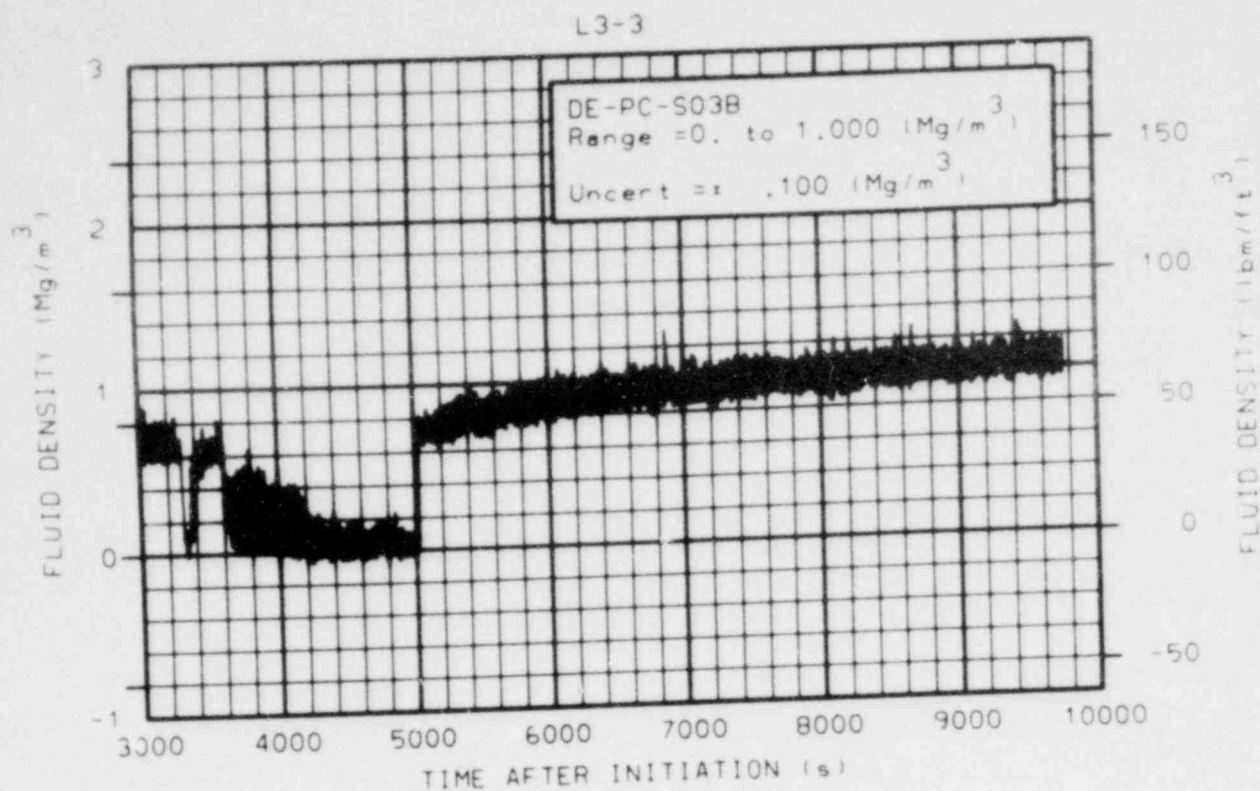


Figure 3M-3. Fluid density in intact loop pressurizer relief line upstream of experiment PORV, chordal density (DE-PC-S03B) (qualified, spikes from 1529 to 1560 s).

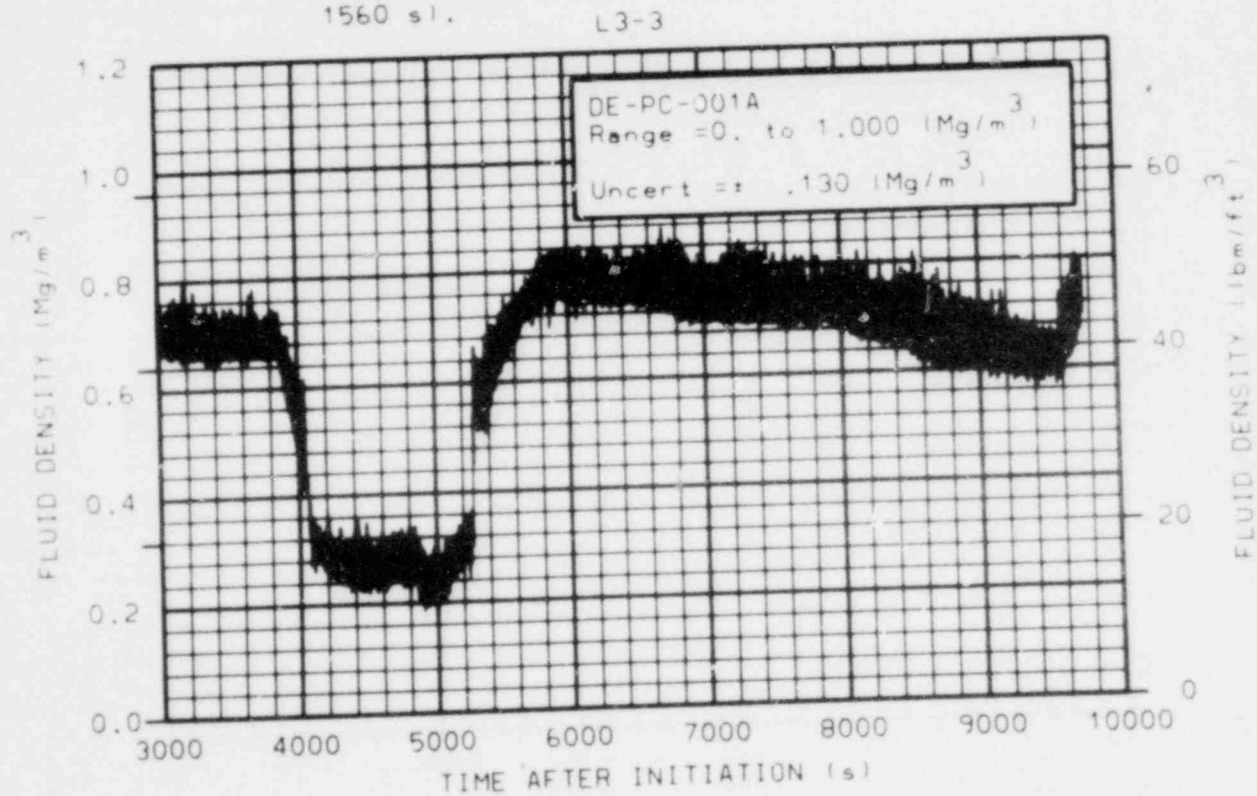


Figure 3M-4. Fluid density in intact loop cold leg, chordal density (DE-PC-001A) (qualified after reactor scram).

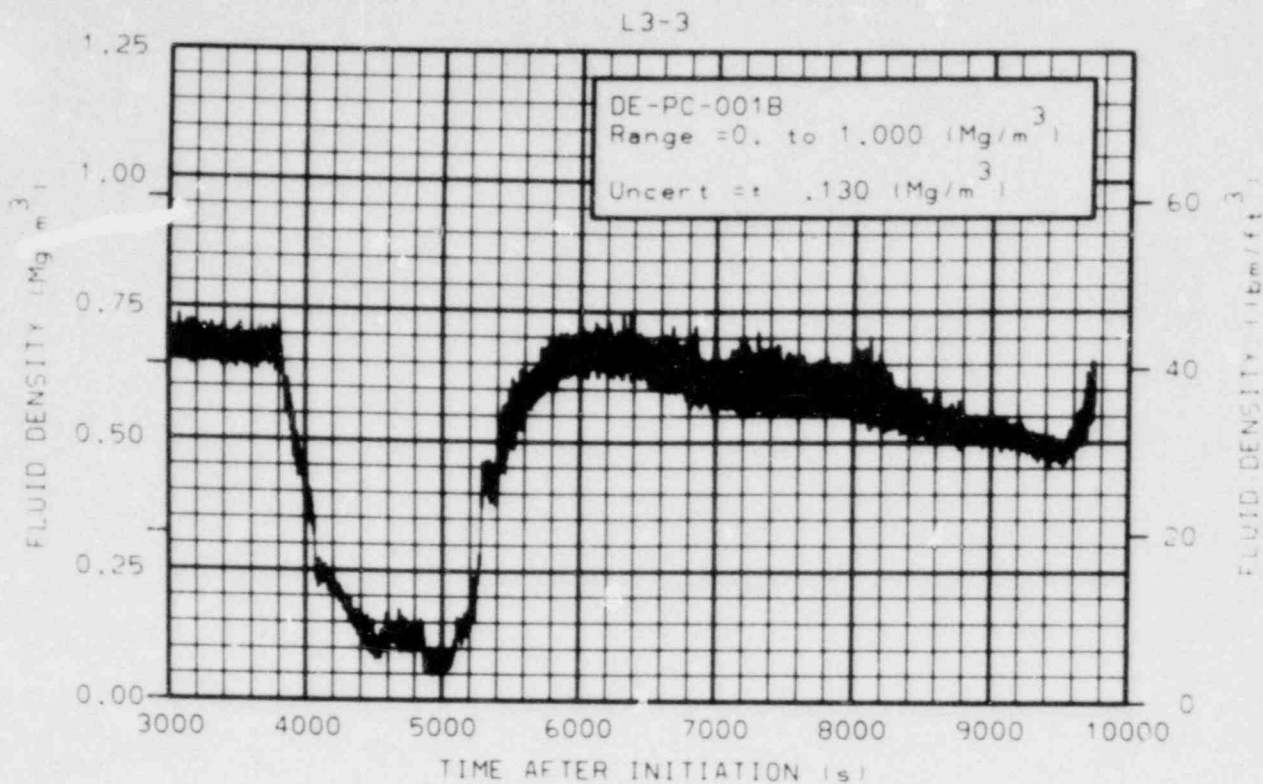


Figure 3M-5. Fluid density in intact loop cold leg, chordal density (DE-PC-001B) (qualified after reactor scram).

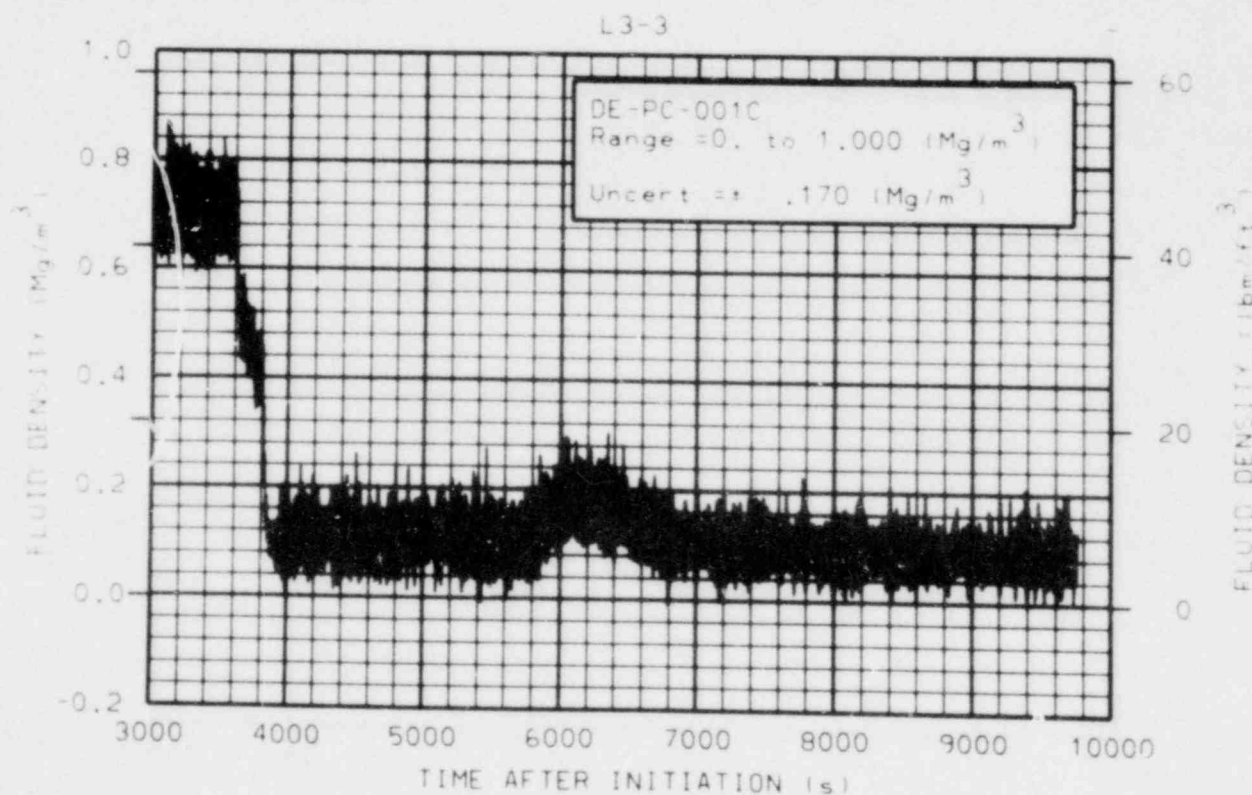


Figure 3M-6. Fluid density in intact loop cold leg, chordal density (DE-PC-001C) (qualified after reactor scram).

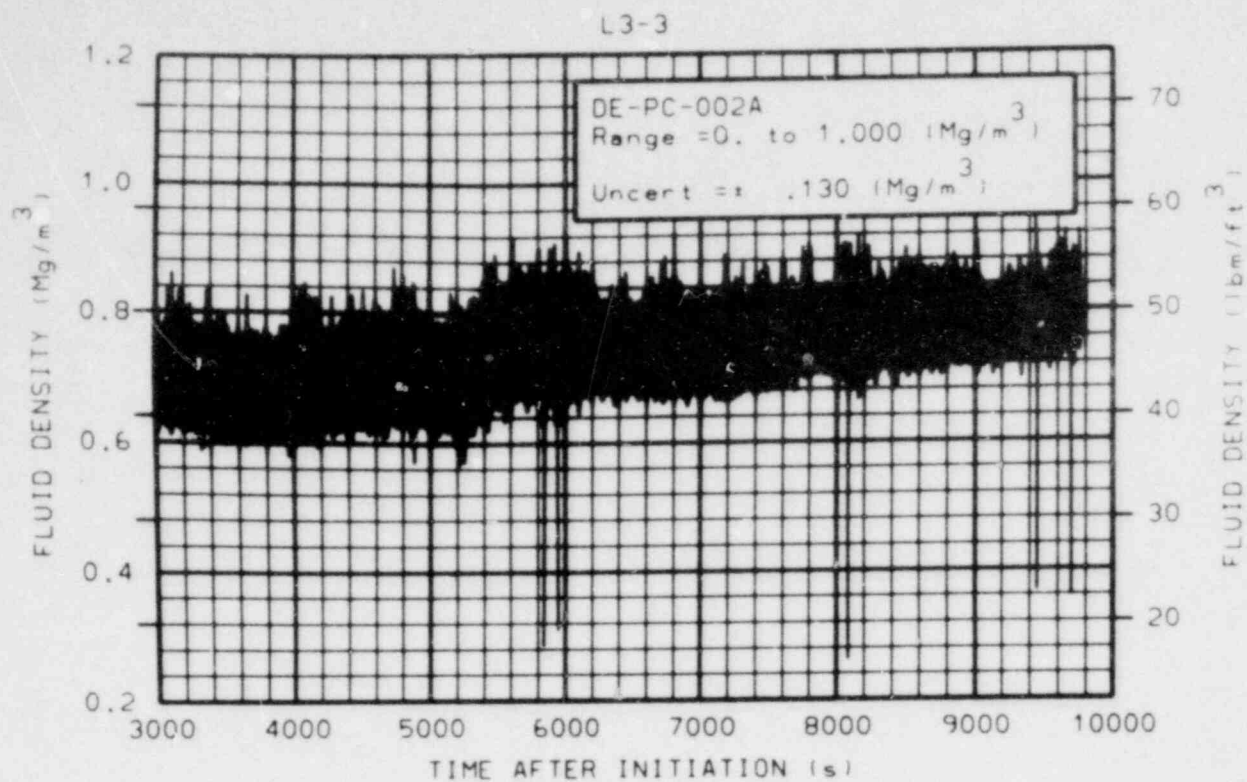


Figure 3M-7. Fluid density in intact loop hot leg, chordal density (DE-PC-002A) (qualified after reactor scram, several anomalous spikes).

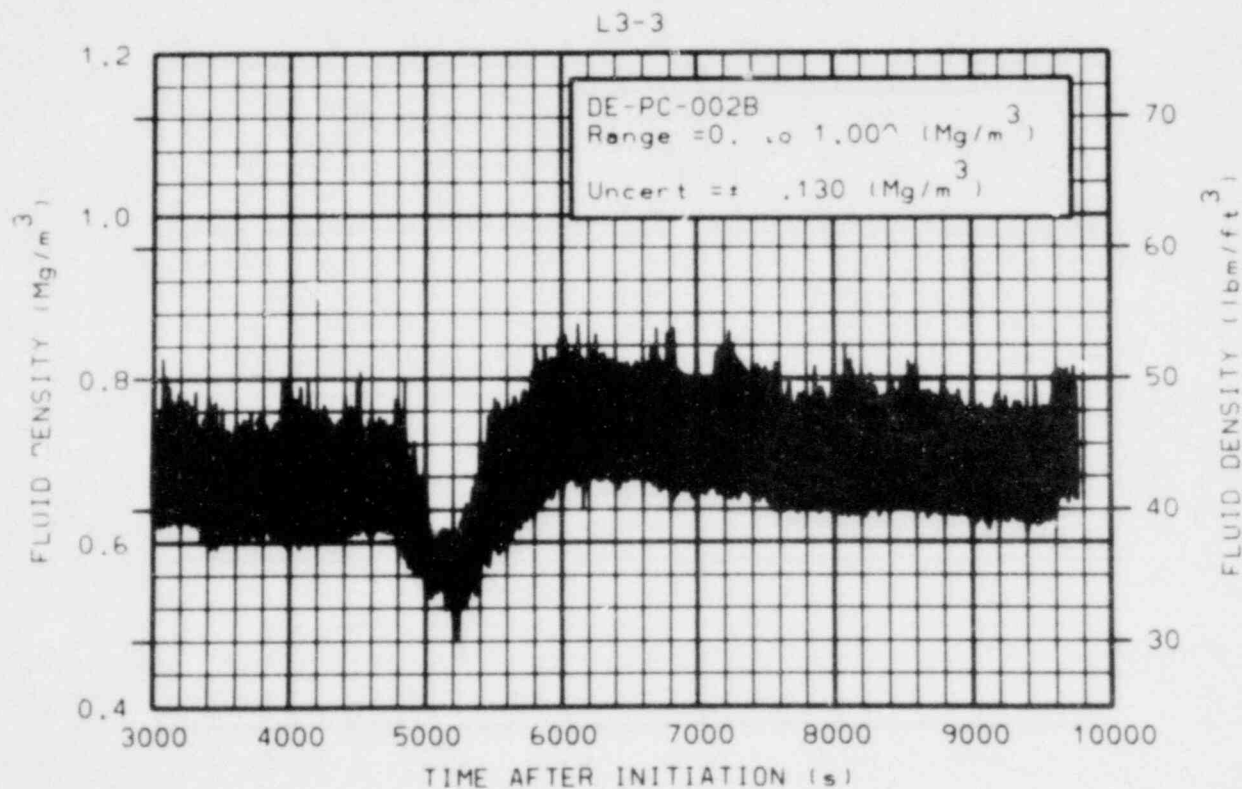


Figure 3M-8. Fluid density in intact loop hot leg, chordal density (DE-PC-002B) (qualified after reactor scram).

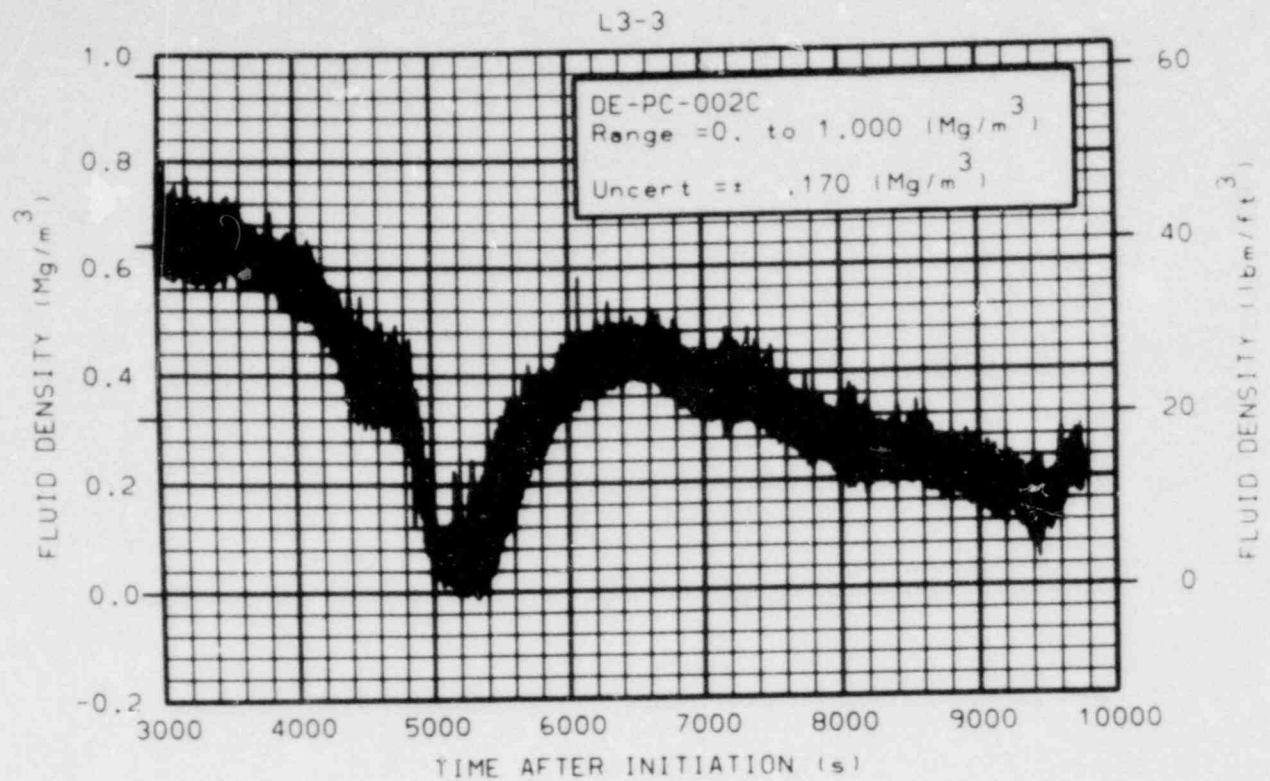


Figure 3M-9. Fluid density in intact loop hot leg, chordal density (DE-PC-002C) (qualified after reactor scram, anomalous spikes at 2000 s).

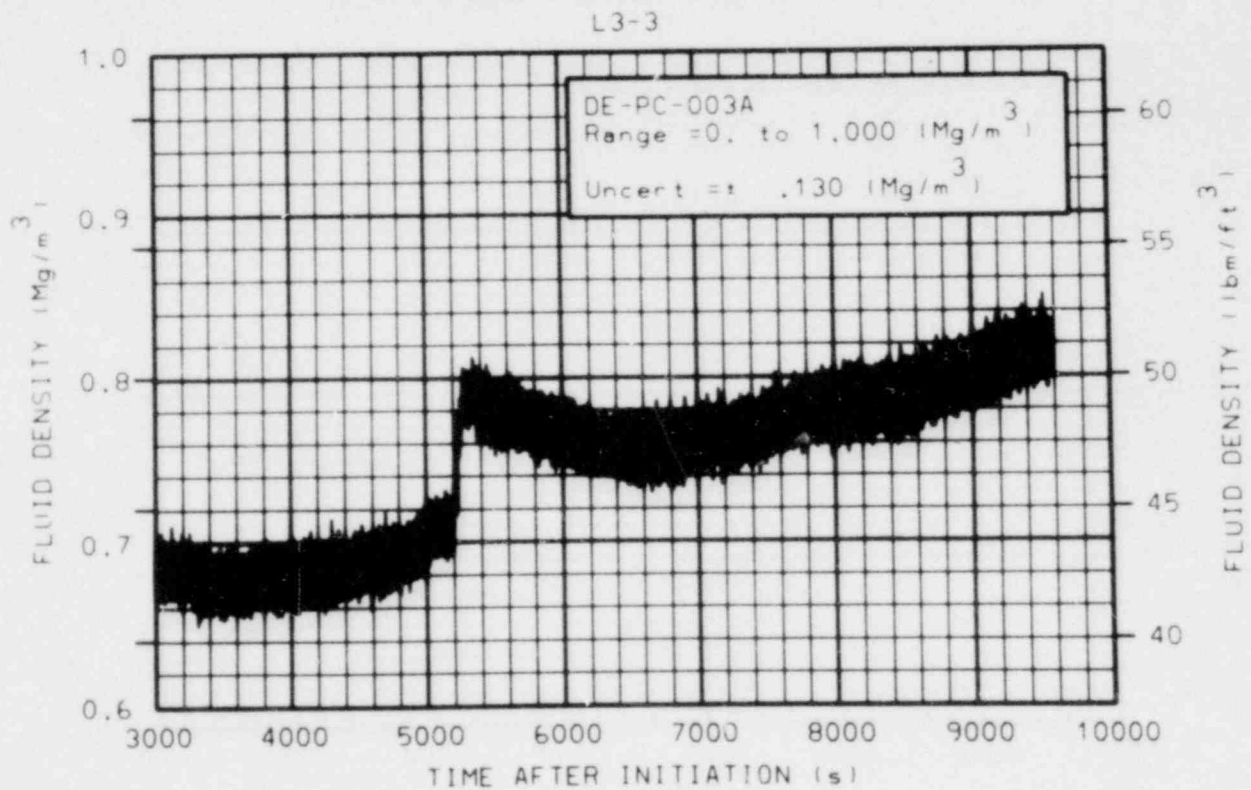


Figure 3M-10. Fluid density in intact loop at steam generator outlet, chordal density (DE-PC-003A) (qualified after reactor scram).

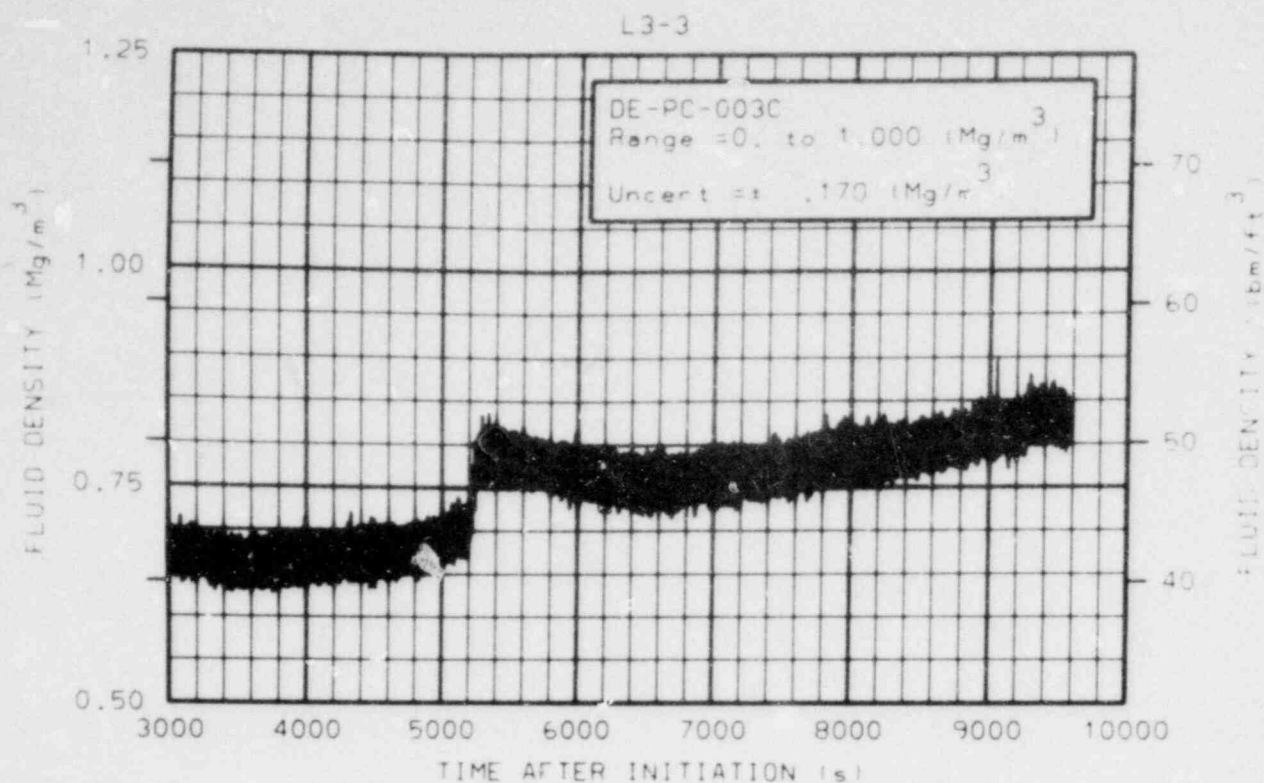


Figure 3M-11. Fluid density in intact loop at steam generator outlet, chordal density (DE-PC-003C) (qualified after reactor scram).

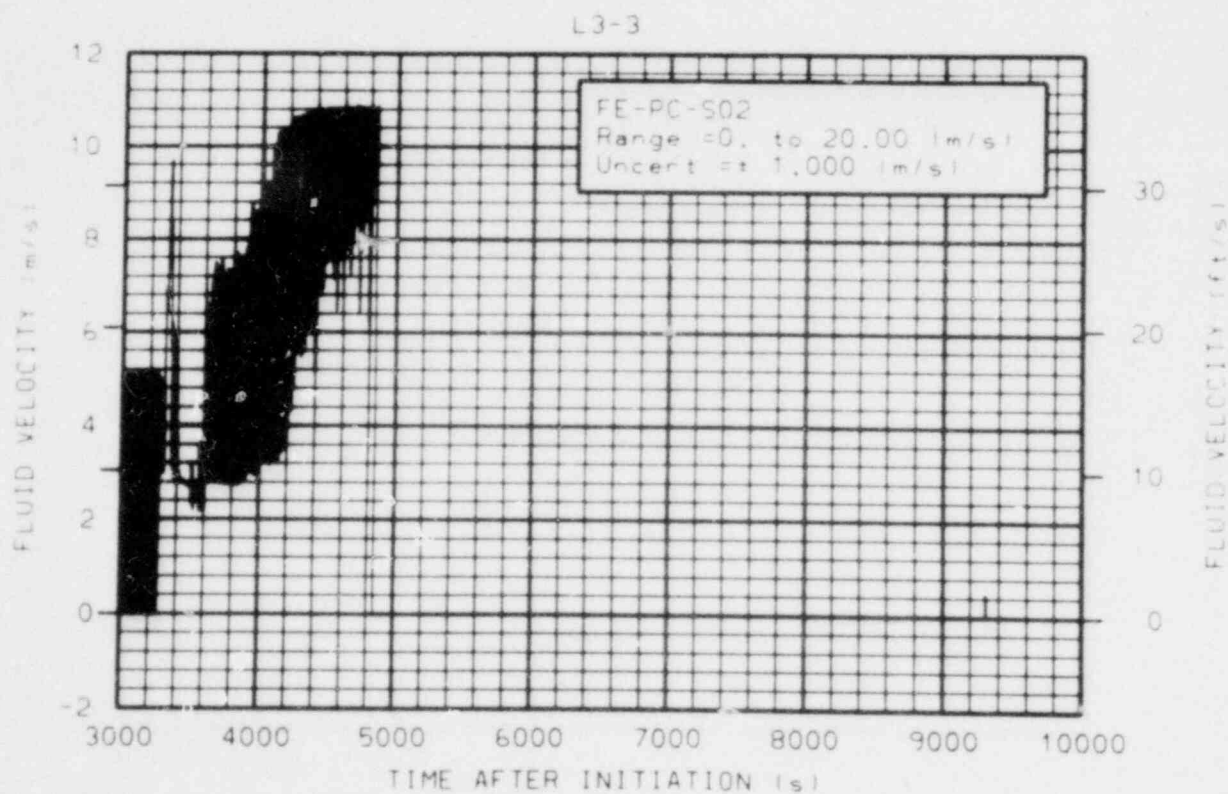


Figure 3I-12. Fluid velocity in intact loop pressurizer relief line upstream of experiment PORV (FE-PC-S02).

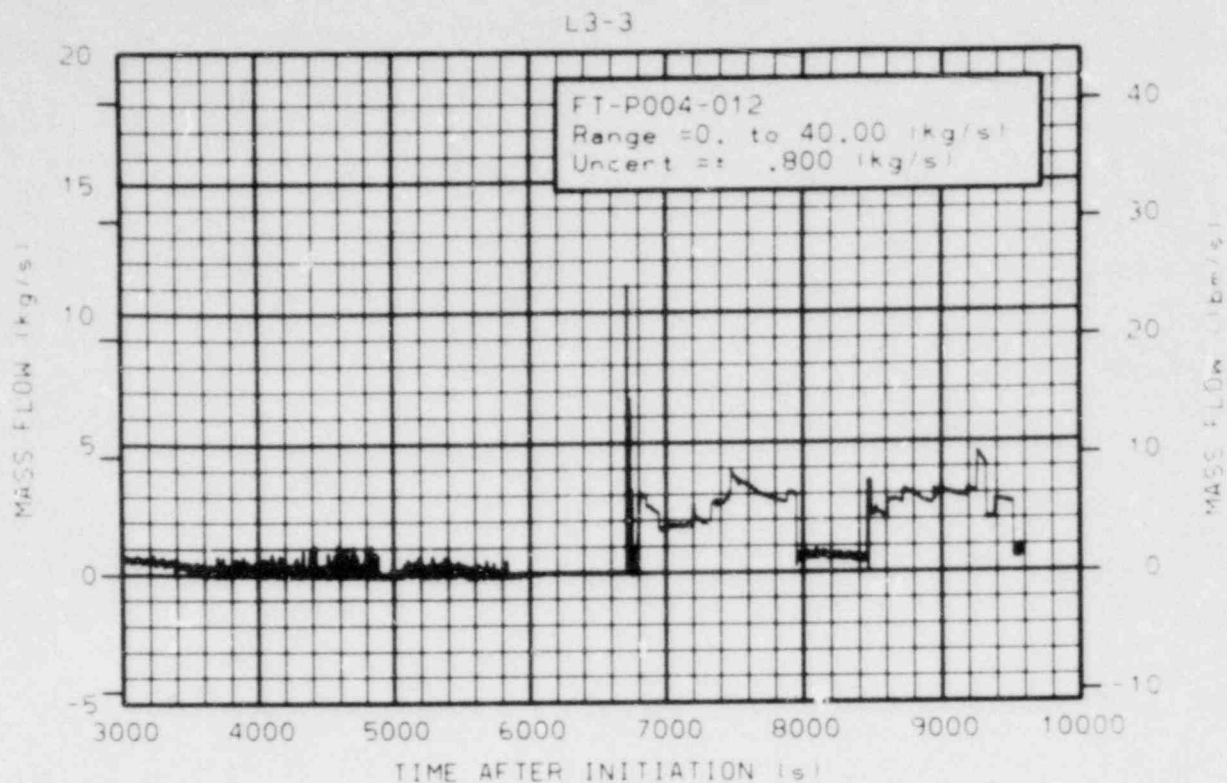


Figure 3M-13. Steam flow rate at condenser inlet (FT-P004-012) (qualified, magnitude uncertain due to instrument drift).

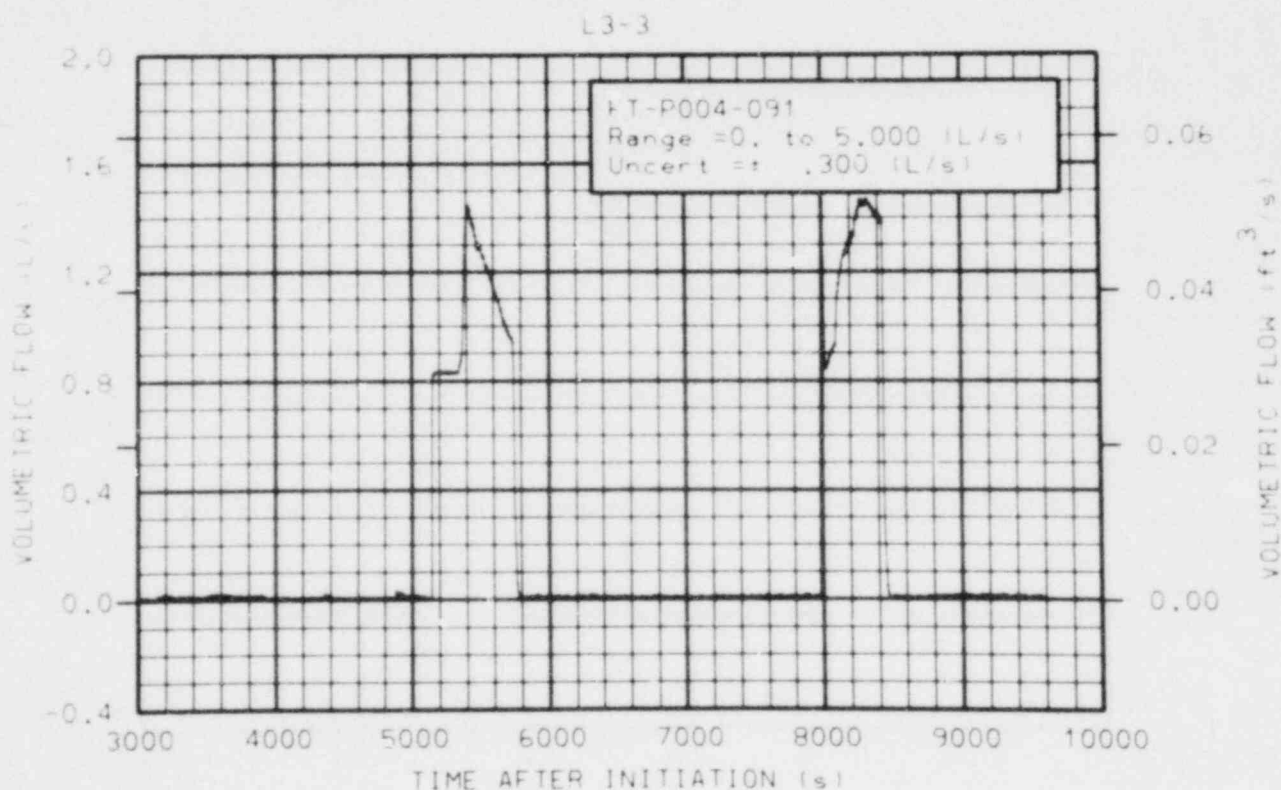


Figure 3M-14. Volumetric flow rate in secondary coolant system main feedwater bypass line (FT-P004-091) (qualified after 5000 s, only indicates presence or absence of flow, flow magnitude is not correct).

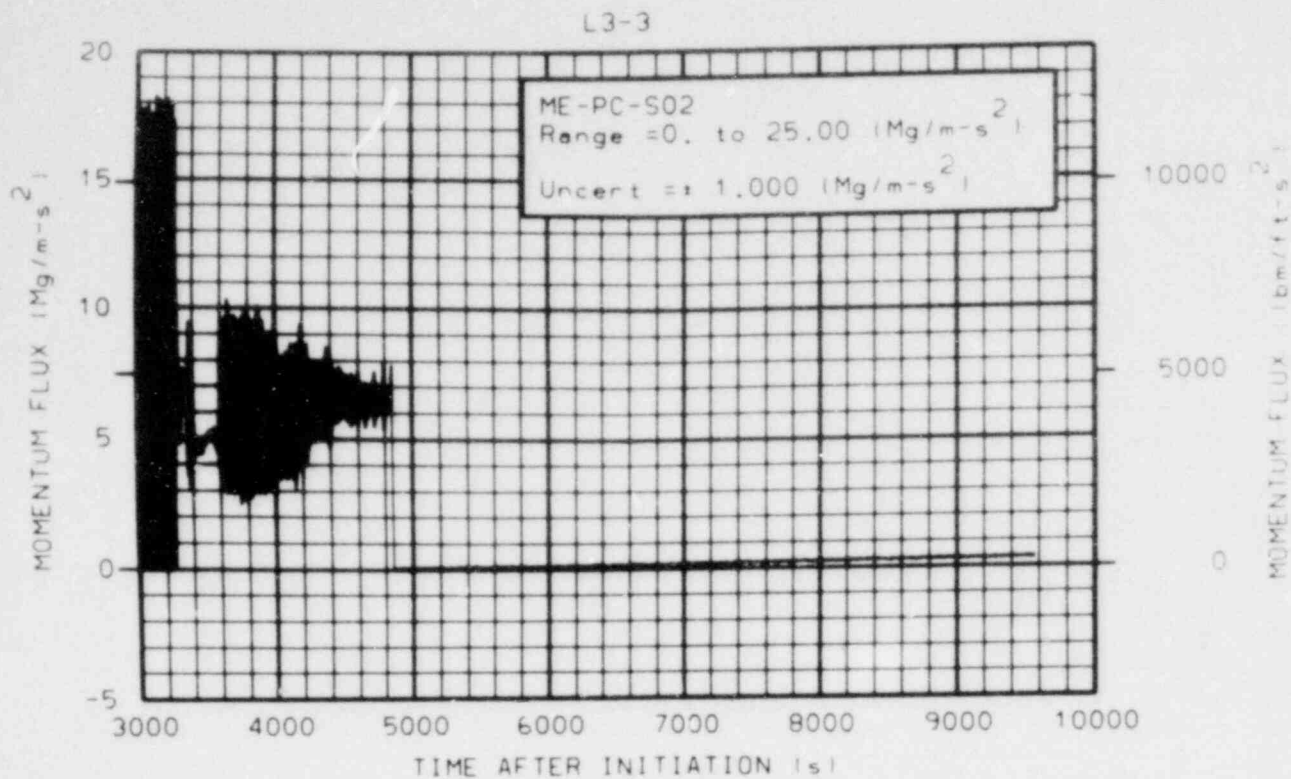


Figure 3M-15. Momentum flux in intact loop pressurizer relief line upstream of experiment PORV (ME-PC-S02) (qualified from 1575 to 4900 s).

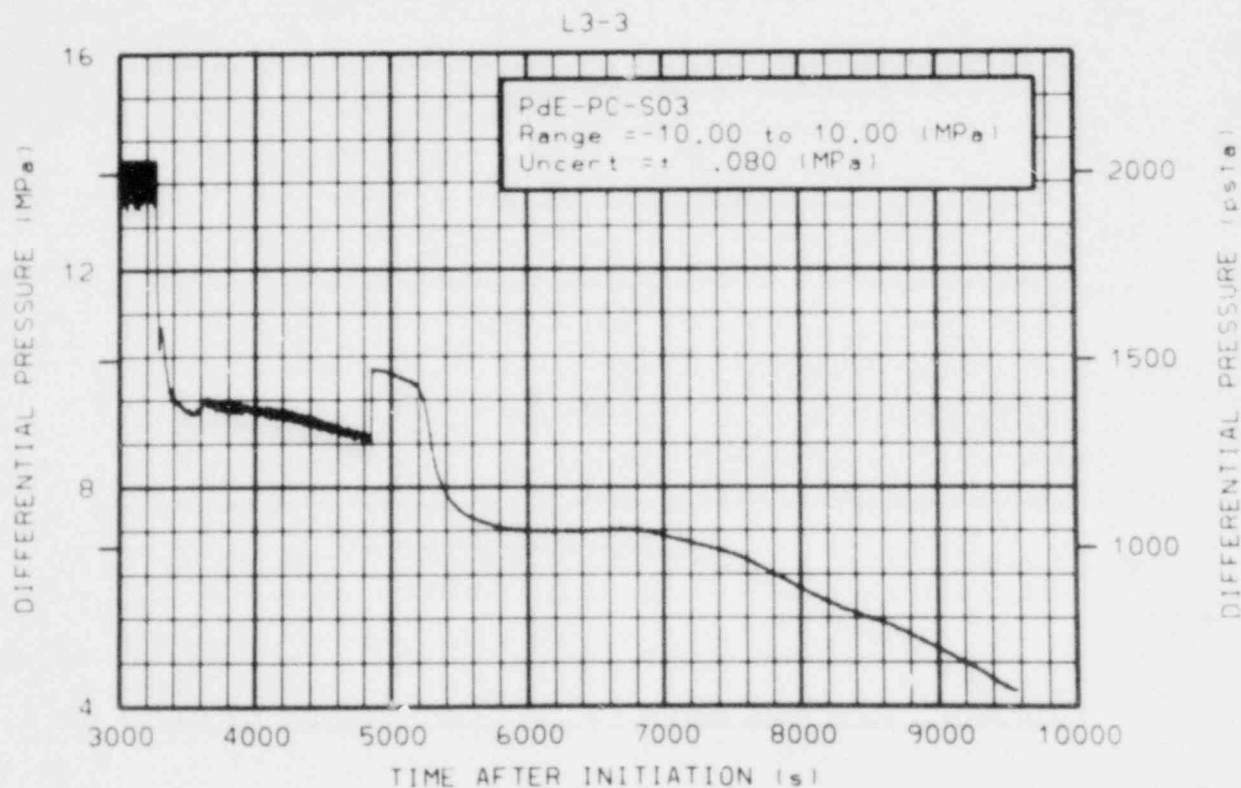


Figure 3M-16. Differential pressure in intact loop pressurizer relief line across experiment PORV (PdE-PC-S03) (qualified after PORV latched open).

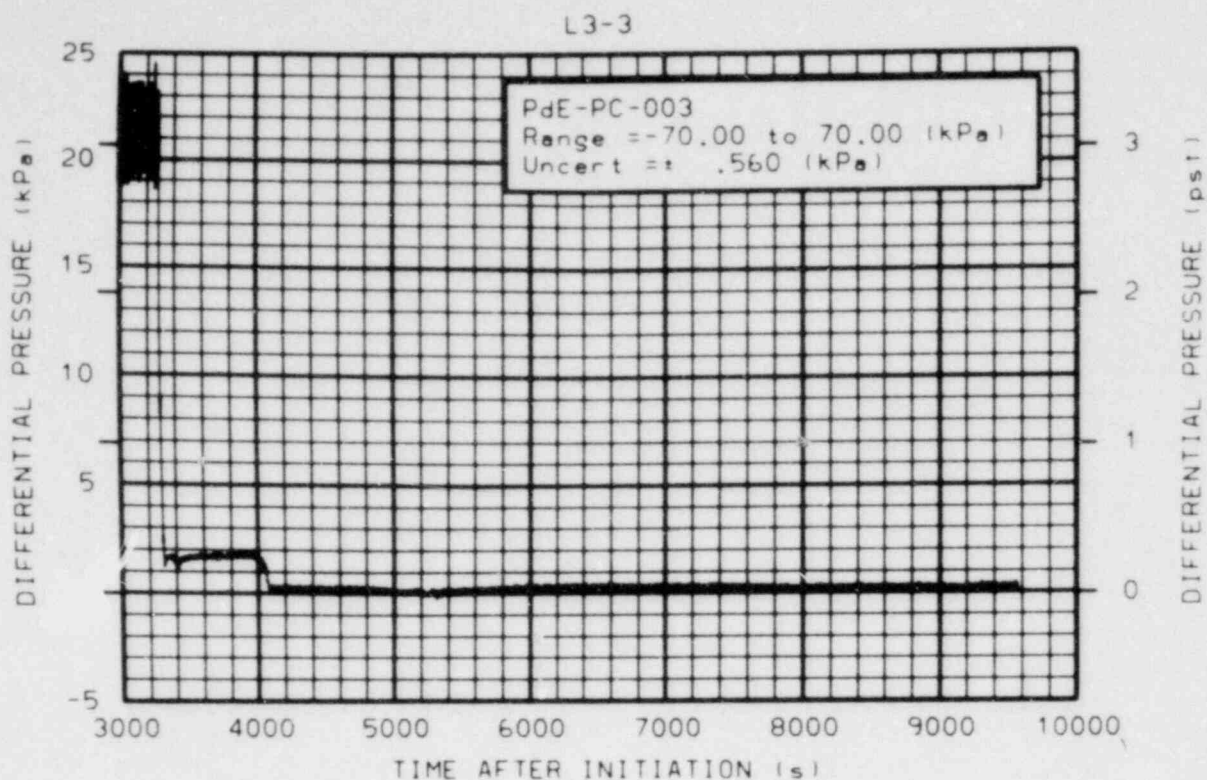


Figure 3M-17. Differential pressure in intact loop hot leg from reactor vessel outlet to steam generator inlet (PdE-PC-003).

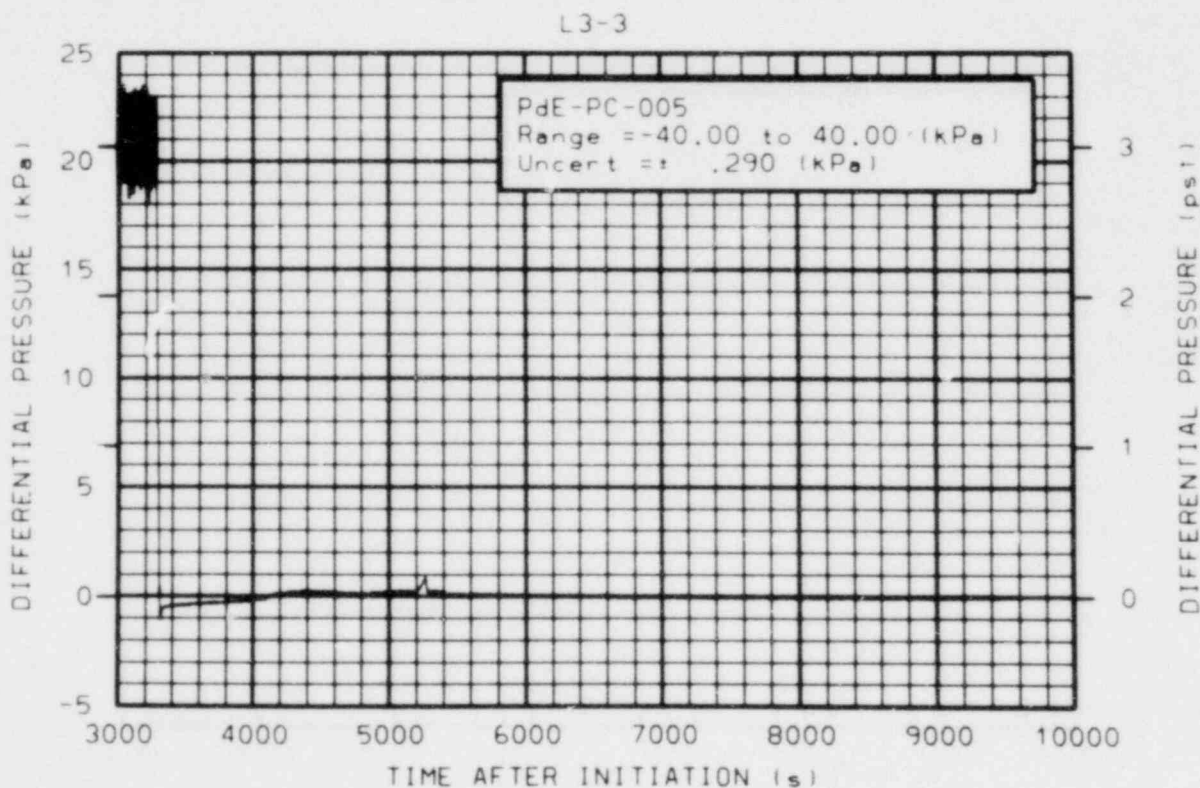


Figure 3M-18. Differential pressure in intact loop cold leg from primary coolant pump discharge to reactor vessel inlet (PdE-PC-005).

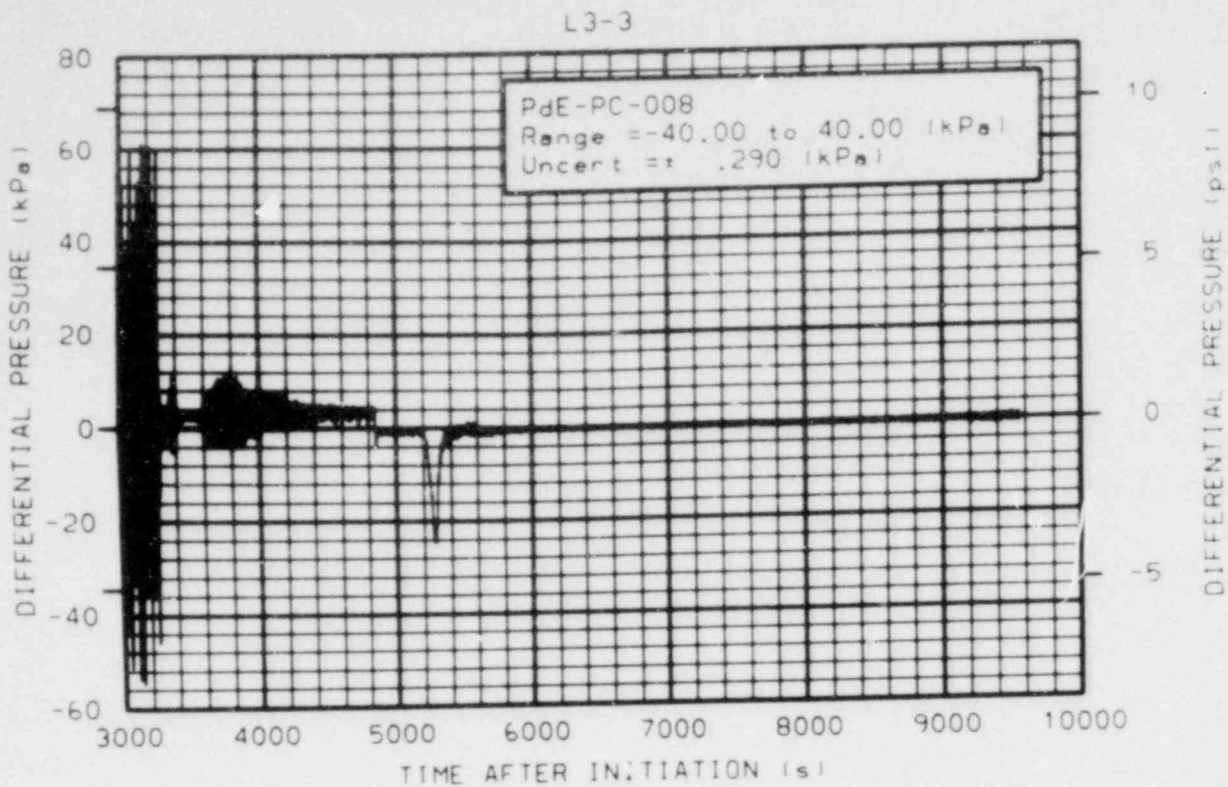


Figure 3M-19. Differential pressure in intact loop across pressurizer surge line (PdE-PC-008).

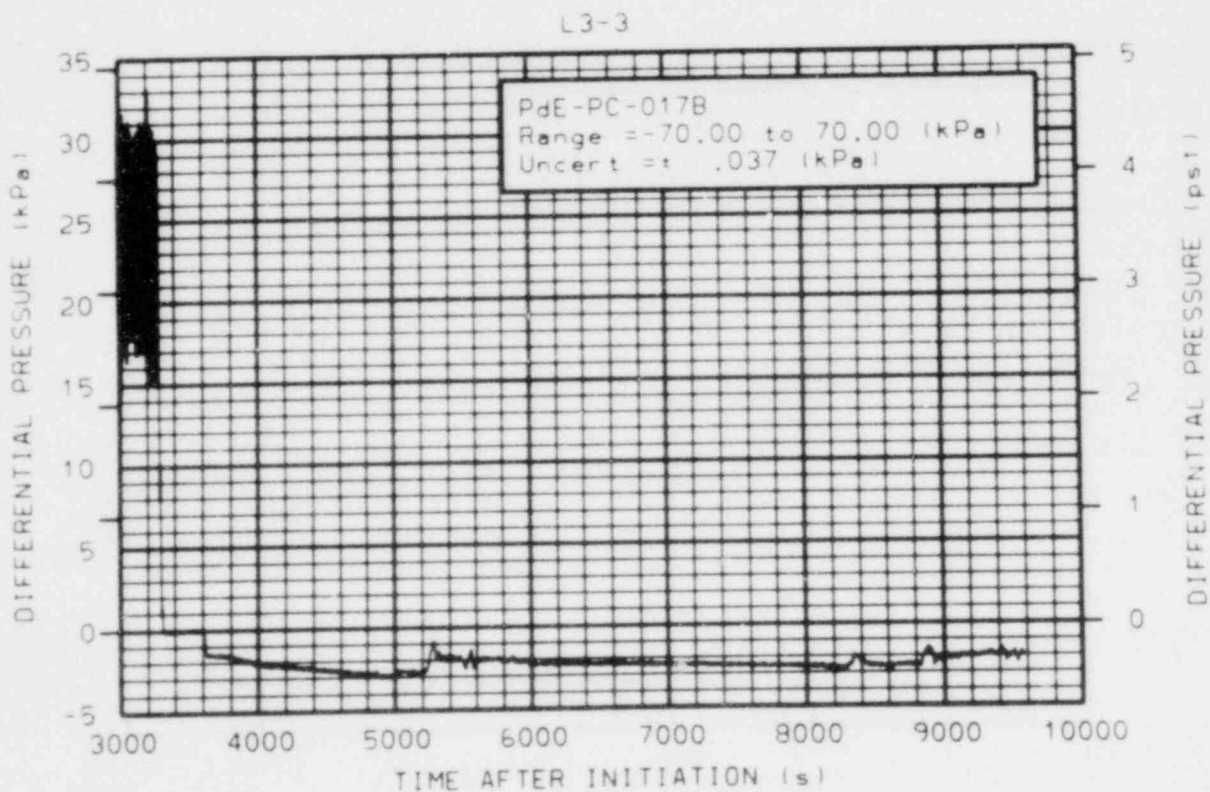


Figure 3M-20. Differential pressure in intact loop next to bottom of ECC Rake 1, pitot tube facing primary coolant pump (PdE-PC-017B).

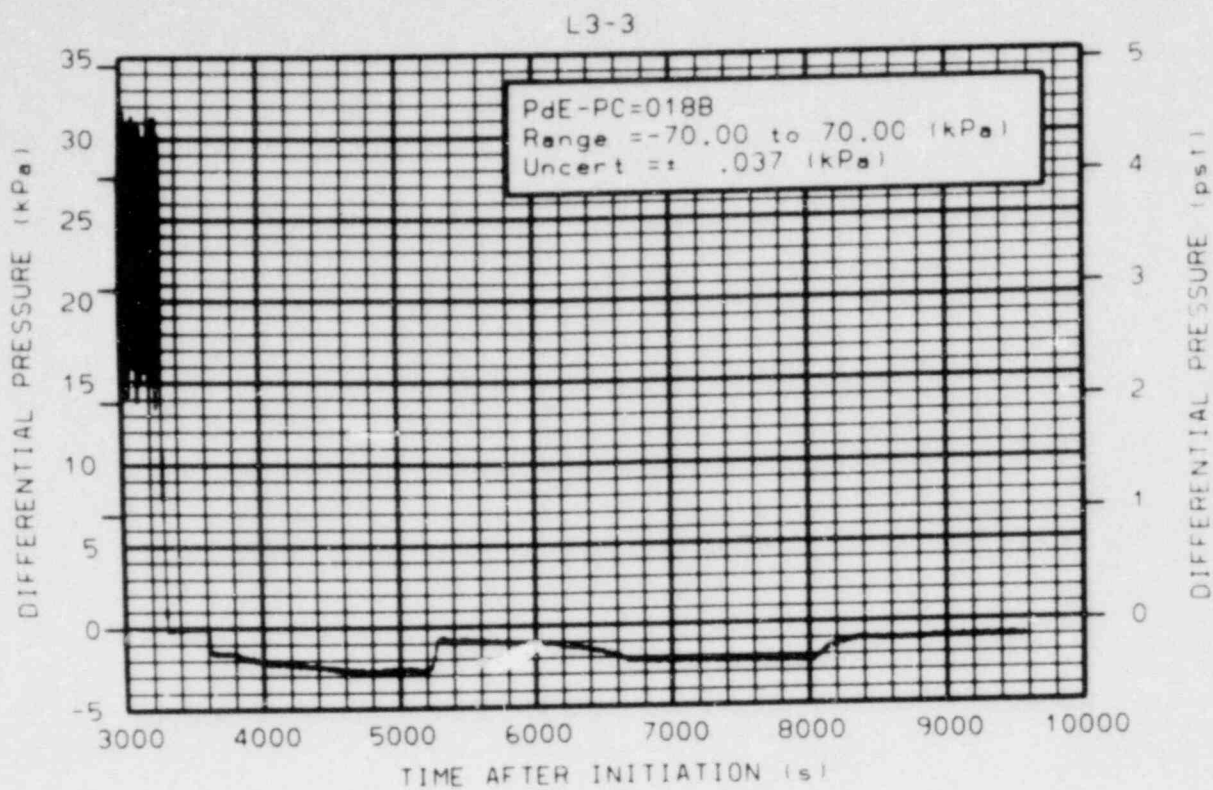


Figure 3M-21. Differential pressure in intact loop at bottom of ECC Rake 1, pitot tube facing primary coolant pump (PdE-PC-018B).

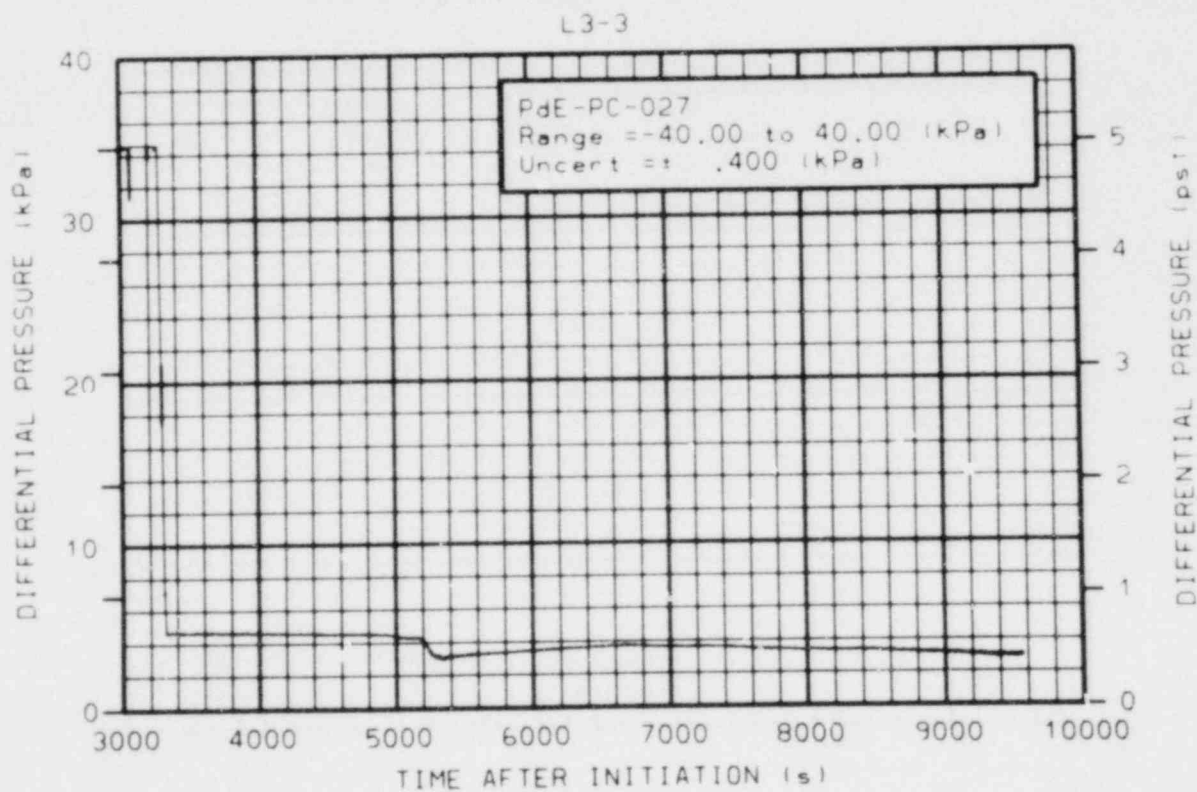


Figure 3M-22. Differential pressure in intact loop from steam generator outlet to bottom of loop seal (PdE-PC-027).

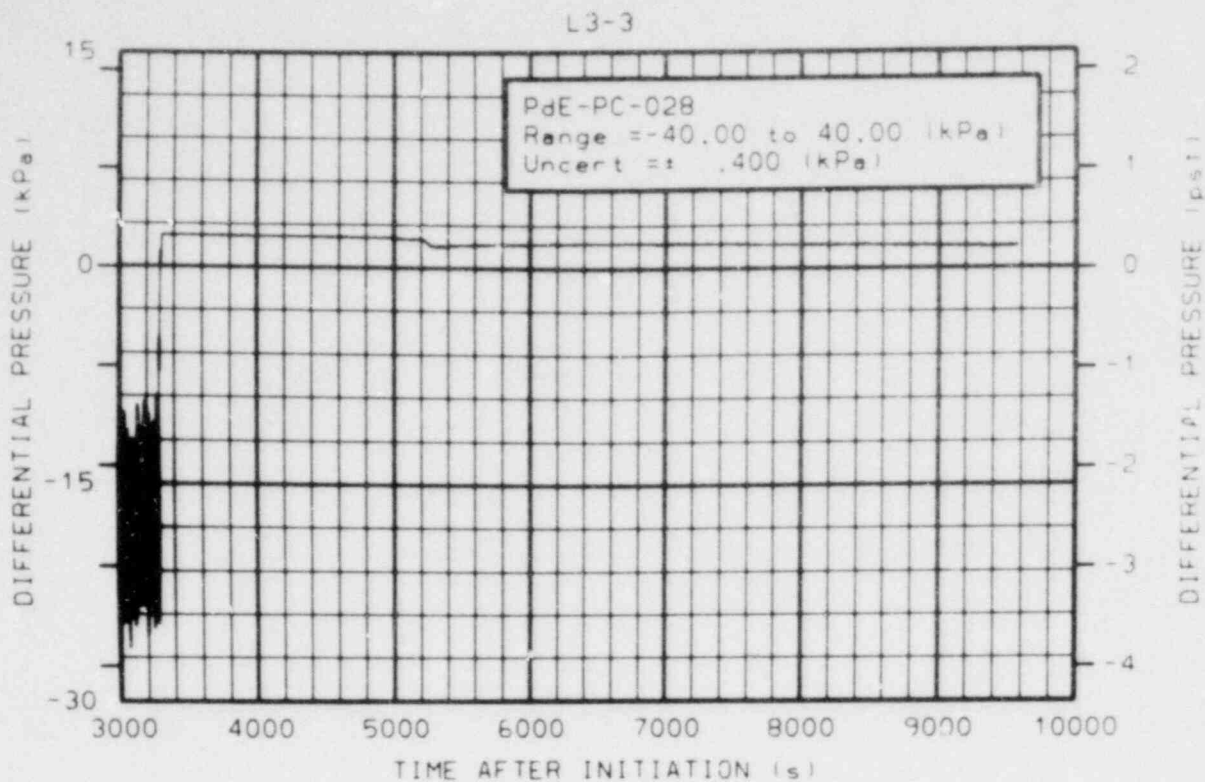


Figure 3M-23. Differential pressure in intact loop from bottom of loop seal to primary coolant Pump 2 (PdE-PC-028).

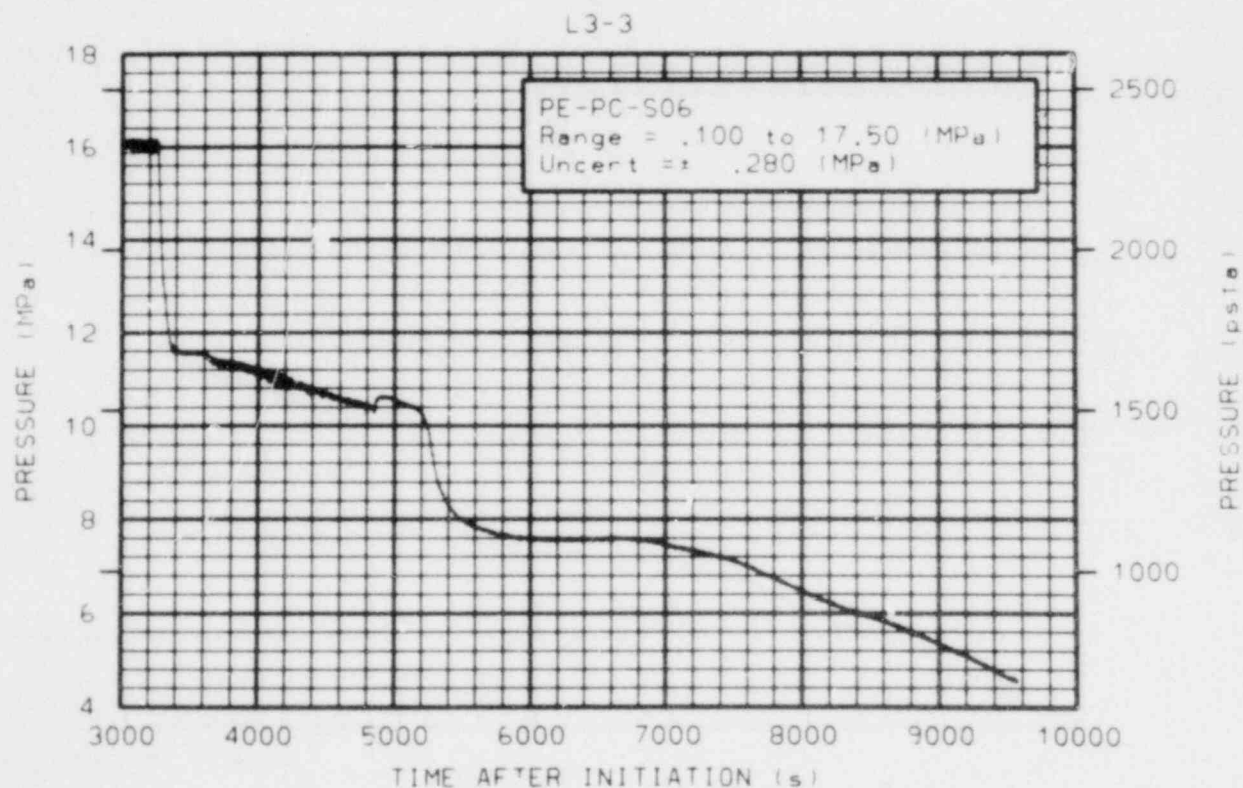


Figure 3M-24. Pressure in intact loop pressurizer relief line upstream of DTT (PE-PC-S06).

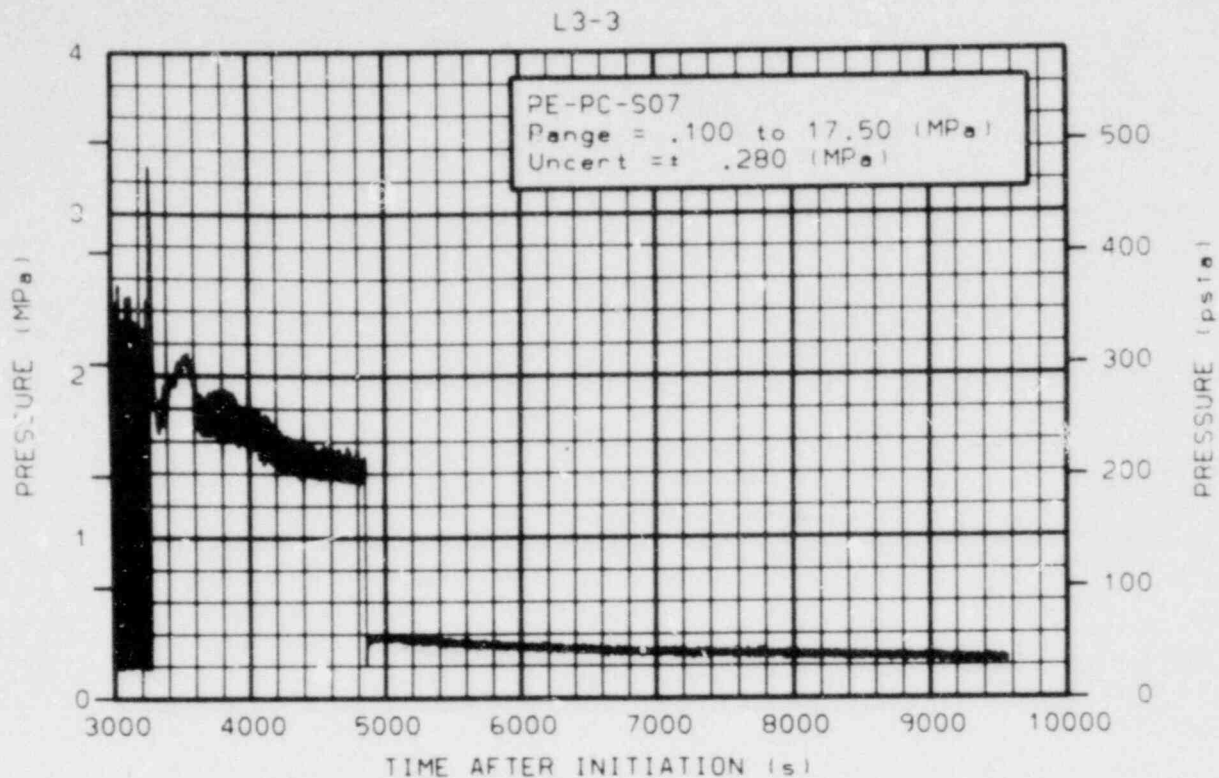


Figure 3M-25. Pressure in intact loop pressurizer relief line downstream of experiment PORV (PE-PC-S07).

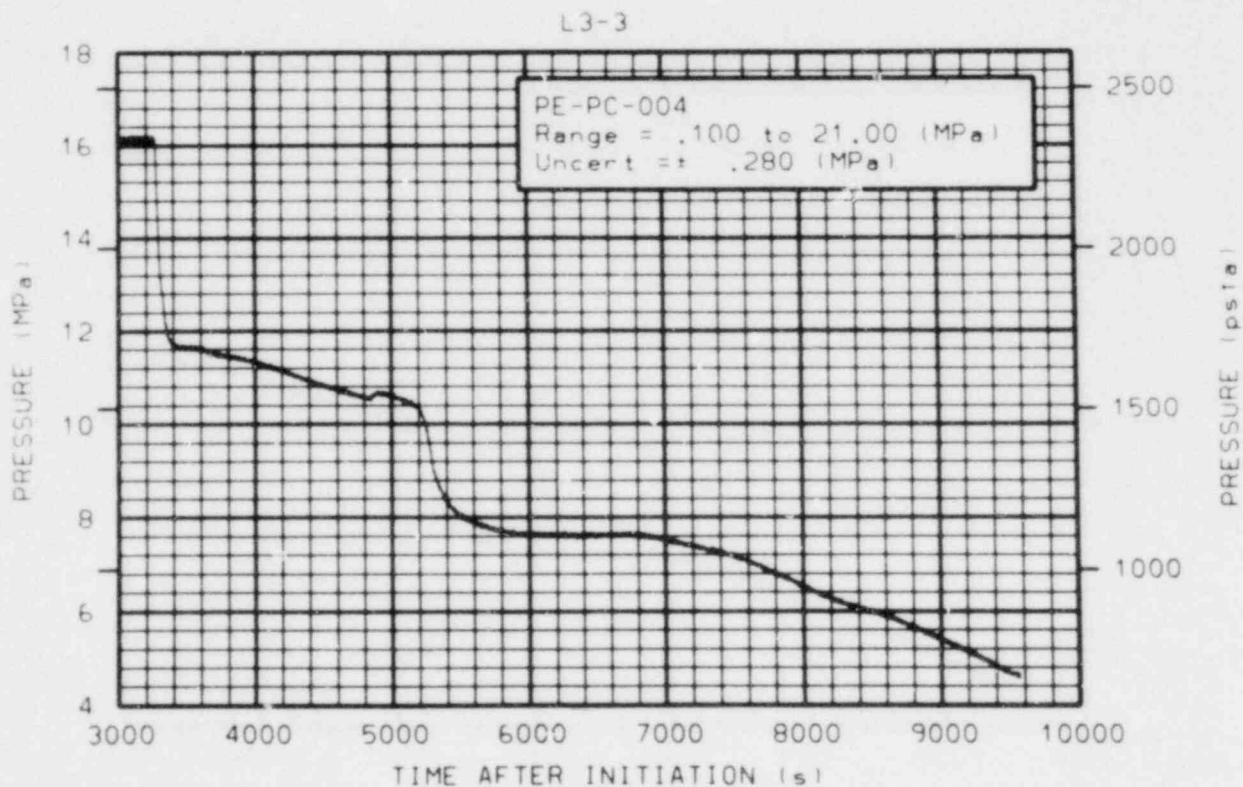


Figure 3M-26. Pressure in pressurizer (PE-PC-004).

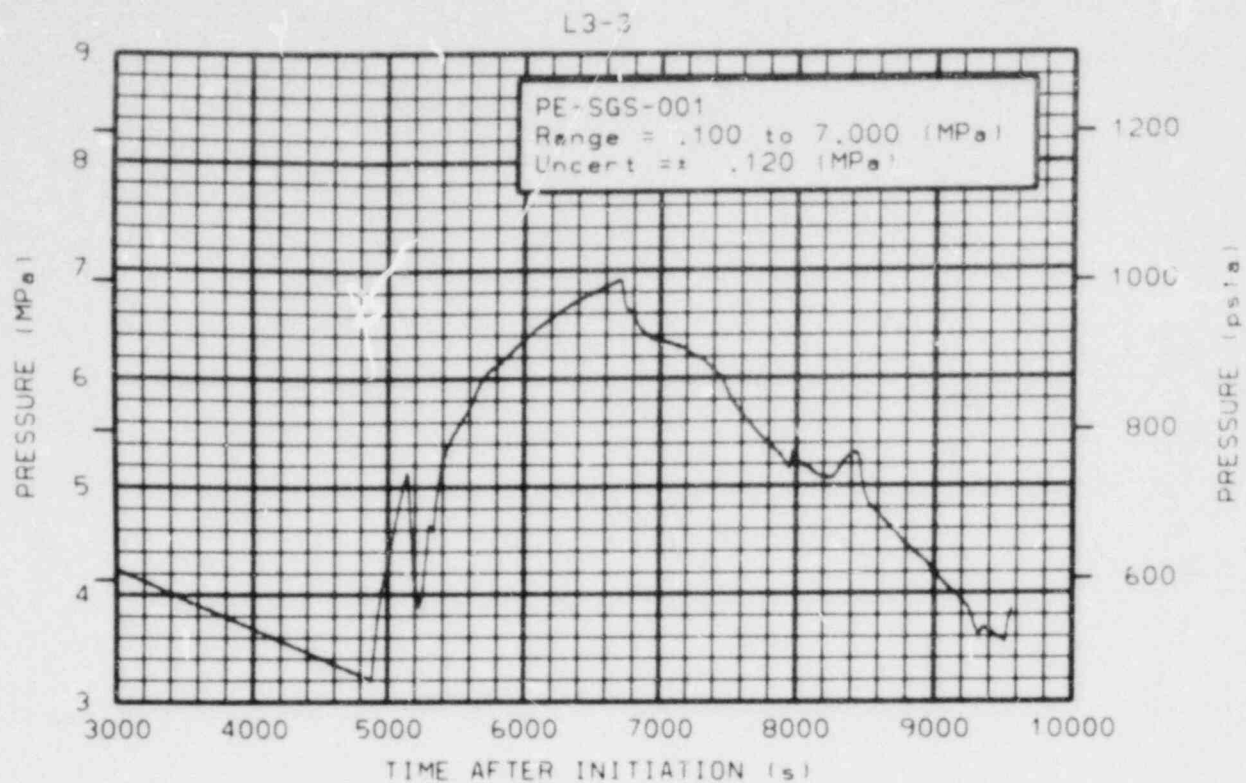


Figure 3M-27. Pressure in steam generator dome (PE-SGS-001).

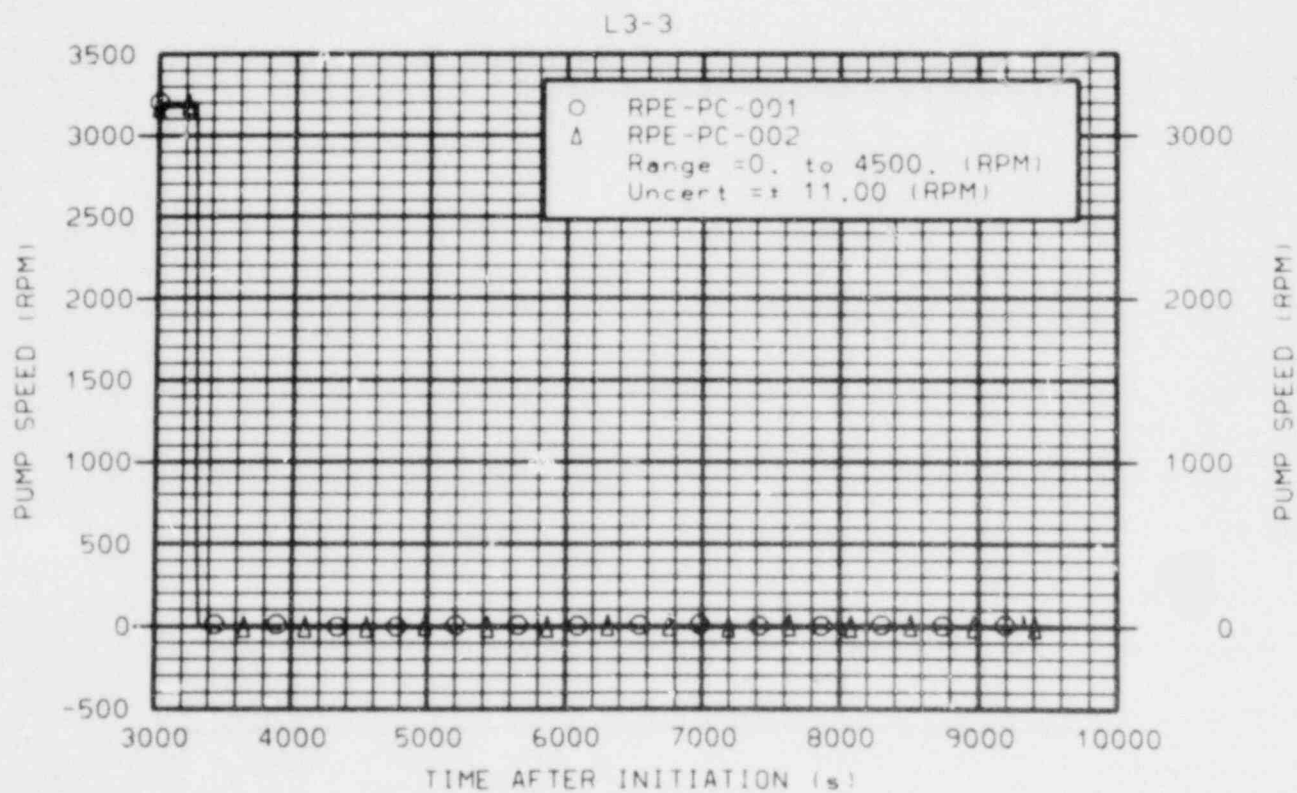


Figure 3M-28. Pump speed for primary coolant Pumps 1 and 2 (RPE-PC-001 and -002).

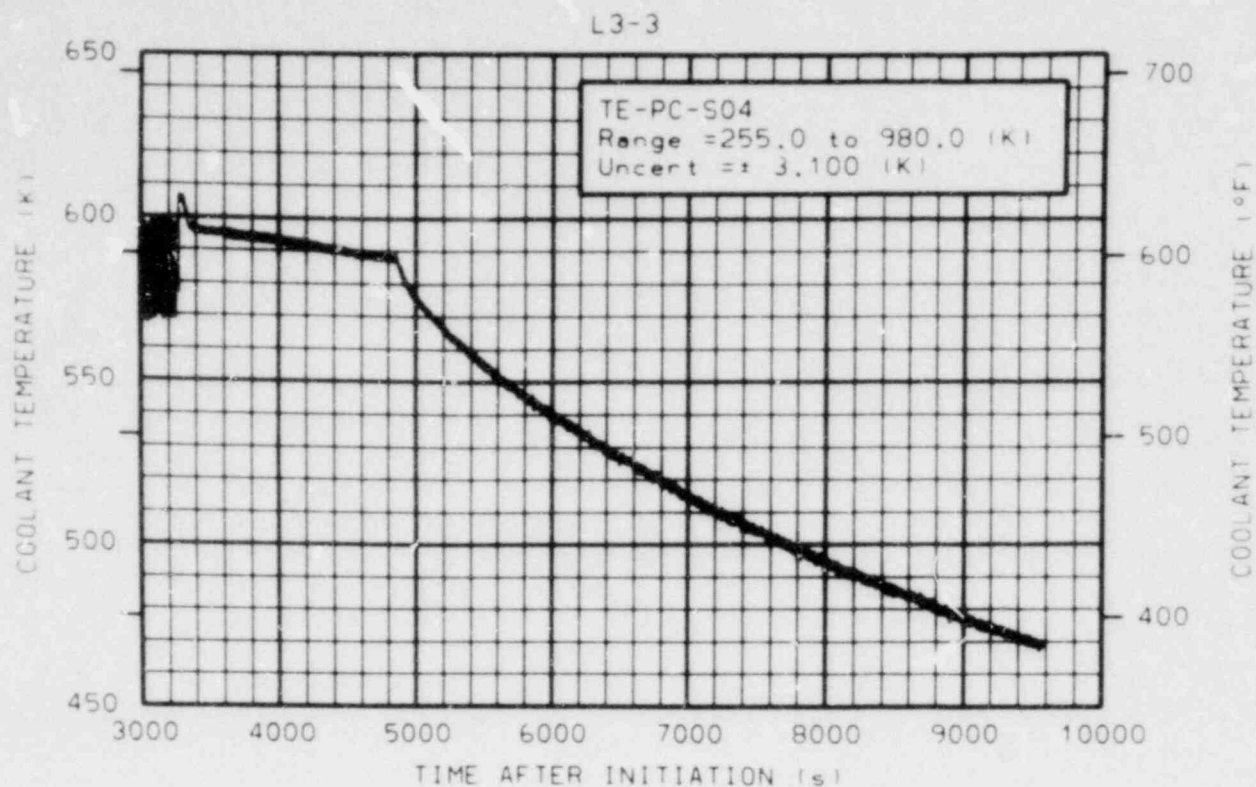


Figure 3M-29. Coolant temperature in intact loop pressurizer relief line at DTT in spool piece (TE-PC-S04).

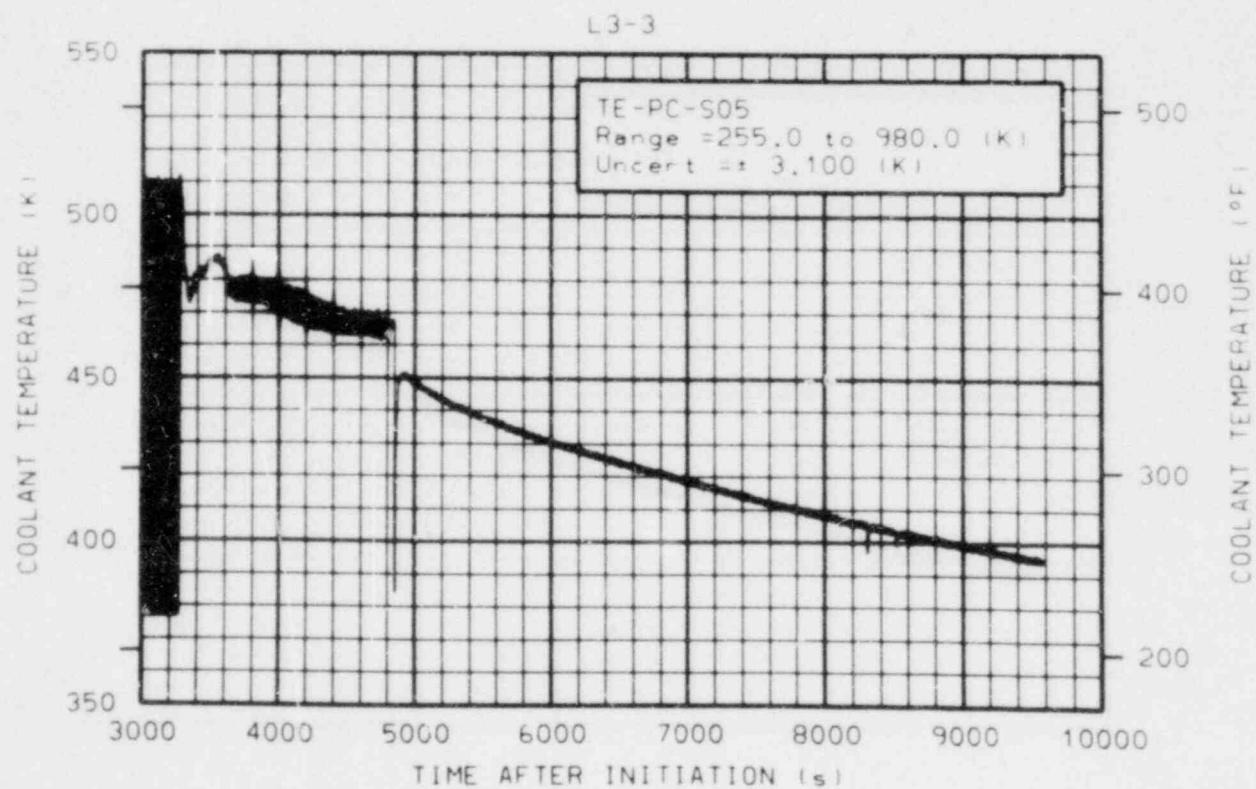


Figure 3M-30. Coolant temperature in intact loop pressurizer relief line downstream of experiment PORV (TE-PC-S05).

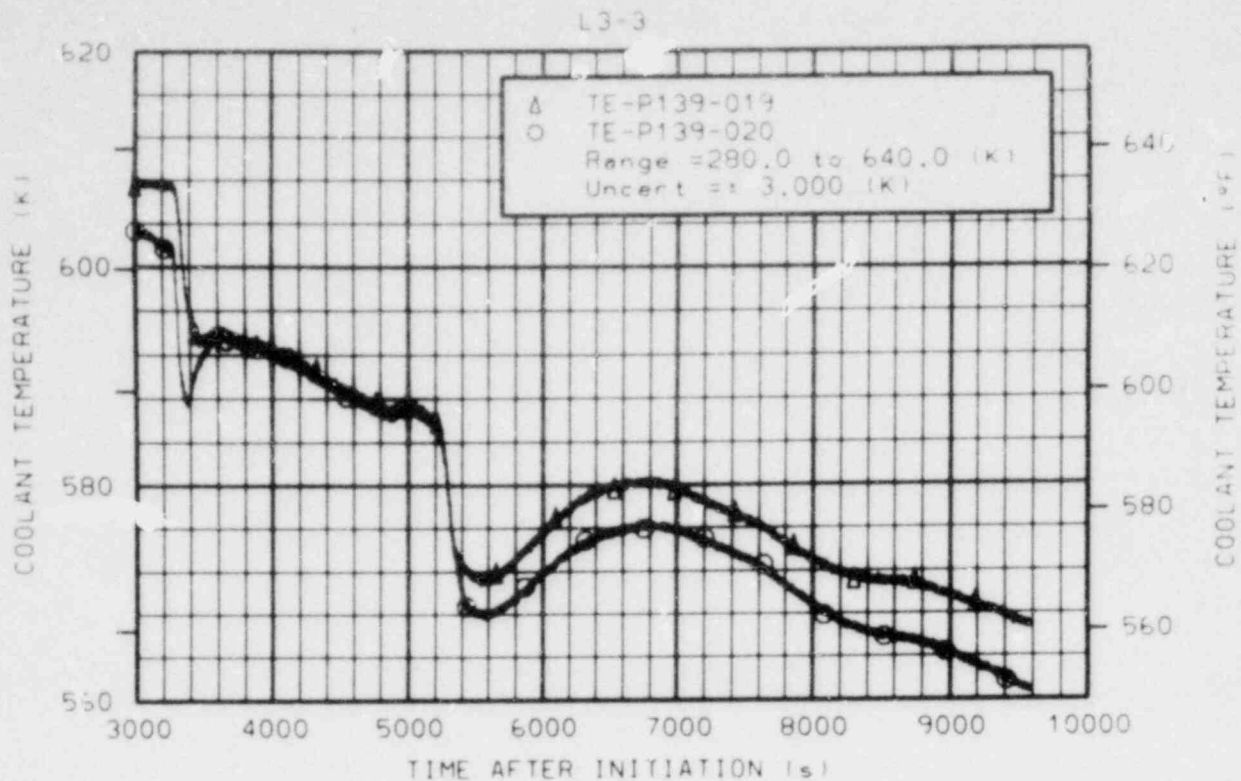


Figure 3M-31. Coolant temperature in intact loop pressurizer vapor and liquid space (TE-P139-019 and -020).

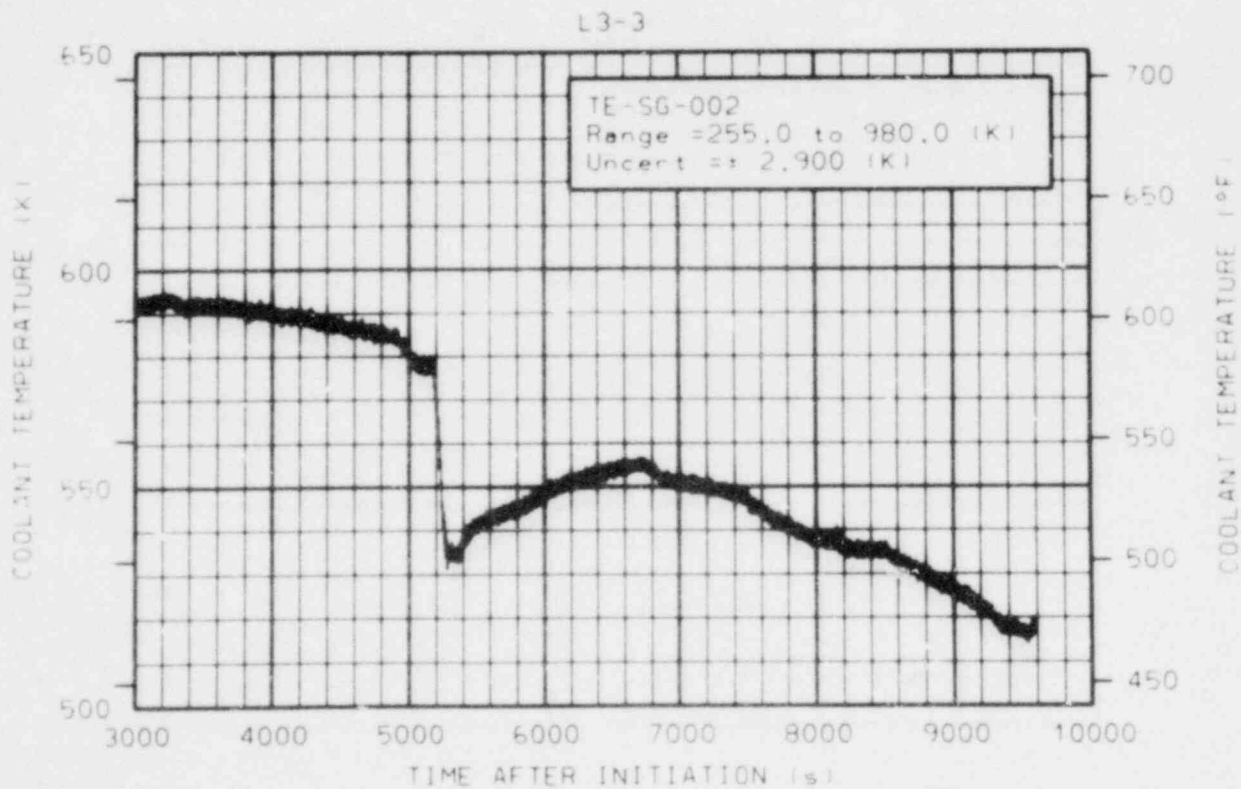


Figure 3M-32. Coolant temperature in intact loop steam generator outlet plenum (TE-SG-002).

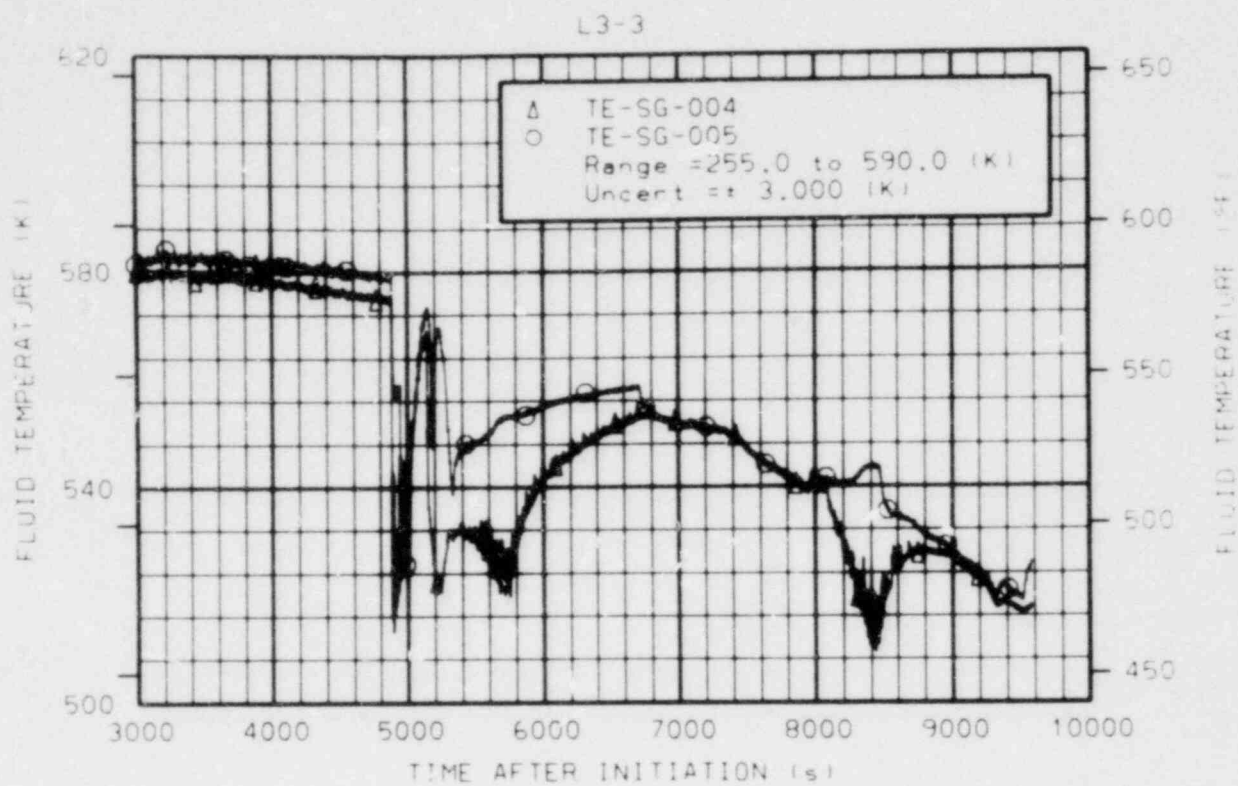


Figure 3M-33. Fluid temperature in steam generator secondary side downcomer at 2.12 and 2.92 m above top of tube sheet (TE-SG-004 and -005).

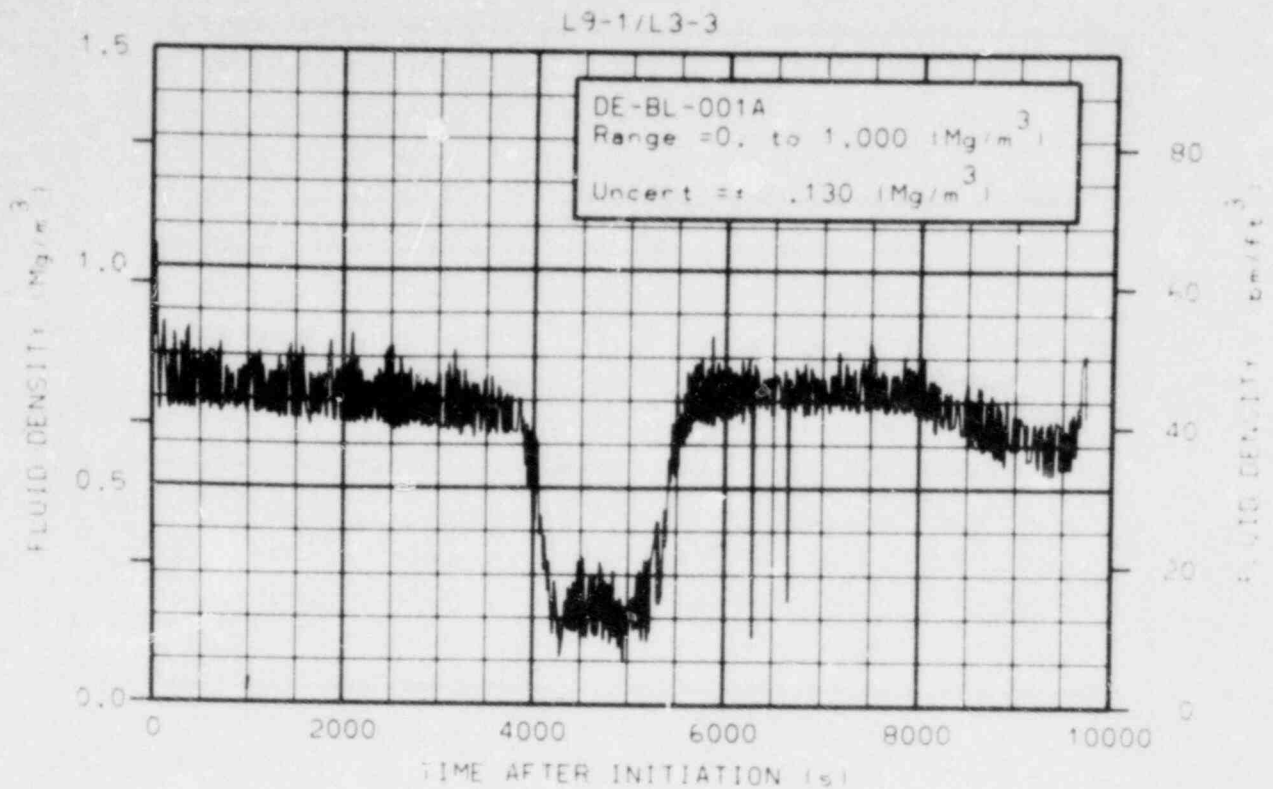


Figure 3L-1. Fluid density in broken loop cold leg, chordal density (DE-BL-001A) (qualified after reactor scram, anomalous spikes at approximately 6000 and 6500 s).

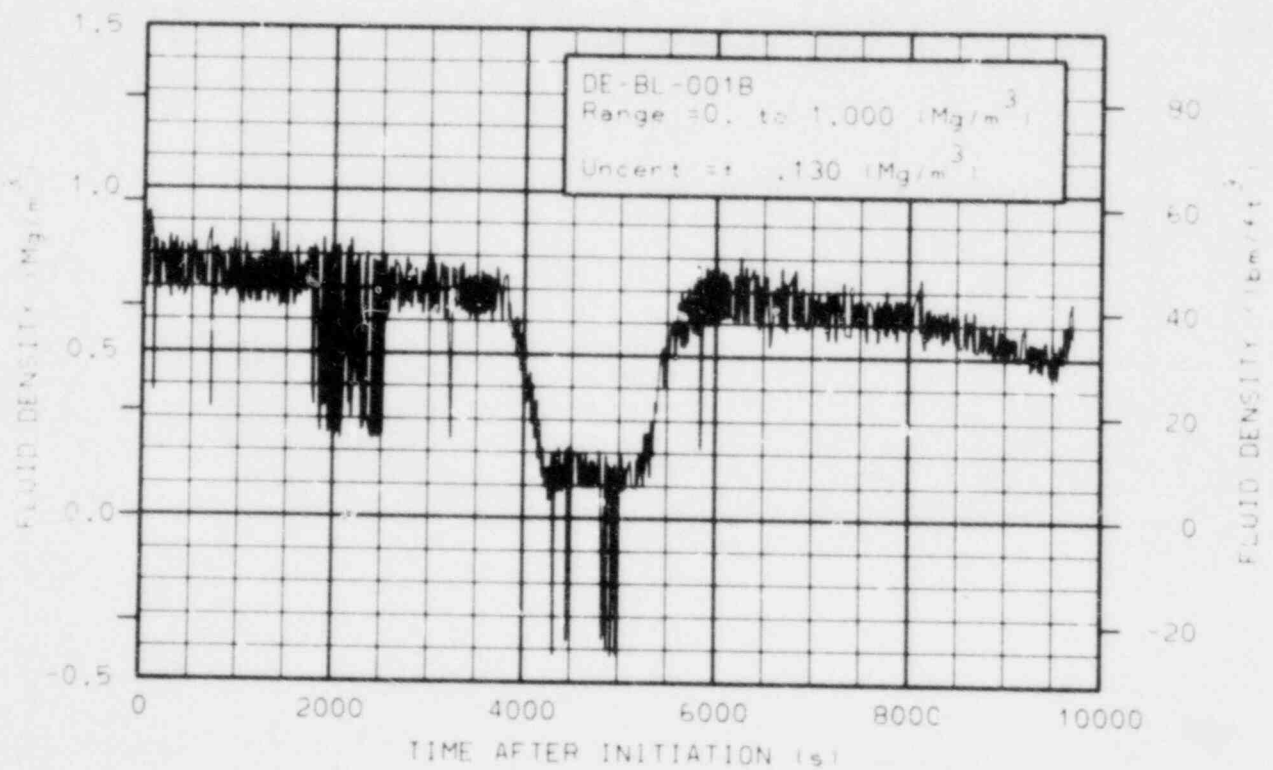


Figure 3L-2. Fluid density in broken loop cold leg, chordal density (DE-BL-001B) (qualified after reactor scram, several anomalous spikes).

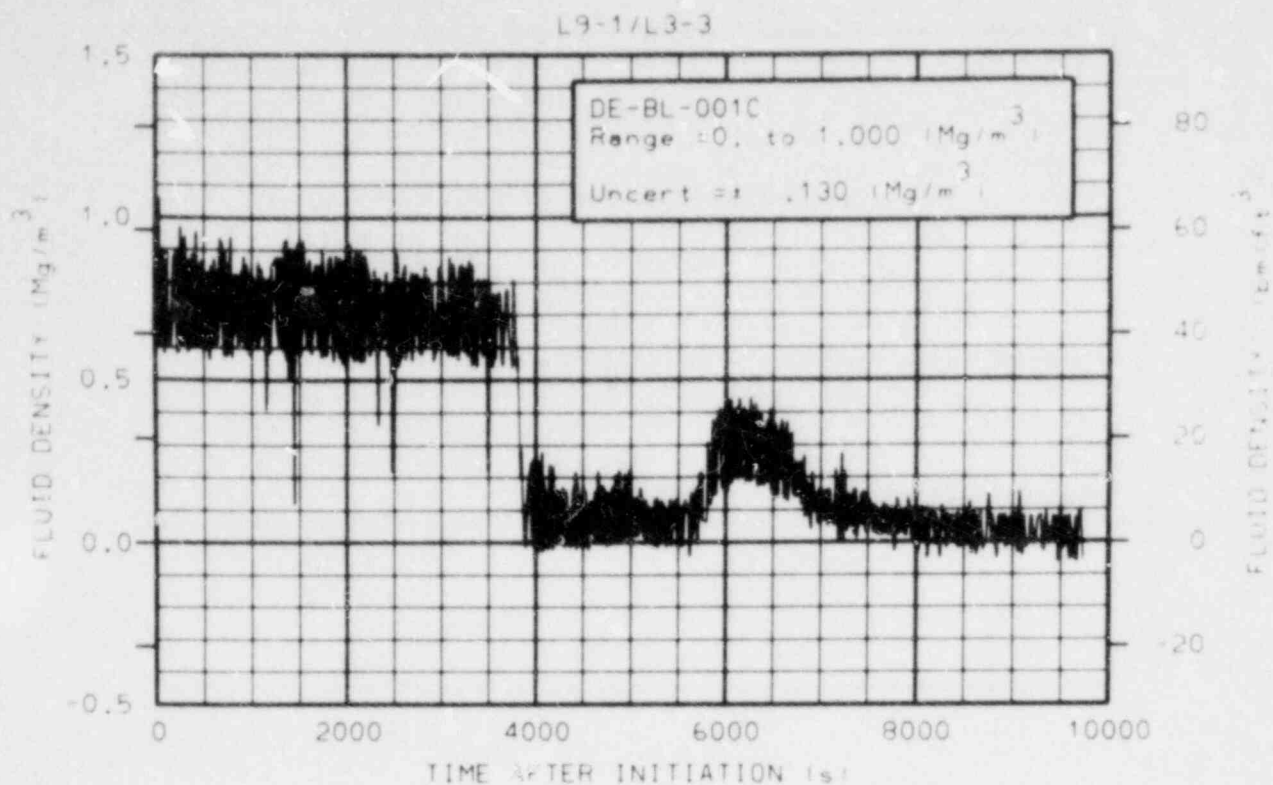


Figure 3L-3. Fluid density in broken loop cold leg, chordal density (DE-BL-001C) (qualified after reactor scram, several anomalous spikes).

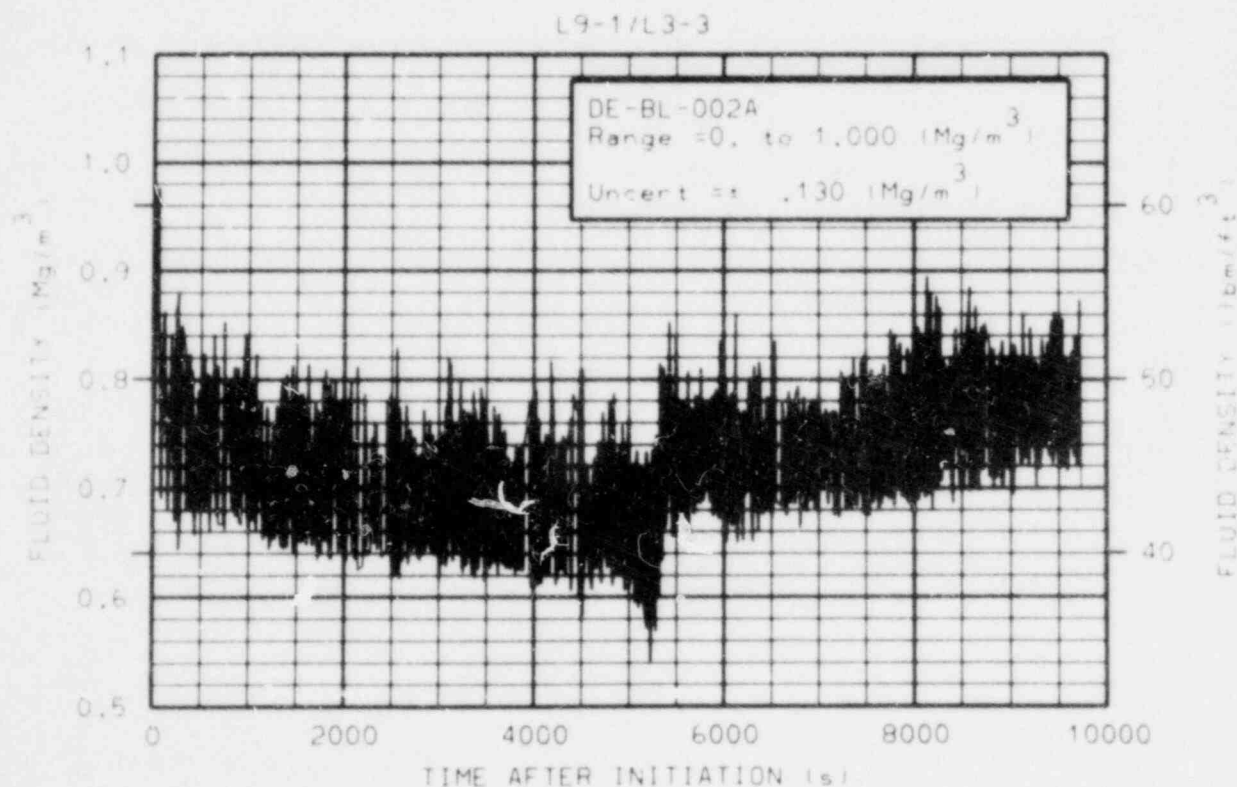


Figure 3L-4. Fluid density in broken loop hot leg, chordal density (DE-BL-002A) (qualified after reactor scram).

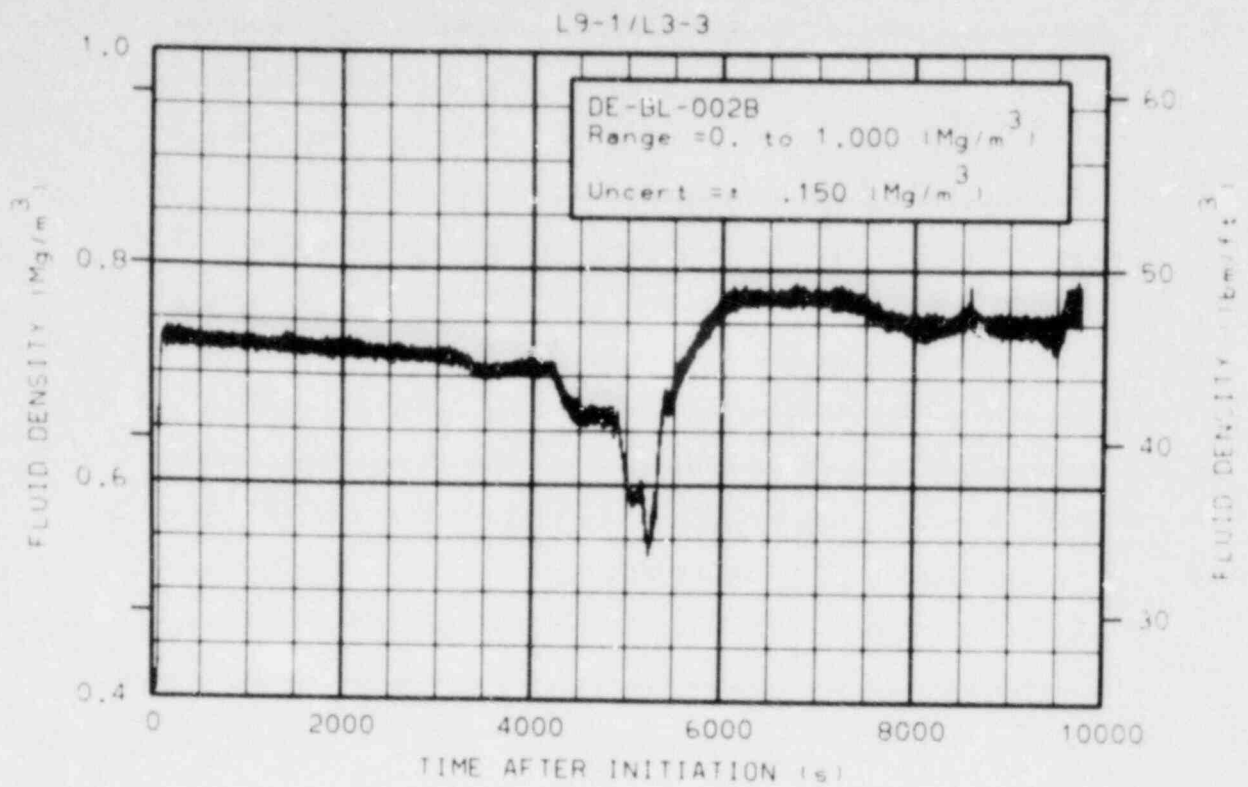


Figure 3L-5. Fluid density in broken loop hot leg, chordal density (DE-BL-002B) (qualified after reactor scram).

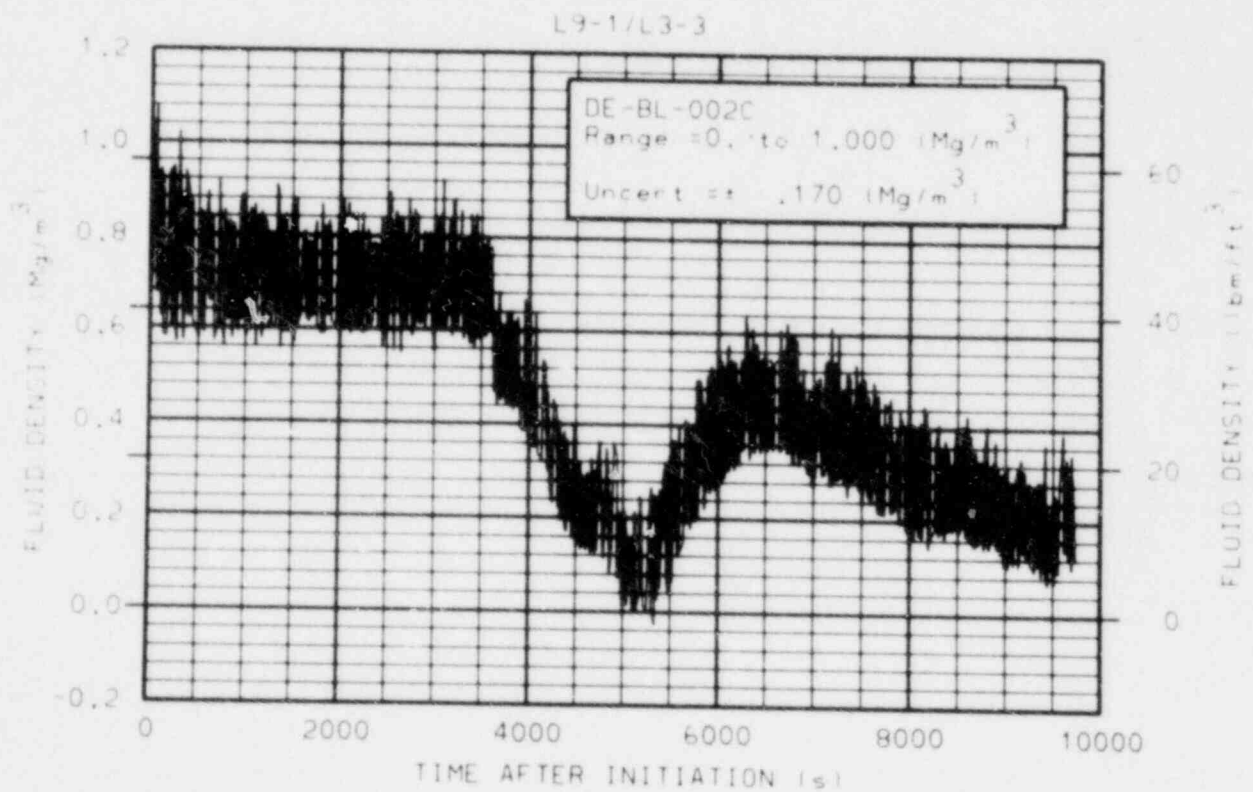


Figure 3L-6. Fluid density in broken loop hot leg, chordal density (DE-BL-002C) (qualified after reactor scram).

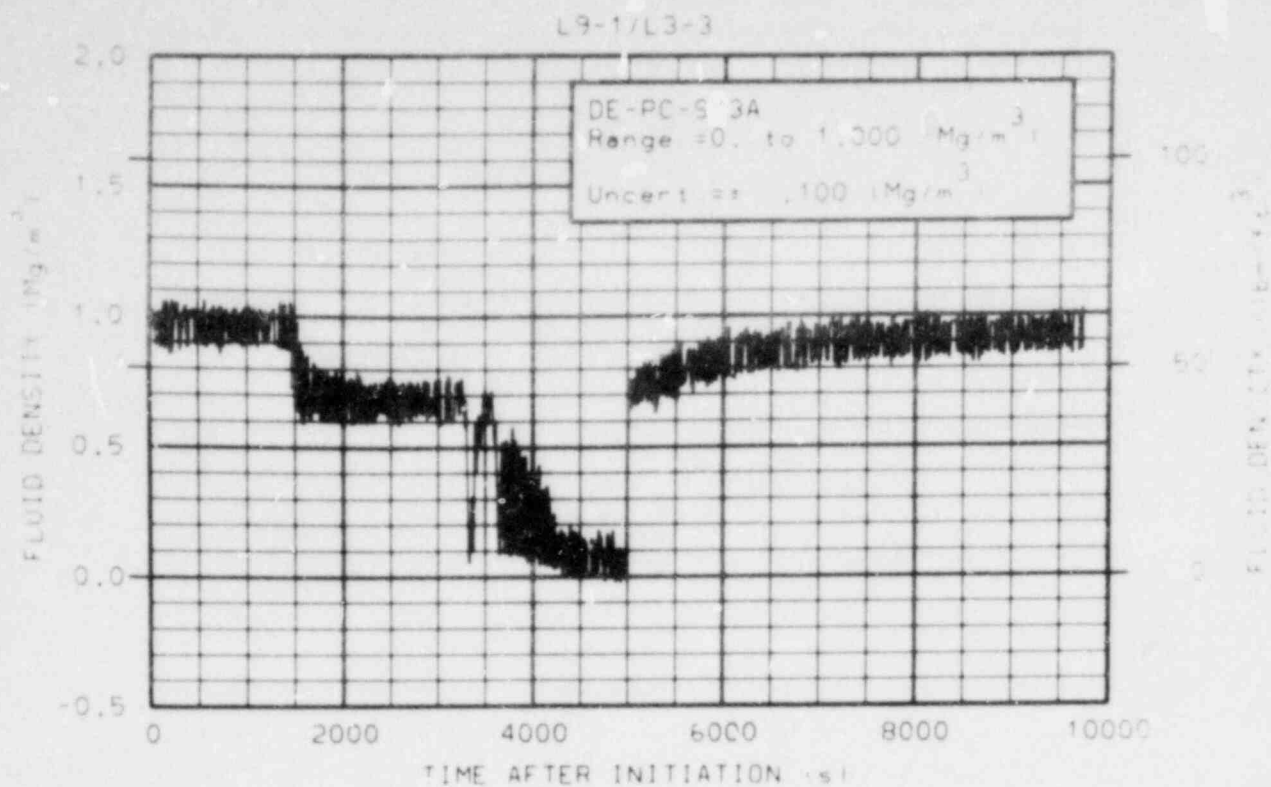


Figure 3L-7. Fluid density in intact loop pressurizer relief line upstream of experiment PORV, chordal density (DE-PC-S03A).

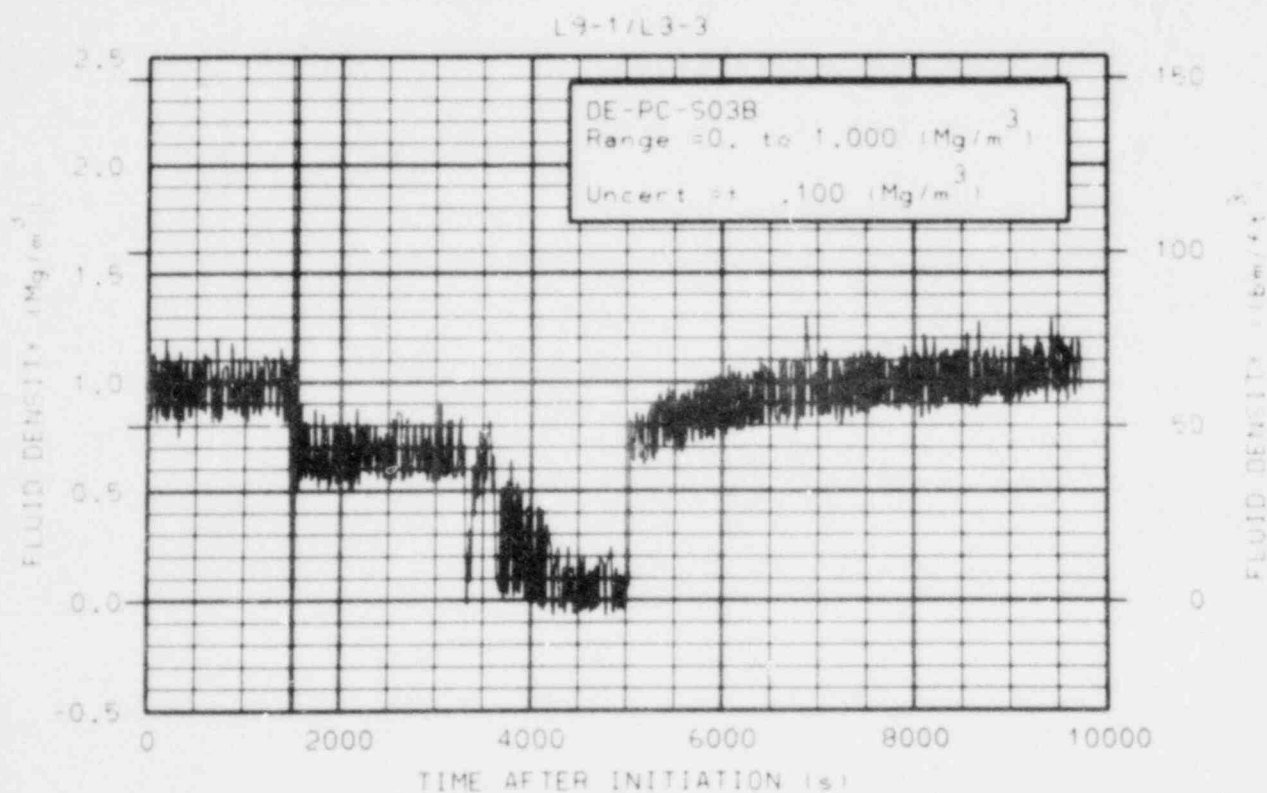


Figure 3L-8. Fluid density in intact loop pressurizer relief line upstream of experiment PORV, chordal density (DE-PC-S03B) (qualified, spikes from 1529 to 1560 s).

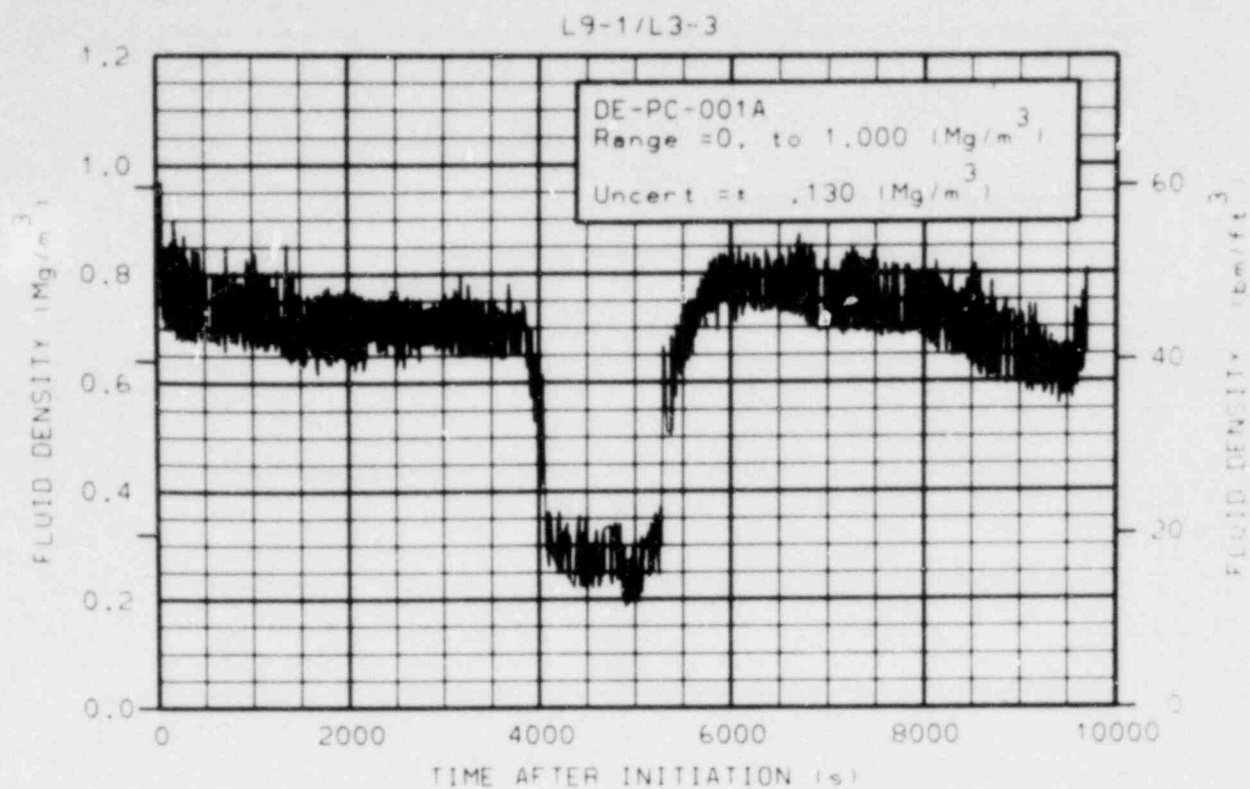


Figure 3L-9. Fluid density in intact loop cold leg, chordal density (DE-PC-001A) (qualified after reactor scram).

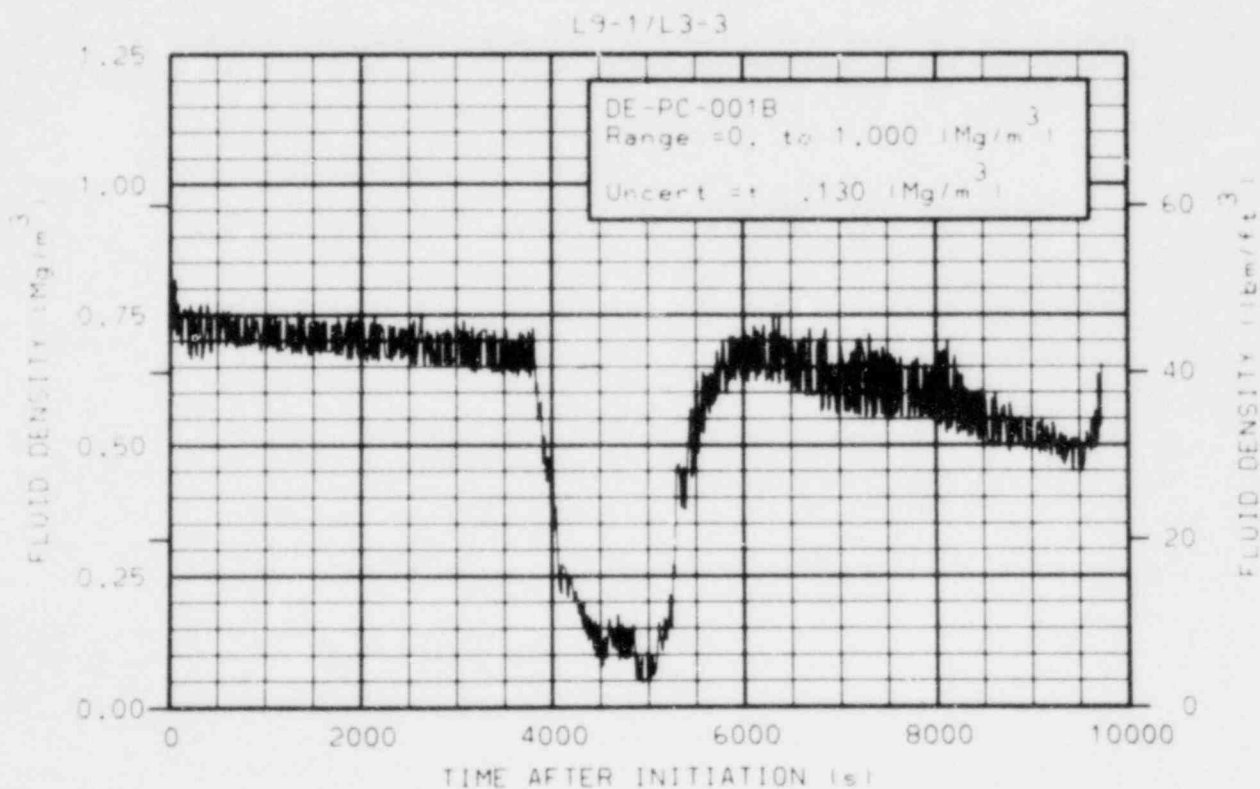


Figure 3L-10. Fluid density in intact loop cold leg, chordal density (DE-PC-001B) (qualified after reactor scram).

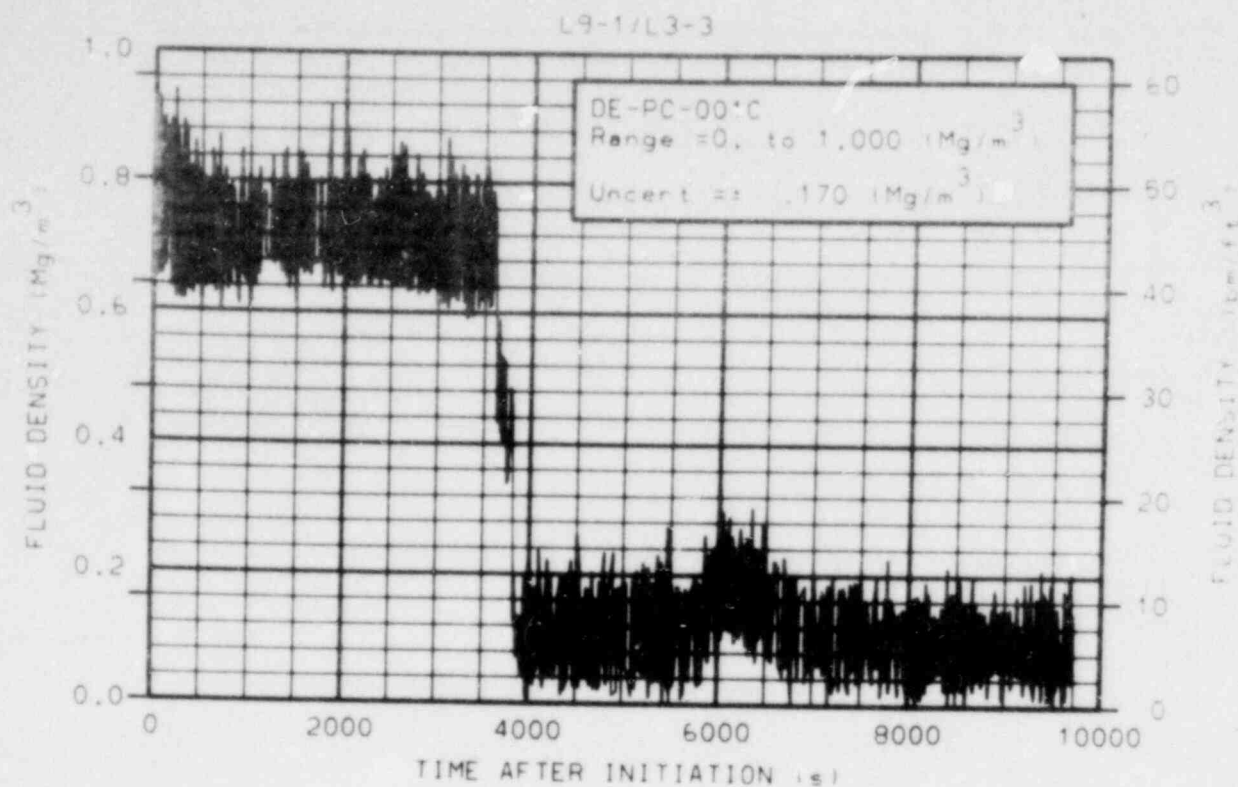


Figure 3L-11. Fluid density in intact loop cold leg, chordal density (DE-PC-001C) (qualified after reactor scram).

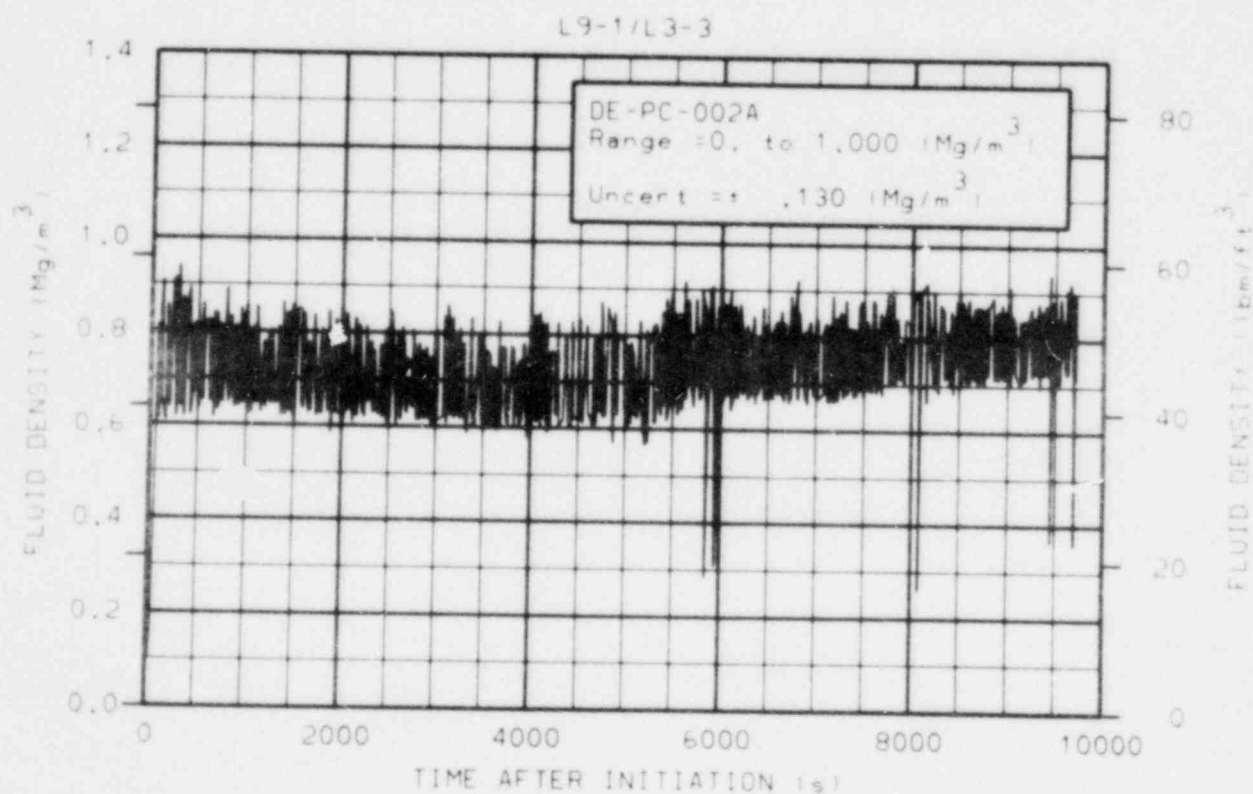


Figure 3L-12. Fluid density in intact loop hot leg, chordal density (DE-PC-002A) (qualified after reactor scram, several anomalous spikes).

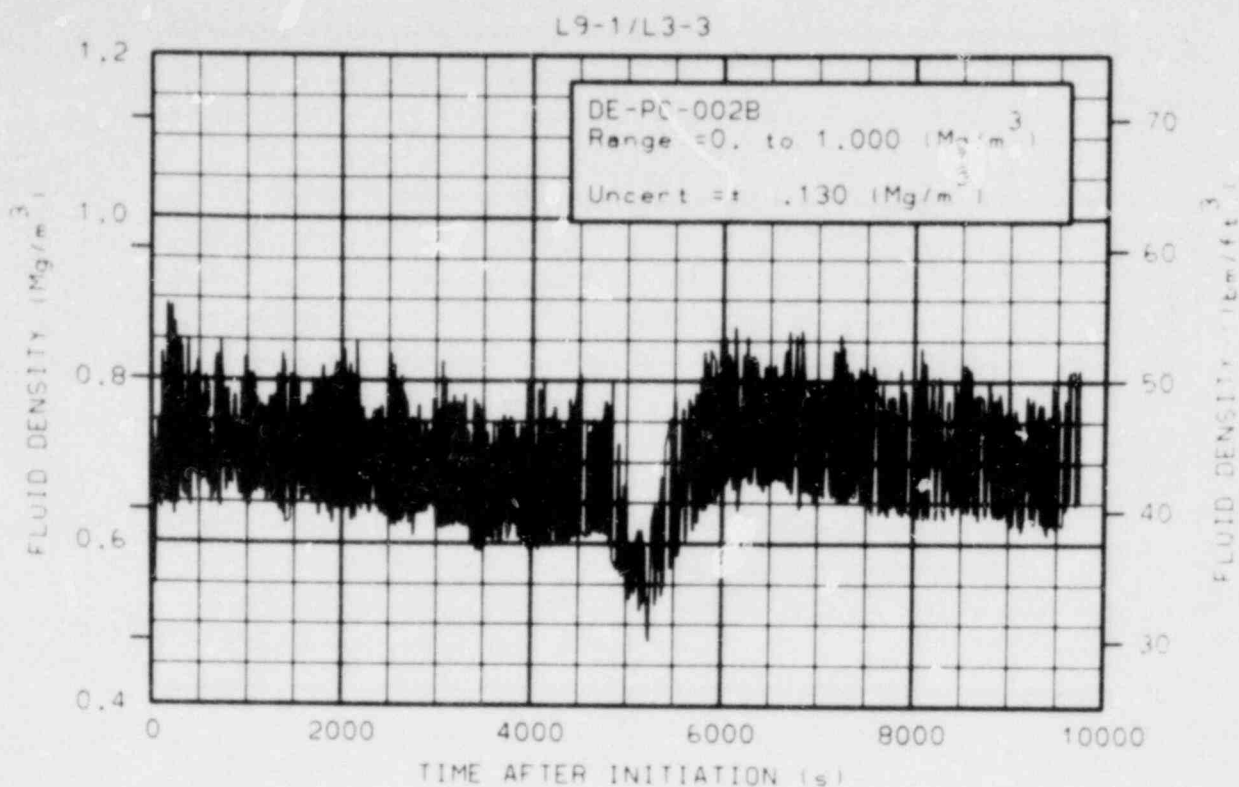


Figure 3L-13. Fluid density in intact loop hot leg, chordal density (DE-PC-002B) (qualified after reactor scram).

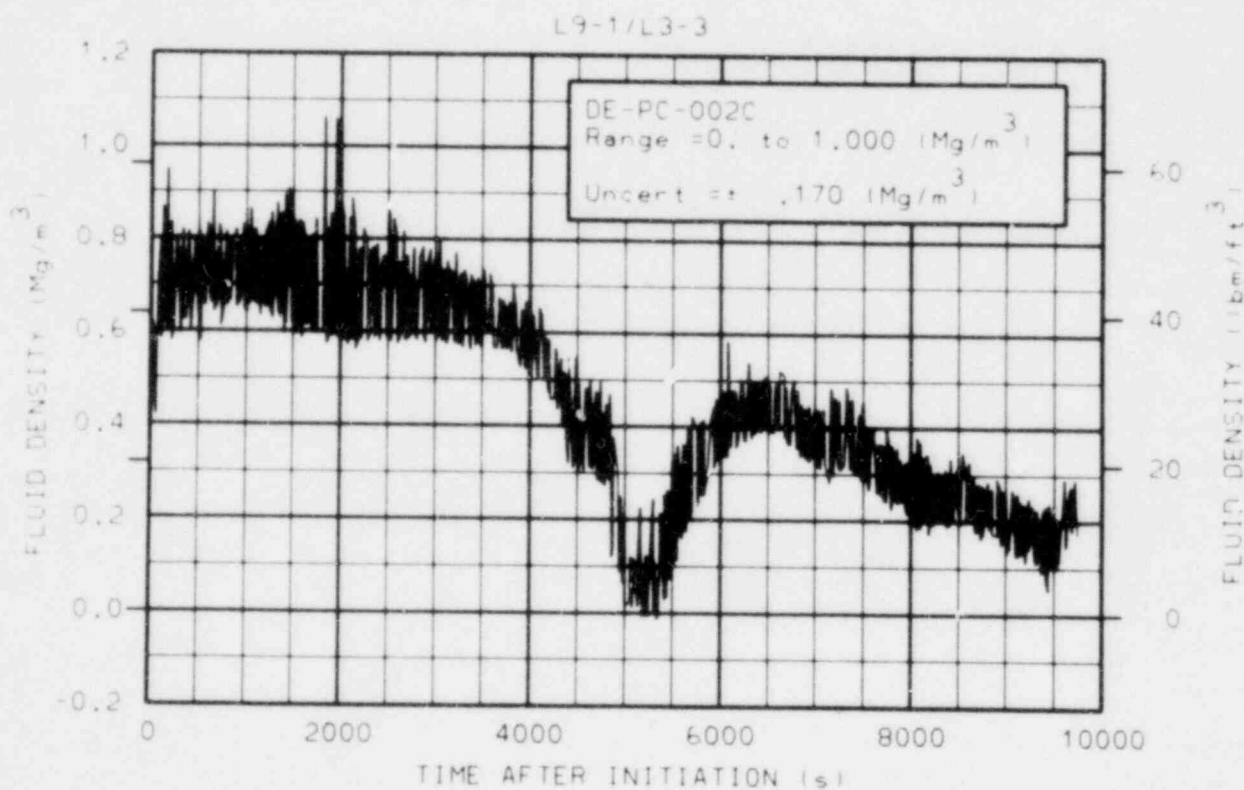


Figure 3L-14. Fluid density in intact loop hot leg, chordal density (DE-PC-002C) (qualified after reactor scram, anomalous spikes at 2000 s).

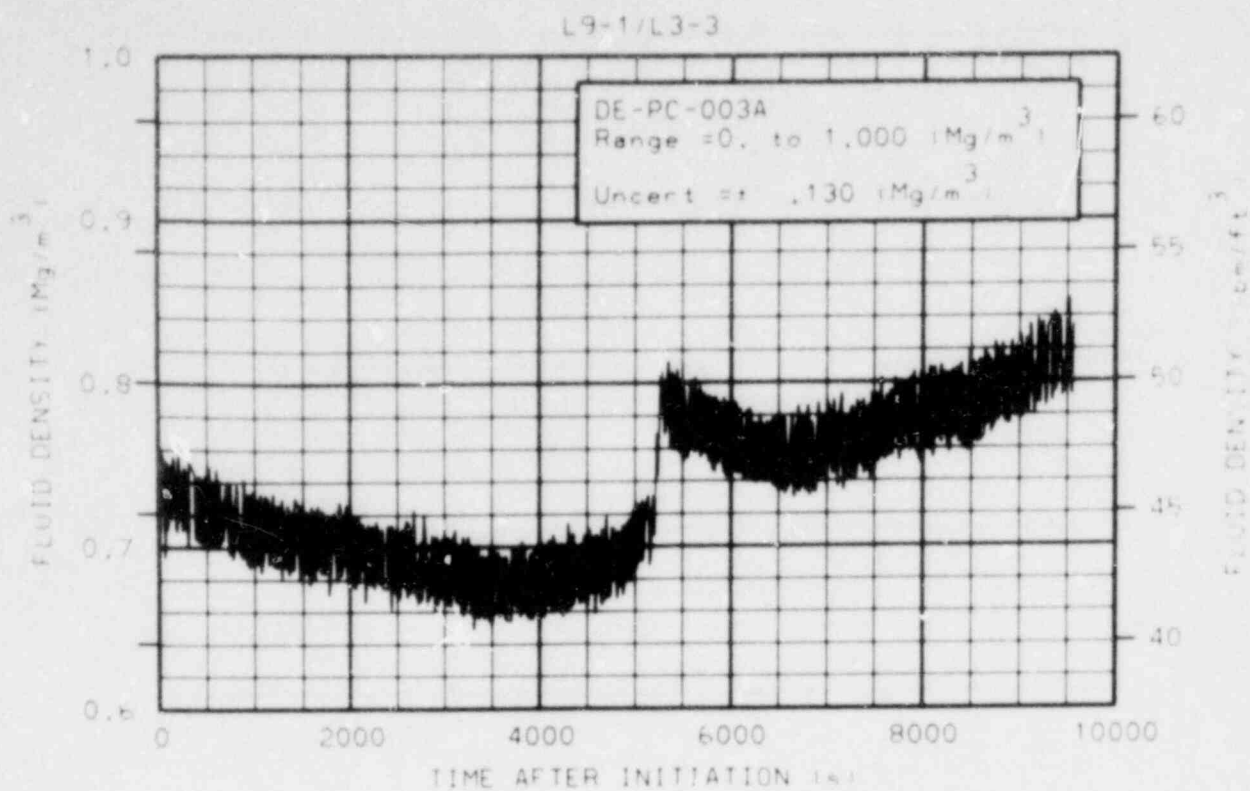


Figure 3L-15. Fluid density in intact loop at steam generator outlet, chordal density (DE-PC-003A) (qualified after reactor scram).

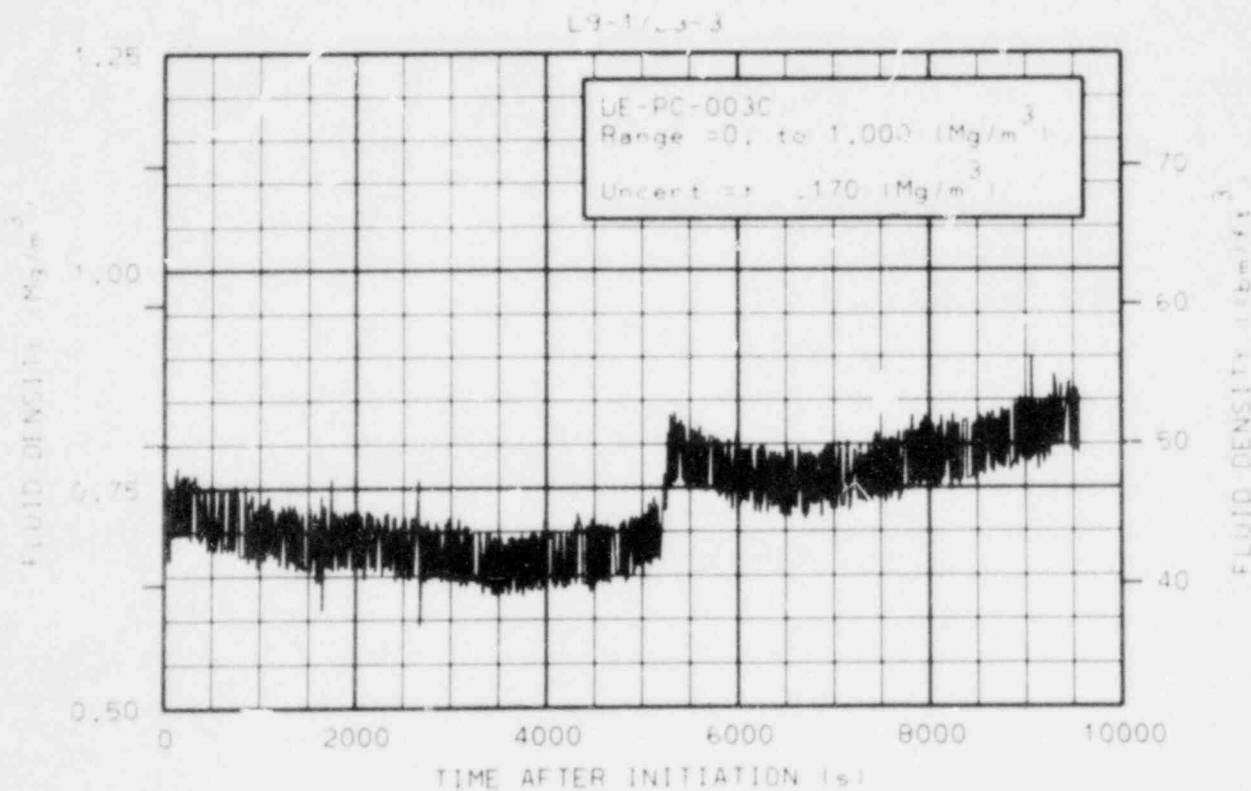


Figure 3L-16. Fluid density in intact loop at steam generator outlet, chordal density (DE-PC-003C) (qualified after reactor scram).

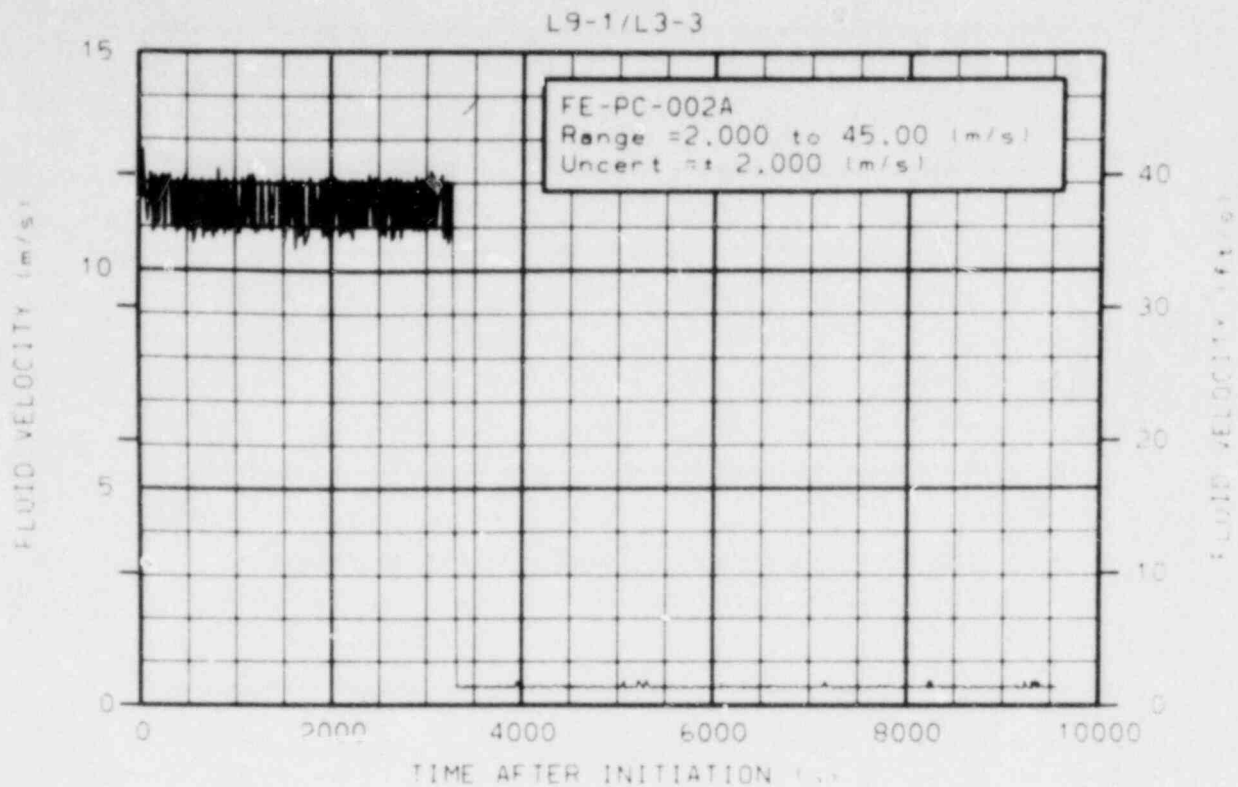


Figure 3L-17. Fluid velocity in intact loop hot leg DTT rake at bottom of pipe (FE-PC-002A) (qualified to 6000 s).

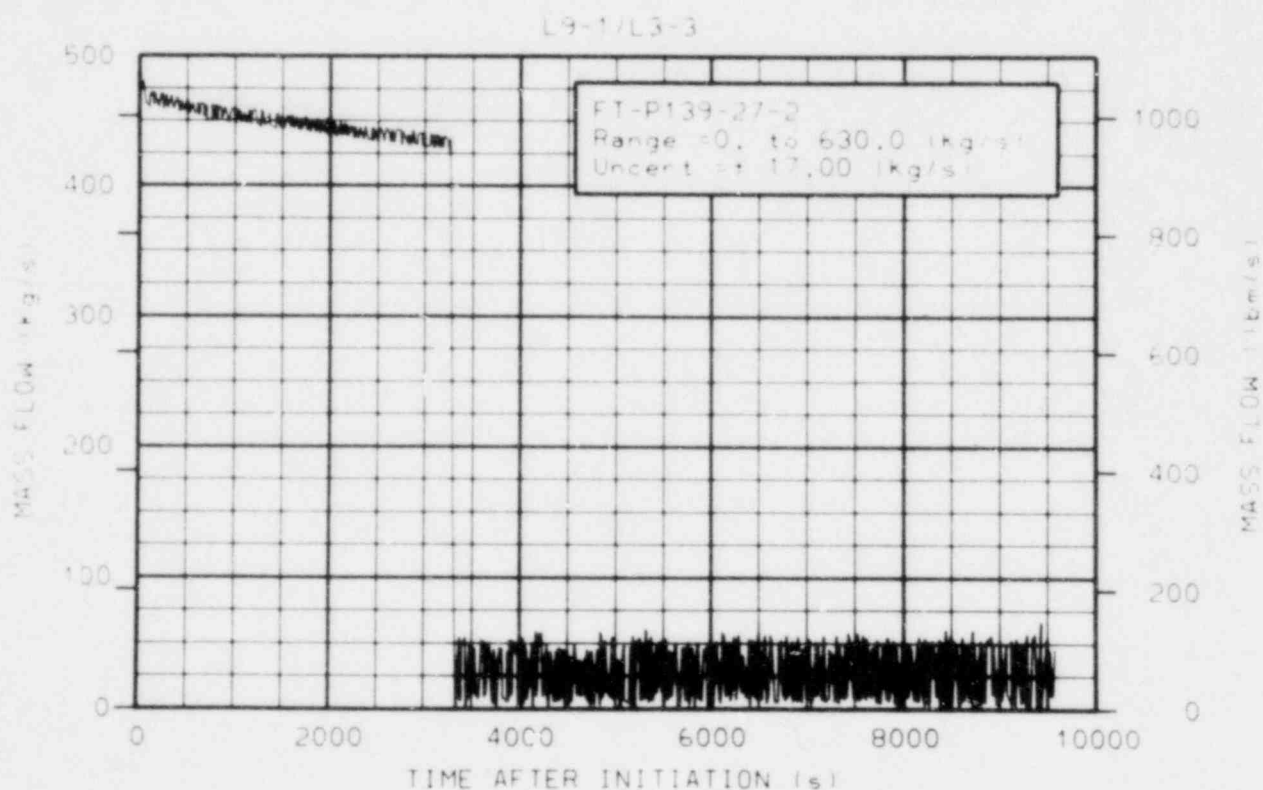


Figure 3L-18. Flow rate in intact loop hot leg venturi (FT-P139-27-2) (qualified to primary coolant pump trip).

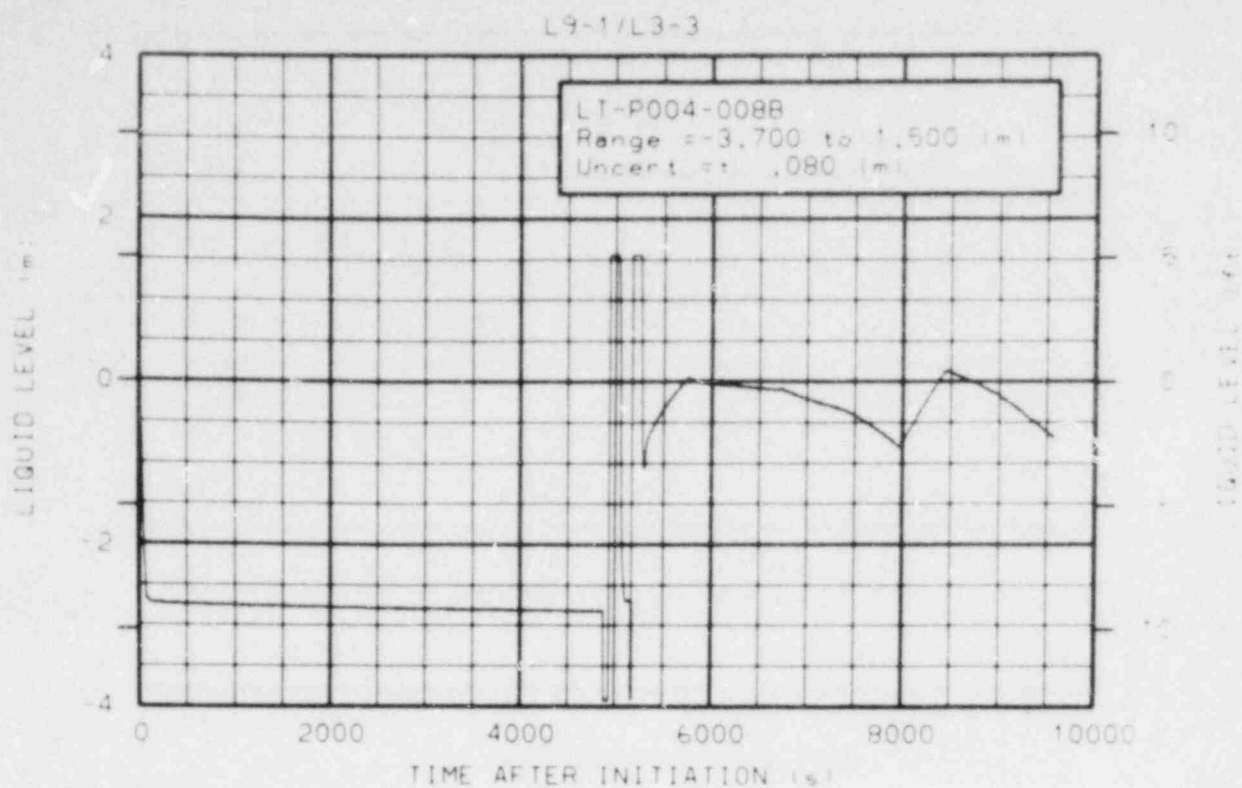


Figure 3L-19. Liquid level in steam generator secondary side, wide range (LT-P004-0088) (qualified after 0 s, not density compensated, oscillations at approximately 5000 s are not indicative of real level).

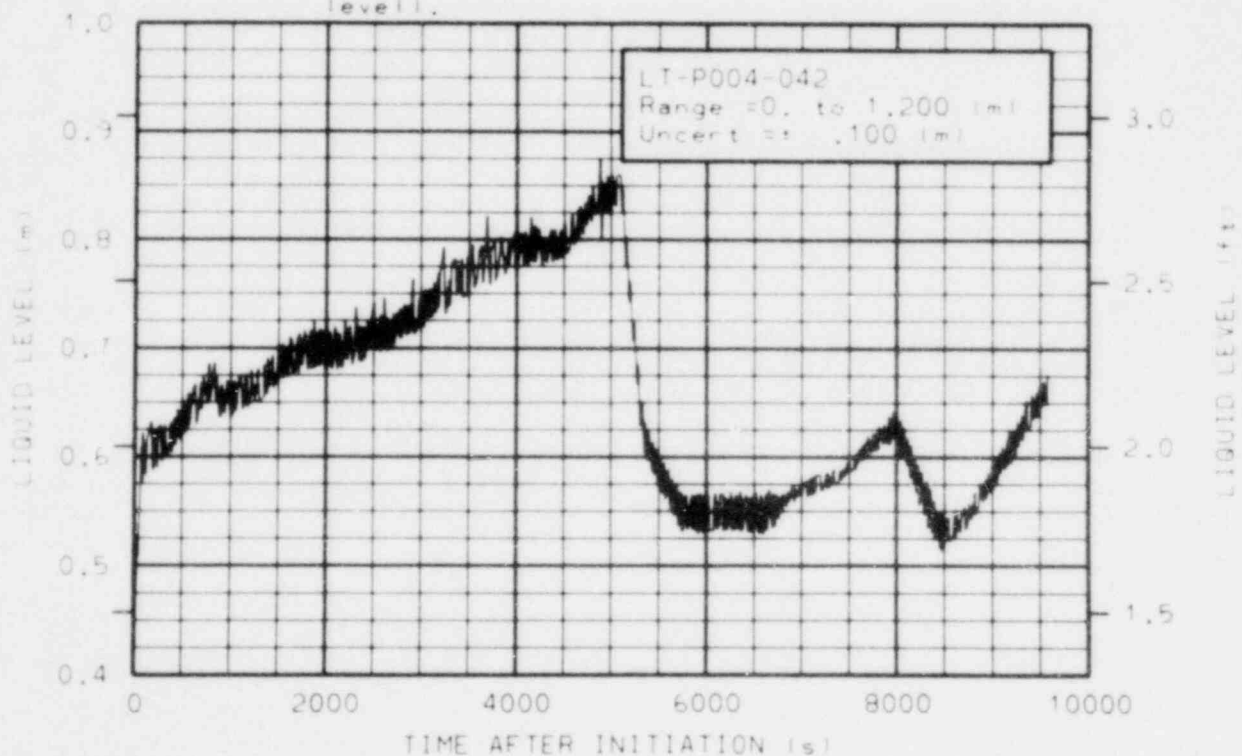


Figure 3L-20. Liquid level in condensate receiver at centerline (LT-P004-042) (qualified, magnitude uncertain).

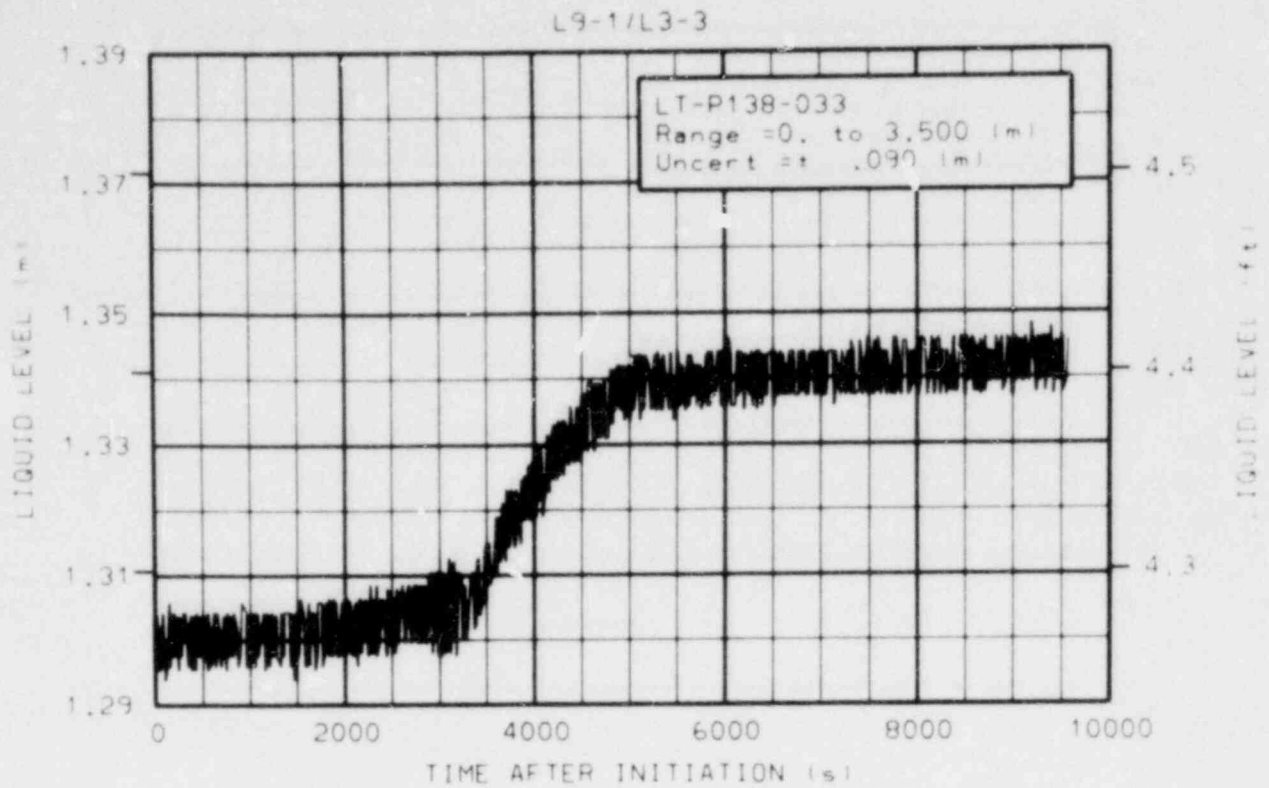


Figure 3L-21. Liquid level in blowdown suppression tank, north end (LT-P138-033) (qualified, not density compensated).

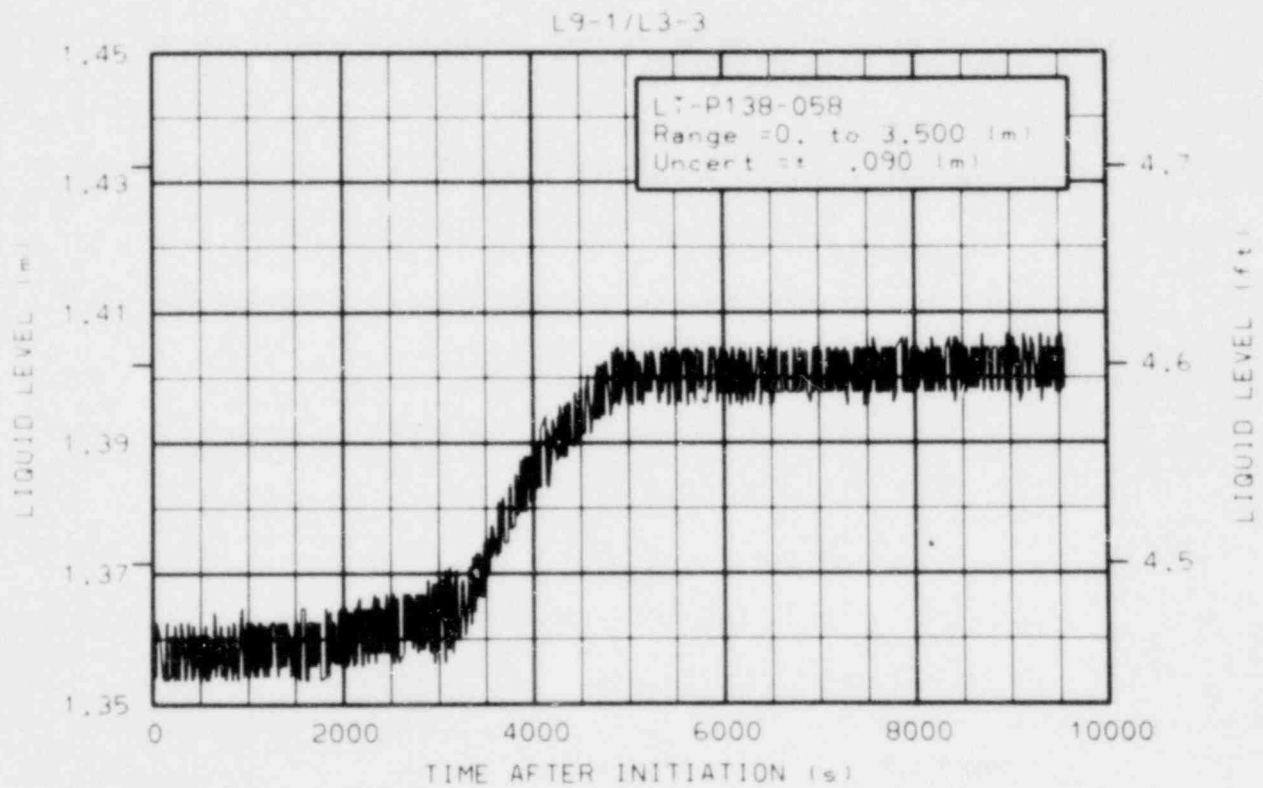


Figure 3L-22. Liquid level in blowdown suppression tank, south end (LT-P138-058) (qualified, not density compensated).

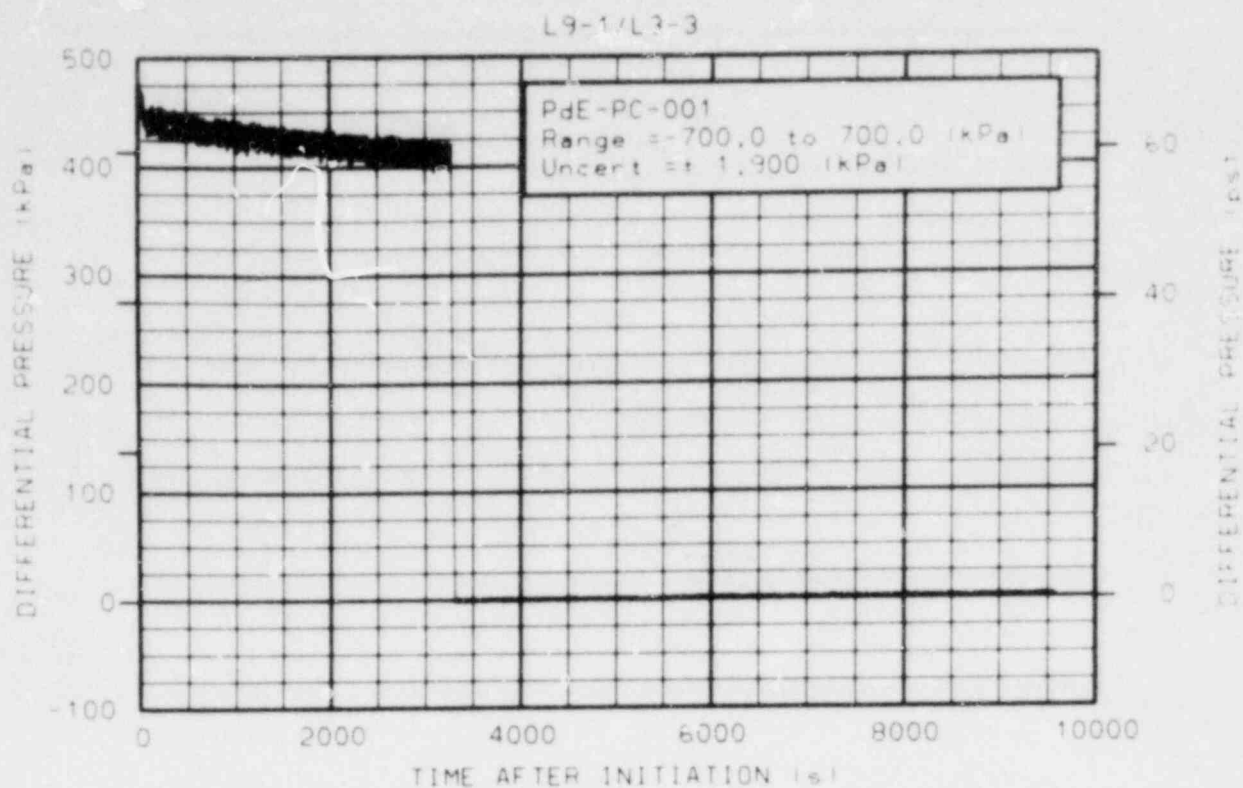


Figure 3L-23. Differential pressure in intact loop across primary coolant Pumps 1 and 2 (PdE-PC-001).

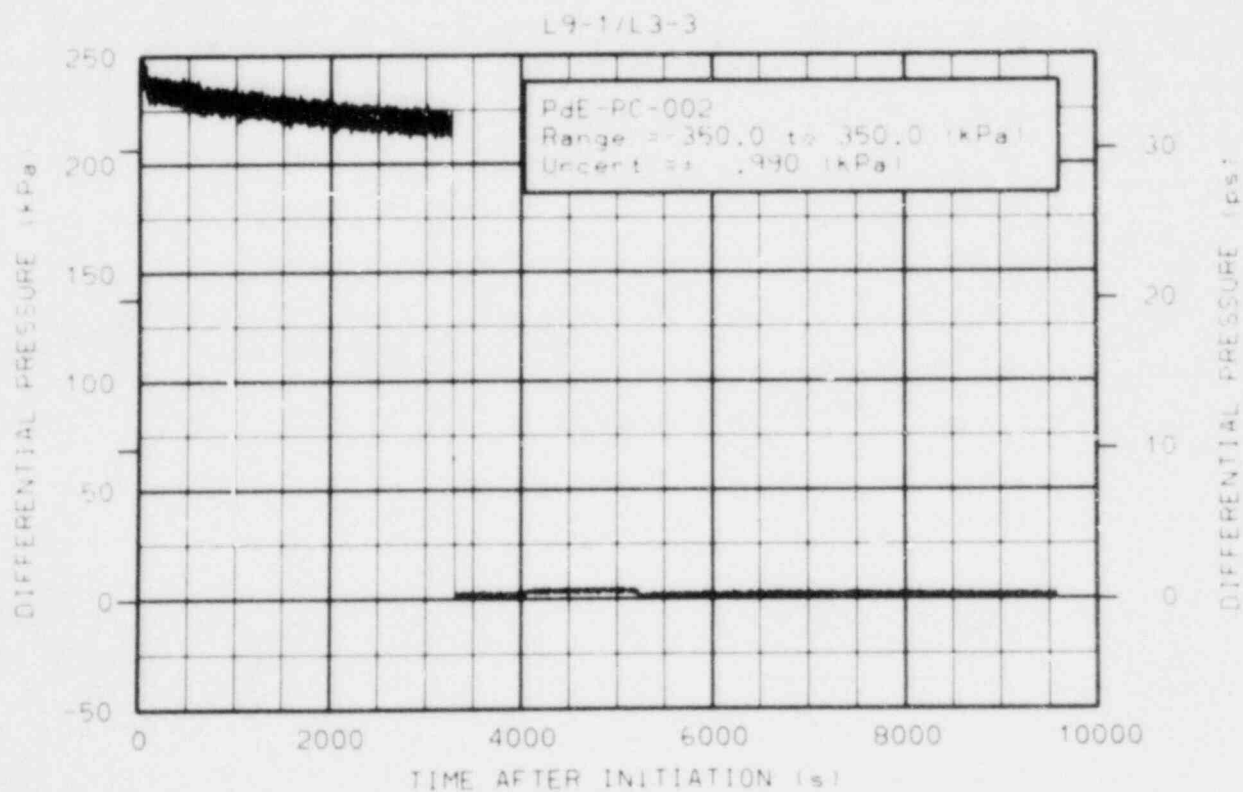


Figure 3L-24. Differential pressure in intact loop across steam generator (PdE-PC-002).

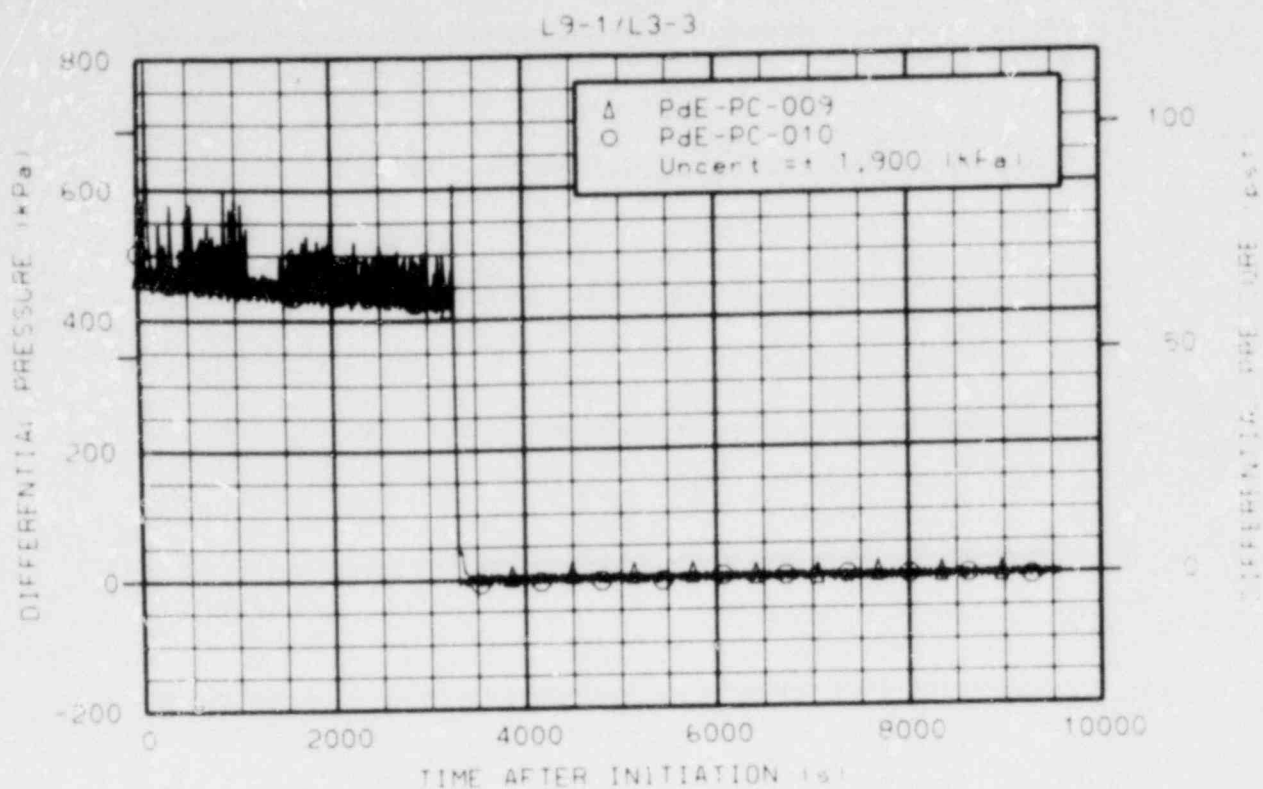


Figure 3L-25. Differential pressure in intact loop across primary coolant Pumps 1 and 2 (PdE-PC-009 and -010) (Ranges: -700 to 700 kPa and -1400 to 1400 kPa, respectively).

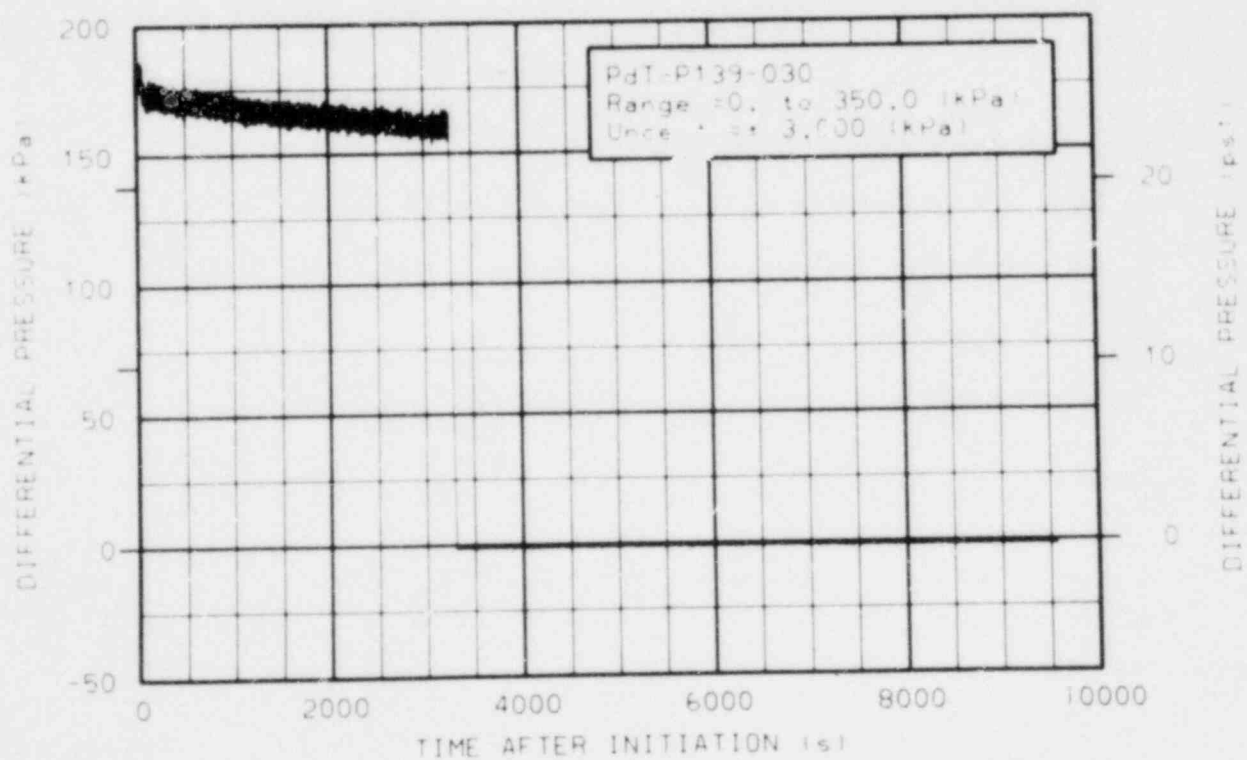


Figure 3L-26. Differential pressure in intact loop across reactor vessel (PdT-P139-030).

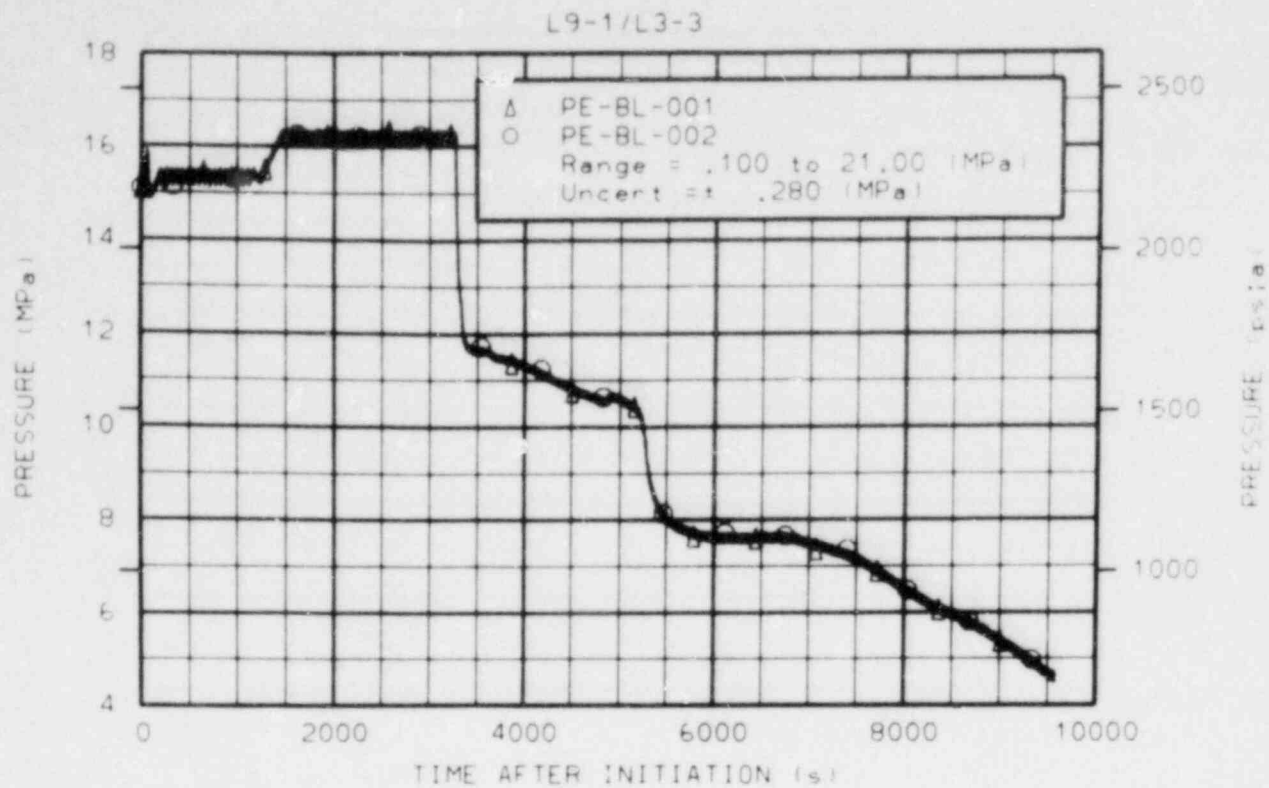


Figure 3L-27. Pressure in broken loop cold and hot legs (PE-BL-001 and -002).

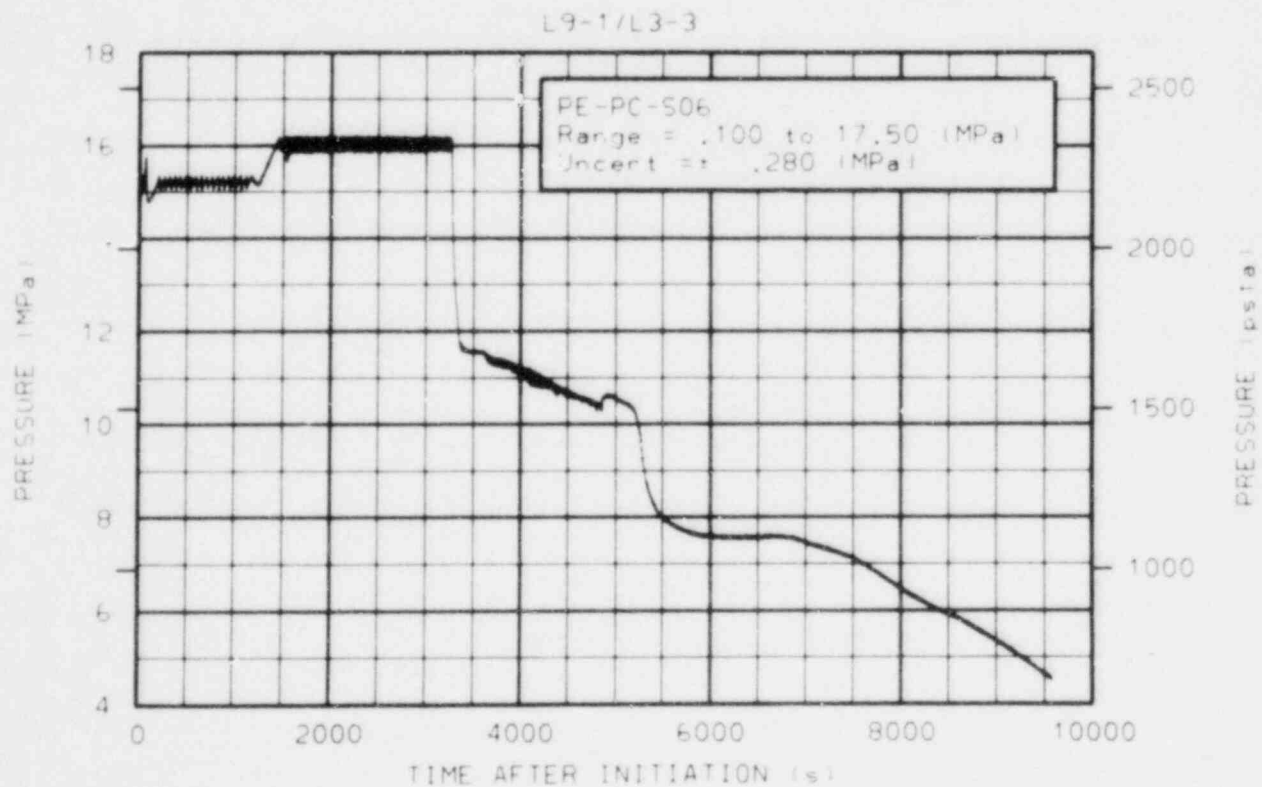


Figure 3L-28. Pressure in intact loop pressurizer relief line upstream of DTT (PE-PC-S06).

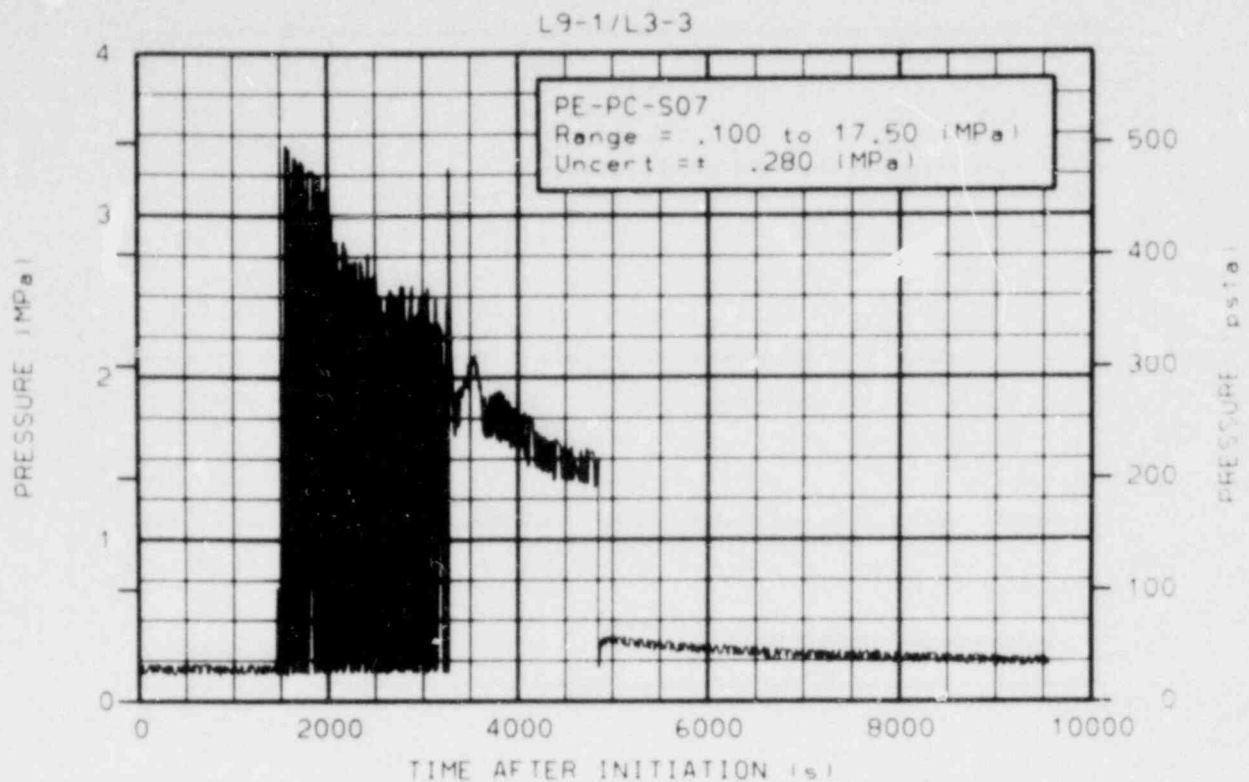


Figure 3L-29. Pressure in intact loop pressurizer relief line downstream of experiment PORV (PE-PC-S07).

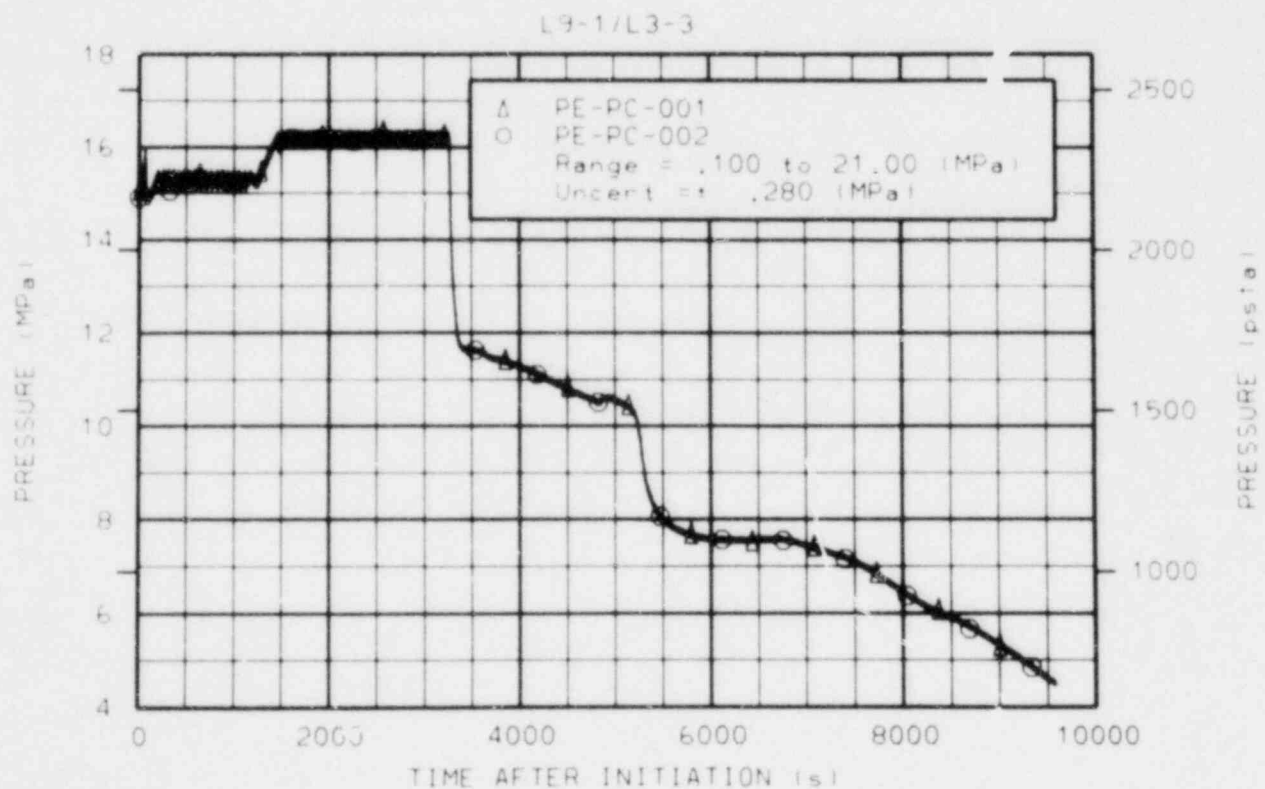


Figure 3L-30. Pressure in intact loop cold and hot legs (PE-PC-001 and -002).

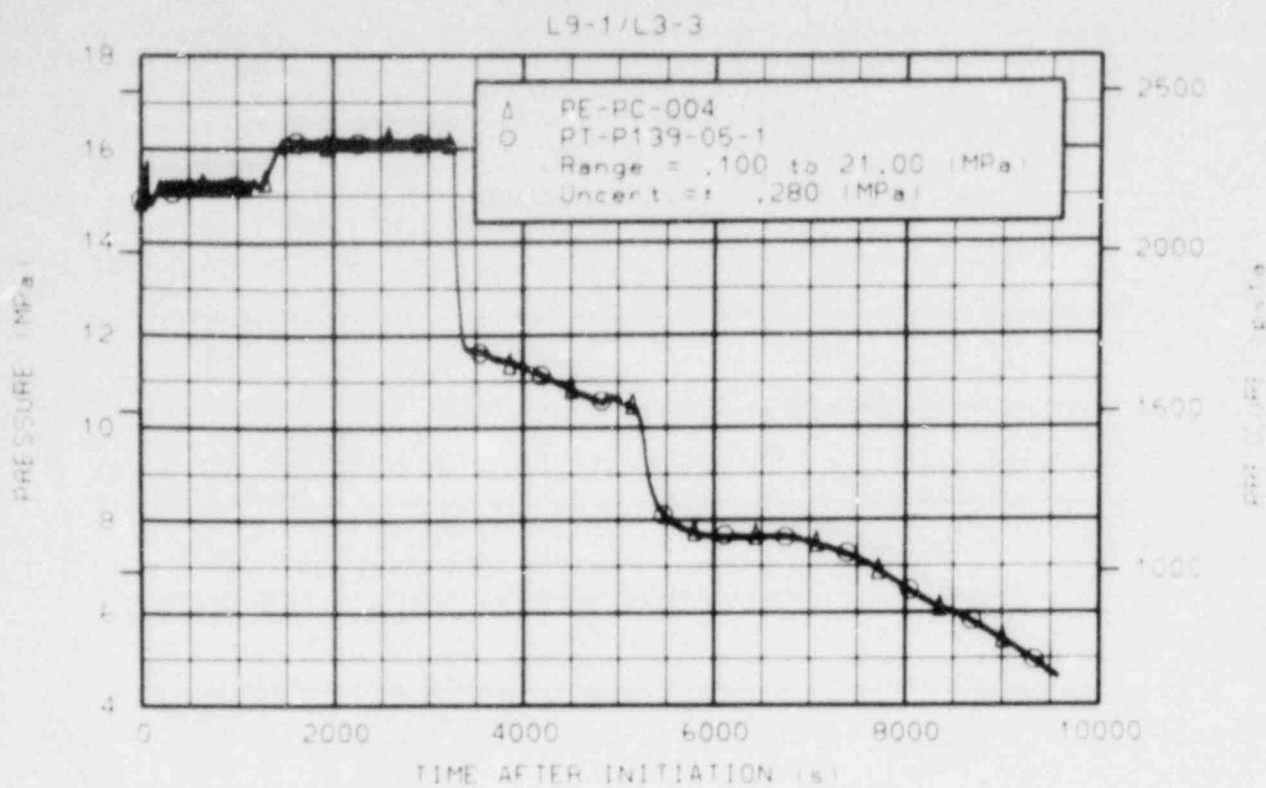


Figure 3L-31. Pressure in intact loop pressurizer vapor space (PE-PC-004 and PT-P139-05-1).

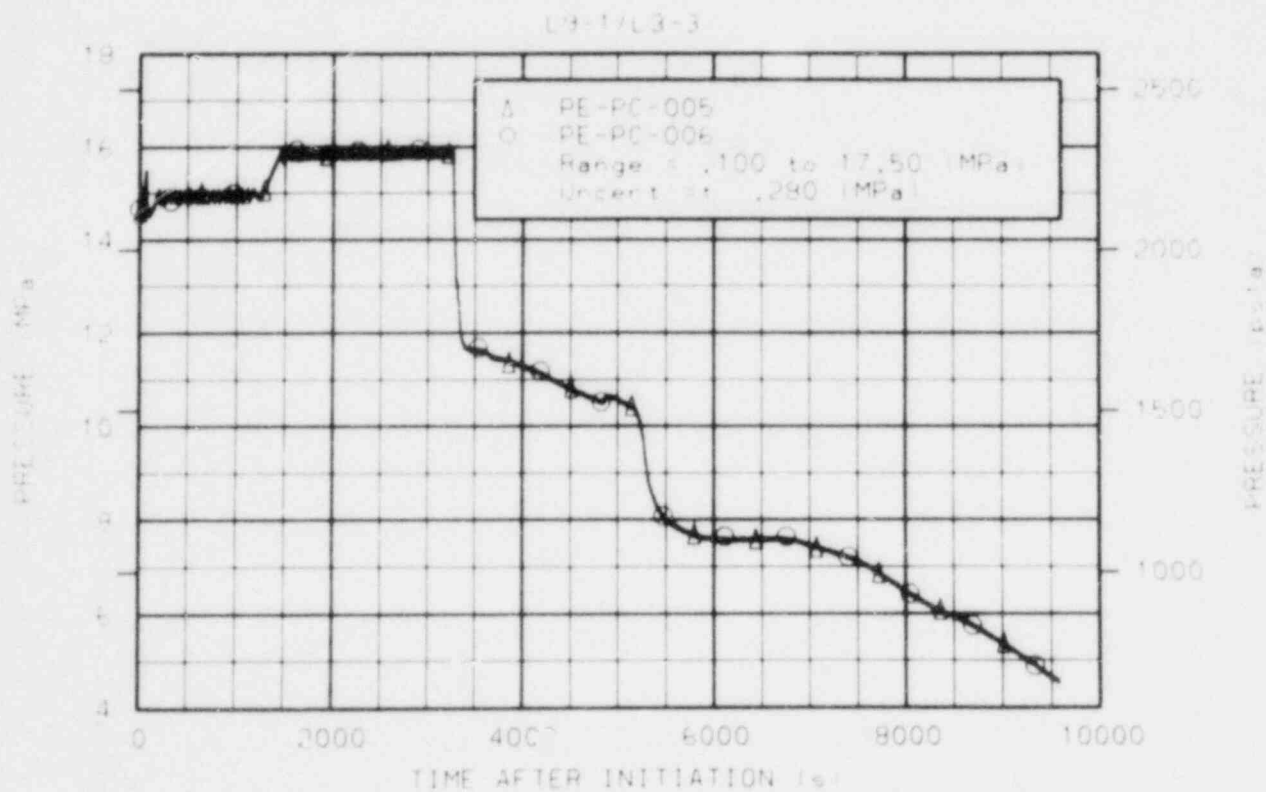


Figure 3L-32. Reference pressure in intact loop between steam generator outlet and primary coolant pump inlet (PE-PC-005 and -006).

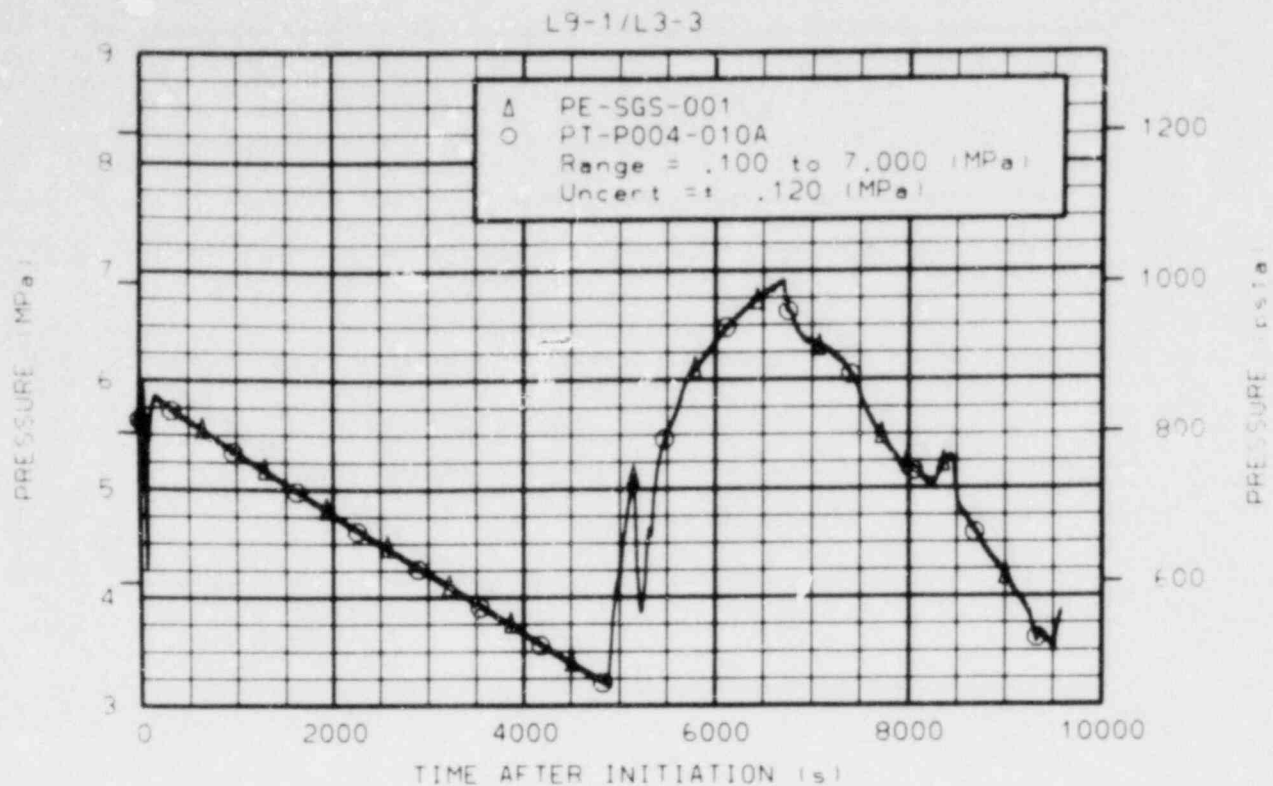


Figure 3L-33. Pressure in steam generator dome and in steam generator secondary side steam outlet line (PE-SGS-001 and PT-P004-010A).

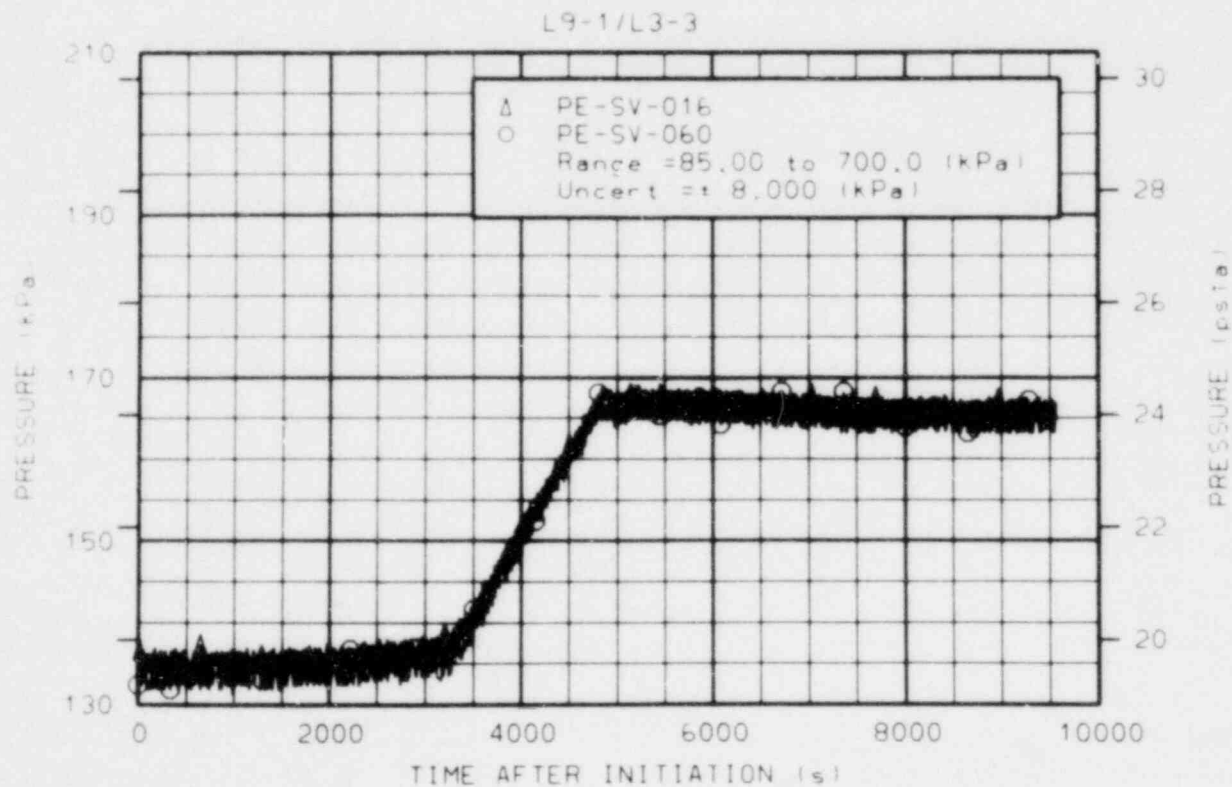


Figure 3L-34. Pressure in blowdown suppression tank near and above Downcomer 1 (PE-SV-016 and 060).

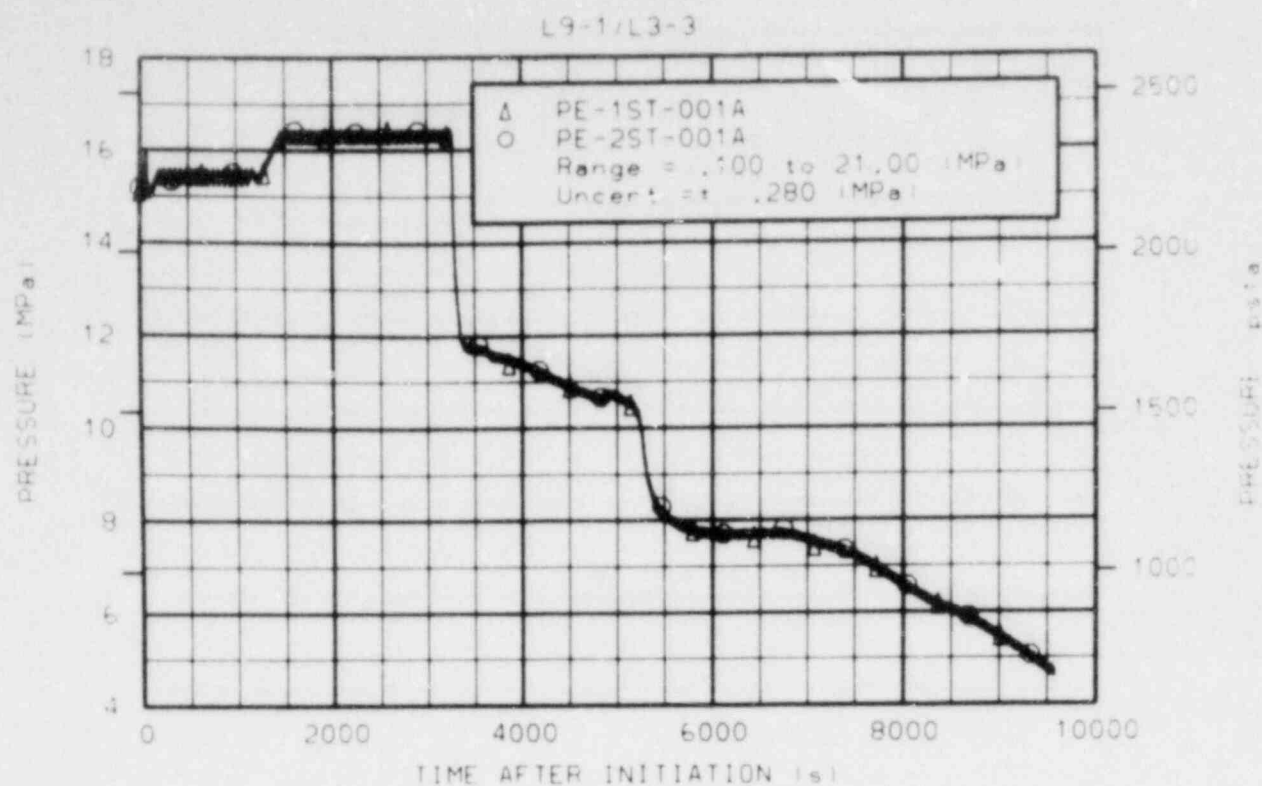


Figure 3L-35. Pressure in reactor vessel Downcomer Stalks 1 and 2 at 0.62 m above reactor vessel bottom, wide range (PE-1ST-001A and -2ST-001A).

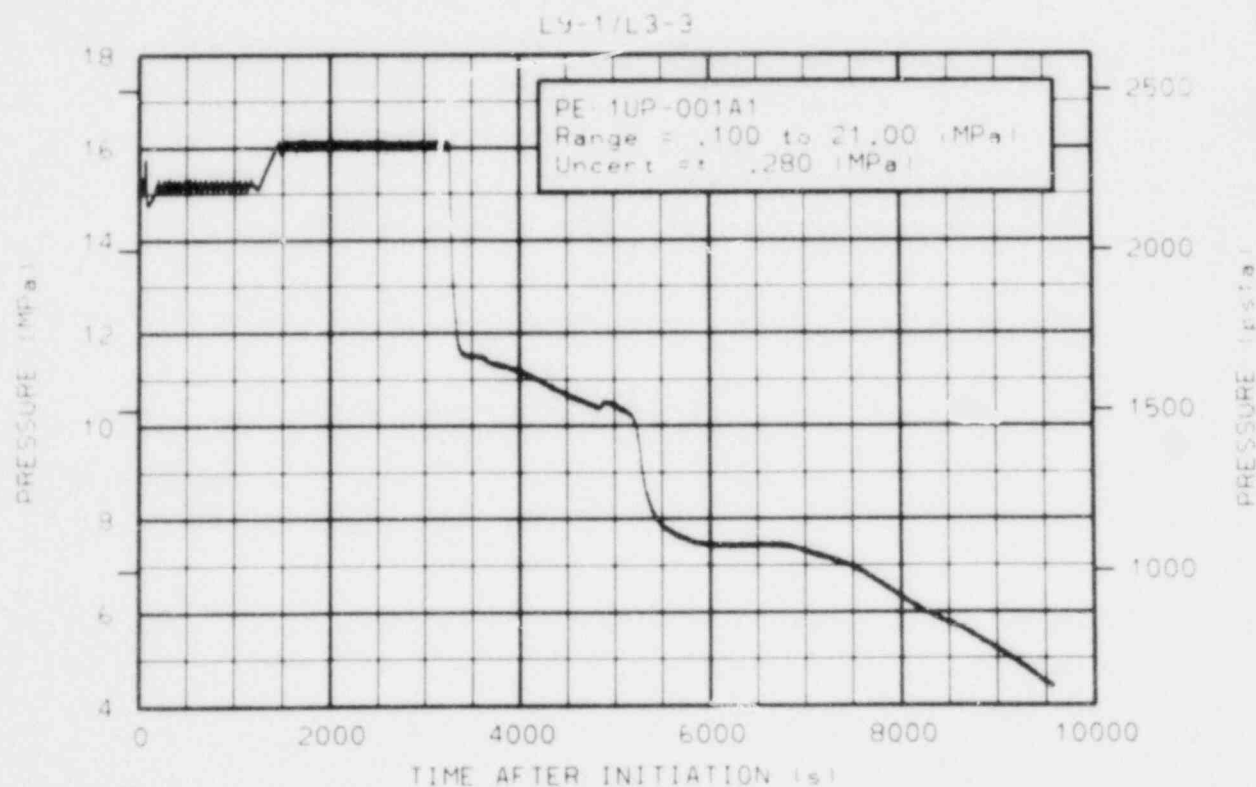


Figure 3L-36. Pressure in reactor vessel above upper end box of Fuel Assembly 1 (PE-1UP-001A1).

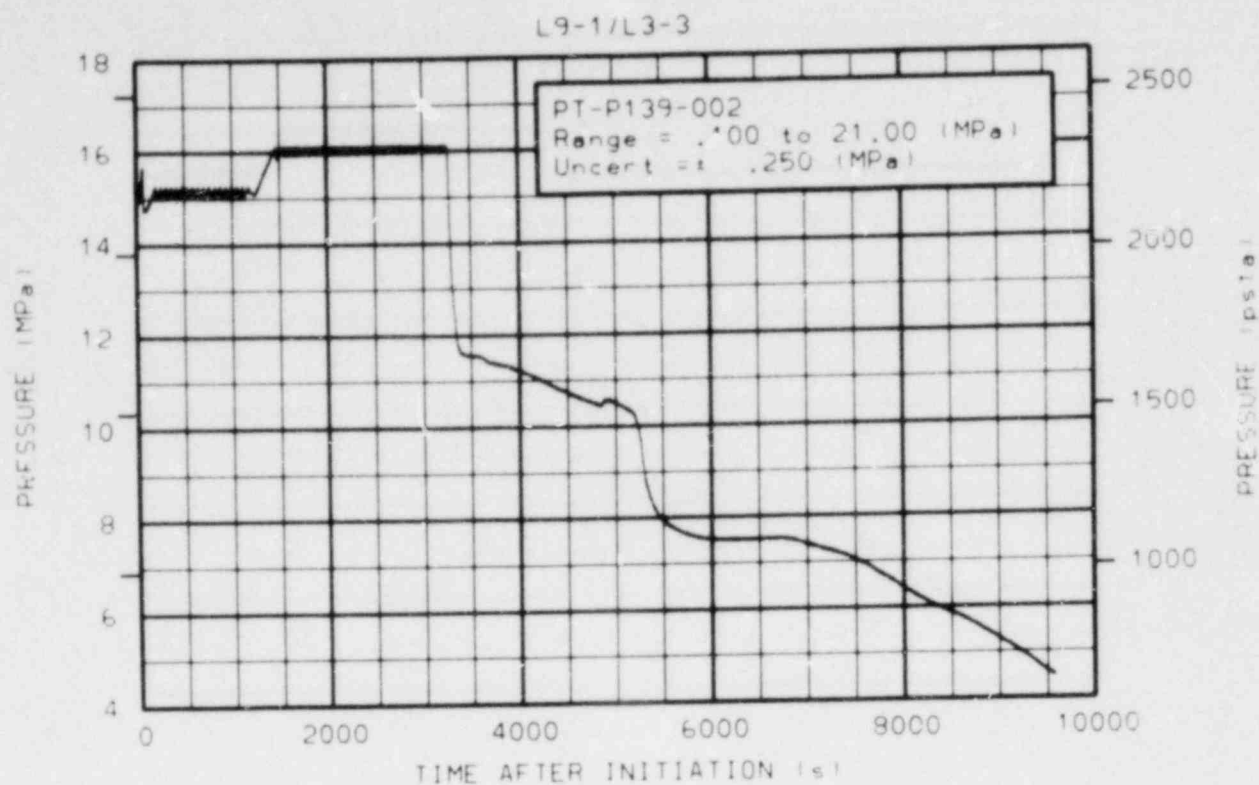


Figure 3L-37. Pressure in intact loop hot leg at venturi on bottom of pipe (PT-P139-002).

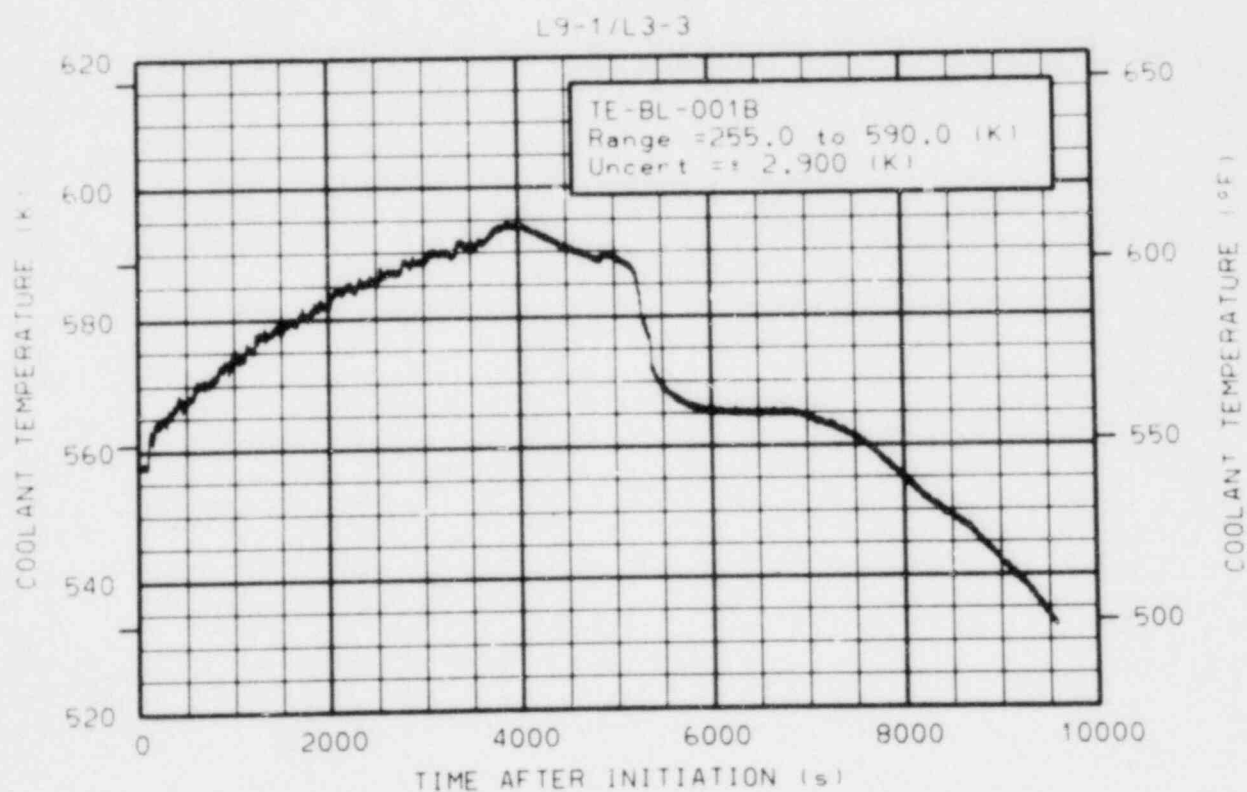


Figure 3L-38. Coolant temperature in broken loop cold leg (TE-BL-001B).

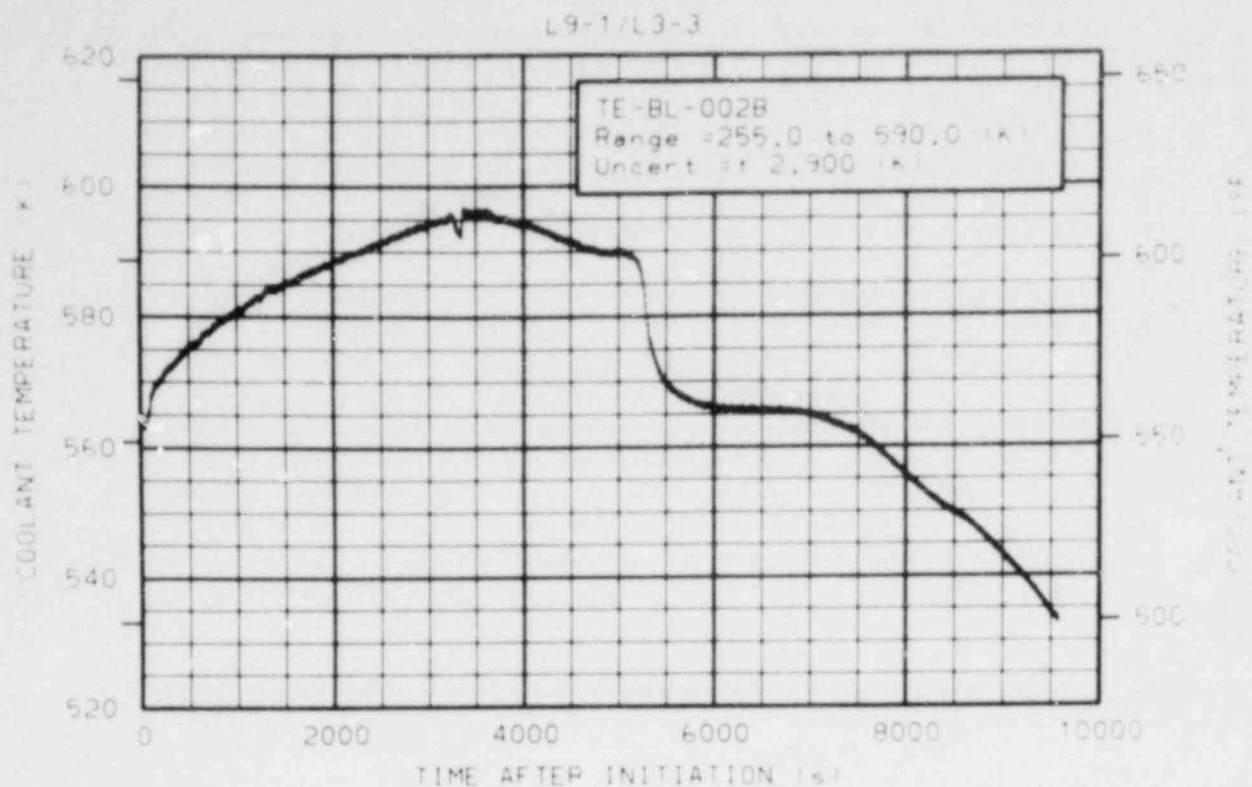


Figure 3L-39. Coolant temperature in broken loop hot leg (TE-BL-002B).

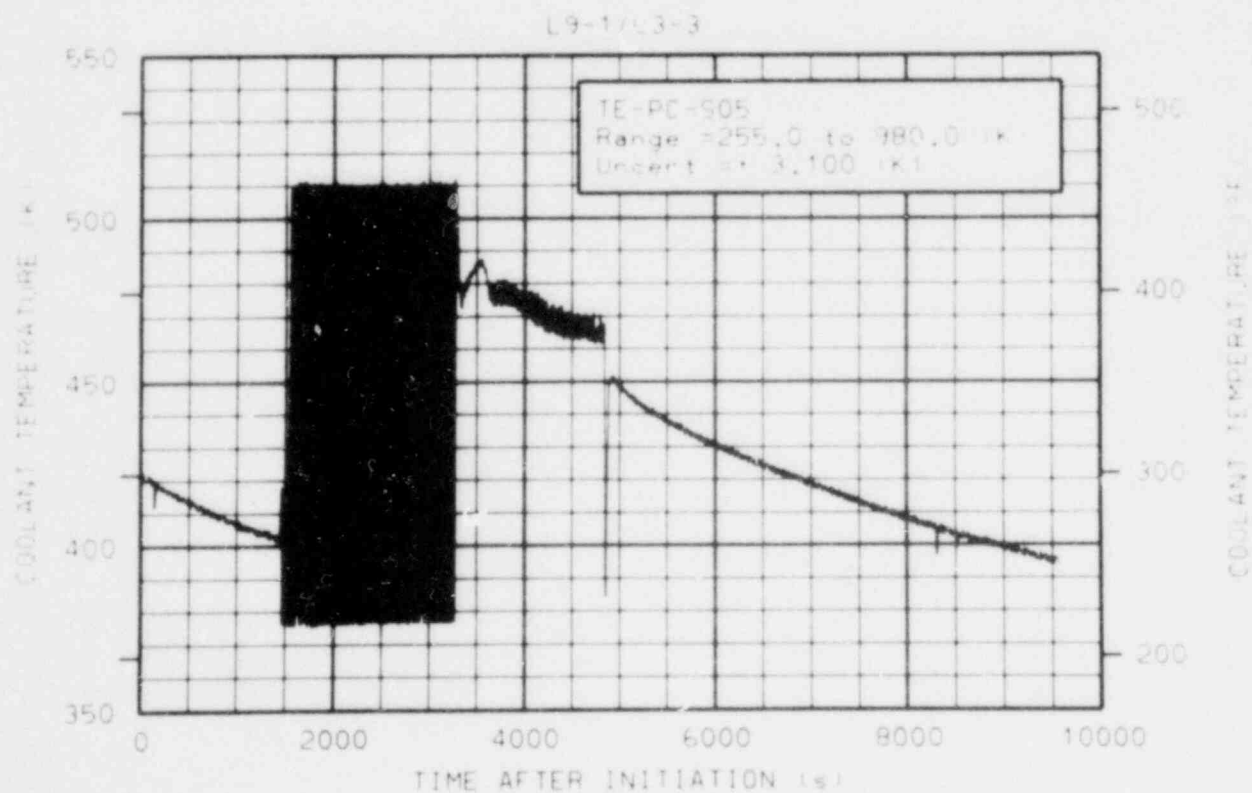


Figure 3L-40. Coolant temperature in intact loop pressurizer relief line downstream of experiment PORV (TE-PC-S05).

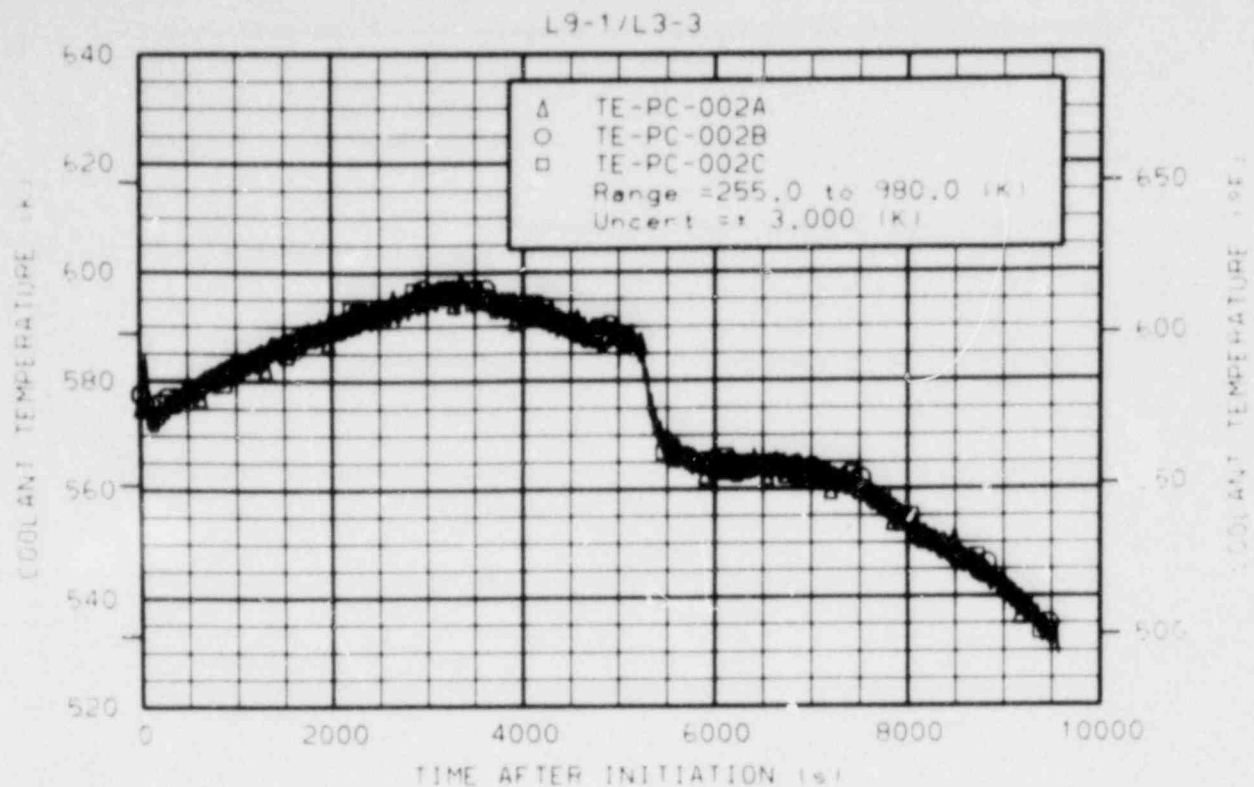


Figure 3L-41. Coolant temperature in intact loop hot leg at DIT rake at bottom, middle, and top of pipe (TE-PC-002A, -002B, and -002C).

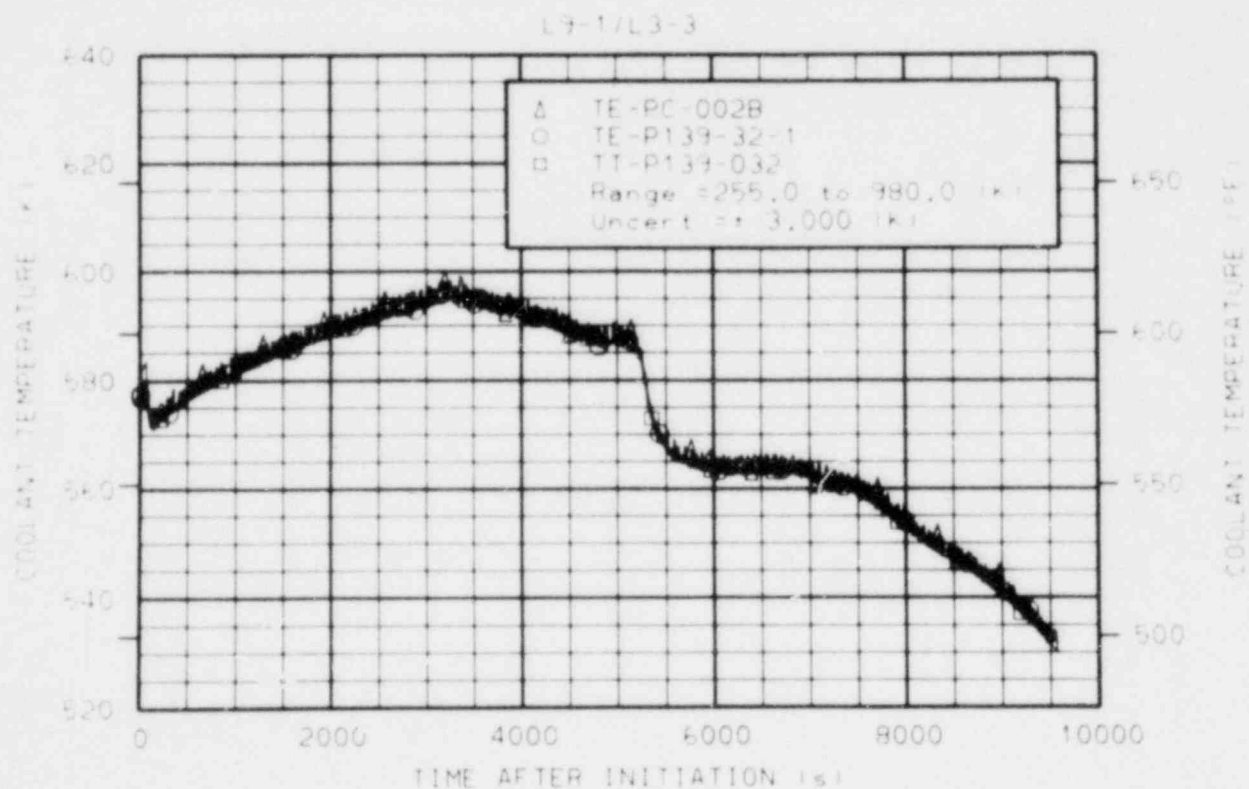


Figure 3L-42. Coolant temperature in intact loop hot leg (TE-PC-002B, -P139-32-1, and TT-P139-032) (TE-P139-32-1 and TT-P139-032 qualified, response limited).

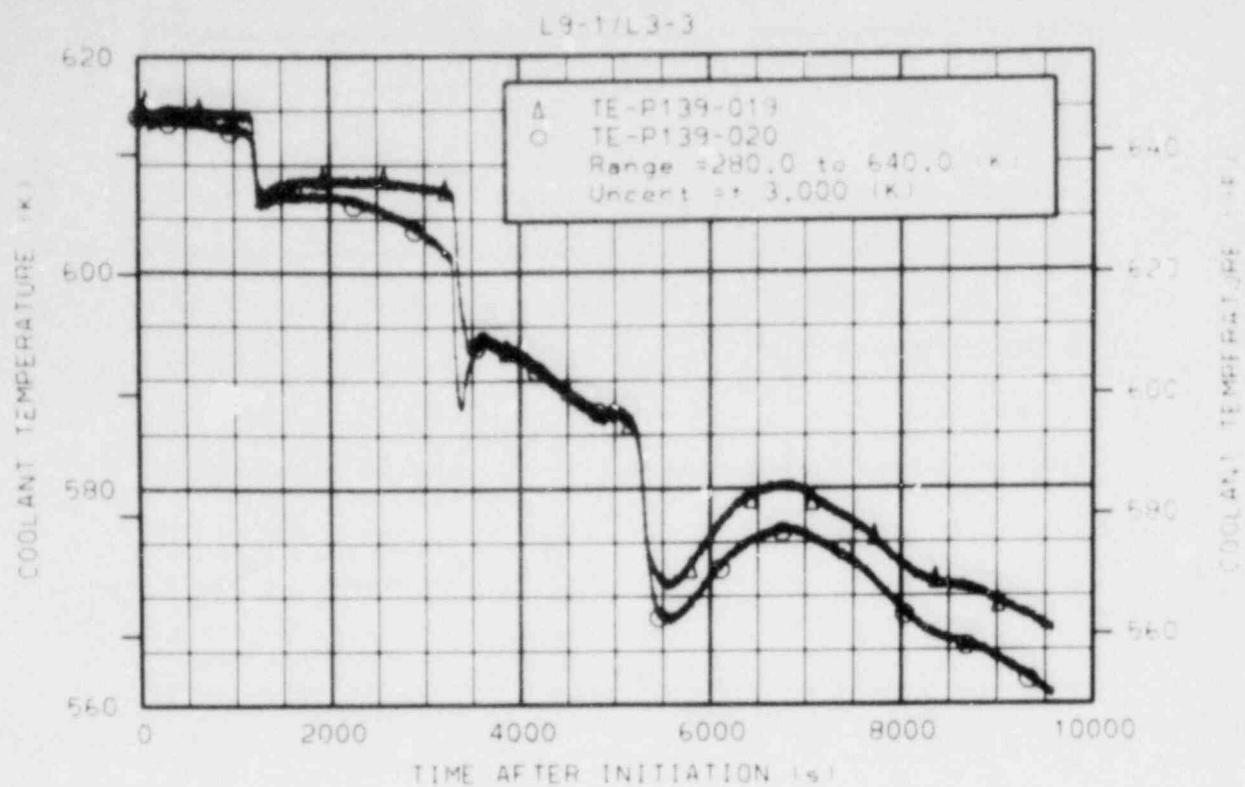


Figure 3L-43. Coolant temperature in intact loop pressurizer, vapor and liquid space (TE-P139-019 and -020).

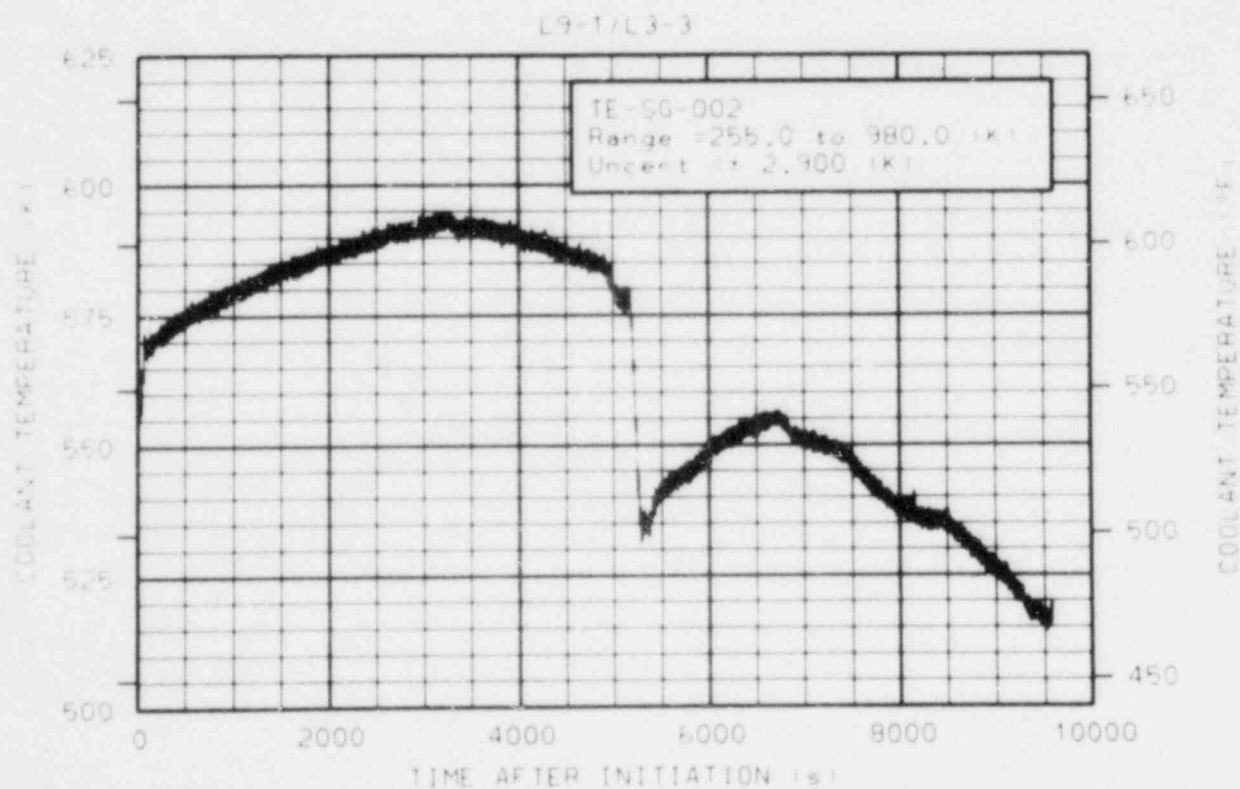


Figure 3L-44. Coolant temperature in intact loop steam generator outlet plenum (TE-SG-002).

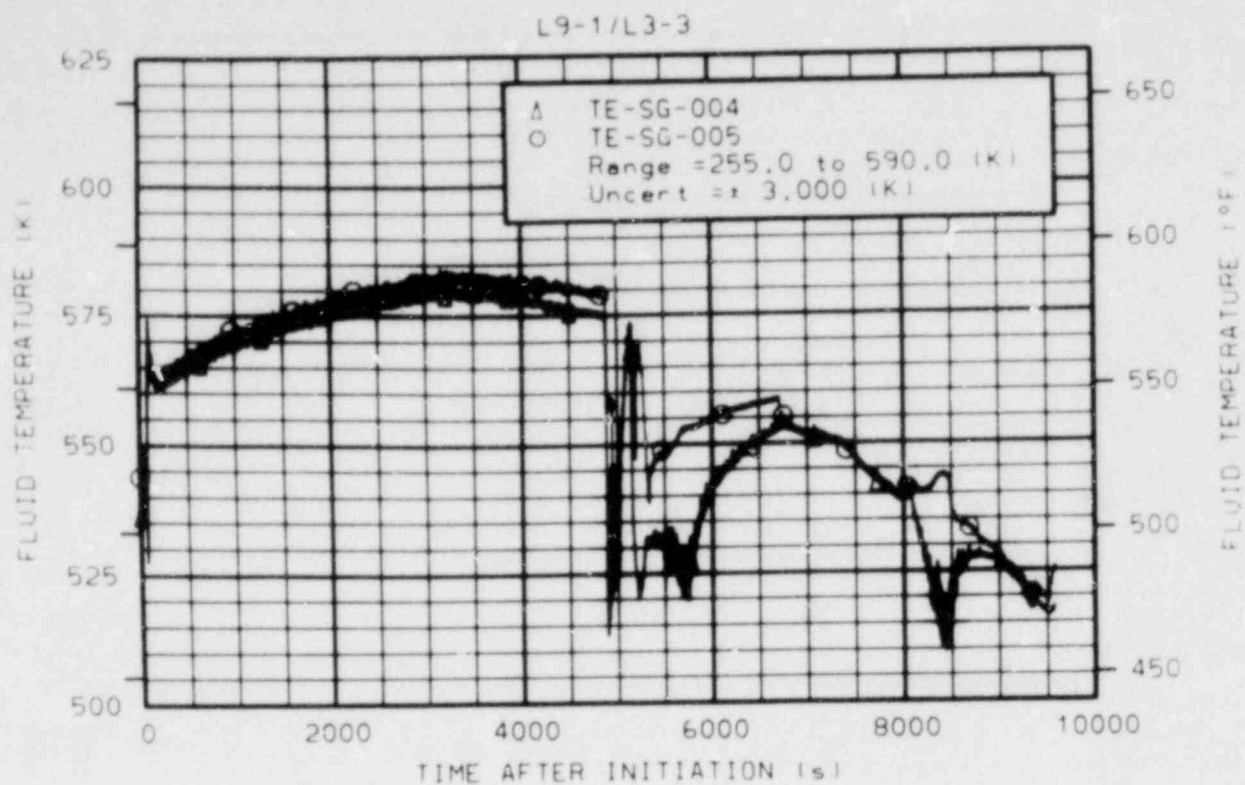


Figure 3L-45. Fluid temperature in steam generator secondary side downcomer at 2.12 and 2.92 m above top of tube sheet (TE-SG-004 and -005).

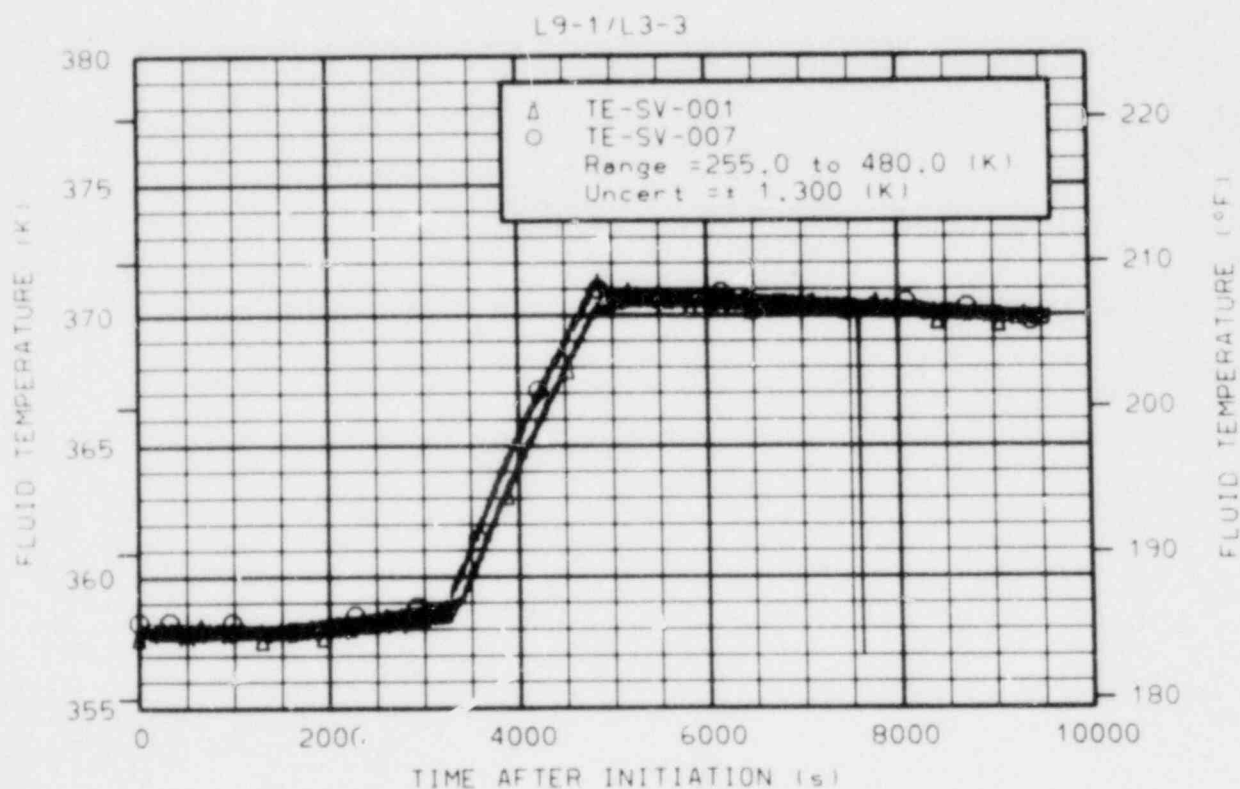


Figure 3L-46. Fluid temperature in blowdown suppression tank at 2.72 m above tank bottom (TE-SV-001 and -007) (TE-SV-001 only, anomalous spike at approximately 7000 s).

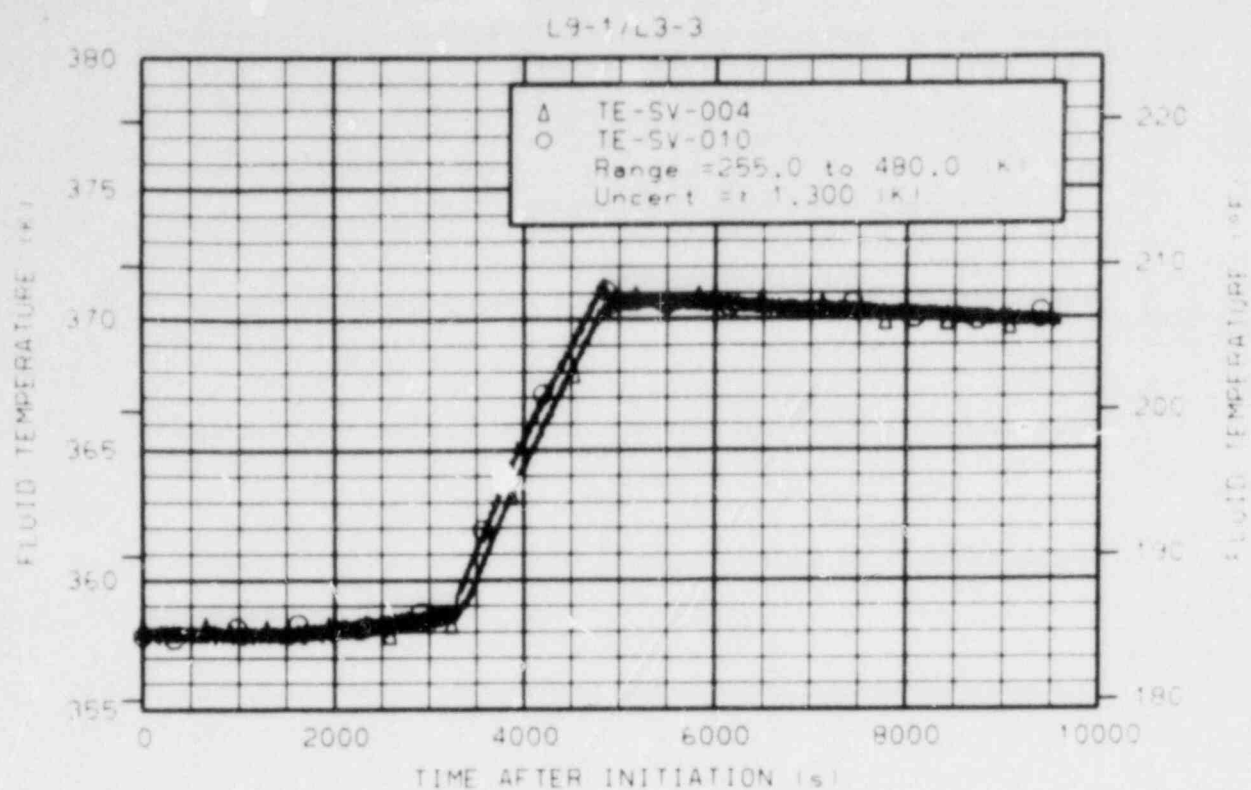


Figure 3L-47. Fluid temperature in blowdown suppression tank at 1.45 m above tank bottom (TE-SV-004 and -010).

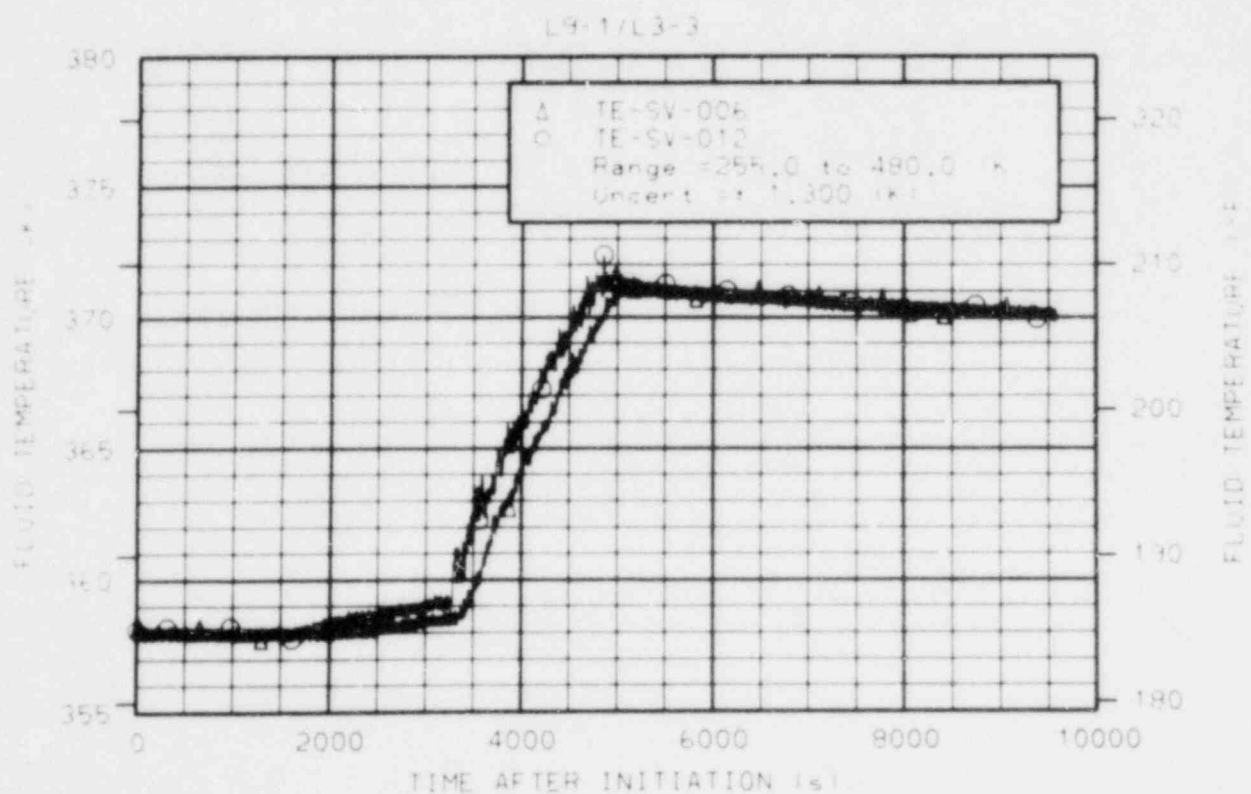


Figure 3L-48. Fluid temperature in blowdown suppression tank at 0.37 m above tank bottom (TE-SV-006 and -012).

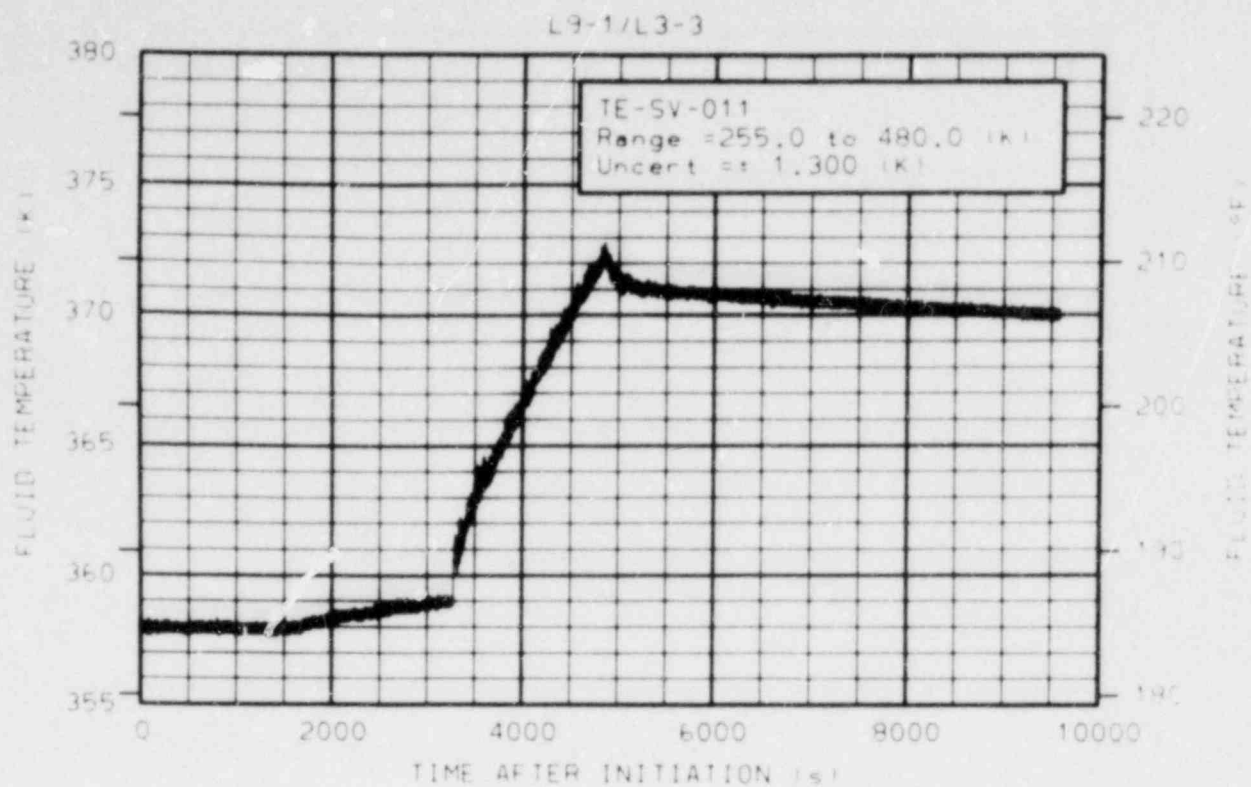


Figure 3L-49. Fluid temperature in blowdown suppression tank at 0.99 m above tank bottom (TE-SV-011).

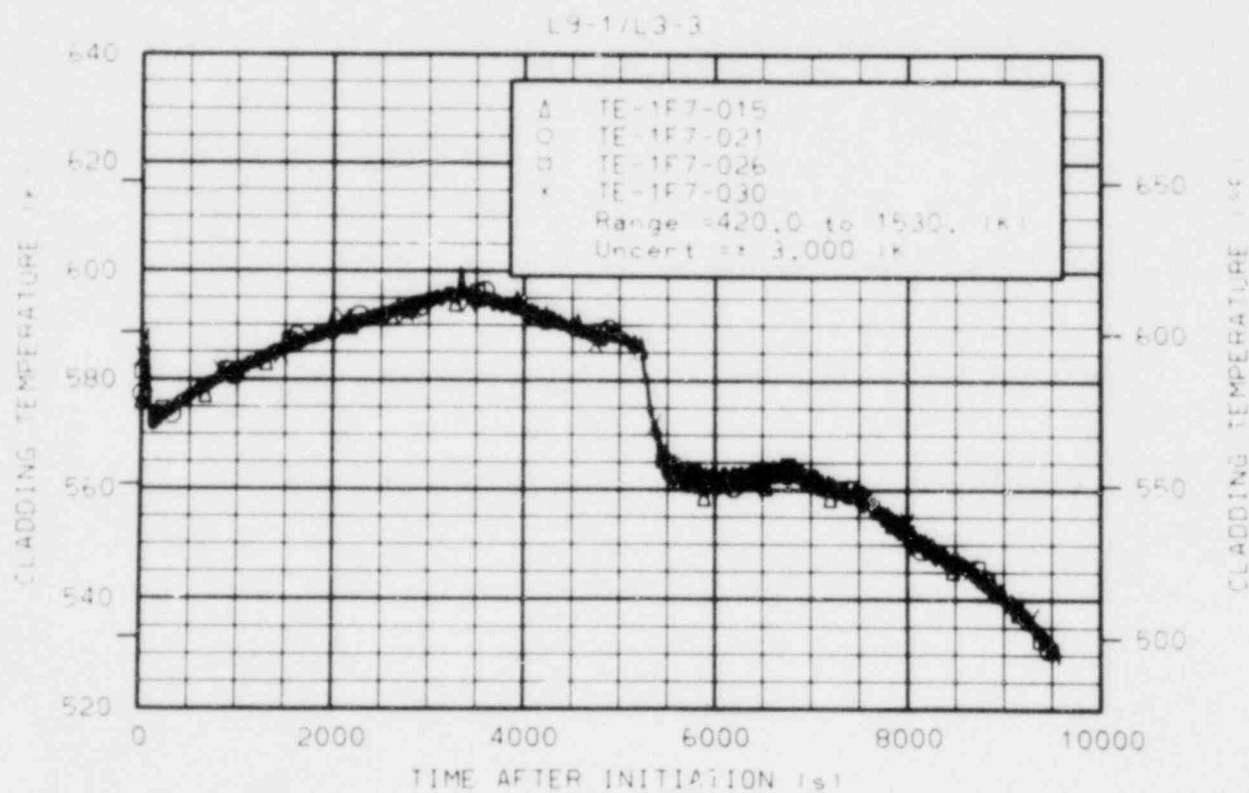


Figure 3L-50. Cladding temperature in reactor vessel at Fuel Assembly 1, Row F, Column 7 at 0.38, 0.53, 0.66, and 0.76 m above bottom of fuel rod (TE-1F7-015, -021, -026, and -030).

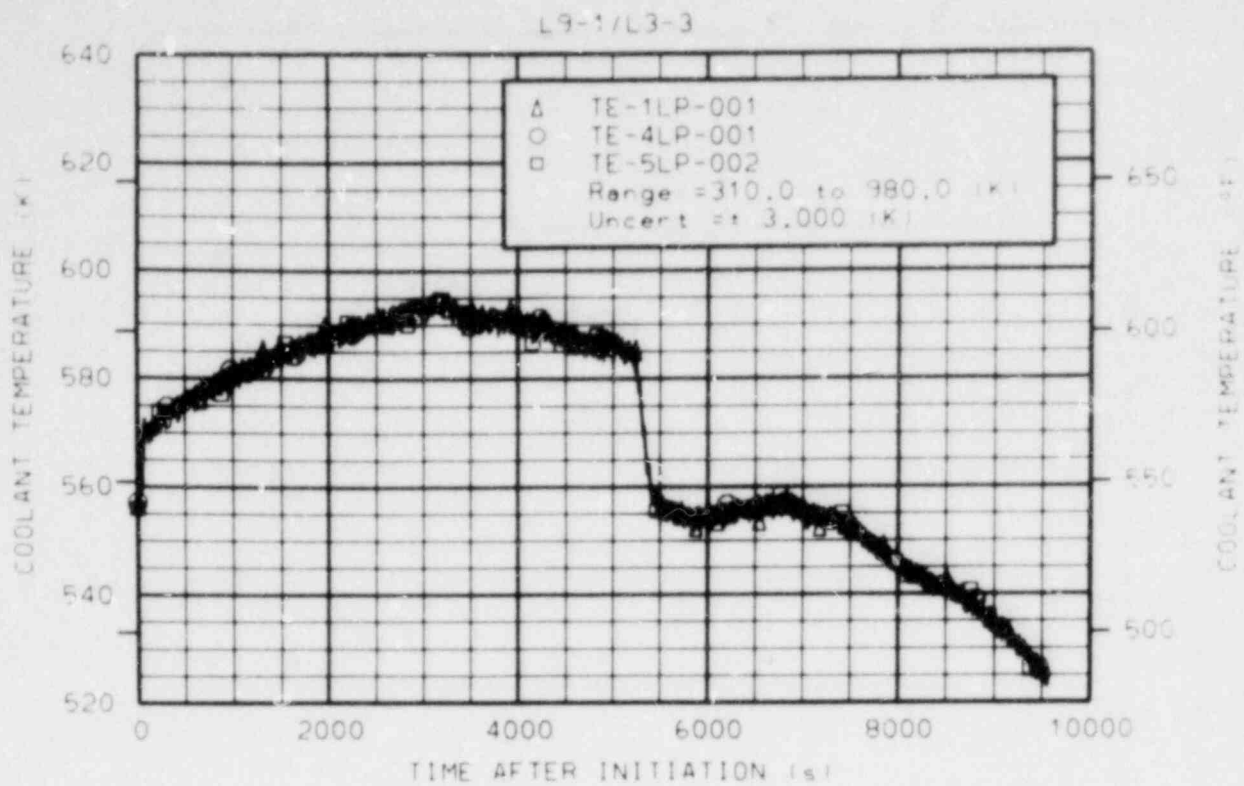


Figure 3L-51. Coolant temperature in reactor vessel at lower end box of Fuel Assemblies 1, 4, and 5, (TE-1LP-001, -4LP-001, and -5LP-002).

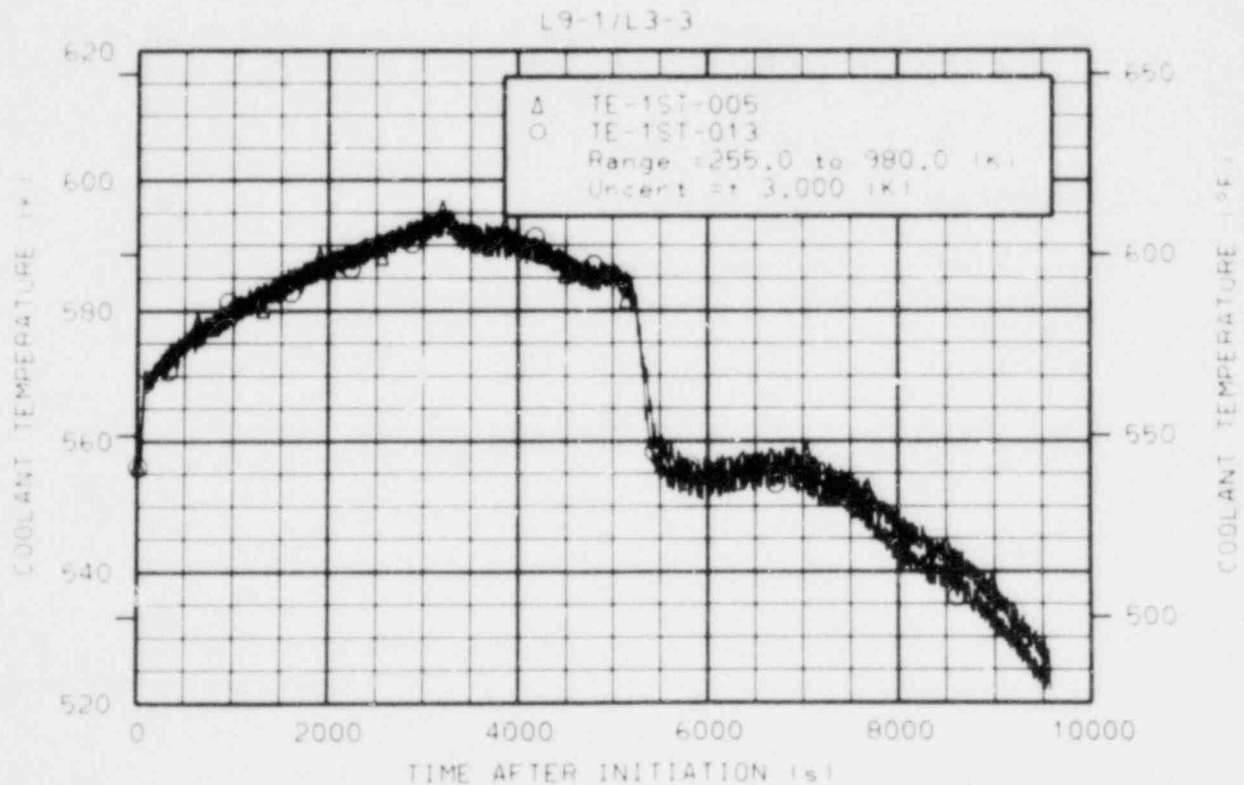


Figure 3L-52. Coolant temperature in reactor vessel Downcomer Stalk 1 at 2.37 and 0.24 m above reactor vessel bottom (TE-1ST-005 and -013).

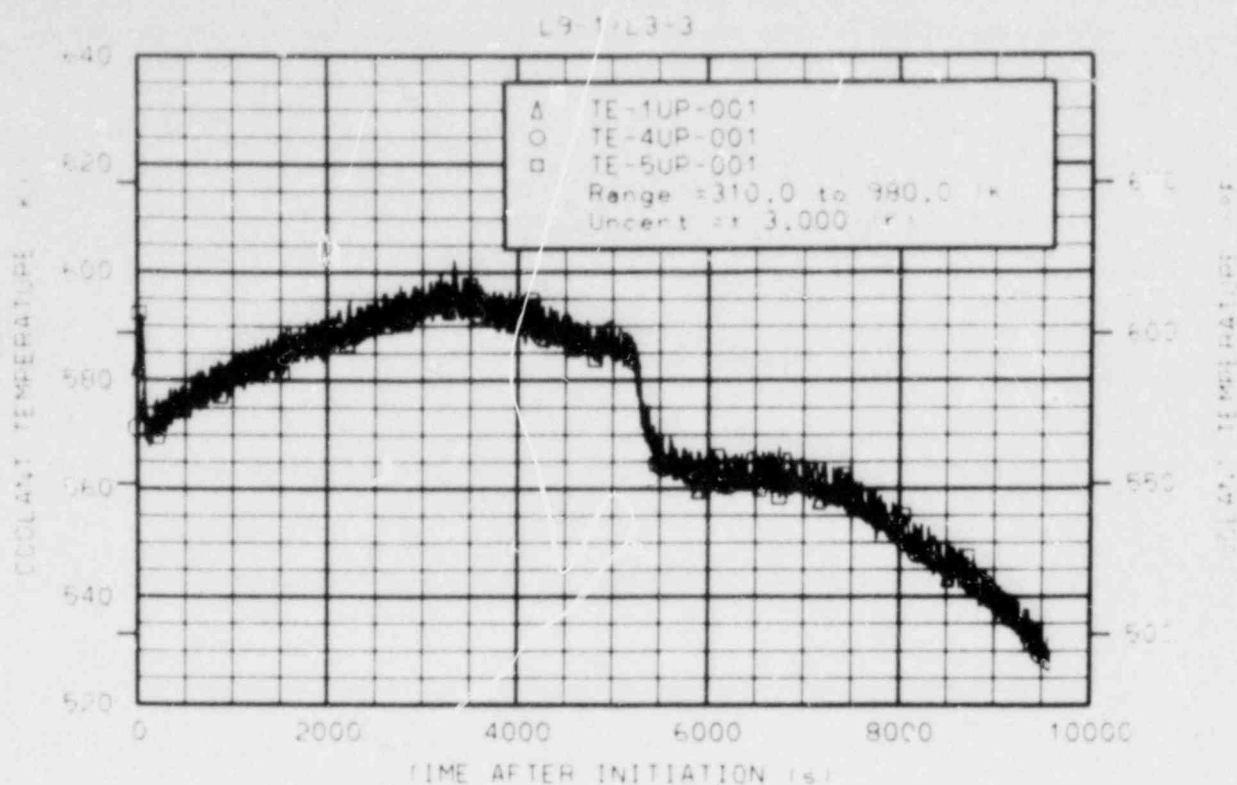


Figure 3L-53. Coolant temperature in reactor vessel at upper end box of Fuel Assemblies 1, 4, and 5 (TE-1UP-001, -4UP-001, and -5UP-001).

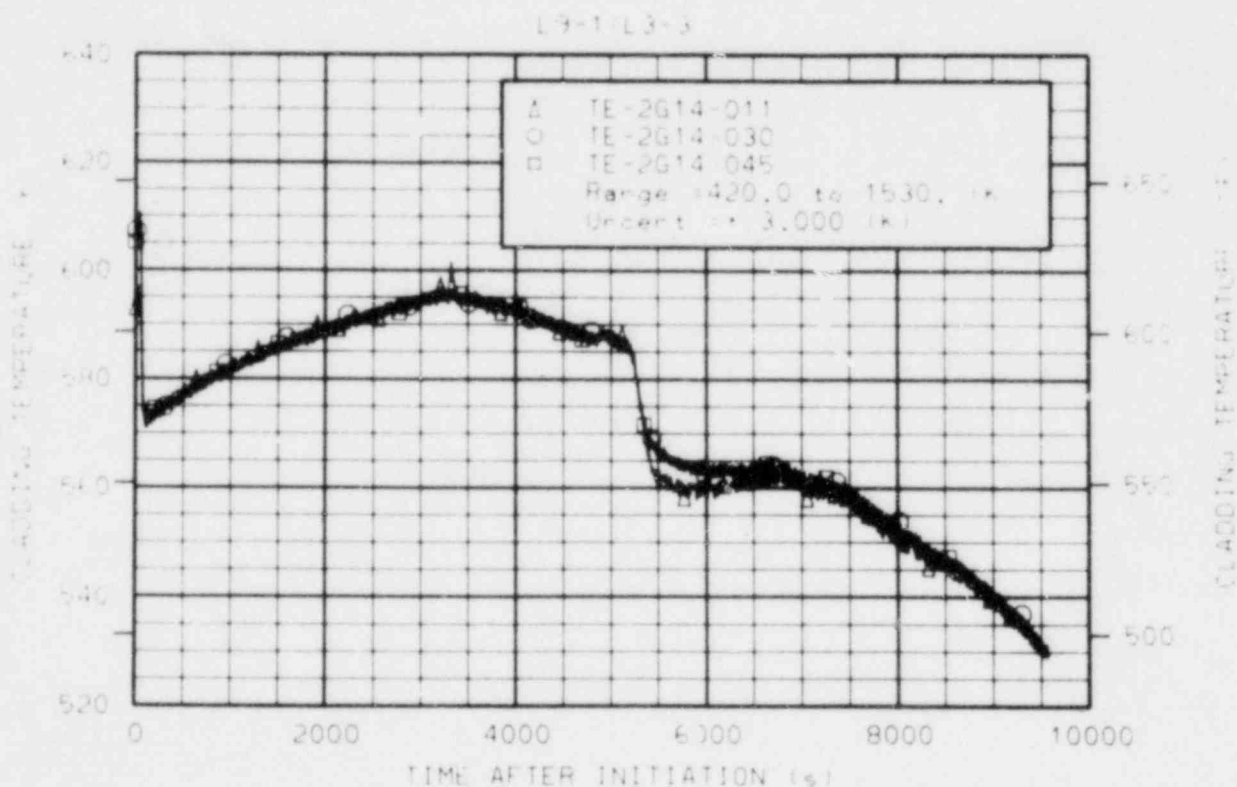


Figure 3L-54. Cladding temperature in reactor vessel at Fuel Assembly 2, Row G, Column 14 at 0.28, 0.76, and 1.14 m above bottom of fuel rod (TE-2G14-011, -030, and -045).

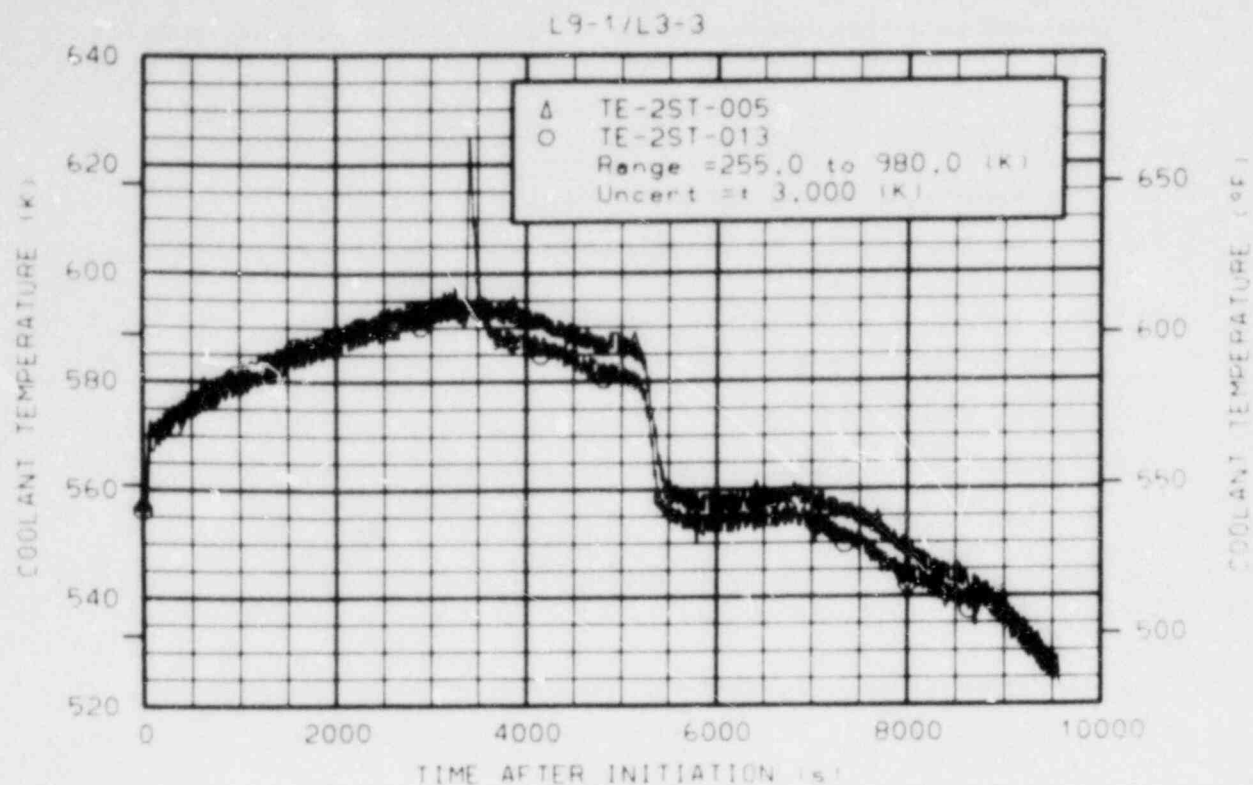


Figure 3L-55. Coolant temperature in reactor vessel Downcomer Stalk 2 at 2.37 and 0.24 m above reactor vessel bottom (TE-2ST-005 and -013).

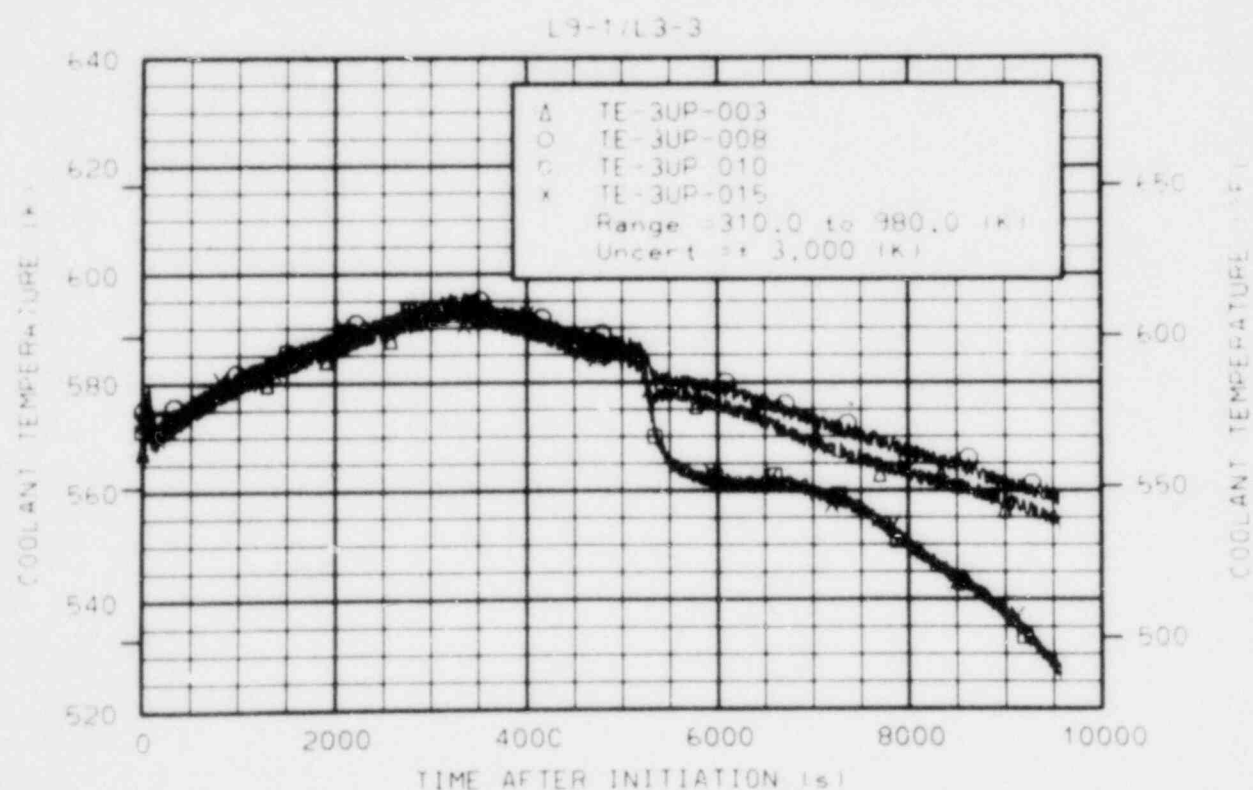


Figure 3L-56. Coolant temperature in reactor vessel at support column above reactor vessel outlet nozzle and at liquid level string above Fuel Assembly 3 (TE-3UP-003, -008, -010, and -015).

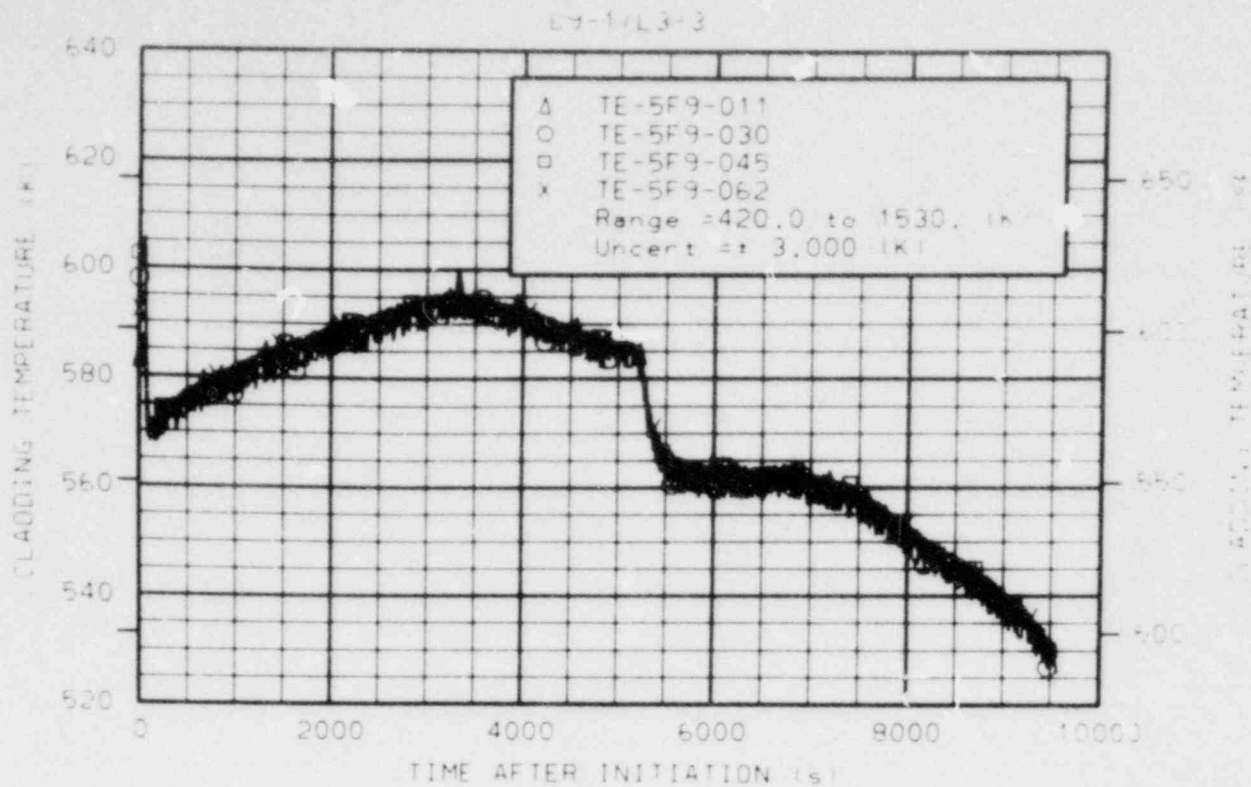


Figure 3L-57. Cladding temperature in reactor vessel at Fuel Assembly 5, Row F, Column 9 at 0.28, 0.76, 1.14, and 1.57 m above bottom of fuel rod (TE-5F9-011, -030, -045, and -062).

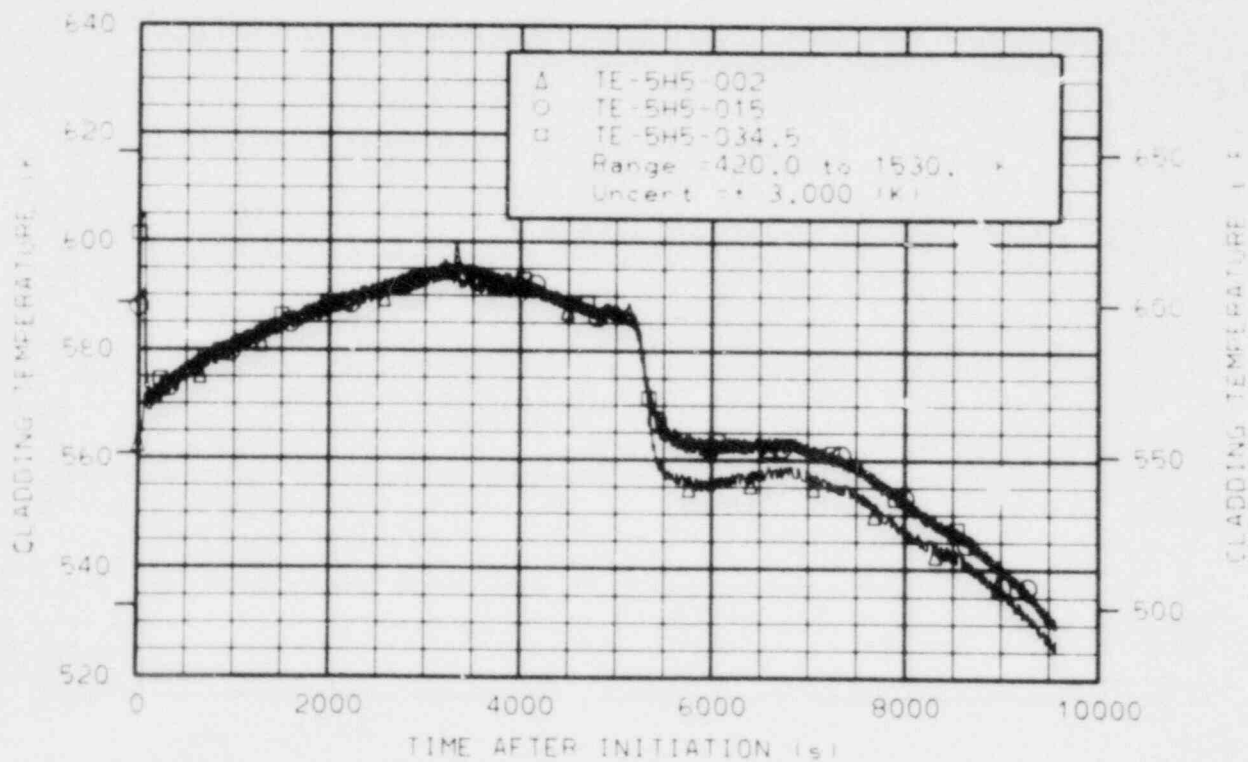


Figure 3L-58. Cladding temperature in reactor vessel at Fuel Assembly 5, Row H, Column 5 at 0.05, 0.38, and 0.88 m above bottom of fuel rod (TE-5H5-002, -015, and -034.5).

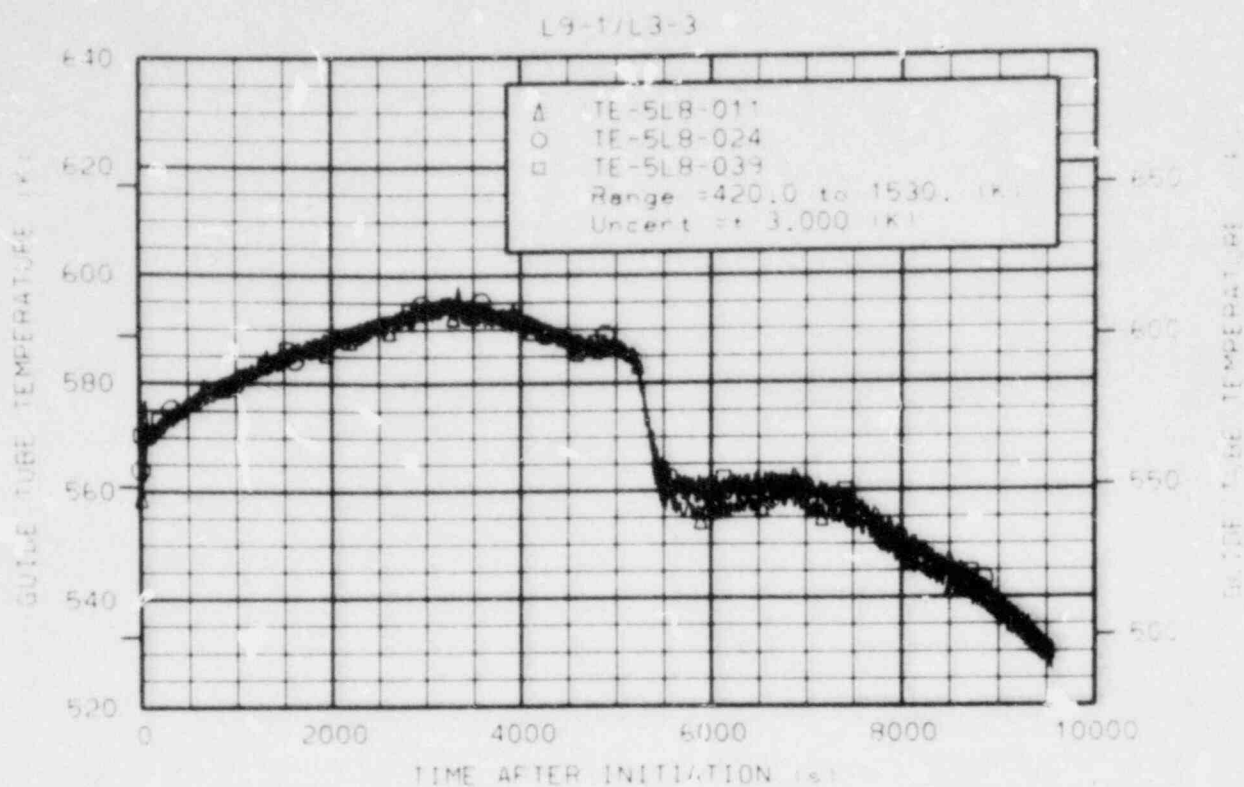


Figure 3L-59. Guide tube temperature in reactor vessel at Fuel Assembly 5, Row L, Column 8 at 0.28, 0.61, and 0.99 m above bottom of guide tube (TE-5L8-011, -024, and -039).

POOR ORIGINAL

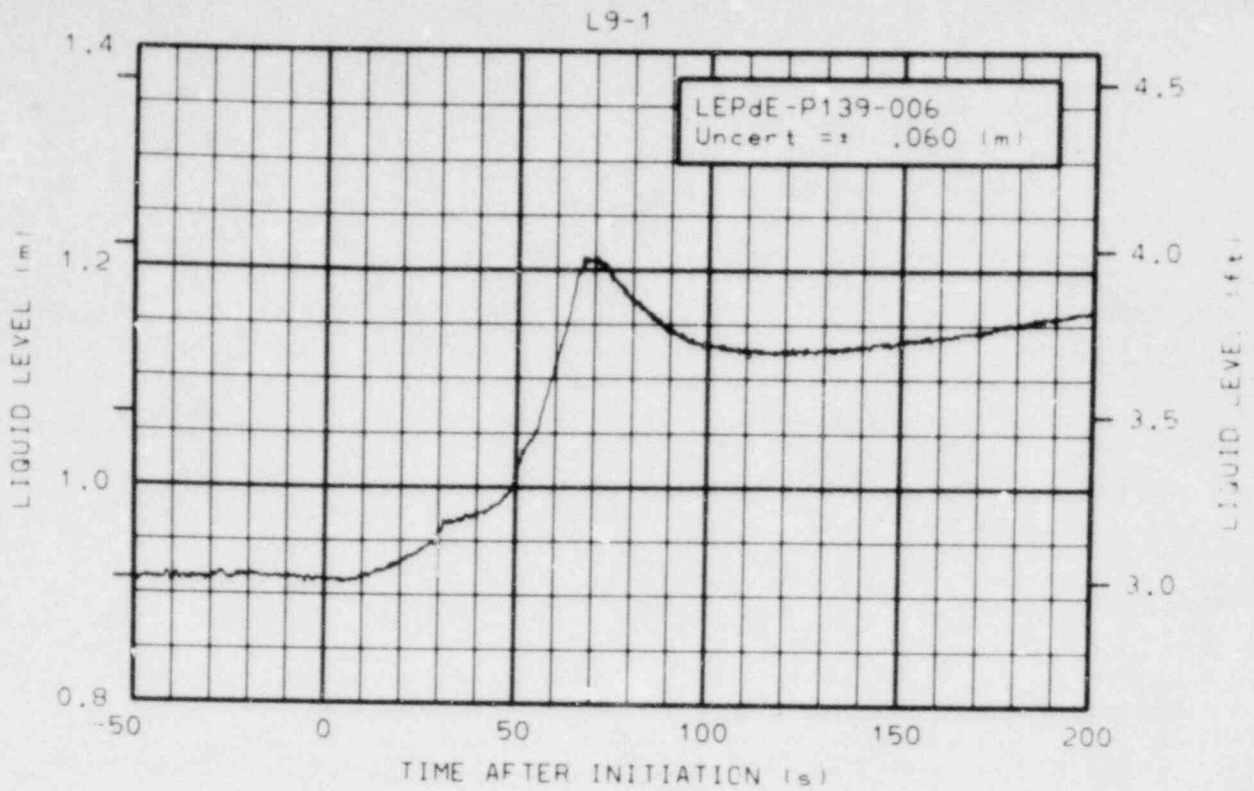


Figure 3C-1. Liquid level in pressurizer (LEPdE-P139-006) (qualified, drift below 0.0 m after 6000 s caused by transmission line flashing).

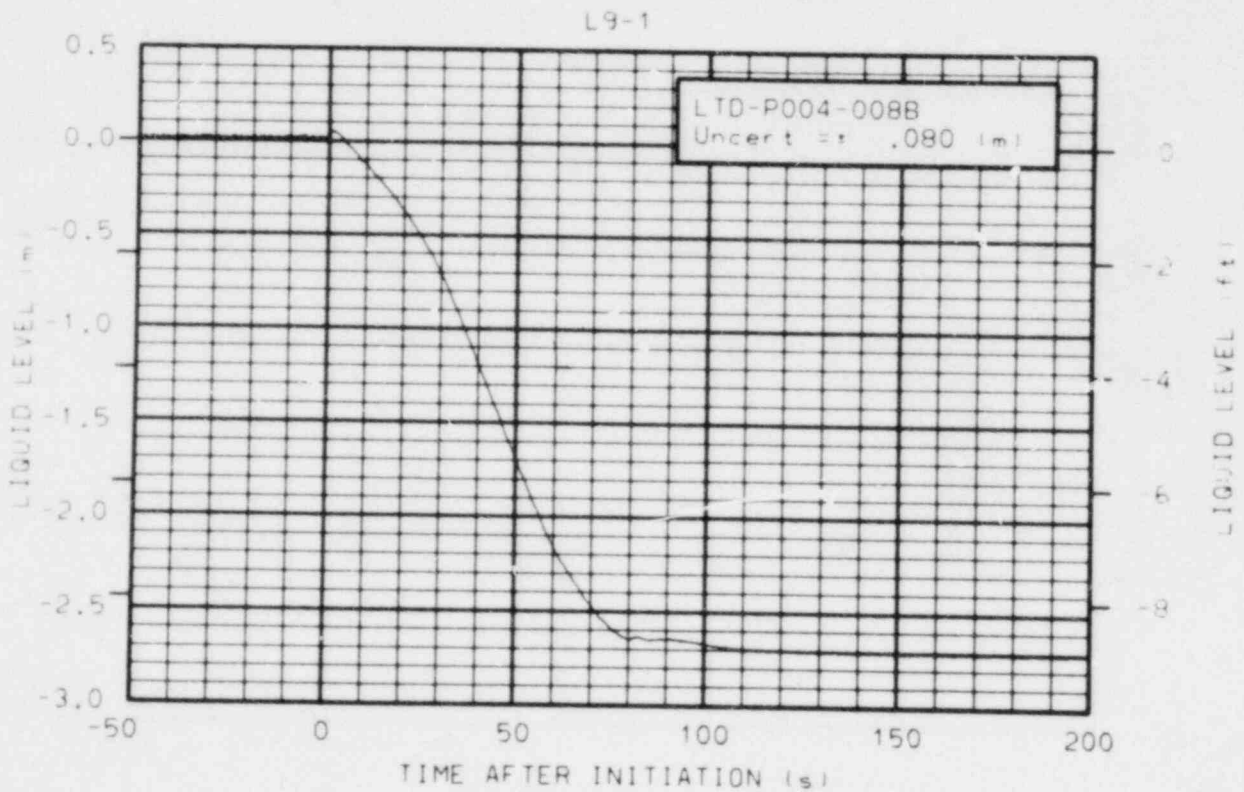


Figure 3C-2. Density corrected liquid level in steam generator (LTD-P004-008B) (qualified after 0 s, oscillations at approximately 5000 s are not indicative of real level).

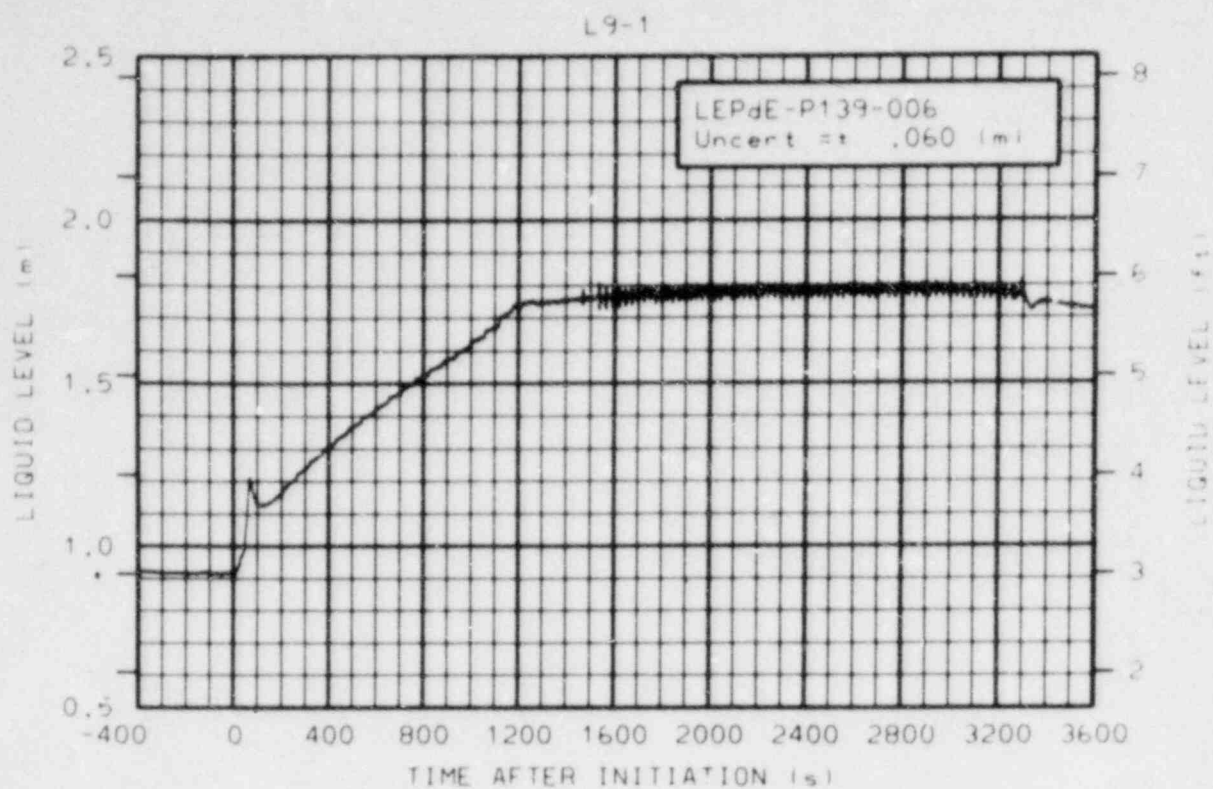


Figure 3C-3. Liquid level in pressurizer (LEPdE-P139-006) equalized, drift below 0.0 m after 6000 s caused by transmission line flashing).

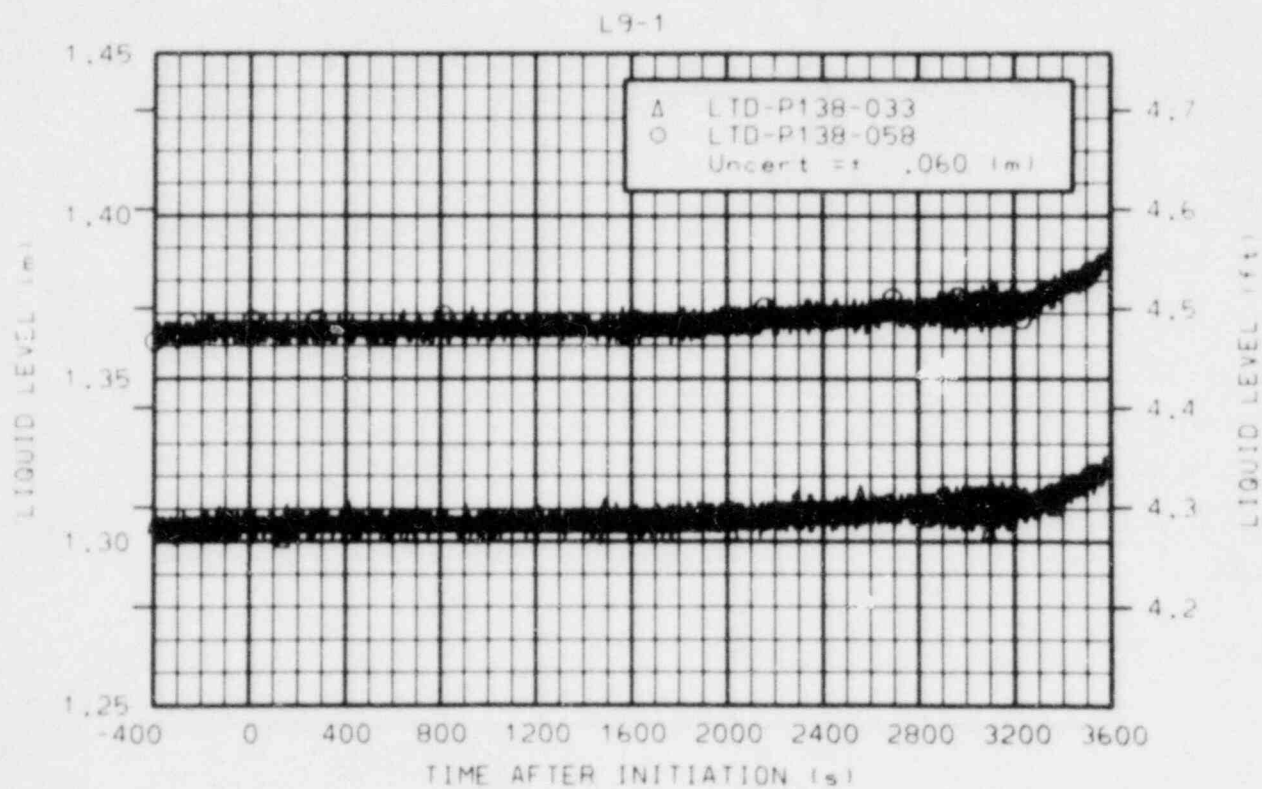


Figure 3C-4. Density corrected liquid level in blowdown suppression tank (LTD-P138-033 and -058).

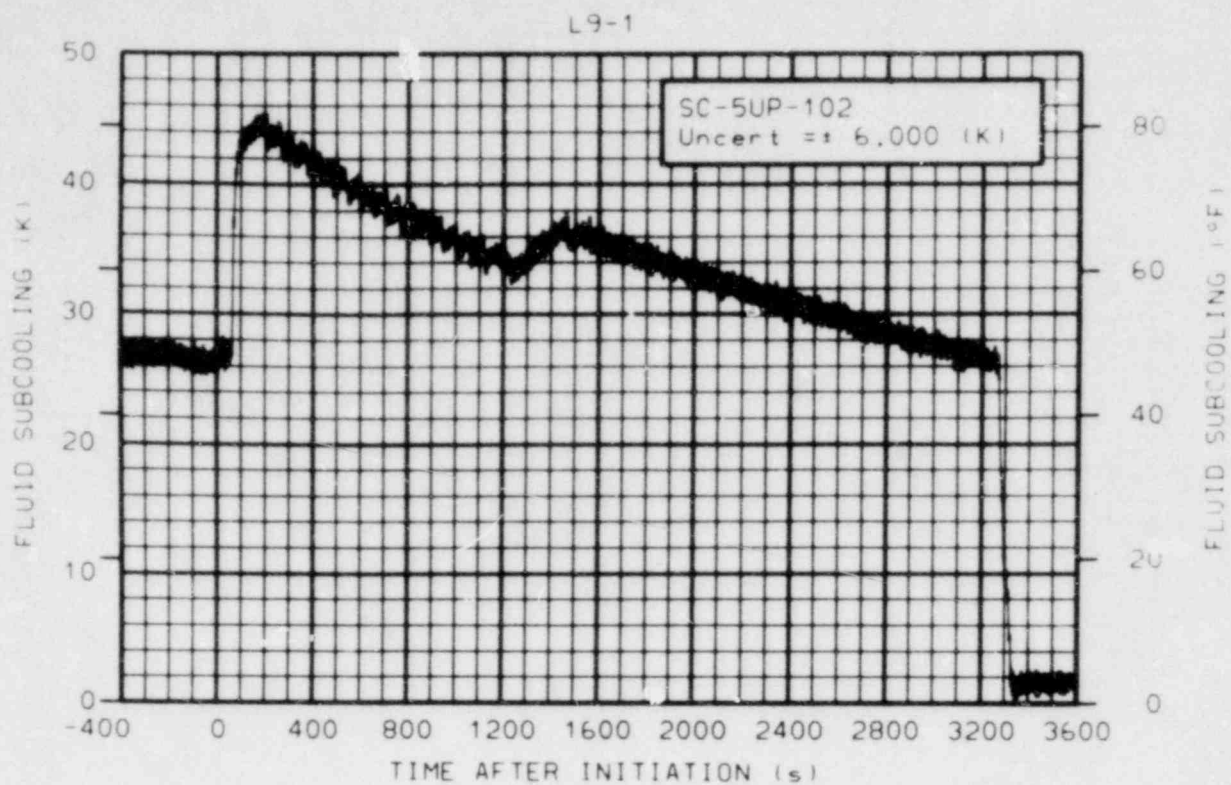


Figure 3C-5. Fluid subcooling in reactor vessel upper plenum (SC-5UP-102).

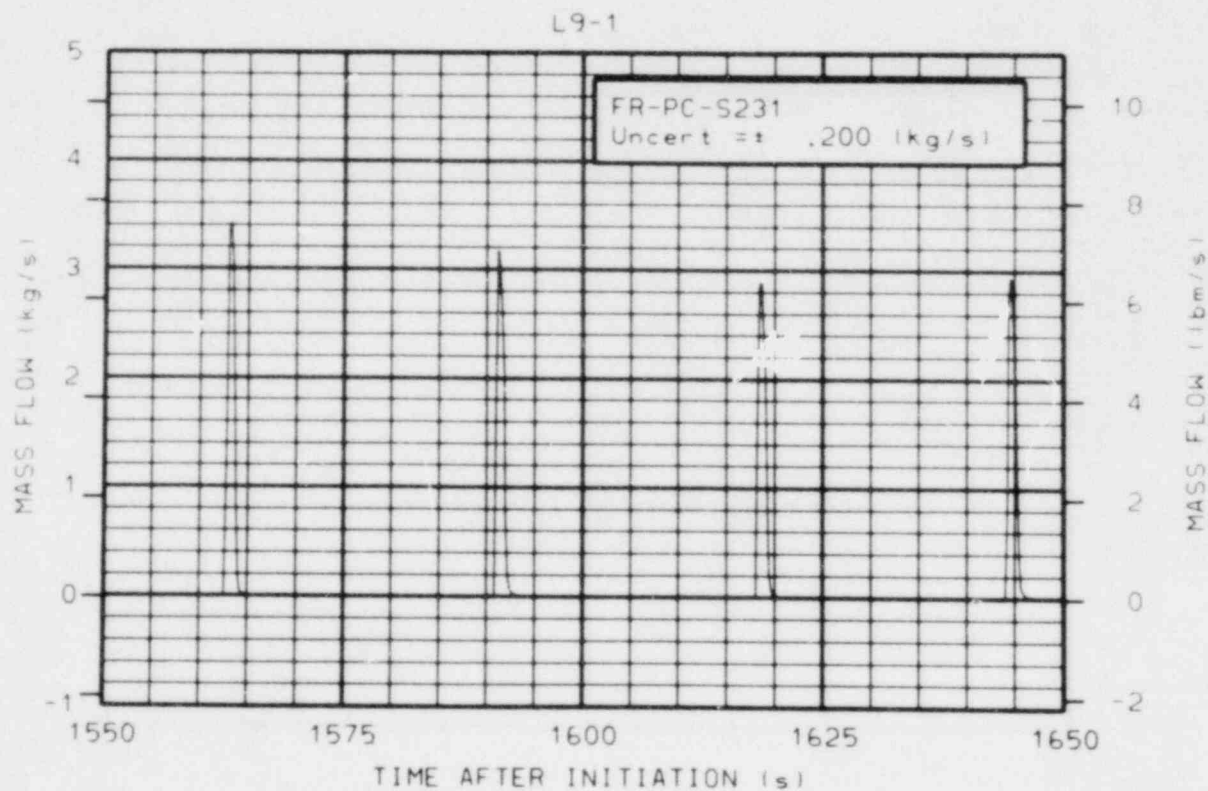


Figure 3C-6. Mass flow rate in the pressurizer relief line calculated from FE-PC-S02 and DE-PC-S03 (FR-PC-S231) (qualifited to 6000 s).

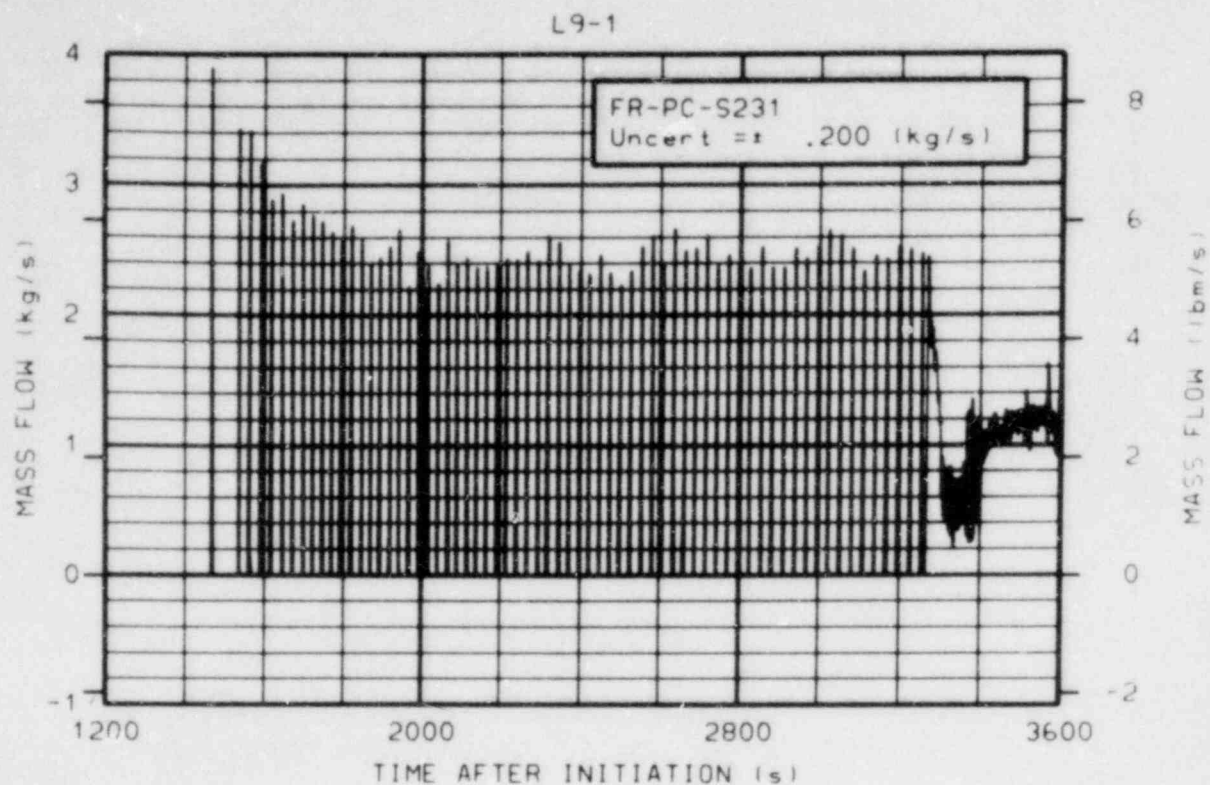


Figure 3C-7. Mass flow rate in the pressurizer relief line calculated from FE-PC-S02 and DE-PC-S03 (FR-PC-S231) (qualified to 6000 s).

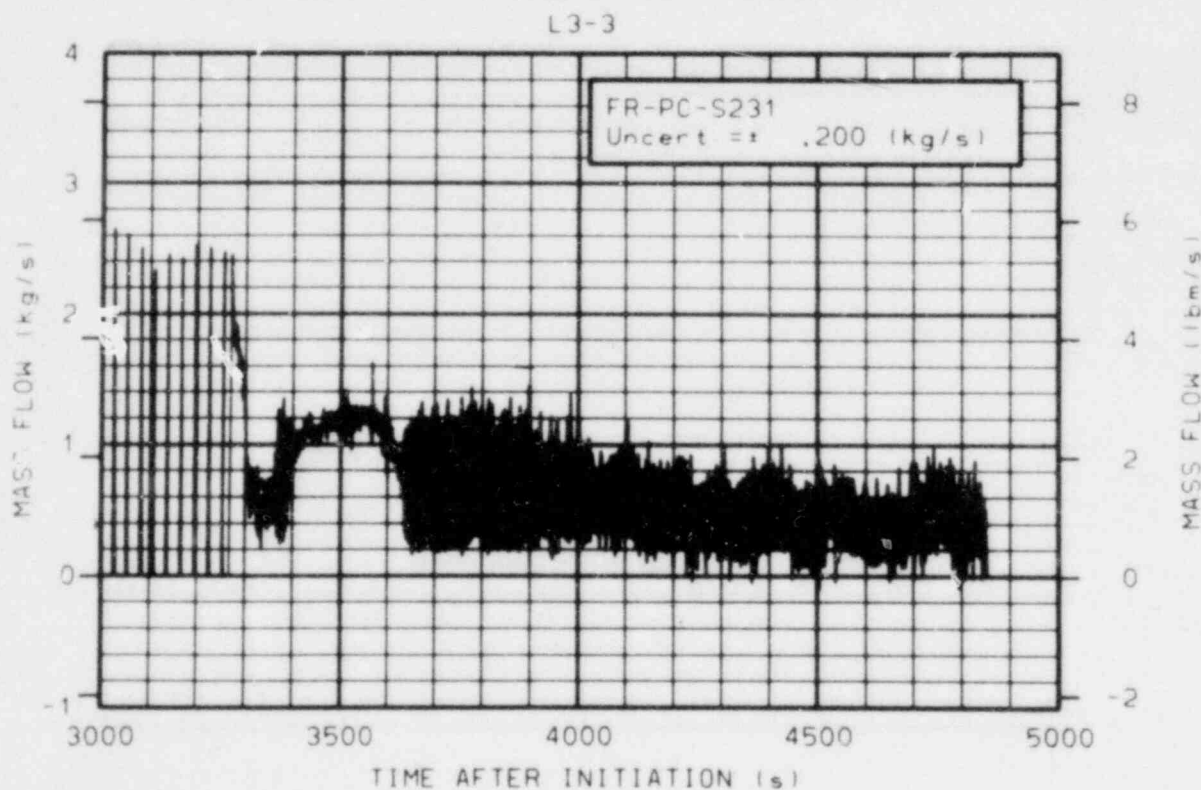


Figure 3C-8. Mass flow rate in the pressurizer relief line calculated from FE-PC-S02 and DE-PC-S03 (FR-PC-S231) (qualified to 6000 s).

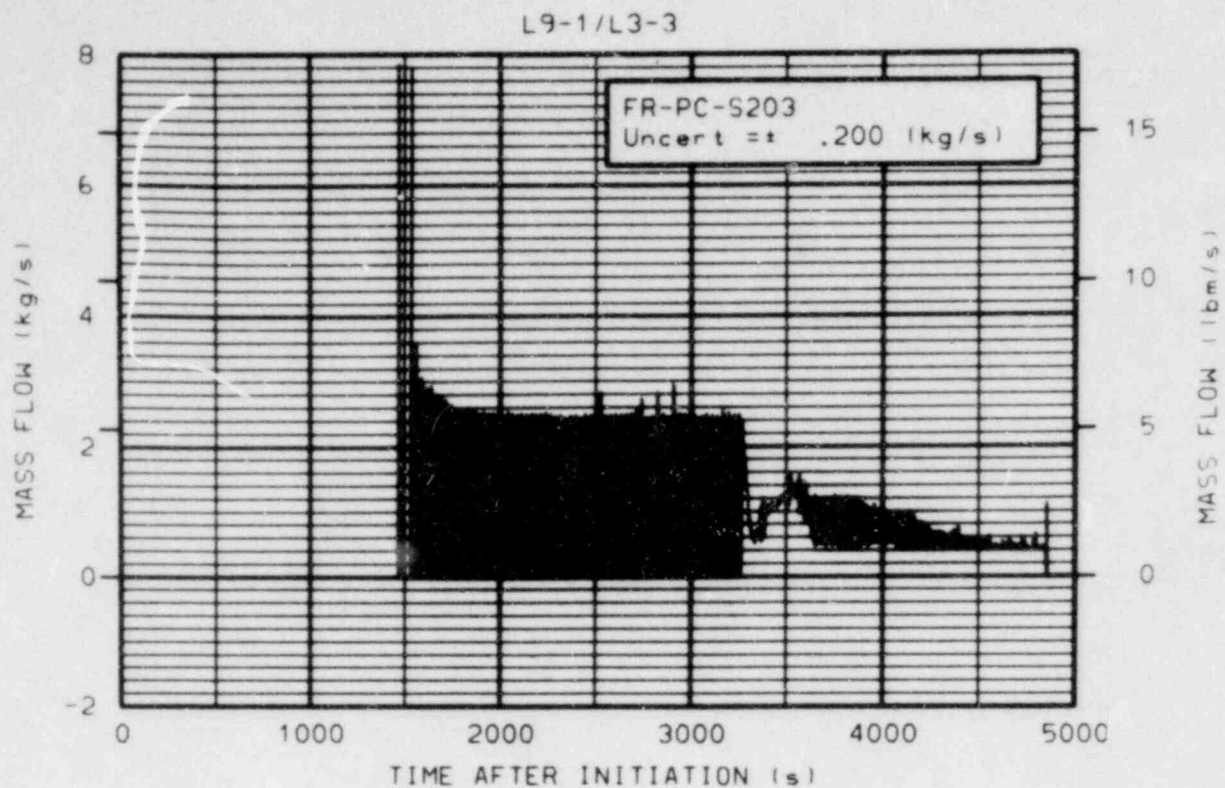


Figure 3C-9. Mass flow rate in the pressurizer relief line calculated from FE-PC-S02 and ME-PC-S02 (FR-PC-S203) (qualified from 1550 to 6000 s).

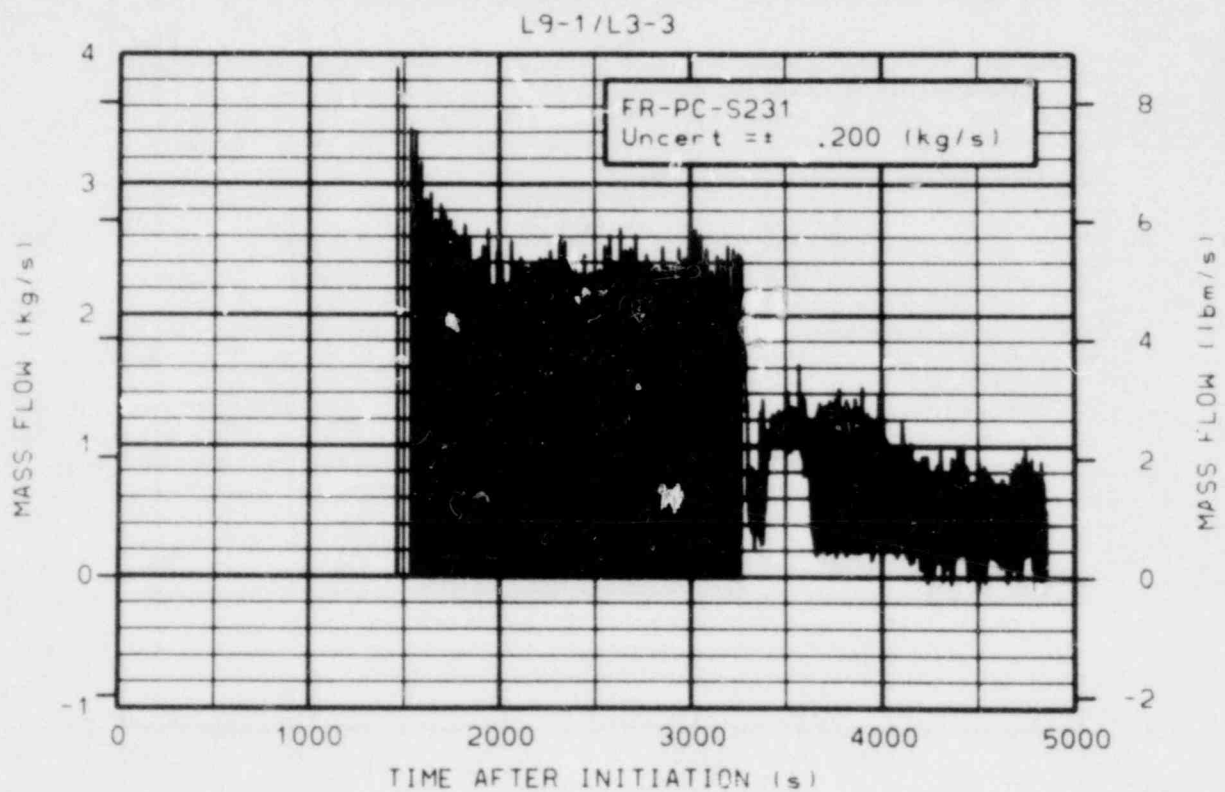


Figure 3C-10. Mass flow rate in the pressurizer relief line calculated from FE-PC-S02 and DE-PC-S03 (FR-PC-S231) (qualified to 6000 s).

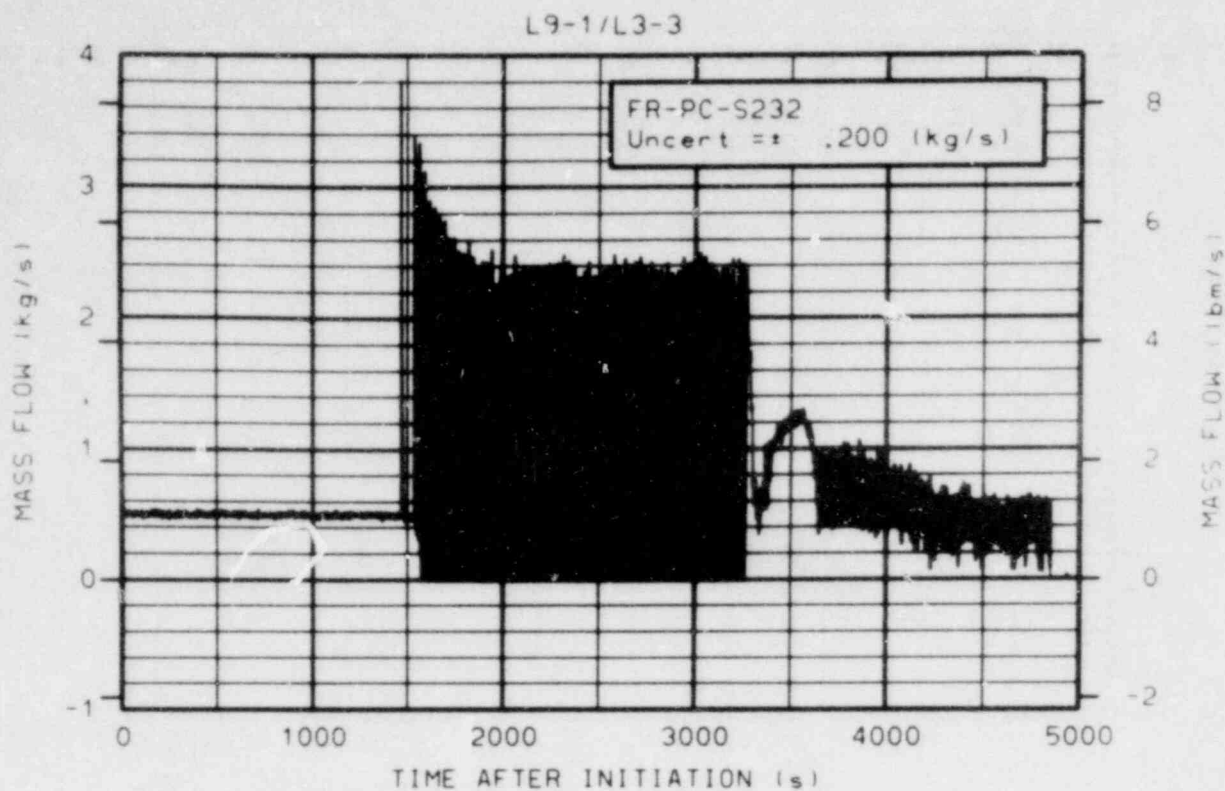


Figure 3C-11. Mass flow rate in the pressurizer relief line calculated from ME-PC-S02 and DE-PC-S03 (FR-PC-S232) (qualified from 1575 to 4900 s).

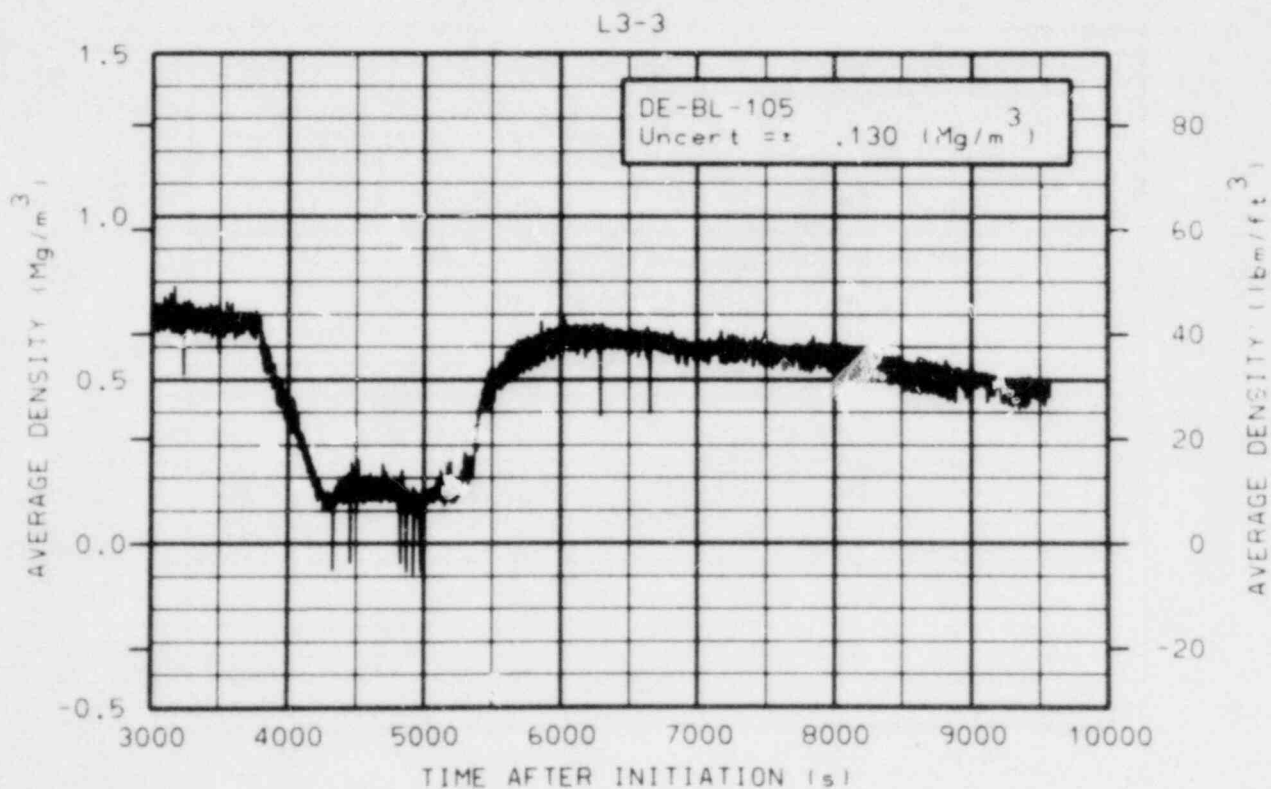


Figure 3C-12. Average fluid density in broken loop cold leg (DE-BL-105) (qualified after reactor scram, several anomalous spikes).

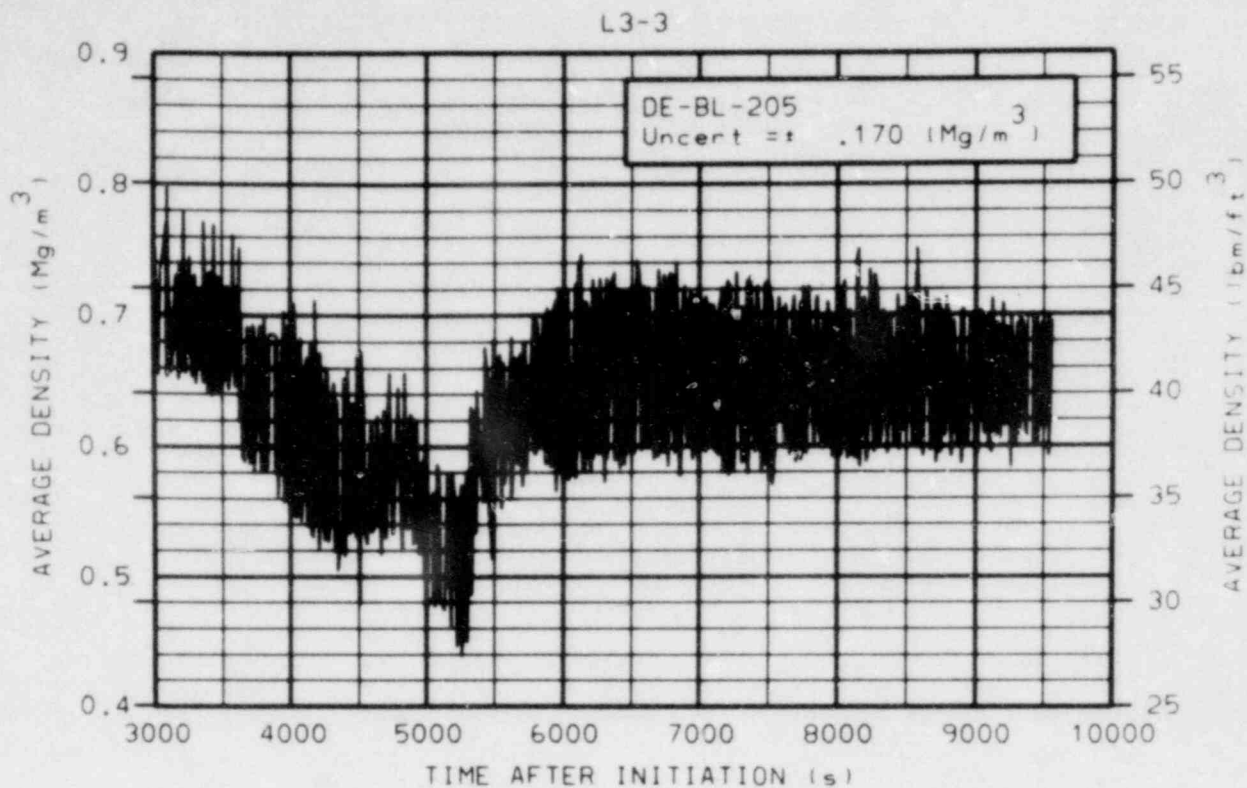


Figure 3C-13. Average fluid density in broken loop hot leg (DE-BL-205) (qualified after reactor scram).

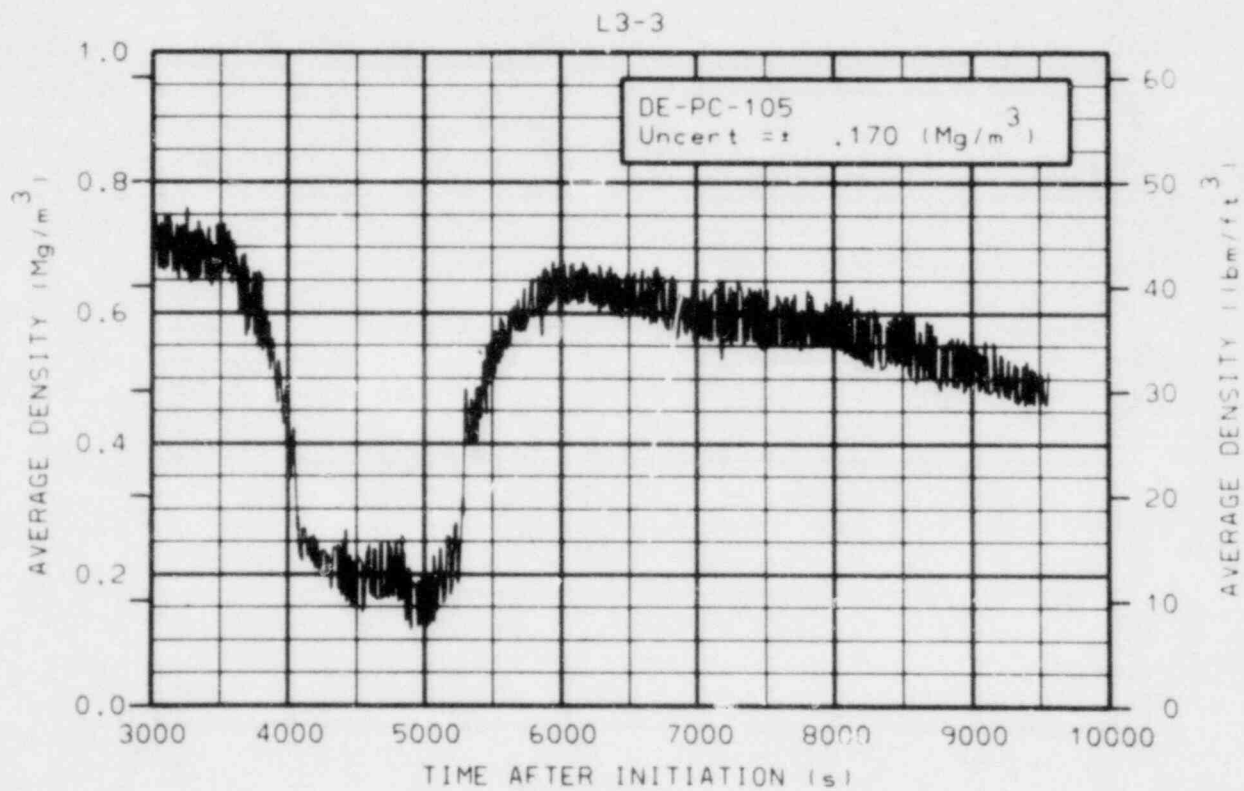


Figure 3C-14. Average fluid density in intact loop cold leg (DE-PC-105) (qualified after reactor scram).

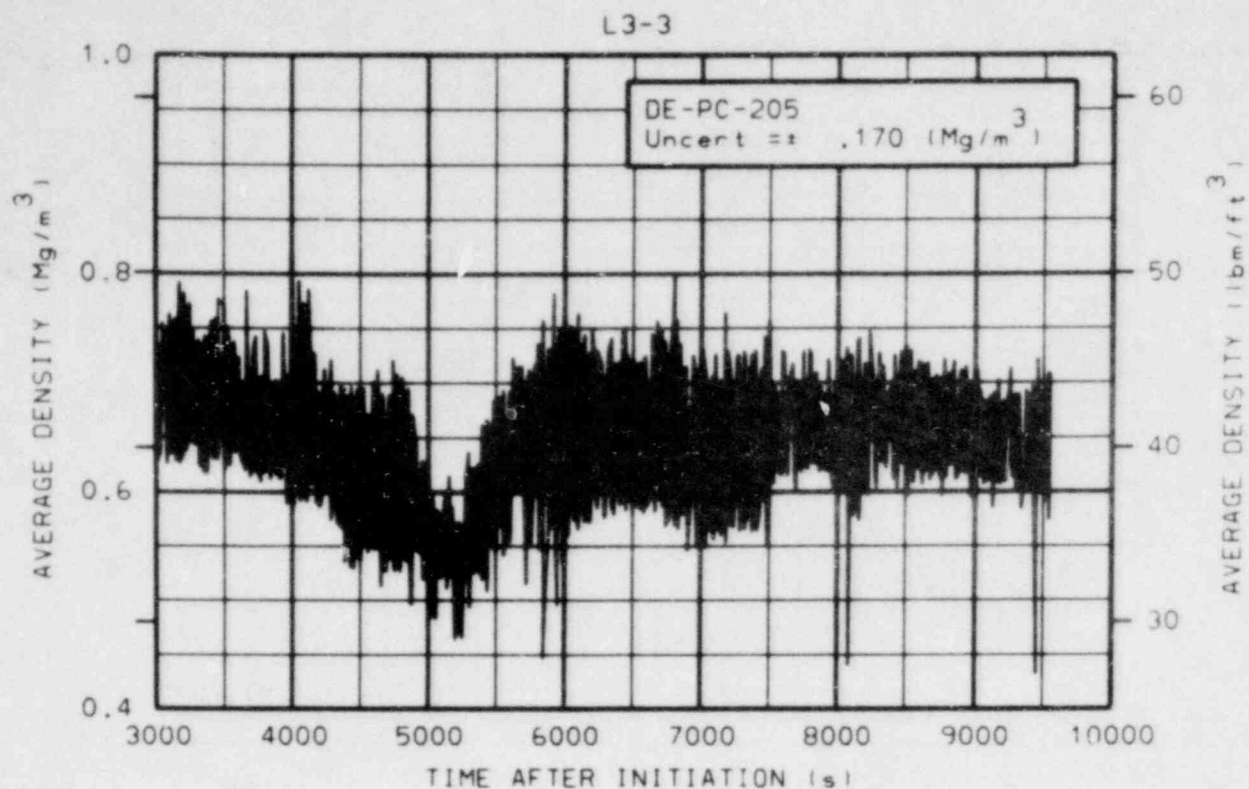


Figure 3C-15. Average fluid density in intact loop hot leg (DE-PC-205) (qualified after reactor scram, several anomalous spikes).

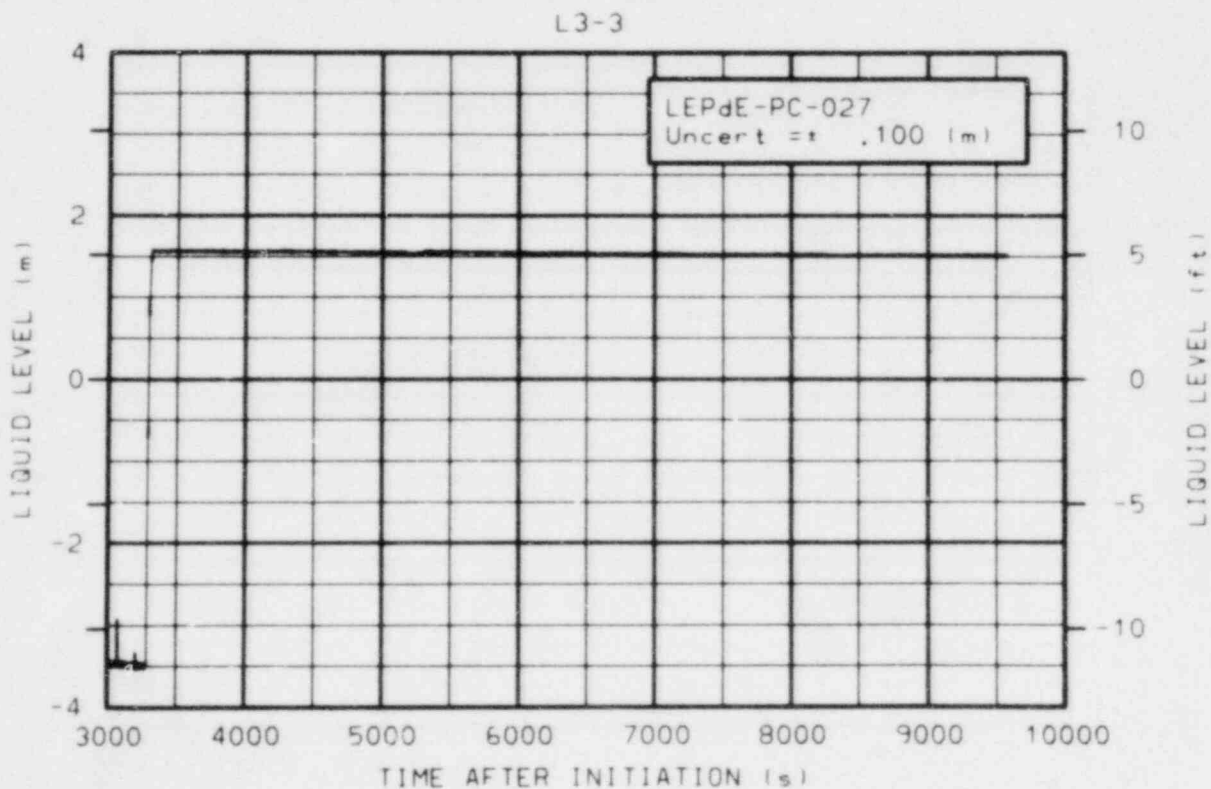


Figure 3C-16. Liquid level in intact loop from steam generator outlet to bottom of loop seal (LEPdE-PC-027) (qualified after pump coastdown).

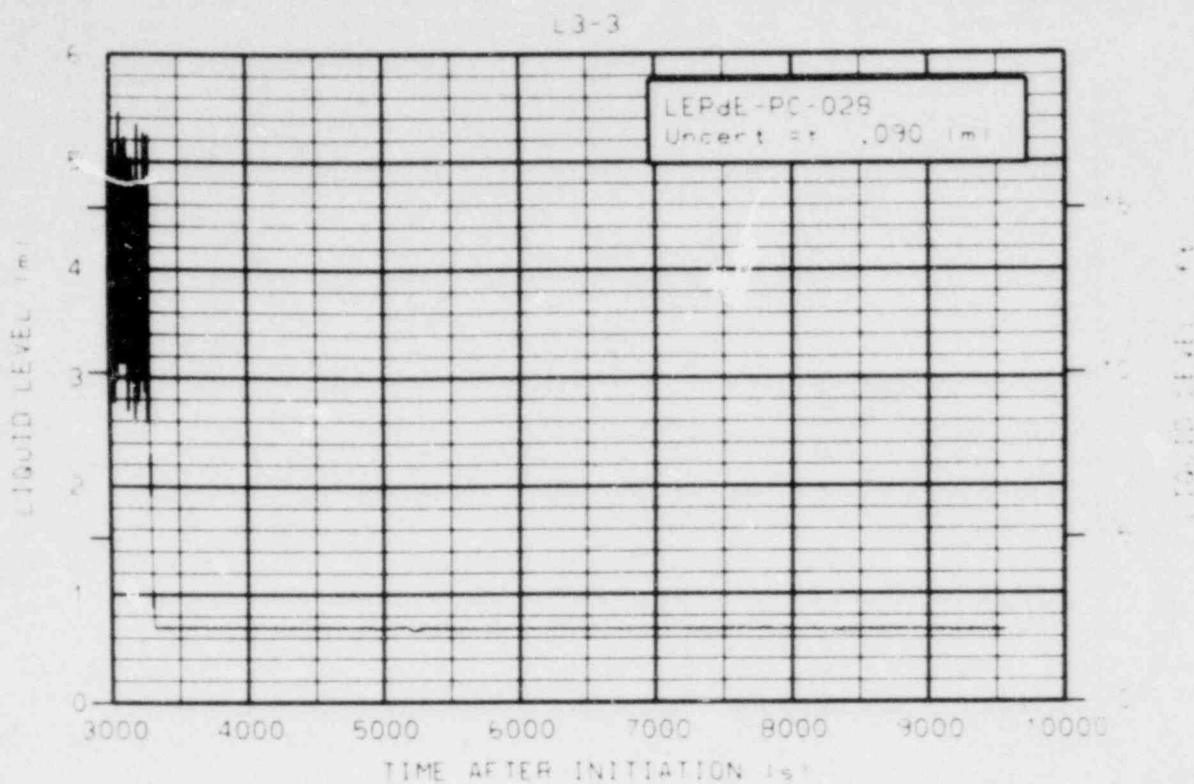


Figure 3C-17. Liquid level in intact loop from bottom of loop seal to primary coolant Pump 2 (LEPdE-PC-028) equalized after pump coastdown.

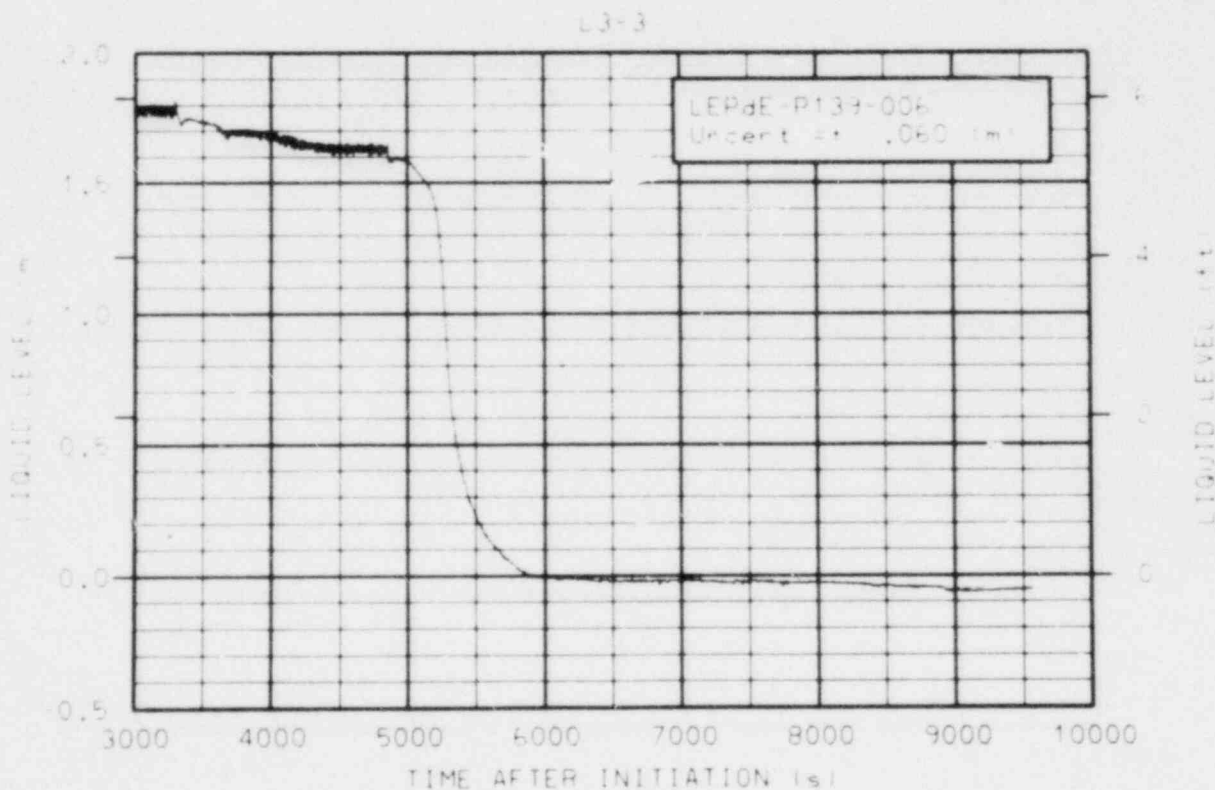


Figure 3C-18. Liquid level in pressurizer (LEPdE-P139-006) equalized, drift below 0.0 m after 6000 s caused by transmission line flashing).

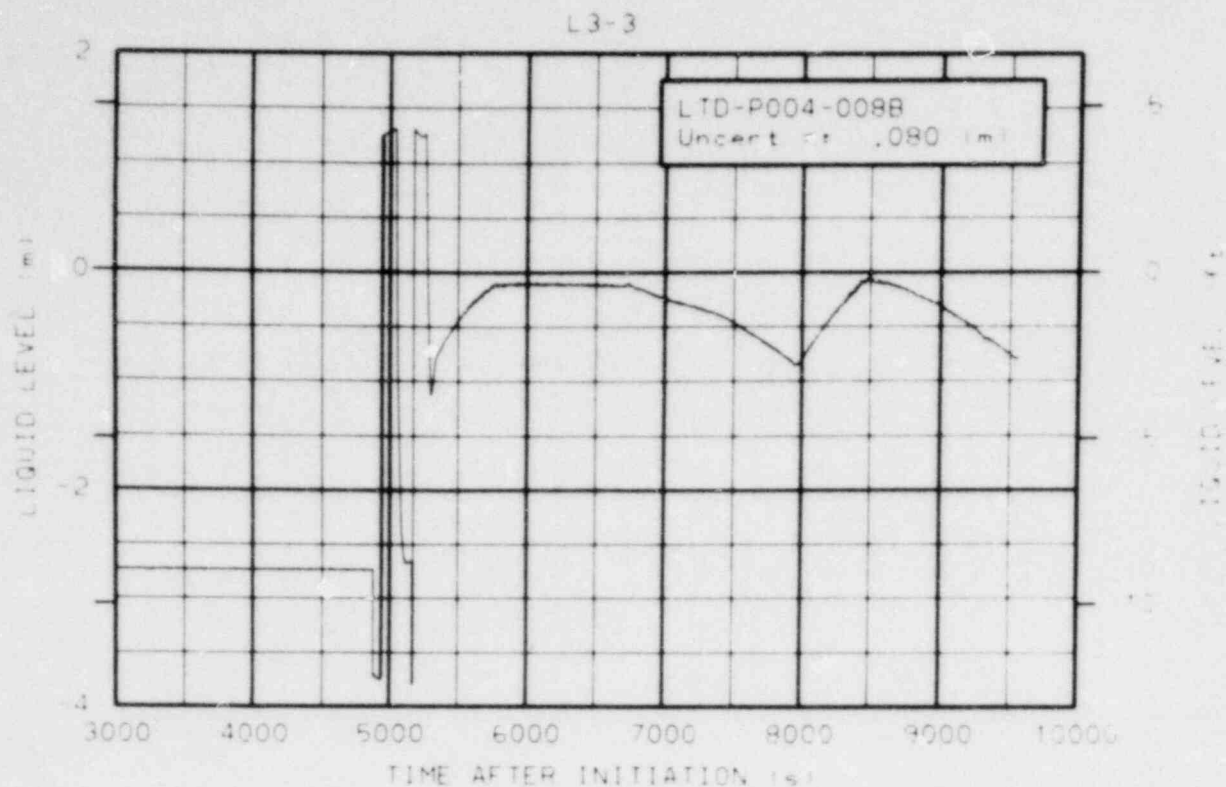


Figure 3C-19. Density corrected liquid level in steam generator (LTD-P004-008B) equalized after 0 s, oscillations at approximately 5000 s are not indicative of real level.

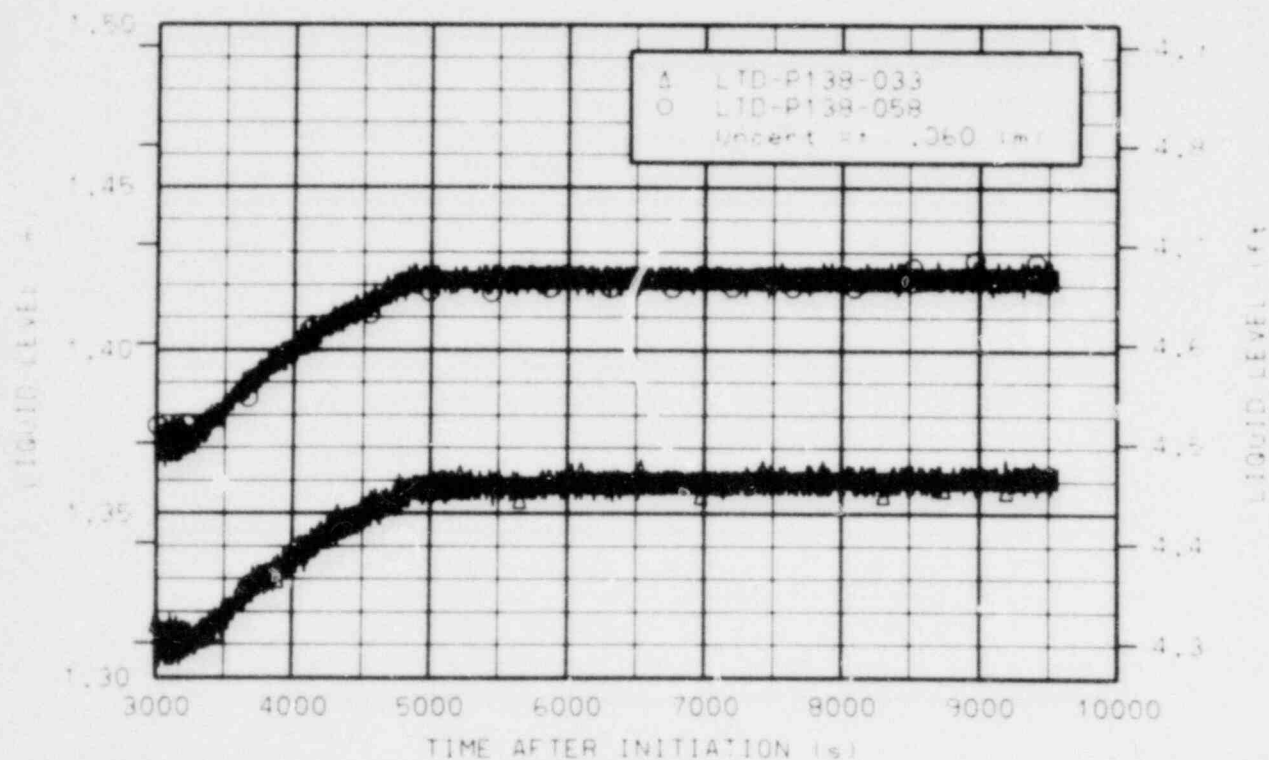


Figure 3C-20. Density corrected liquid level in blowdown suppression tank (LTD-P138-033 and -058).

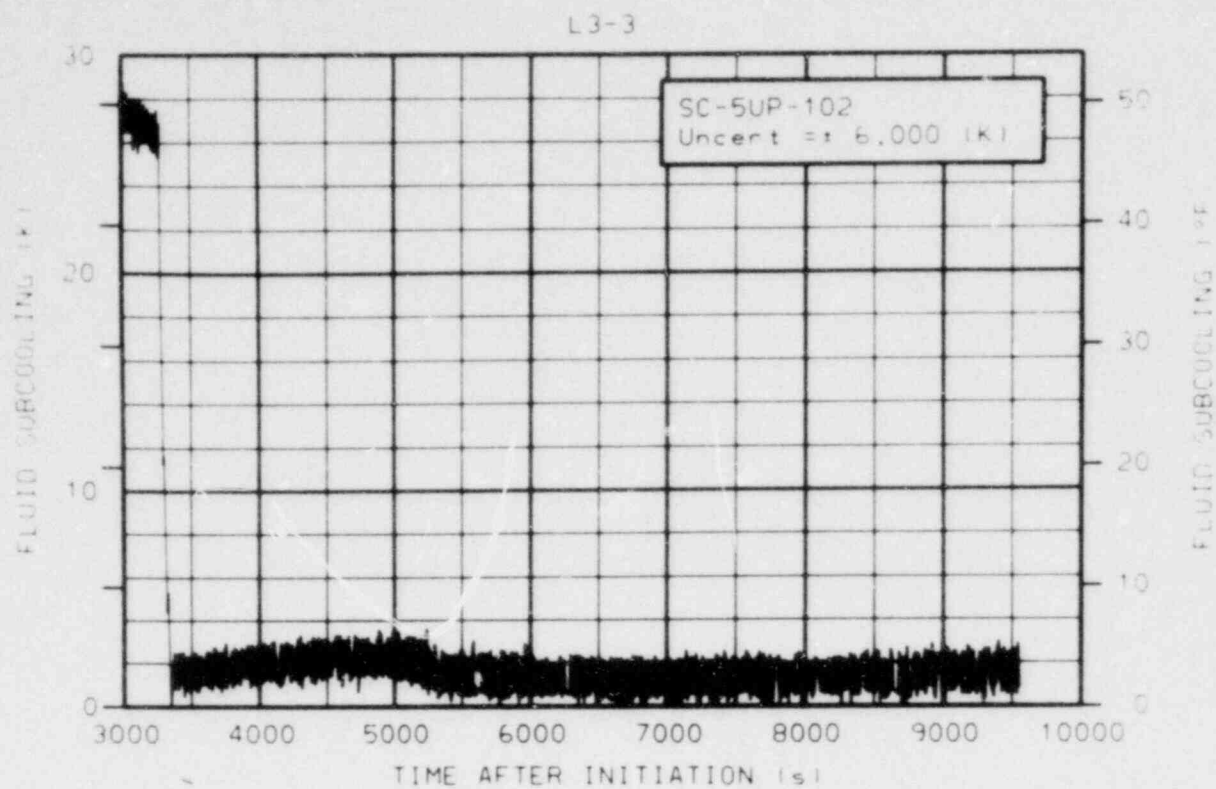


Figure 3C-21. Fluid subcooling in reactor vessel upper plenum (SC-5UP-102).

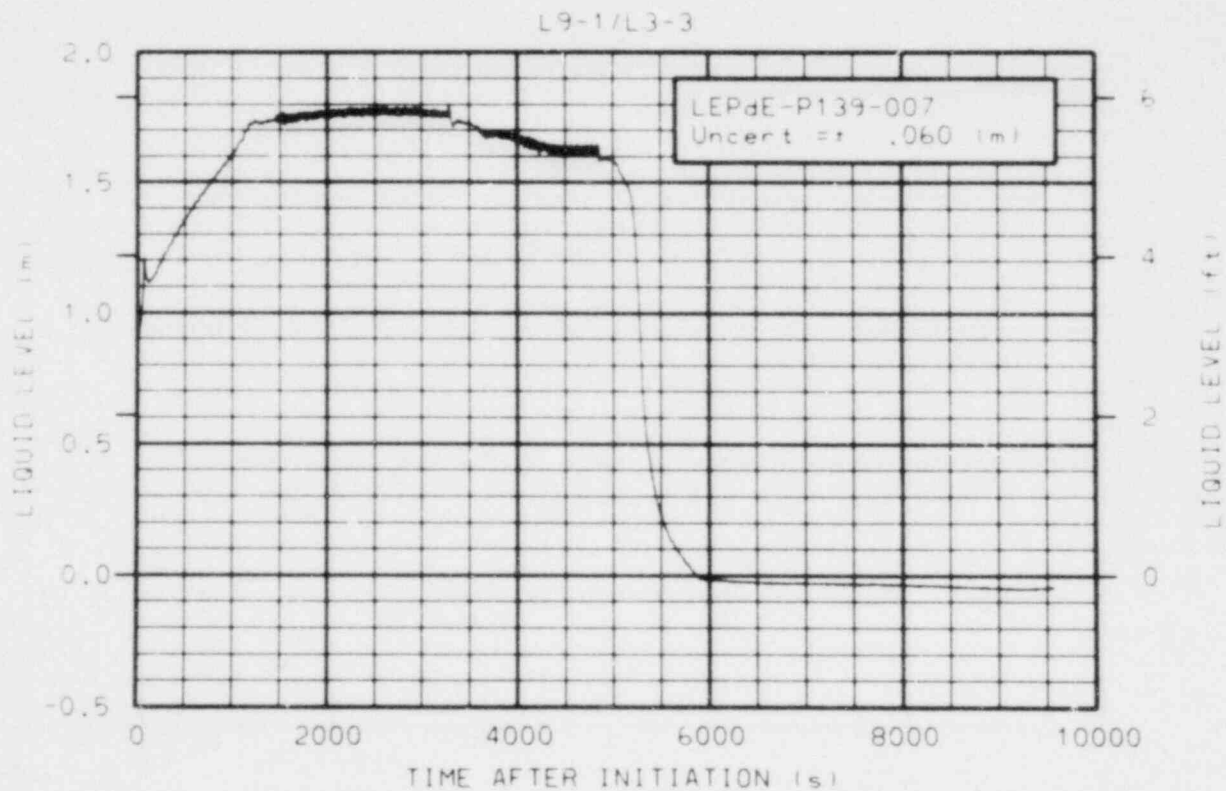


Figure 3C-22. Liquid level in pressurizer (LEPdE-P139-007) (qualified, drift below 0.0 m after 6000 s caused by transmission line flashing).

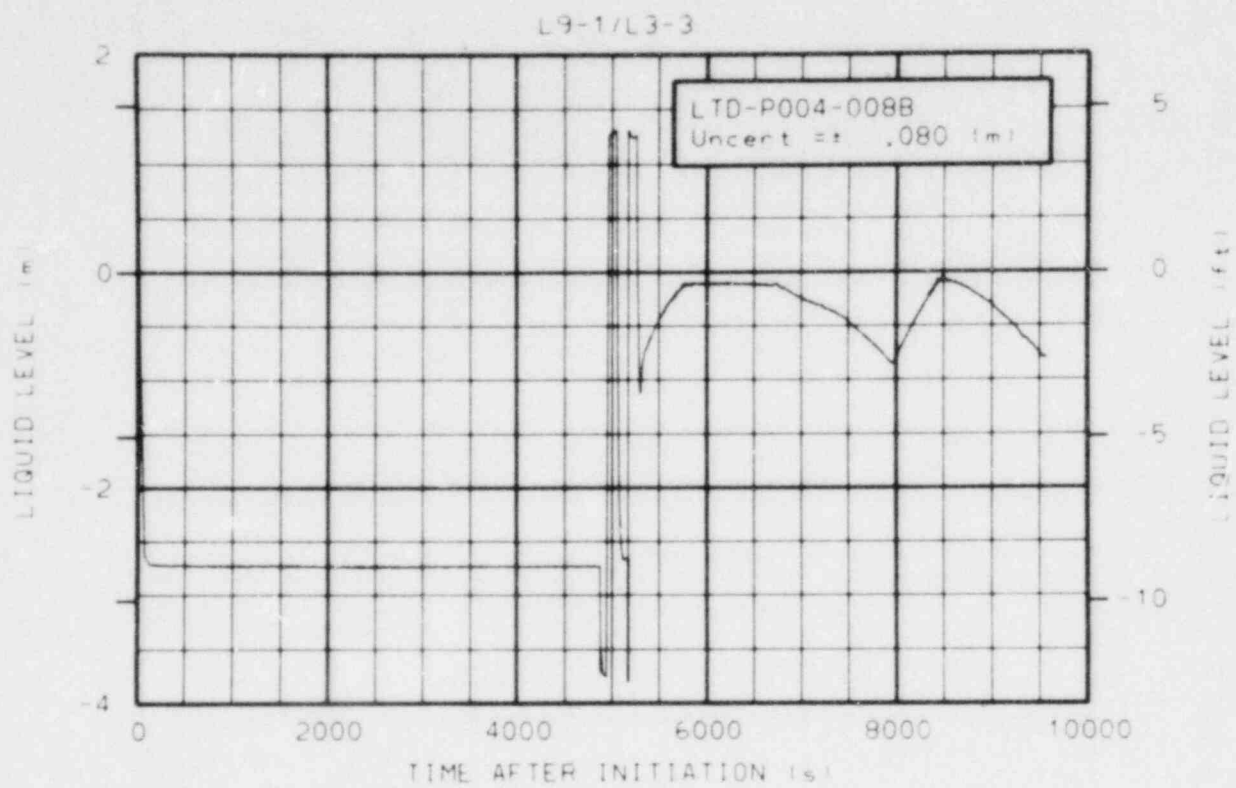


Figure 30-23. Density corrected liquid level in steam generator (LTD-P004-008B) equalized after 0 s, oscillations at approximately 5000 s are not indicative of real level.

LE-3UP-001

Level (cm)	TIME (s)
278.90	100.000
208.60	290.600
497.60	491.800
427.60	692.800
	893.800
	1094.800
	1295.800
	1496.800
	1697.800
	1898.800
	2099.800
	2300.800
	2501.800

Level (cm)	TIME (s)
278.90	2600.000
208.60	2800.000
497.60	3000.000
427.60	3200.000
	3400.000
	3600.000
	3800.000
	4000.000
	4200.000
	4400.000
	4600.000
	4800.000
	5000.000

Level (cm)	TIME (s)
278.90	5000.000
208.60	5200.000
497.60	5400.000
427.60	5600.000
	5800.000
	6000.000
	6200.000
	6400.000
	6600.000
	6800.000
	7000.000
	7200.000
	7400.000

Level (cm)	TIME (s)
278.90	7500.000
208.60	7700.000
497.60	7900.000
427.60	8100.000
	8300.000
	8500.000
	8700.000
	8900.000
	9100.000
	9300.000
	9500.000
	9700.000
	9900.000

Figure 3C-25. Liquid level in reactor vessel upper plenum above Fuel Assembly 3, bubble plot (LE-3UP-001).

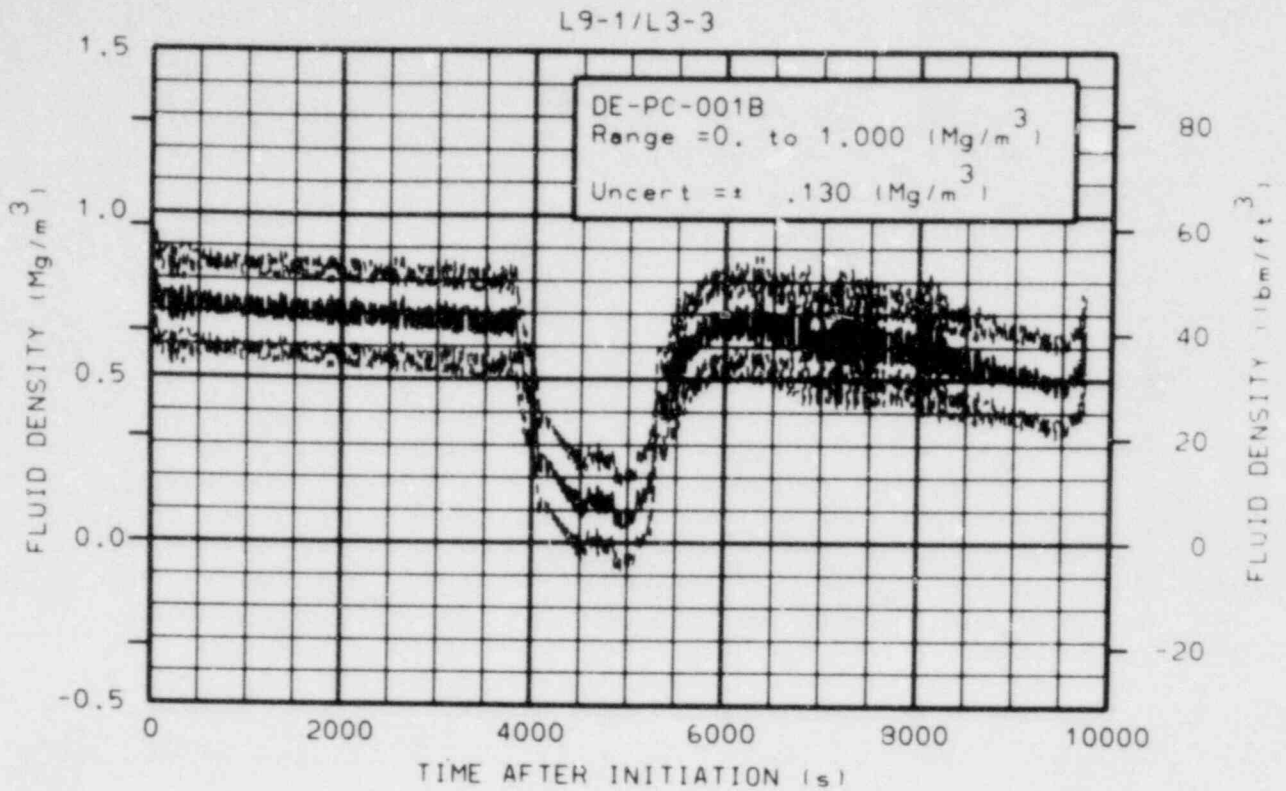


Figure 3U-1. Fluid density in intact loop cold leg, chordal density (DE-PC-001B) (qualified after reactor scram).

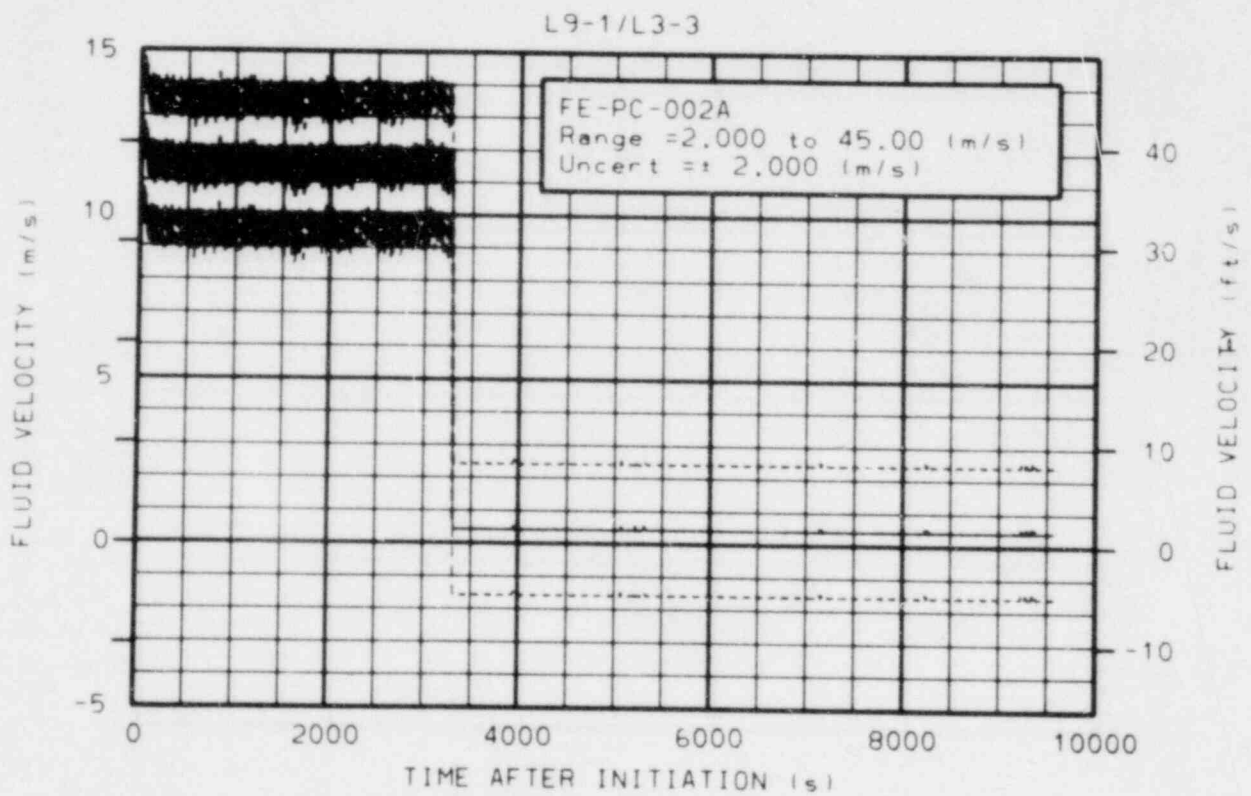


Figure 3U-2. Fluid velocity in intact loop hot leg DTT rake at bottom of pipe (FE-PC-002A) (qualified to 6000 s).

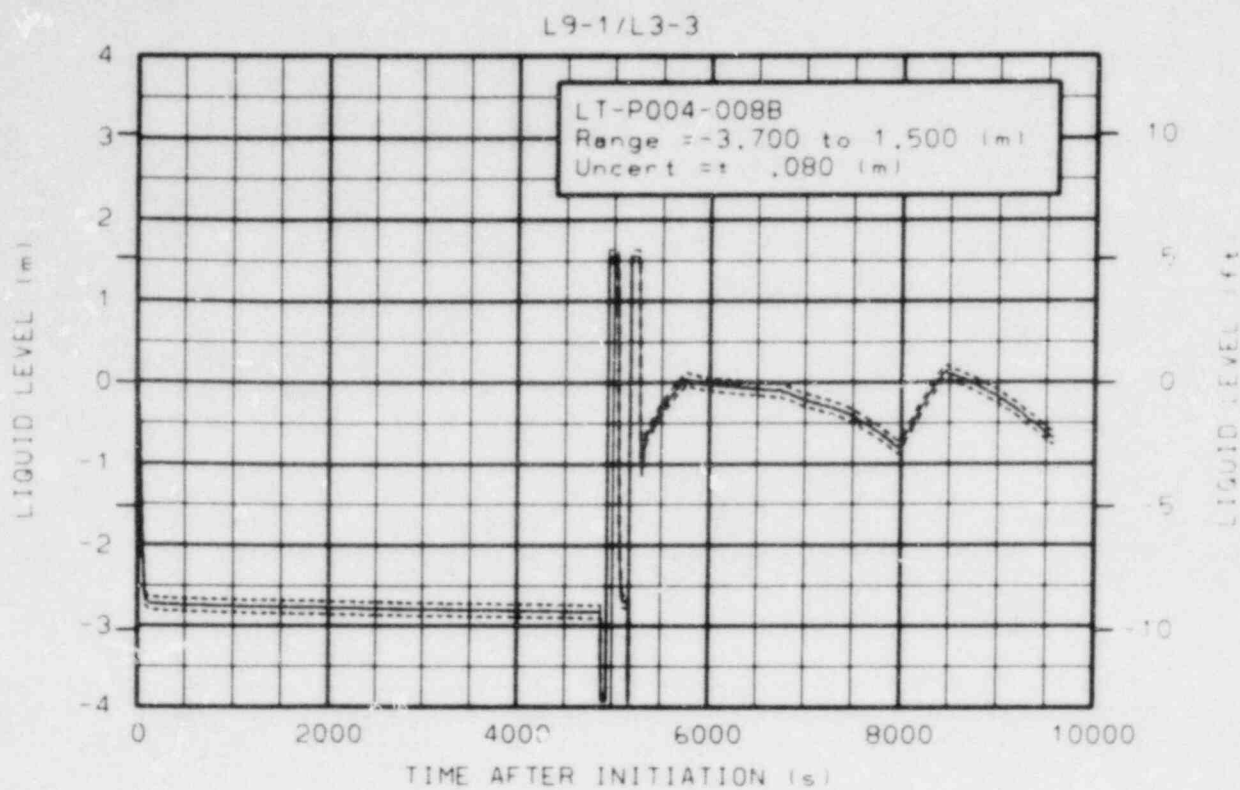


Figure 3U-3. Liquid level in steam generator (LT-P004-008B) (qualified after 0 s, not density compensated, oscillations at approximately 5000 s are not indicative of real level).

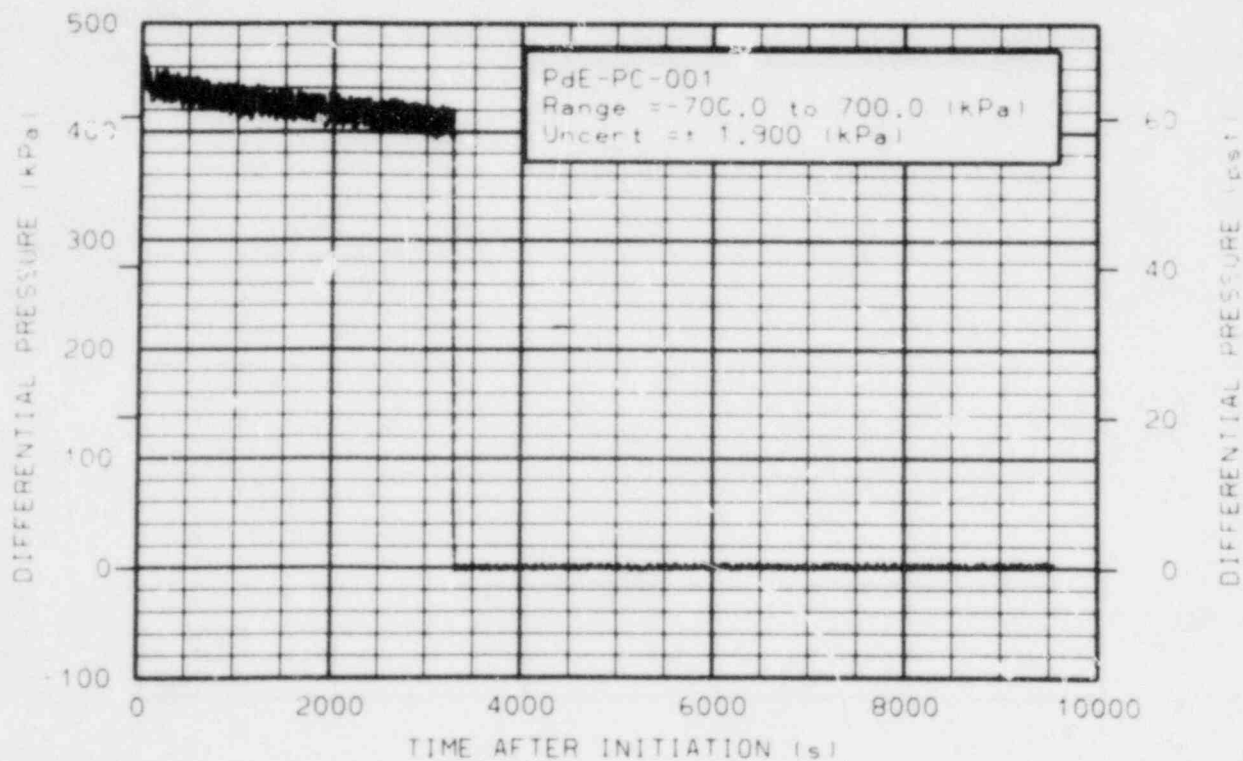


Figure 3U-4. Differential pressure in intact loop across primary coolant Pumps 1 and 2 (PdE-PC-001).

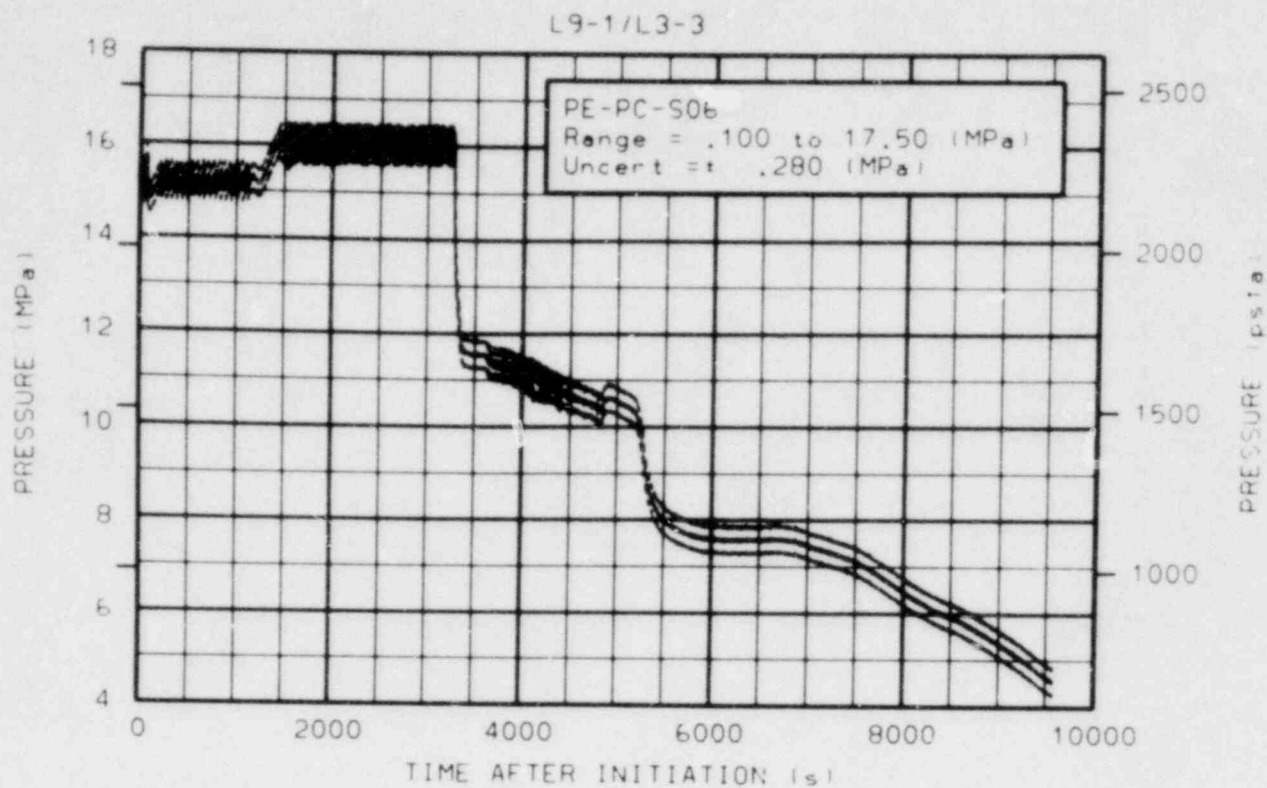


Figure 3U-5. Pressure in intact loop pressurizer relief line upstream of DTT (PE-PC-S06).

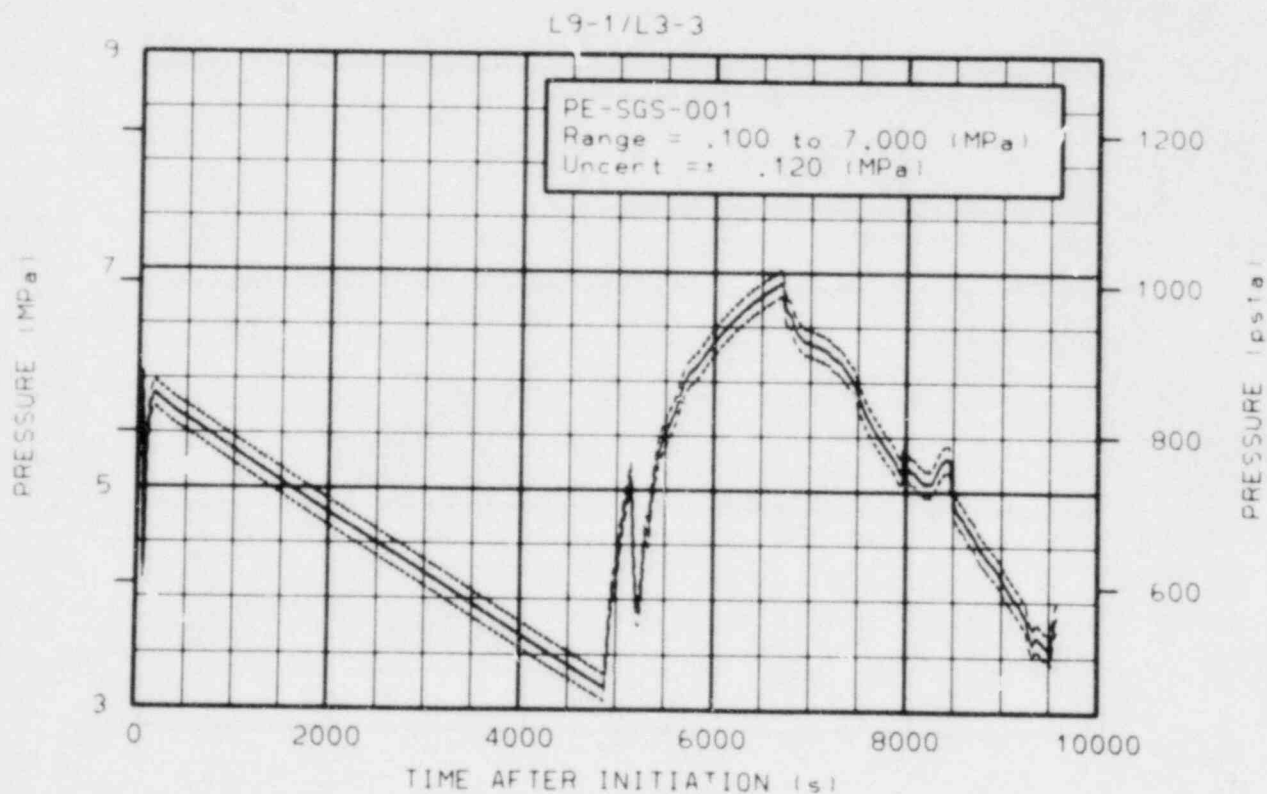


Figure 3U-6. Pressure in steam generator dome (PE-SGS-001).

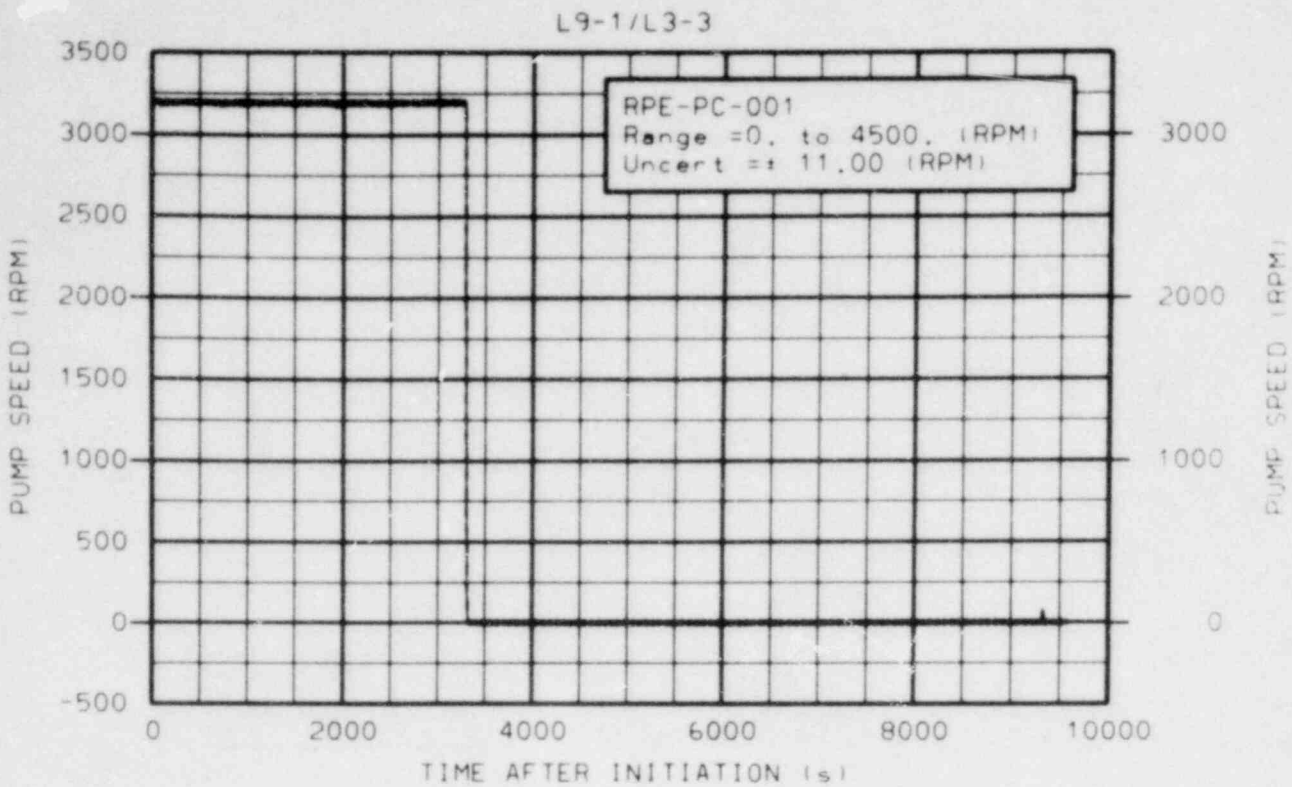


Figure 3U-7. Pump speed for primary coolant Pump 1 (RPE-PC-001).

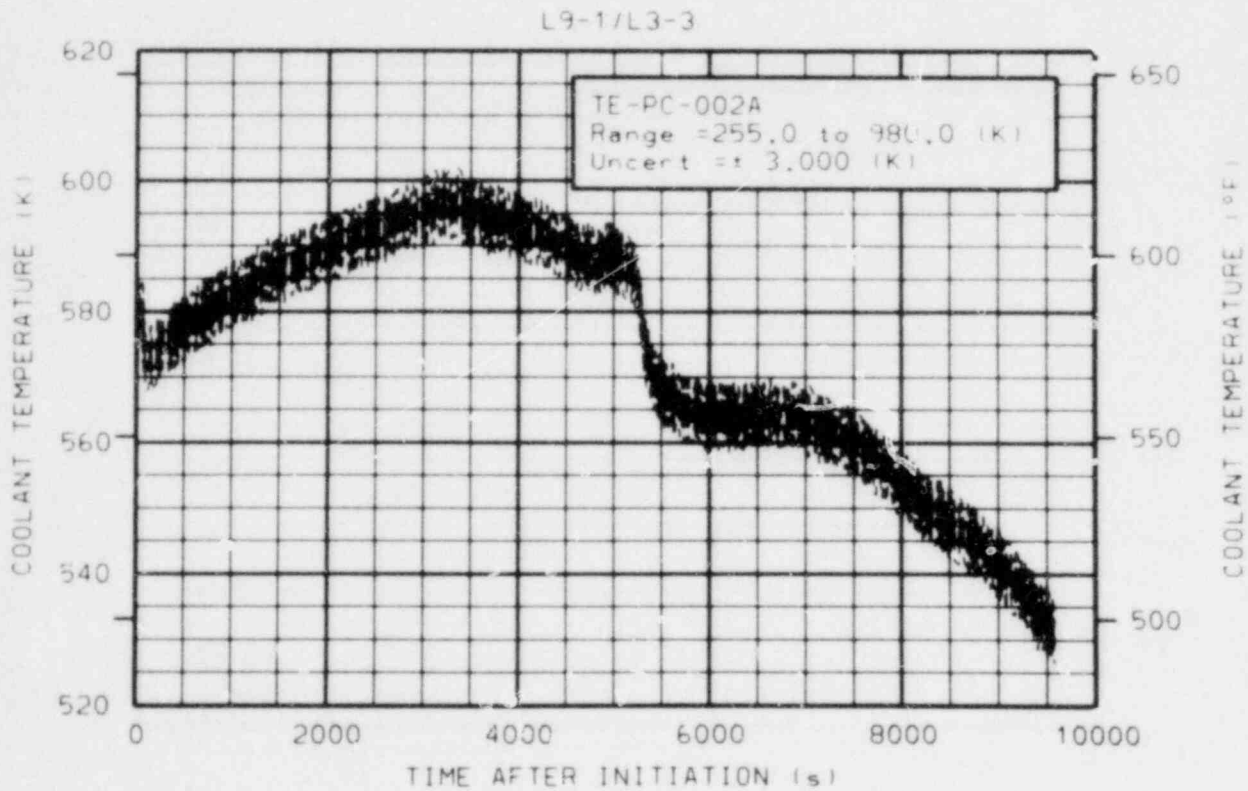


Figure 3U-8. Coolant temperature in intact loop hot leg DTT rake at bottom of pipe (TE-PC-002A).

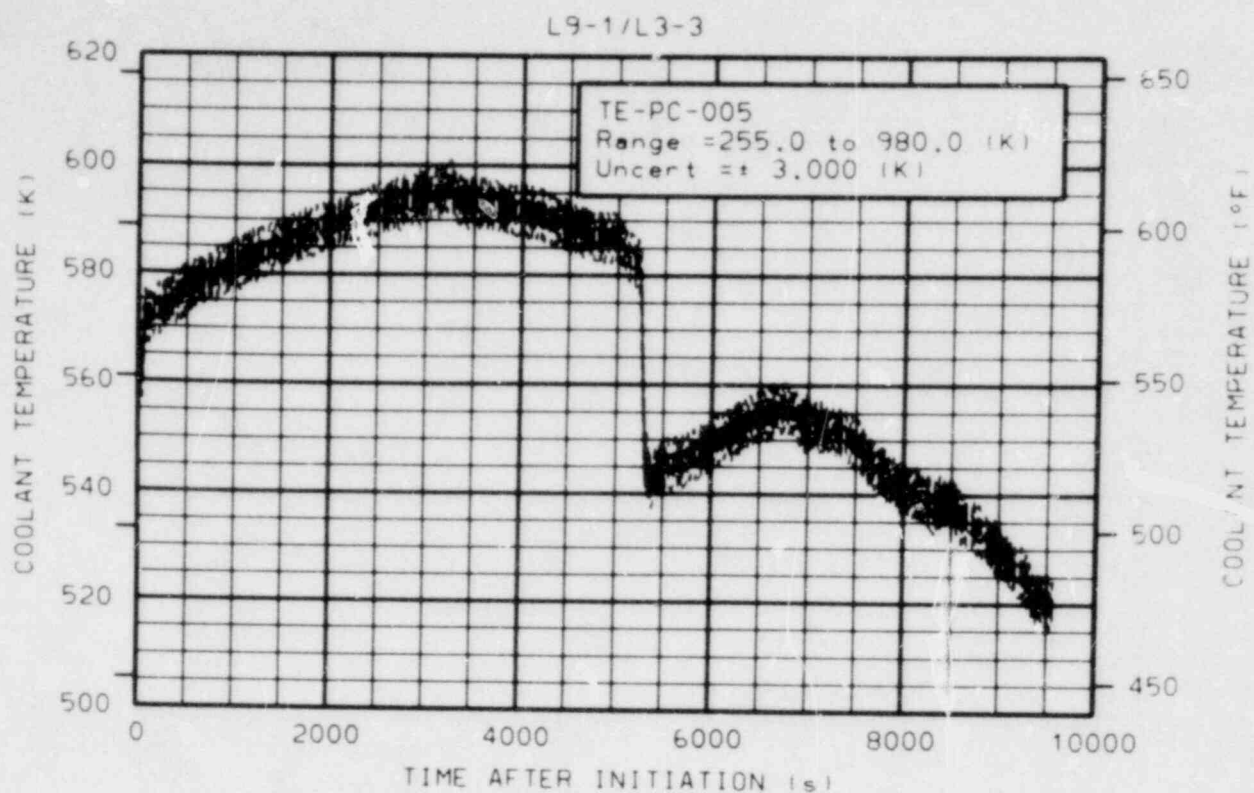


Figure 3U-9. Coolant temperature in intact loop cold leg next to bottom of ECC Rake 1 (TE-PC-005).

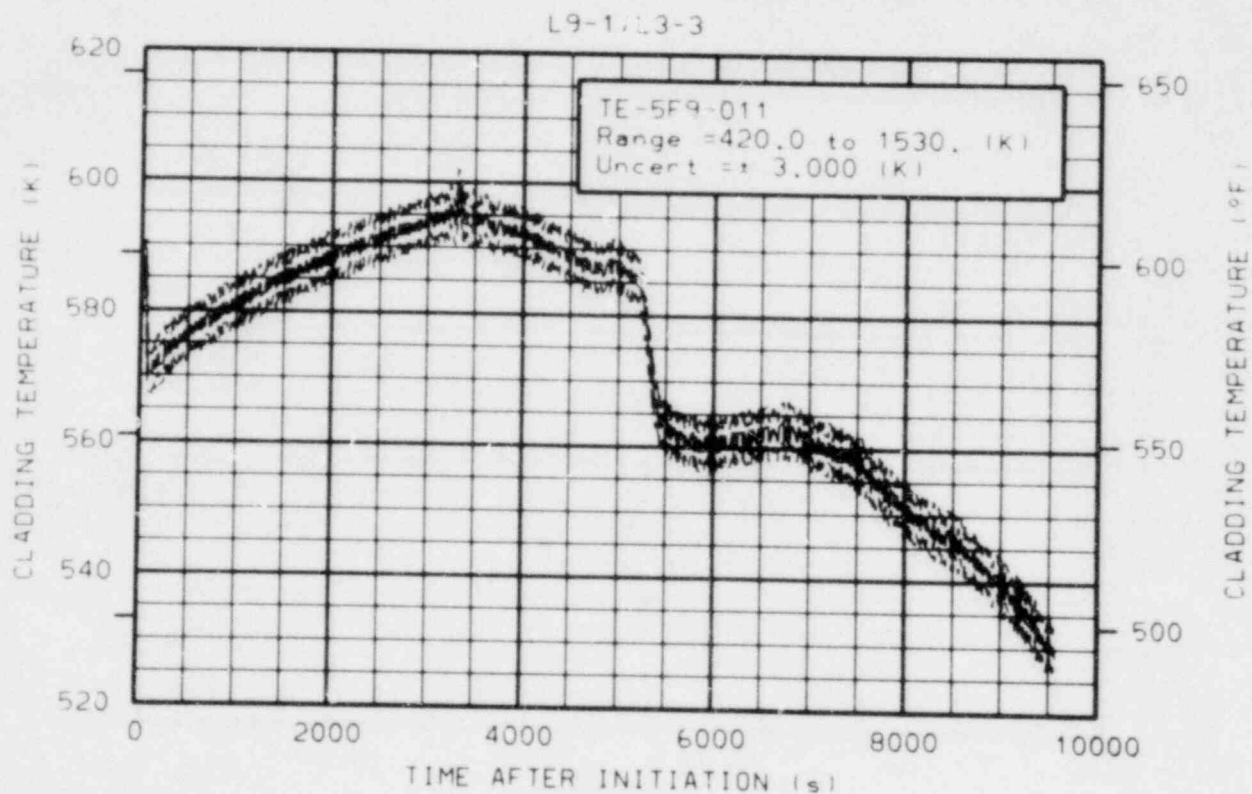


Figure 3U-10. Cladding temperature in reactor vessel at Fuel Assembly 5, Row F, Column 9 at 0.28 m above bottom of fuel rod (TE-5F9-011).

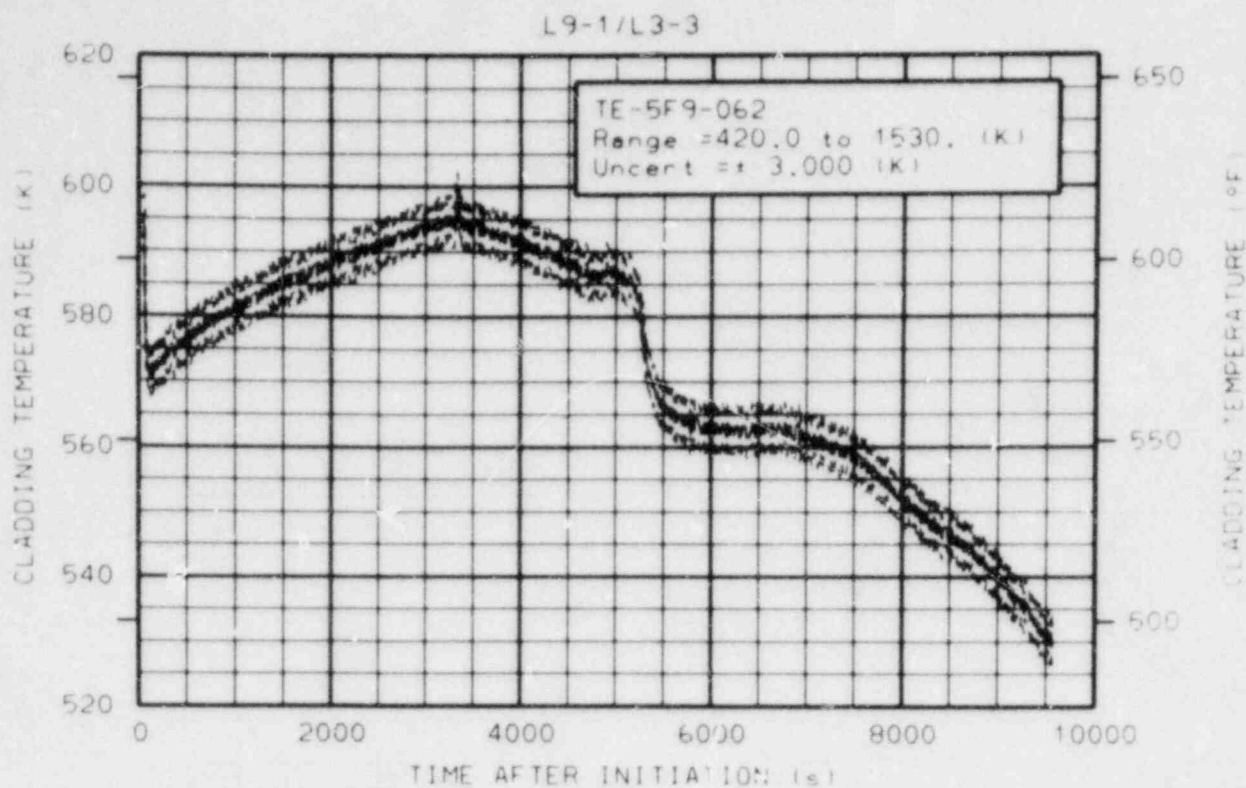


Figure 30-11. Cladding temperature in reactor vessel at Fuel Assembly 5, Row F, Column 9 at 1.57 m above bottom of fuel rod (TE-5F9-062).

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2. B. W. Sherron, *Generic Assessment of Delayed Reactor Coolant Pump Trip During Small Break Loss-of-Coolant Accidents in Pressurized Water Reactors*, NUREG-0623, November 1979.
3. F. S. Miyasaki, *Digital Data Acquisition Program*, ANCR-1250, August 1975.
4. *Proposed ANS Standard 5.1 Decay Heat Power in Light Water Reactors*, September 1978.

APPENDIX A
SYSTEM CONFIGURATION

APPENDIX A

SYSTEM CONFIGURATION

The Loss-of-Fluid Test (LOFT) facility has been designed to simulate the major components and system responses of a commercial pressurized water reactor (PWR) during a loss-of-coolant accident. The experimental assembly includes five major subsystems which have been instrumented such that system variables can be measured and recorded during a loss-of-coolant experiment. The subsystems include (a) the reactor vessel, (b) the intact loop, (c) the broken loop, (d) the blowdown suppression system, and (e) the emergency core cooling system (ECCS). The LOFT major components are shown in Figure A-1.

The LOFT reactor vessel has an annular downcomer, a lower plenum, lower core support plates, a nuclear core, and an upper plenum. The downcomer is connected to the cold legs of the intact and broken loops and contains two instrument stalks. The upper plenum is connected to the hot legs of the intact and broken loops. The core contains 1300 unpressurized nuclear fuel rods arranged in five square (15 x 15 assemblies) and four triangular (corner) fuel modules, shown in Figure A-2 and described in Reference A-1. The center assembly is highly instrumented. Two of the corner and one of the square assemblies are not instrumented. The fuel rods have an active length of 1.67 m and an outside diameter of 10.72 mm.

The fuel consists of UO_2 sintered pellets with an average enrichment of 4.0 wt% fissile uranium (^{235}U) and with a density that is 93% of theoretical density. The fuel pellet diameter and length are 9.29 and 15.24 mm, respectively. Both ends of the pellets are dished with the total dish volume equal to 2% of the pellet volume. The cladding material is zircaloy-4. The cladding inside and outside diameters are 9.48 and 10.72 mm, respectively.

The intact loop simulates three loops of a commercial four-loop PWR and contains a steam generator, two primary coolant pumps in parallel, a pressurizer, a venturi flowmeter, and connecting piping. The break location for Experiment L9-1/L3-3 is the experiment power-operated relief valve (PORV) located in the pressure relief line which

connects the pressurizer to the blowdown suppression tank (BST). This valve was installed in parallel with the plant PORV.

The broken loop consists of a hot leg and a cold leg that are connected to the reactor vessel and the BST header. Each leg consists of a break plane orifice, a quick-opening blowdown valve (QOBV), a recirculation line, an isolation valve, and connecting piping. The recirculation lines establish a small flow from the broken loop to the intact loop and are used to warm up the broken loop. In this experiment, the QOBVs and isolation valves remained closed because the break was in the pressurizer relief line. The broken loop hot leg also contains a simulated steam generator and a simulated pump. These simulators have hydraulic orifice plate assemblies which have similar (passive) resistances to flow as an active steam generator and a pump.

The blowdown suppression system is comprised of the BST header, the BST, the nitrogen pressurization system, and the BST spray system. The blowdown header is connected to the suppression tank downcomers which extend inside the tank below the water level. The header is also directly connected to the BST vapor space to allow pressure equilibration. The nitrogen pressurization system is supplied by the LOFT inert gas system and uses a remote controlled pressure regulator to establish and maintain the specified BST initial pressure. The spray system consists of a centrifugal pump that discharges through a heatup heat exchanger and any of three spray headers or a pump recirculation line that contains a cooldown heat exchanger. The spray pump suction can be aligned to either the BST or the borated water storage tank. The three spray headers have flow rate capacities of 1.3, 3.8, and 13.9 L/s, respectively, and are located in the BST along the upper centerline. For Experiment L9-1/L3-3, the BST header was not used to carry flow. Break flow entered the BST via a 4-in. pipe that was connected to the north end of the BST, and was discharged below the water level. The BST spray pump suction was connected to the BST, and the liquid in the BST was recirculated at full spray pump capacity.

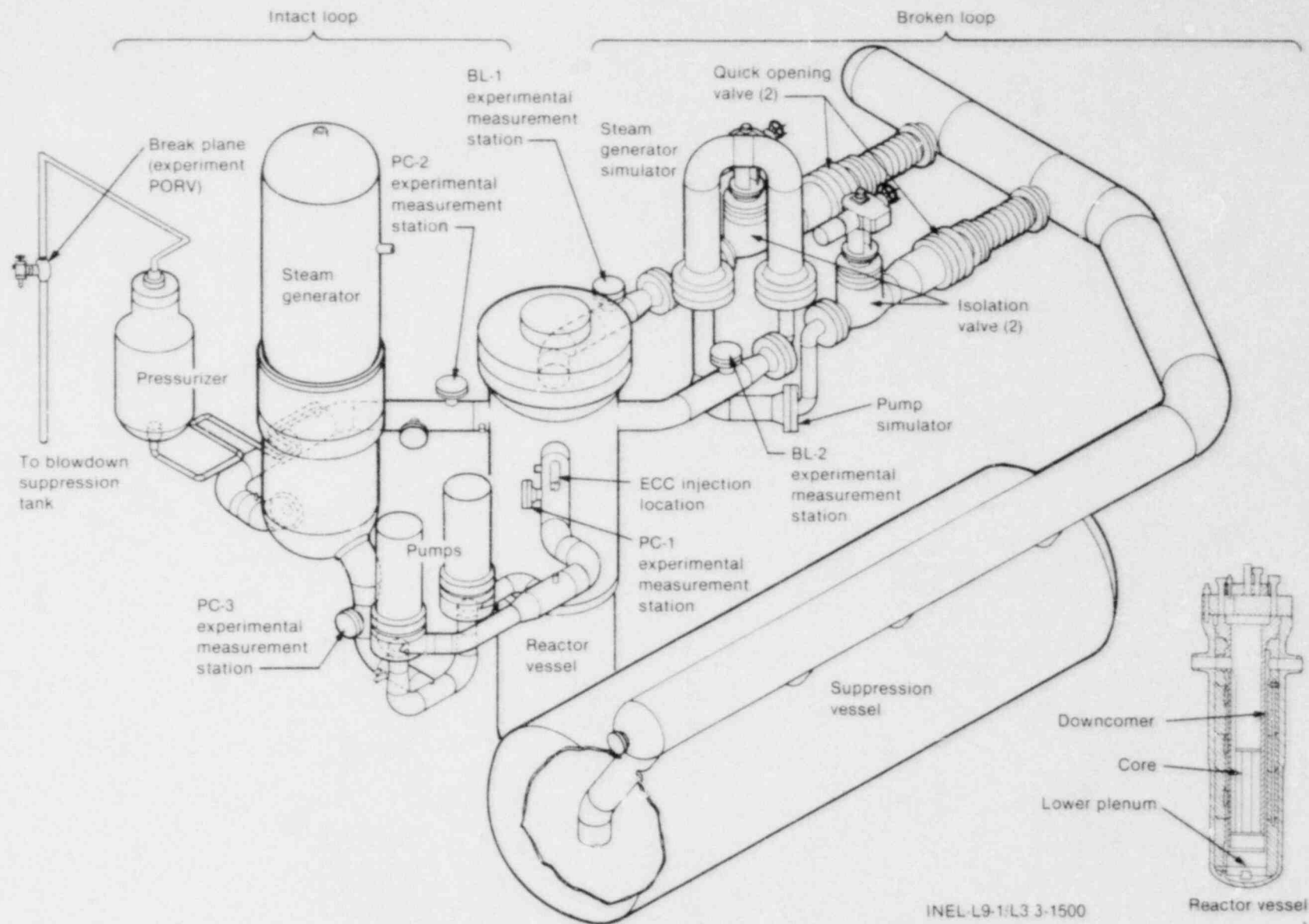


Figure A-1. LOFT major components.

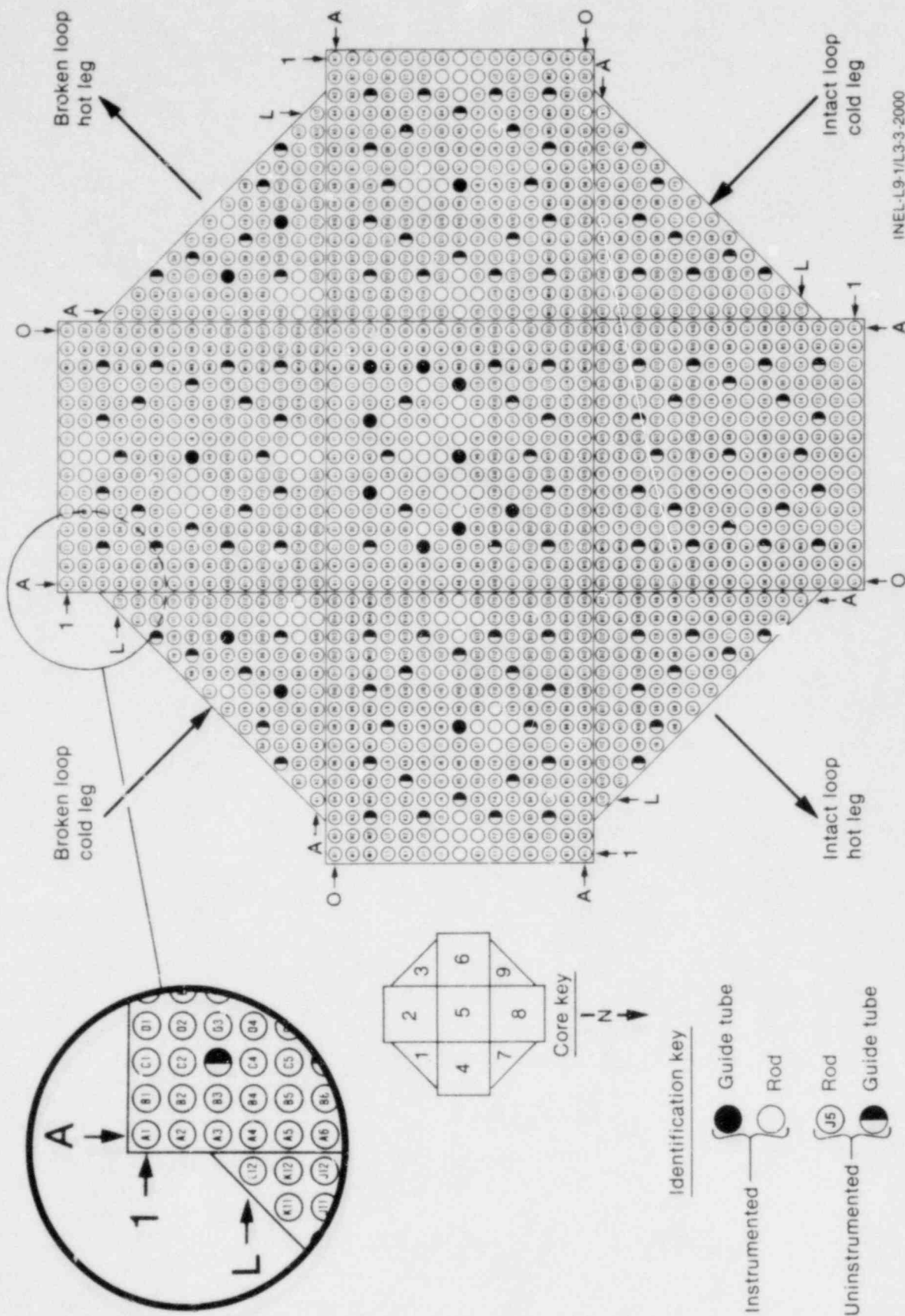


Figure A-2. LOFT Core 1 configuration showing rod designations.

The LOFT ECCS simulates the ECCS of a commercial PWR. It consists of two accumulators, a high-pressure injection system, and a low-pressure injection system. Each system is

arranged to inject scaled flow rates of emergency core coolant directly into the primary coolant system. The ECCS was not used during Experiment L9-1/ L3-3.

REFERENCE

- A-1. M. L. Russell, *LOFT Fuel Modules Design, Characterization, and Fabrication Program*, TREE-NUREG-1131, June 1977.

APPENDIX B
MEASUREMENTS AND INSTRUMENTATION

APPENDIX B

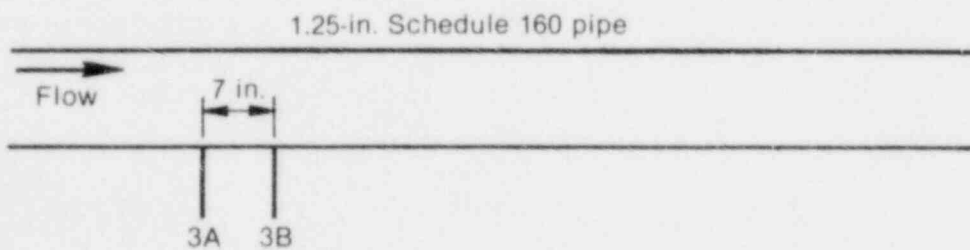
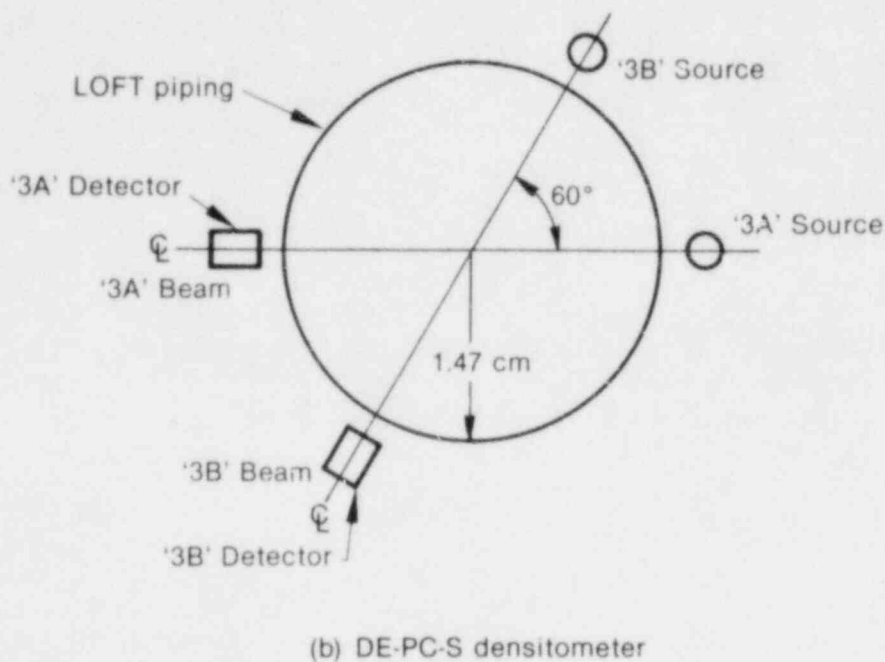
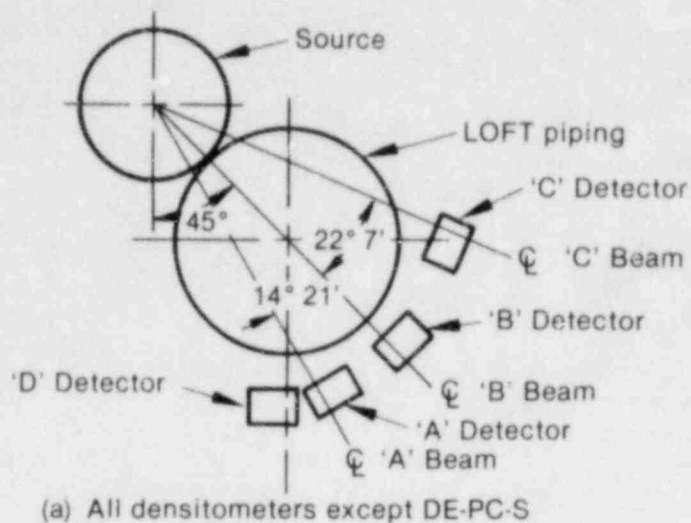
MEASUREMENTS AND INSTRUMENTATION

The Loss-of-Fluid Test (LOFT) instrumentation system is designed to measure and record the important parameters and events that occur during an experiment. The parameters measured and types of instruments used are

1. Temperatures at all major locations in the system are obtained from thermocouples and resistance temperature detectors.
2. Pressure measurements are obtained with strain gauge transducers with pressure transmission lines connecting the transducers to the measurement points.
3. Differential pressures are measured by strain gauge transducers with double chambers. The transducers are externally located and connected to the measurement points with pressure transmission lines.
4. Flow velocity is measured by turbine flowmeters.
5. Momentum flux is measured by drag discs and drag screens. The data presented for fluid velocity and momentum flux are based on the following flow areas at the instrument locations:

Instrument	Flow Area (m ²)
ME-2ST-1	0.141
FE-5UP-1 ME-3UP-1 and ME-5UP-1	0.125
FE-PC-S2 ME-PC-S2	0.000682
FE-PC-2A, -2B, and -2C ME-PC-2A, -2B, and -2C	0.0634

6. Fluid density is measured by gamma densitometers. All but the pressurizer relief line gamma densitometer consist of a ⁶⁰Co source and three detectors as shown in Figure B-1. Each of the three detectors sees a collimated gamma ray beam, emitted from a single source, that has passed through the pipe. Each of these densitometers also has a detector (D) located so that it measures background radiation continuously. The relief line gamma densitometer has two combined ²⁴¹Am-⁵⁷Co sources and two detectors; no background detector was used. Each detector sees a collimated gamma ray beam emitted from a single source. The two gamma ray beams pass horizontally through a vertical section of the pressurizer relief line. They are 60° apart radially and 17.8 cm apart axially. The attenuation of the gamma rays varies inversely with the density of the fluid in the pipe. The DE-PC-3 and DE-PC-S3 densitometers are located in vertical piping; the rest of the densitometers are located in horizontal piping. Figure B-1 shows the gamma densitometer configuration relative to the piping.
7. Liquid levels are obtained by means of (a) differential pressure transducers in the pressurizer, steam generator simulator, accumulator, steam generator secondary side, pump suction piping, reactor vessel upper plenum, and blowdown suppression tank; and (b) liquid detectors which sense the conductivity of the fluid near each of a series of electrical contacts in the reactor vessel.
8. Control rod position is indicated by means of proximity switches. The circuitry associated with the proximity switches controls a set of lamps. Each set of lamps consists of a "rod bottom" lamp and four "rod location" lamps. The rod bottom lamp lights only when the control rod is bottomed. Each rod location lamp lights as the leadscrew on the control rod passes its



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Figure B-1. Relation of source and detectors to pipe for gamma densitometers.

switch position during withdrawal, and it remains lit whenever the leadscrew is above this position.

9. Valve positions (analog indication from 0 to 100% of opening) are measured by either resistance potentiometers or differential transformers.
10. Mechanical pump speed is measured by an eddy current displacement transducer that uses a slotted metallic target attached to the top of the pump motor shaft. The target contains six asymmetrical slots so that pump speed can be determined. Electrical pump power is measured by a watt transducer.
11. The steady state local linear heat generation rate is measured by two types of instruments, as described below:
 - a. Each self-powered neutron detector consists of a cylindrical ^{59}Co emitter, a layer of aluminum oxide for electrical insulation, and an outer sheath of Inconel. The cable connected to the detector consists of two Inconel wires in an Inconel sheath with magnesium oxide insulation. One of the wires is connected to the cobalt emitter and the other is open ended. The open-ended wire gives a background subtraction signal to compensate for the radiation sensitivity of the cable.
 - b. Neutron flux measurements are taken with a traversing in-core probe at four guide tube locations in the core. This instrument consists of a ^{235}U fission chamber attached to a flexible cable and its own data recording system. The probe was withdrawn and stored outside the core prior to experiment initiation.

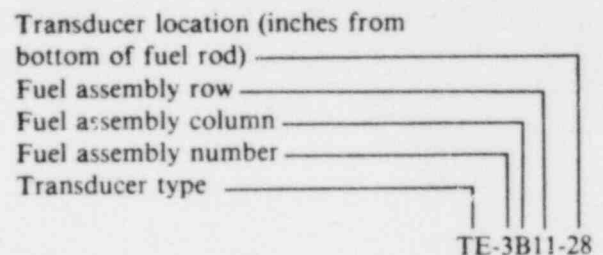
The data acquisition and visual display system is used to record measured data from the various instrumentation systems on a combination of digital recorders, wide-band frequency modulation (FM) tape recorders, and oscillographic recorders.^{B-1} Redundant records are made where use dictates more than one recording mode or where an extra measure of assurance is desired for critical measurements.

A digital computer is used to collect the experiment data in a multiplexed format at the LOFT facility and to perform equipment calibrations, posttest data reduction, and plotting.^{B-2} The recorded FM data are converted into digital form, and then demultiplexed to be compatible with the CDC CYBER 176 computer system.

The CDC CYBER 176 computer system is used to further reduce the data. Calibration factors are first applied to produce data plots in engineering units so that engineering specialists can examine each channel for discrepancies or unexpected events. Where possible, instrument channel outputs and computed variables are compared with previous experiments, corresponding parameter channels, and calculated quantities. Instruments are labeled as "Qualified" if the measurement comparisons are determined to be within the accuracy of the particular instrument.

Most transducers were calibrated under laboratory conditions prior to installation in the LOFT system. Verification of calibration constants is accomplished by special tests performed during heatup and by analysis of initial conditions data. In addition, post-experiment checks are performed to pinpoint questionable data and to verify data consistency. Appendix C discusses the techniques used to perform data consistency checks.

Figure B-2 shows a piping schematic indicating instrument locations. Table B-1 gives the nomenclature for LOFT experimental and process instrumentation. Both types of instrumentation are included in this report. Thermocouples and neutron flux detectors located in the nuclear core have special identification. Each of these transducers has been given an identification number which identifies the type of transducer and its location within the core as follows:



Figures B-3 and B-4 show isometric views of the major system components with instrument locations indicated. Figures B-5 through B-17 give

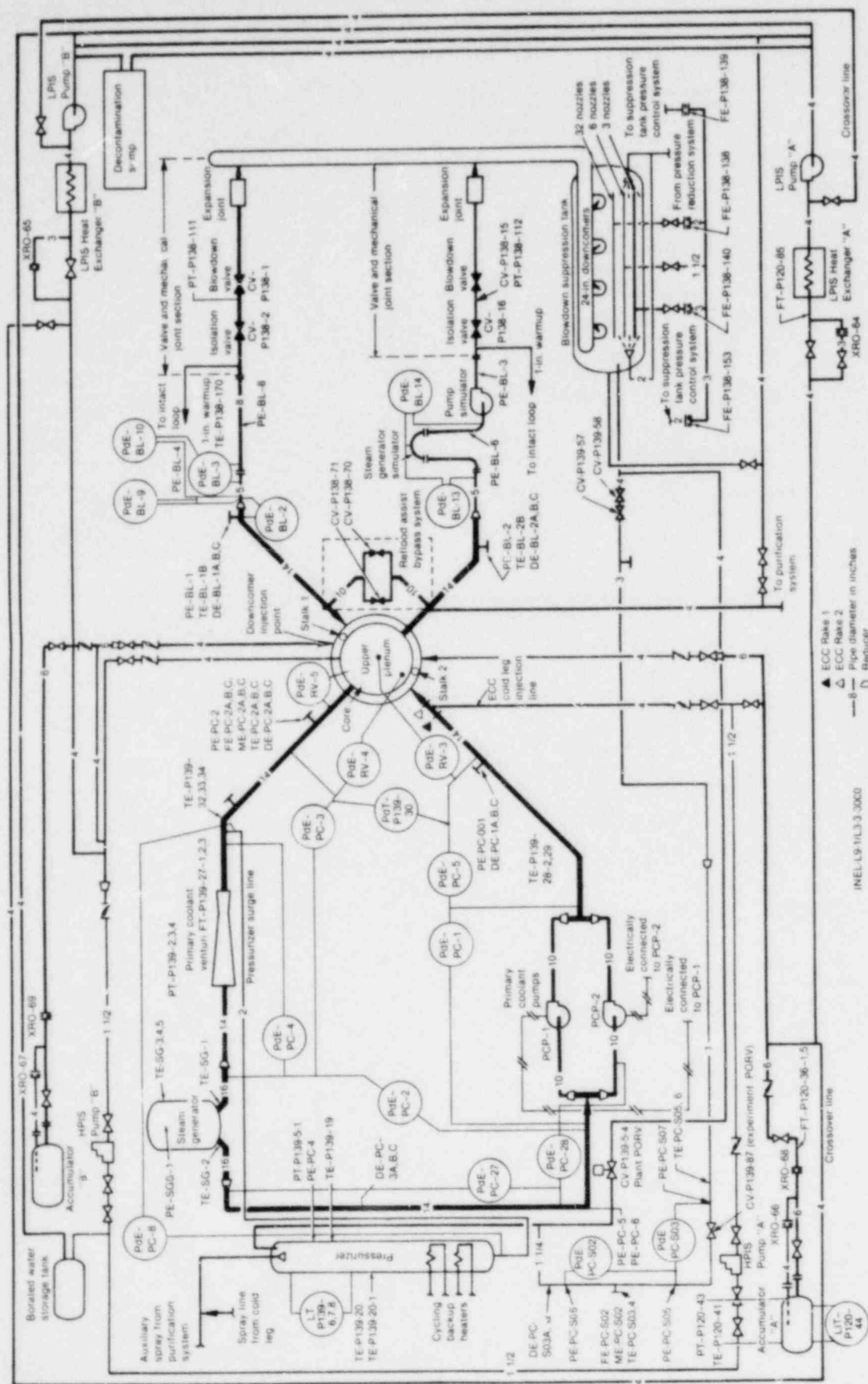


Figure B-2. LOFT piping schematic with instrumentation.

TABLE B-1. NOMENCLATURE FOR LOFT INSTRUMENTATION

Designations for the Different Types of Experimental Instruments

AE	Accelerometer
DE	Densitometer
DIE	Displacement element
FE	Coolant flow element
LD	Density compensated liquid level element
LE	Coolant level element
ME	Momentum flux detector
NE	Neutron detector
PCP	Primary coolant pump
PdE	Differential pressure element
PE	Pressure element
RPE	Pump speed element
TE	Temperature element

Designations for the Different Experimental Systems, Except the Core

BL	Broken loop
LP	Lower plenum
PC	Primary coolant intact loop
PC-S	Spool piece in pressurizer relief line
RV	Reactor vessel
SG	Steam generator
SGS	Steam generator secondary
1ST	Downcomer Stalk 1
2ST	Downcomer Stalk 2
SV	Suppression tank
UP	Upper plenum

Designations for the Different Types of Process Instruments

CV	Control valve
FE	Flow element
FT	Flow transmitter
LIT	Level indicating transmitter
LT	Liquid level transmitter
PdT	Differential pressure transmitter
PT	Absolute pressure transmitter
RE	Radiation element
TE	Temperature element
TT	Temperature transmitter

Designations for the Different Systems Associated with Process Instruments

P004	Secondary coolant system
P120	Emergency core cooling system
P128	Primary coolant addition and control system and high-pressure injection system
P138	Broken loop and pressure suppression system
P139	Intact loop
P141	Primary component cooling system
T-77, T-87	Power range

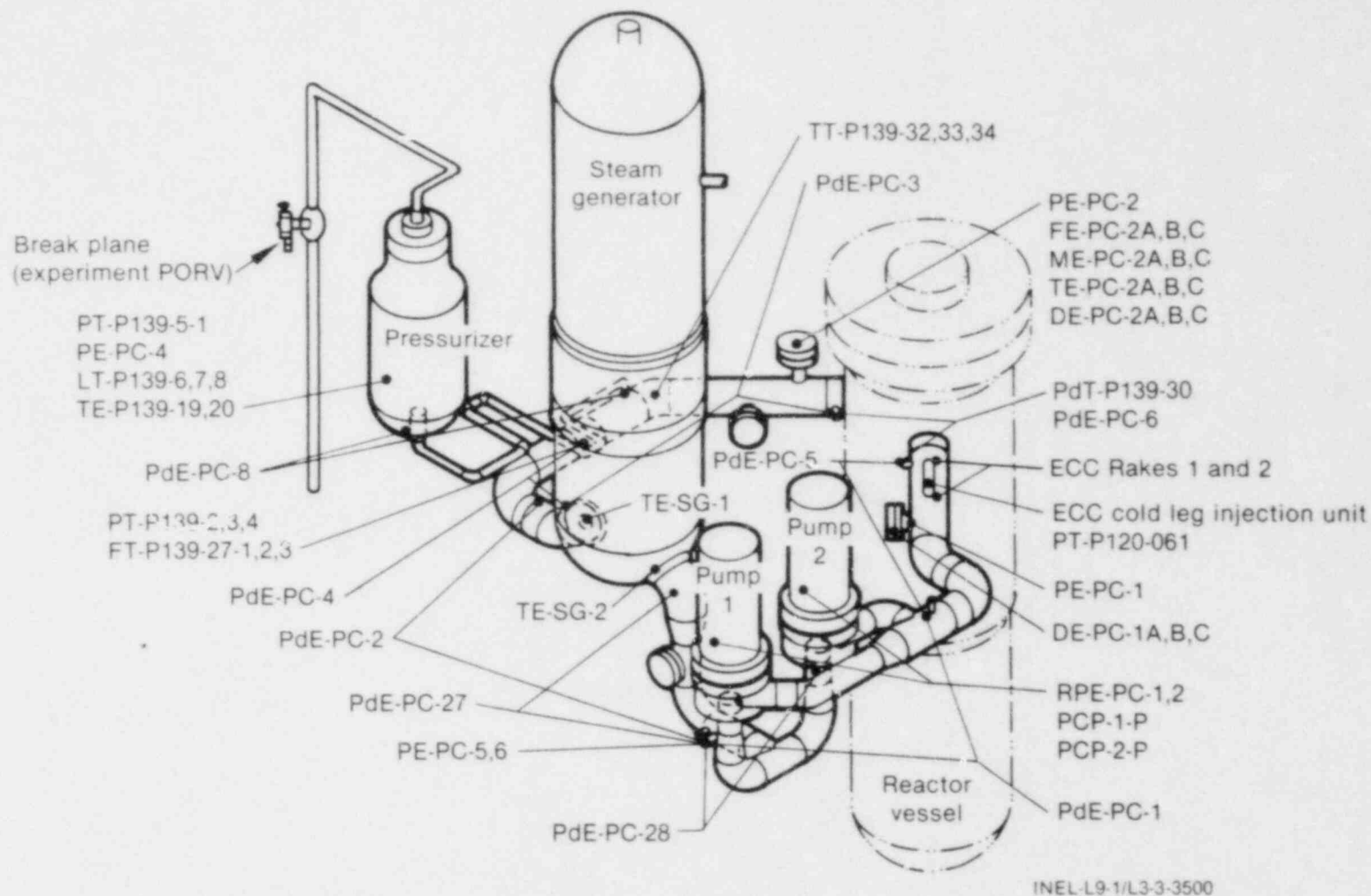


Figure B-3. LOFT thermal-hydraulic instrumentation for intact loop.

TABLE B-1. NOMENCLATURE FOR LOFT INSTRUMENTATION

Designations for the Different Types of Experimental Instruments

AE	Accelerometer
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DIE	Displacement element
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PdE	Differential pressure element
PE	Pressure element
RPE	Pump speed element
TE	Temperature element

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BL	Broken loop
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2ST	Downcomer Stalk 2
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P138	Broken loop and pressure suppression system
P139	Intact loop
P141	Primary component cooling system
T-77, T-87	Power range

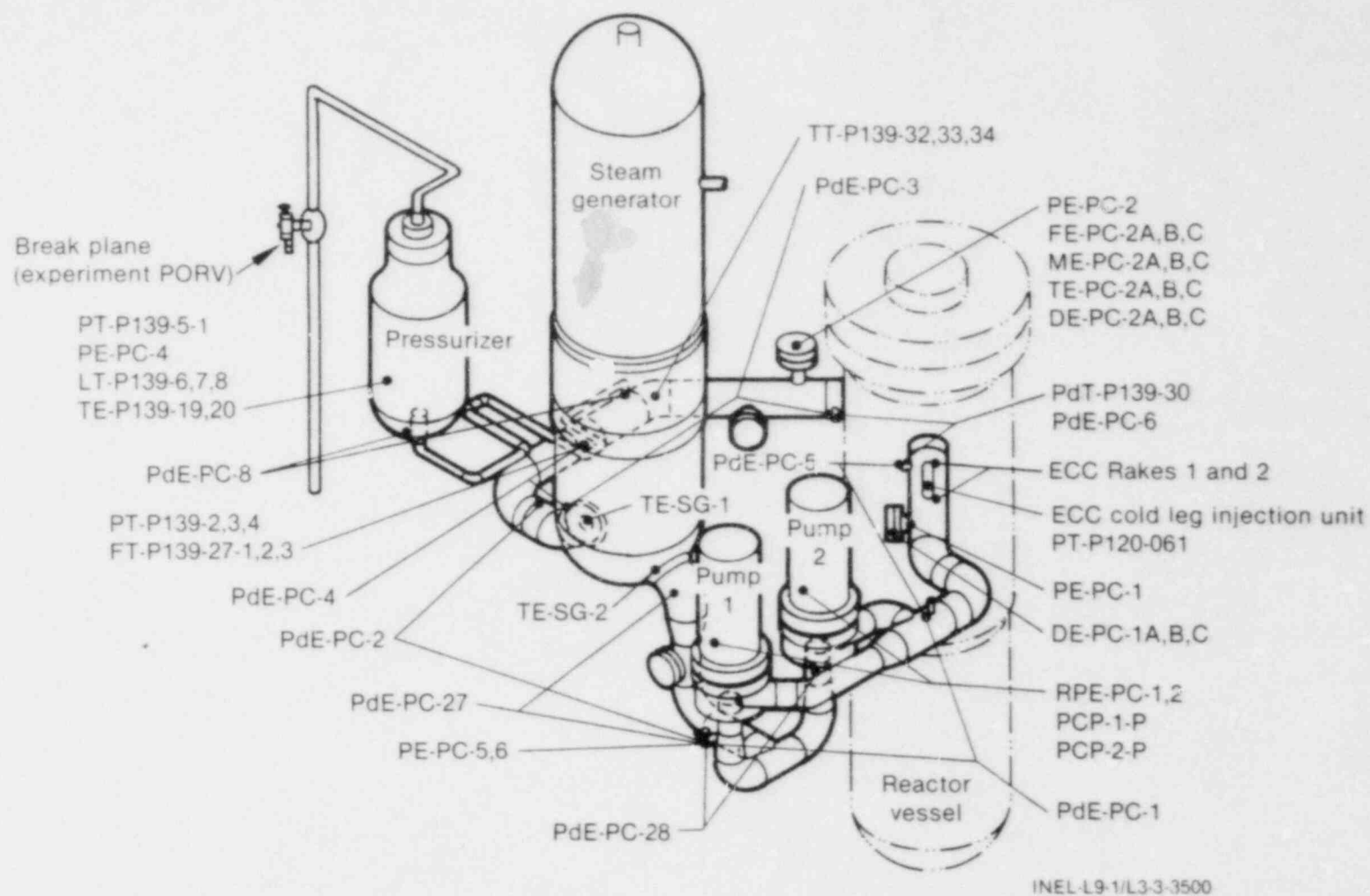


Figure B-3. LOFT thermal-hydraulic instrumentation for intact loop.

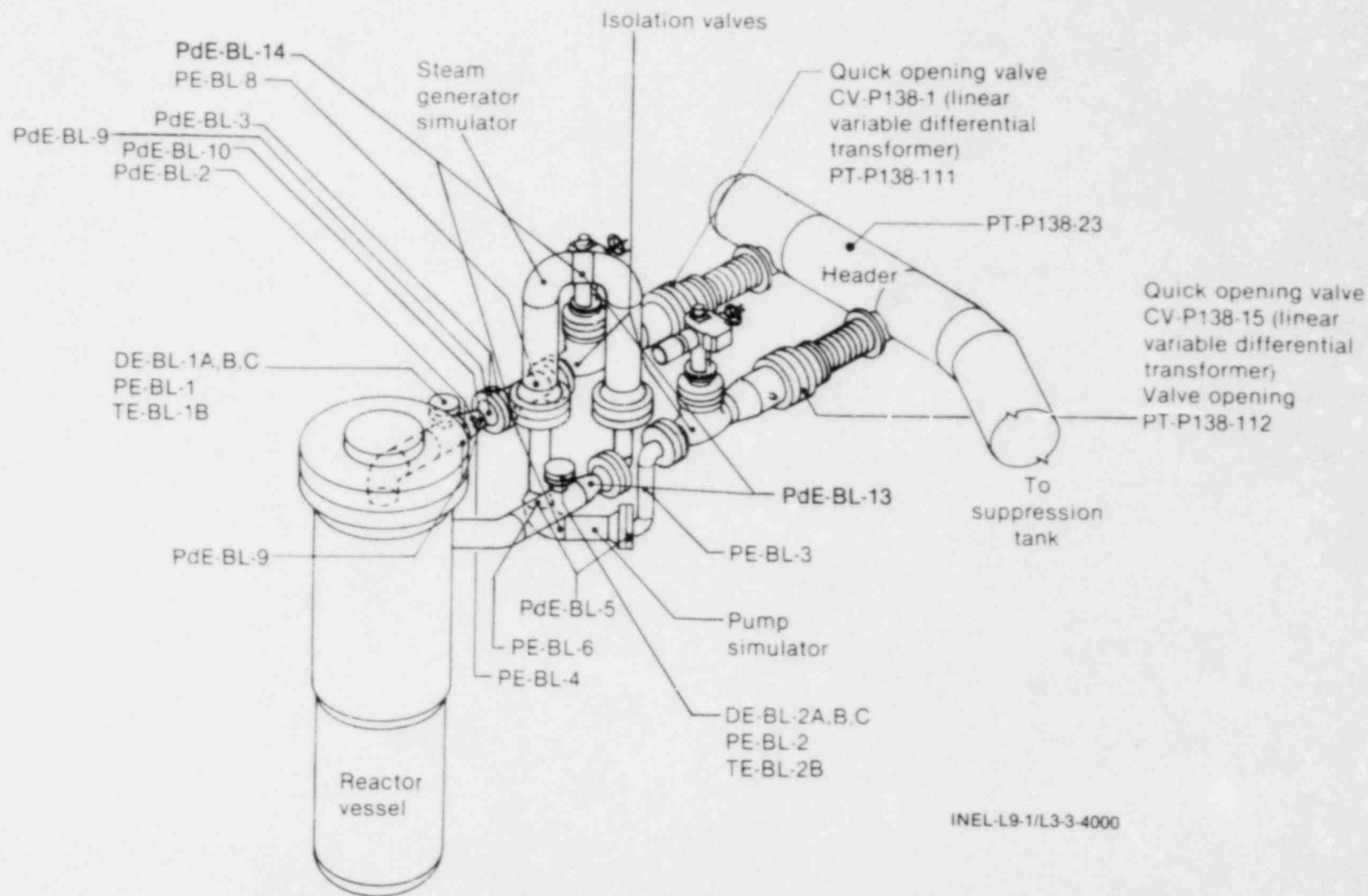


Figure B-4. LOFT thermal-hydraulic instrumentation for broken loop.

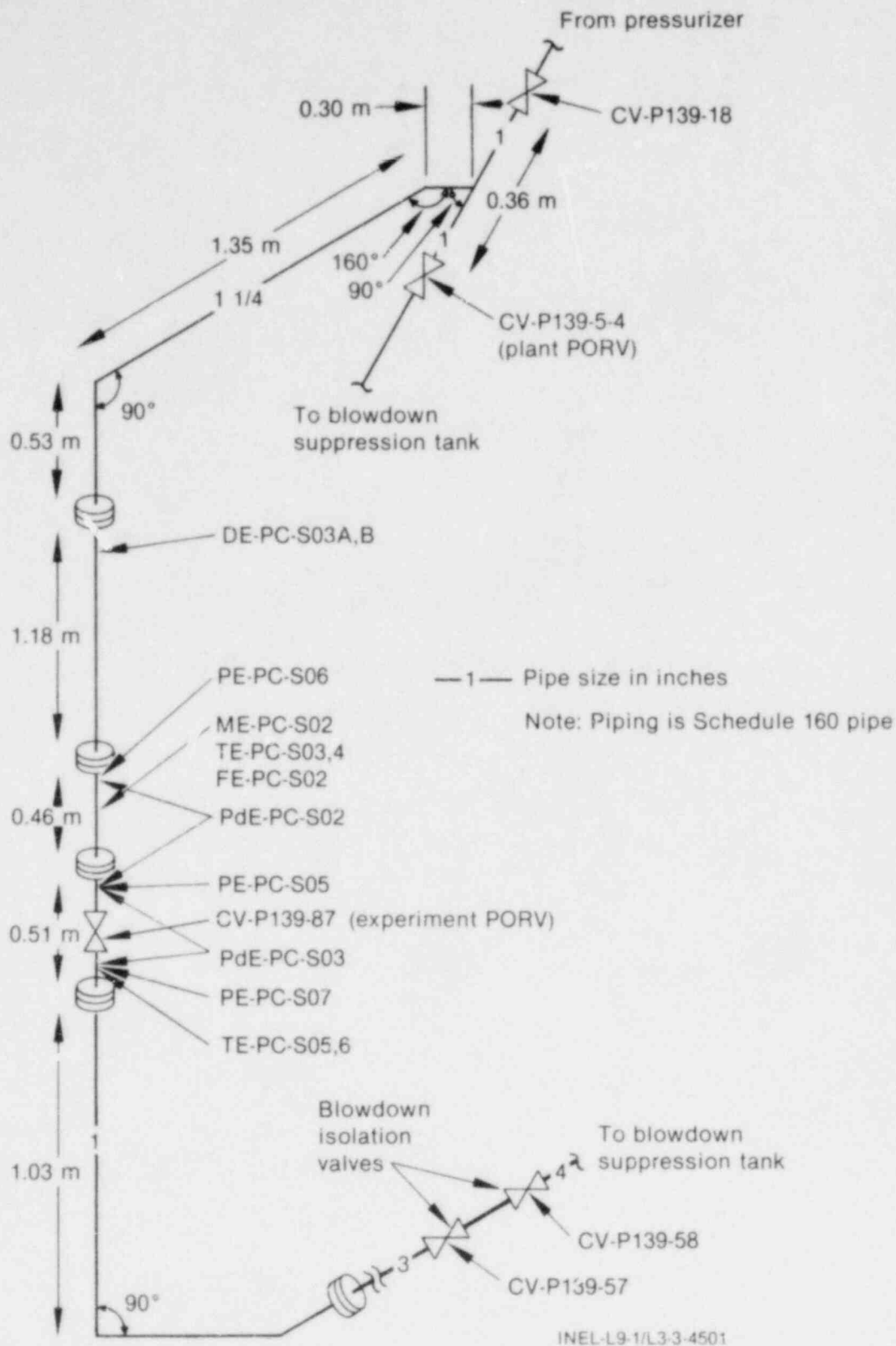
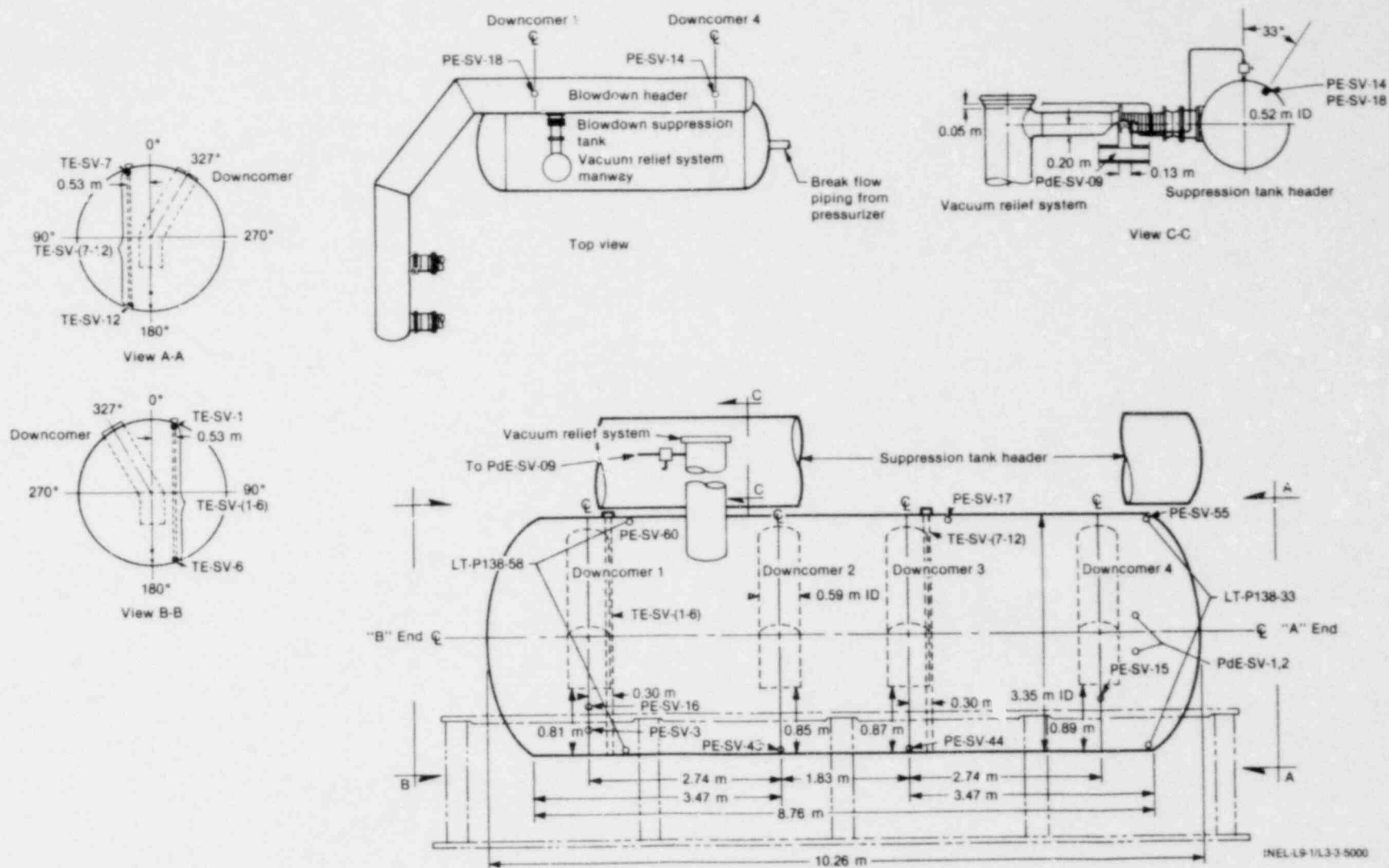


Figure B-5. LOFT thermal-hydraulic instrumentation for pressurizer relief line



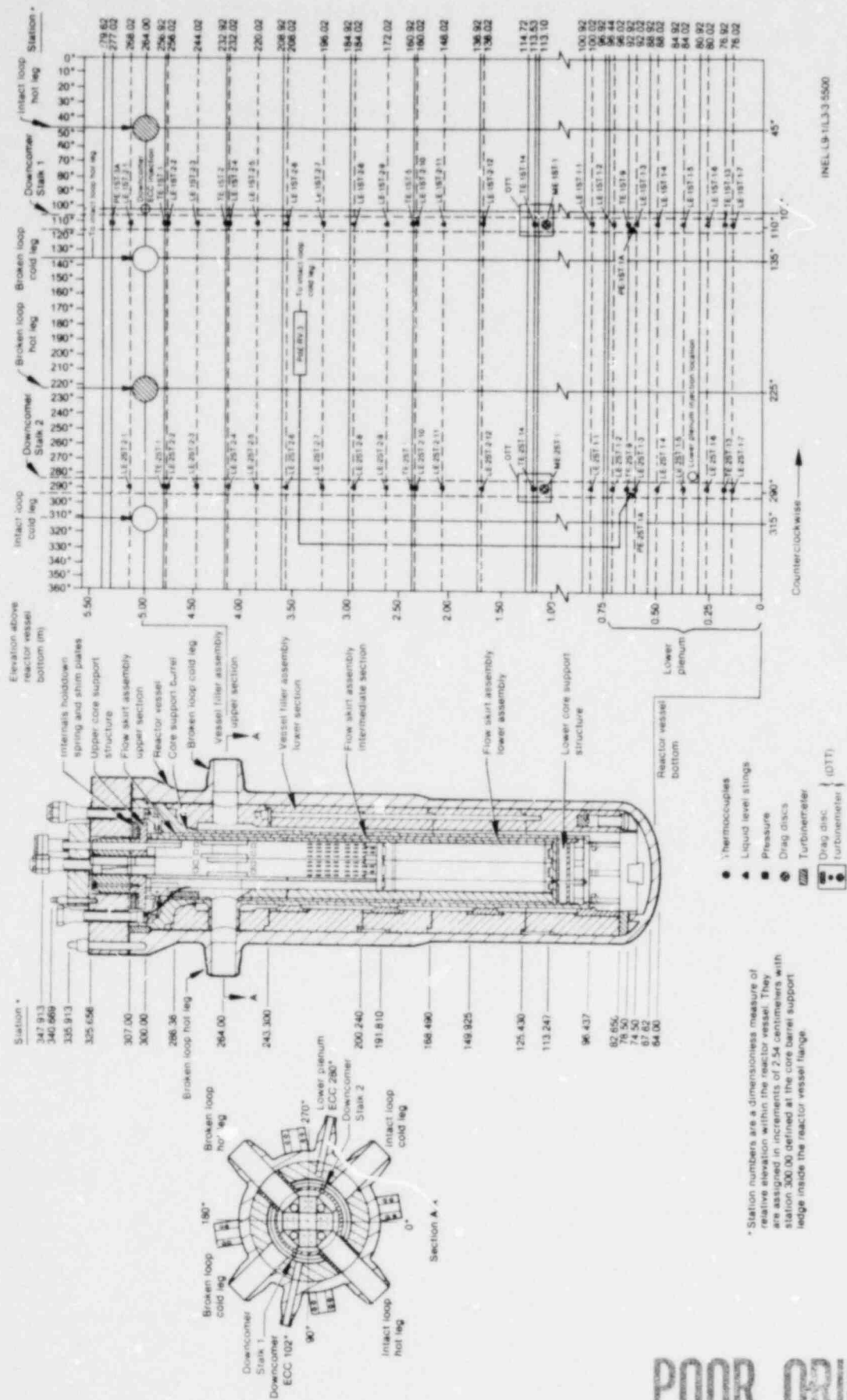


Figure B-7. LOFT reactor vessel instrumentation.

* Station numbers are a dimensionless measure of relative elevation within the reactor vessel. They are assigned in increments of 25.4 mm with Station 300.00 defined at the core barrel support ledge inside the reactor vessel flange.

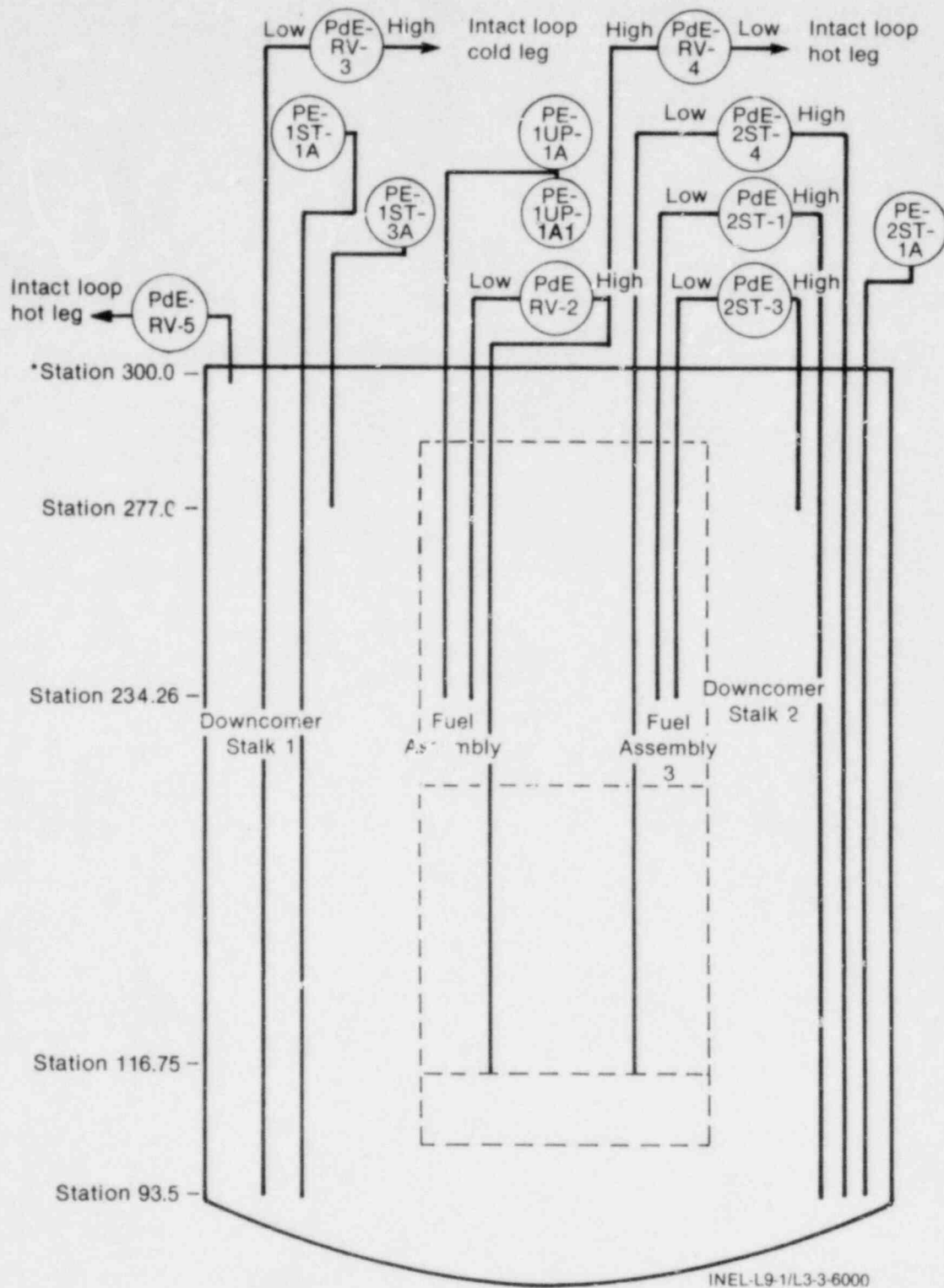
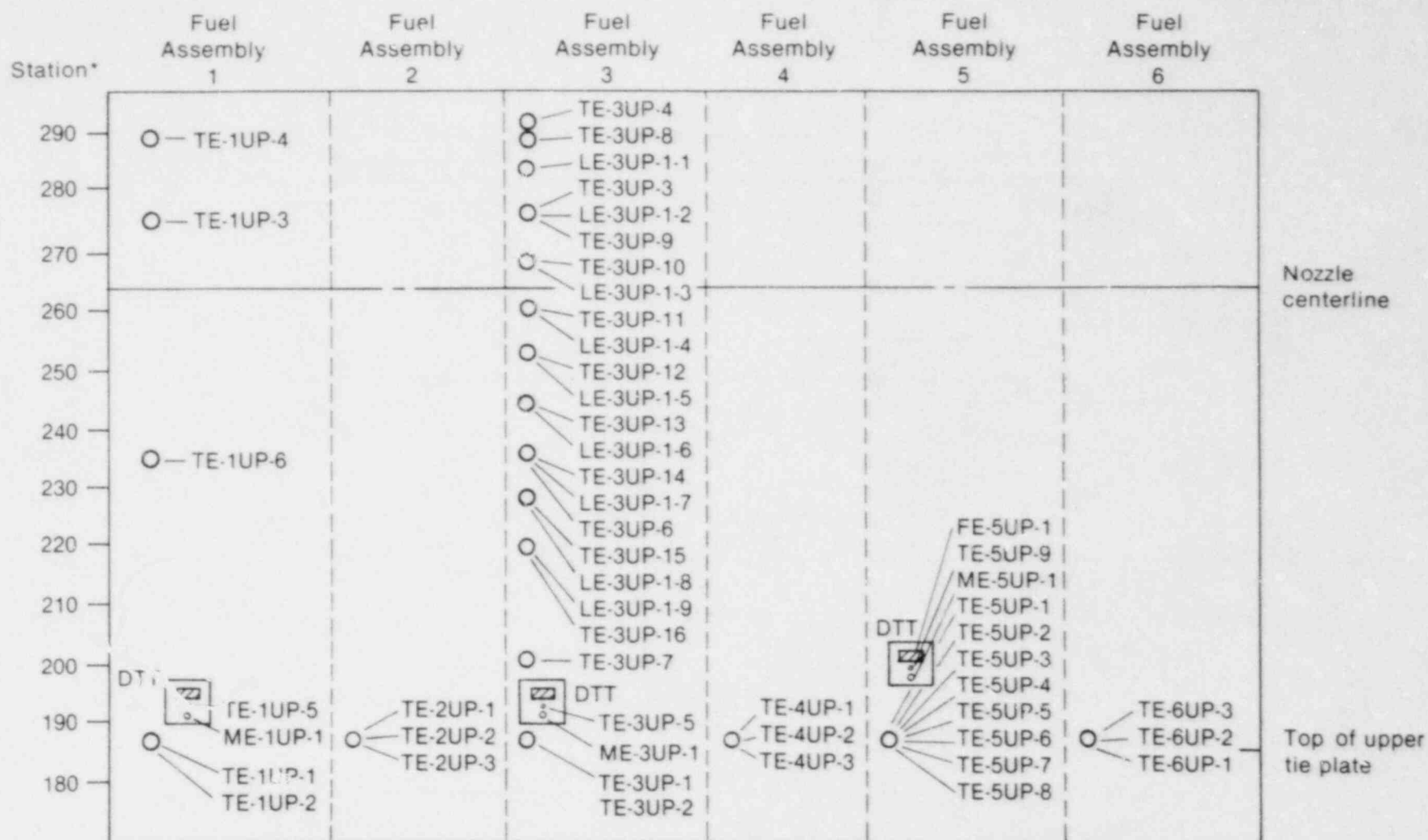


Figure B-8. LOFT reactor vessel pressure and differential pressure instrumentation.



*Station numbers are a dimensionless measure of relative elevation within the reactor vessel. They are assigned in increments of 25.4 mm with station 300.00 defined at the core barrel support ledge inside the reactor vessel flange.

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Figure B-9. LOFT reactor vessel upper plenum DTT, LE, and TE elevations.

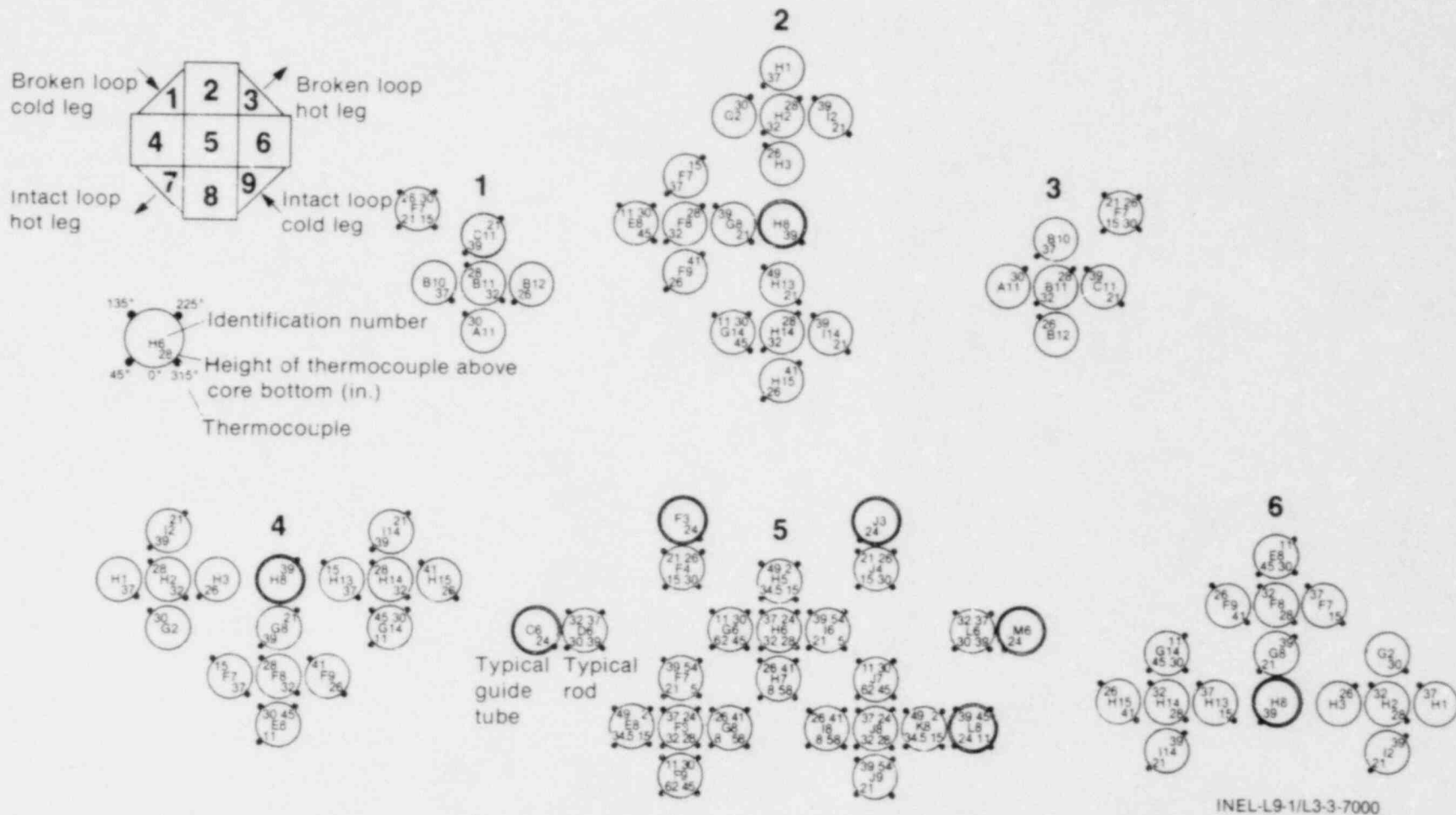


Figure B-10. In-core thermocouple locations for LOFT Core 1.

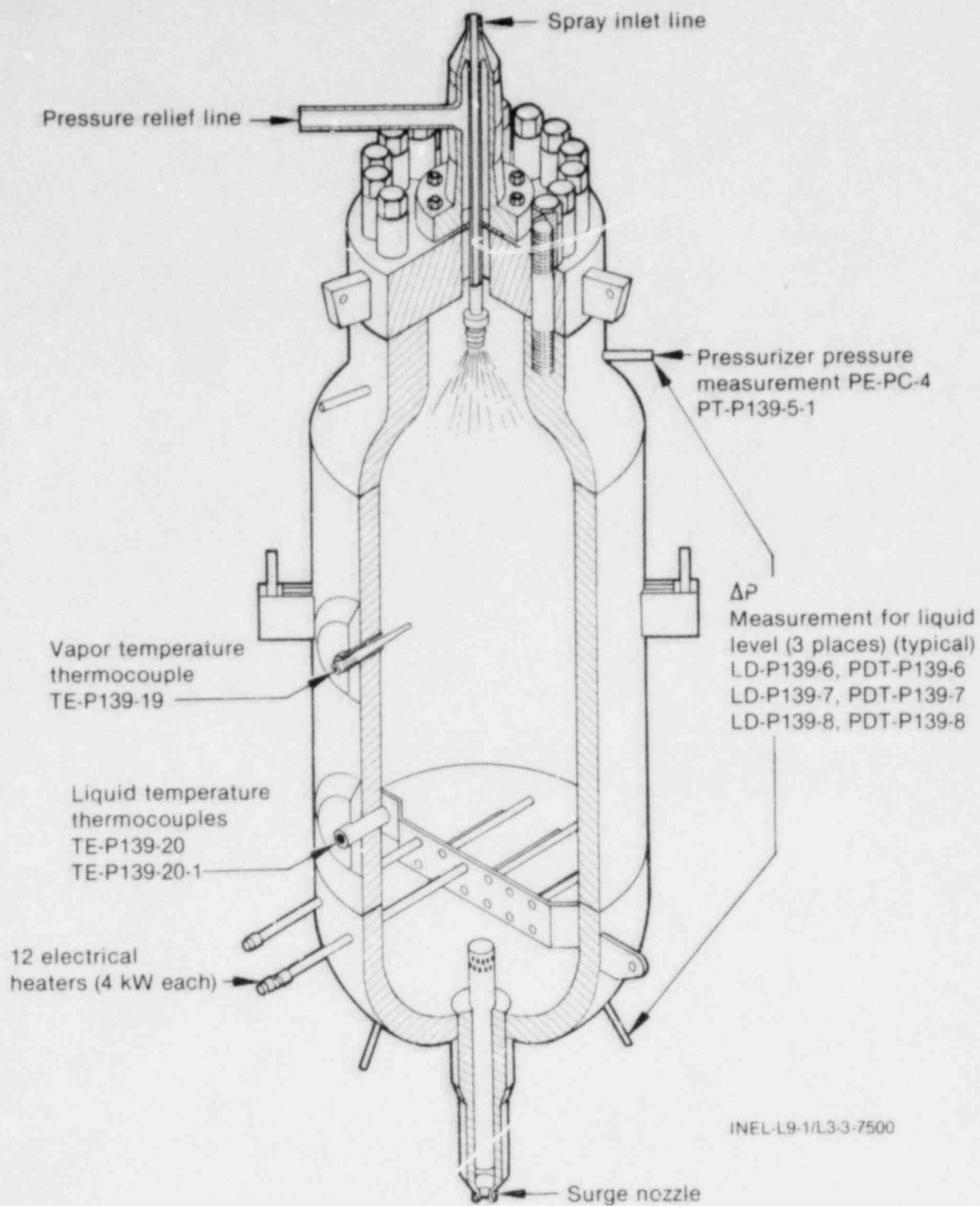


Figure P-11. LOFT pressurizer instrumentation.

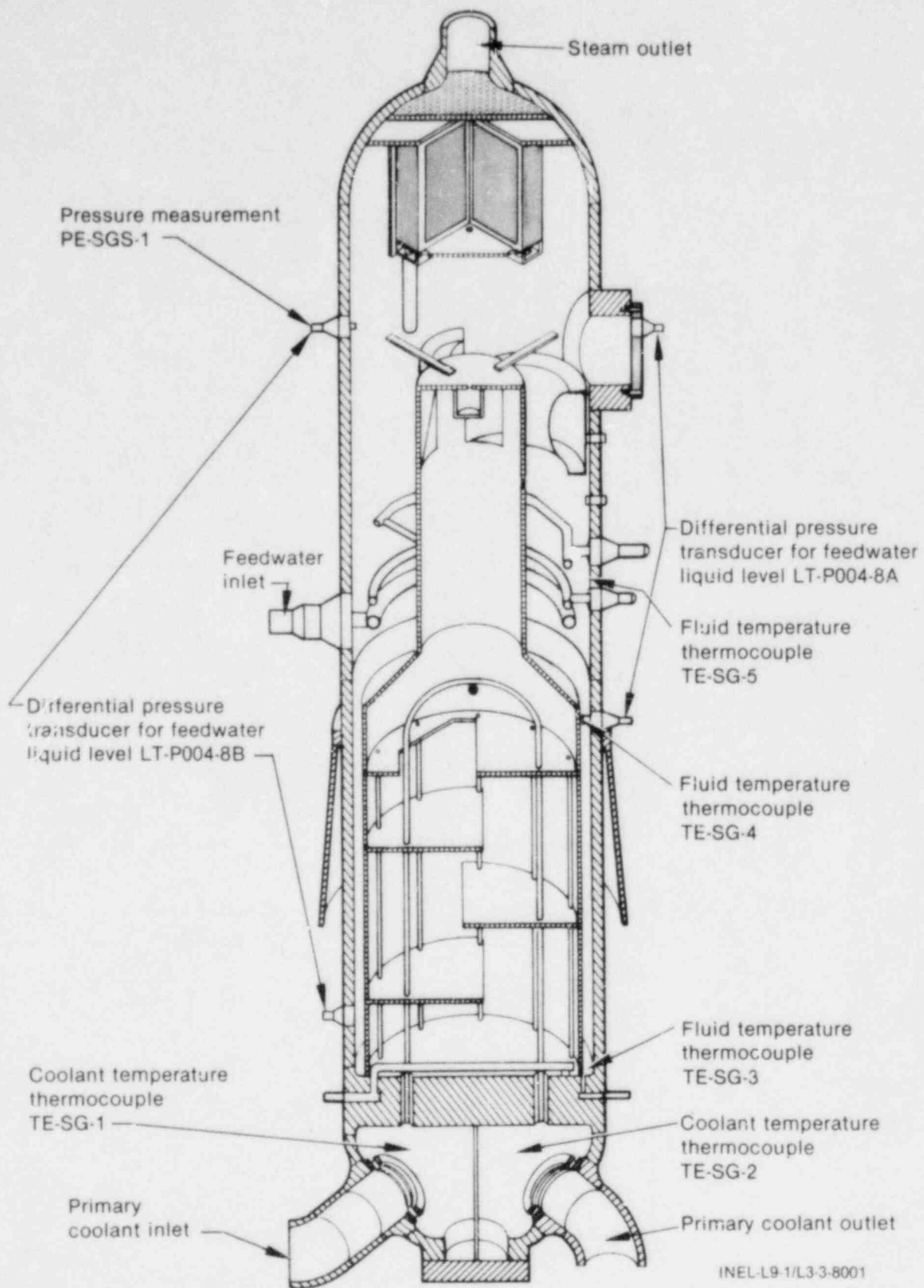
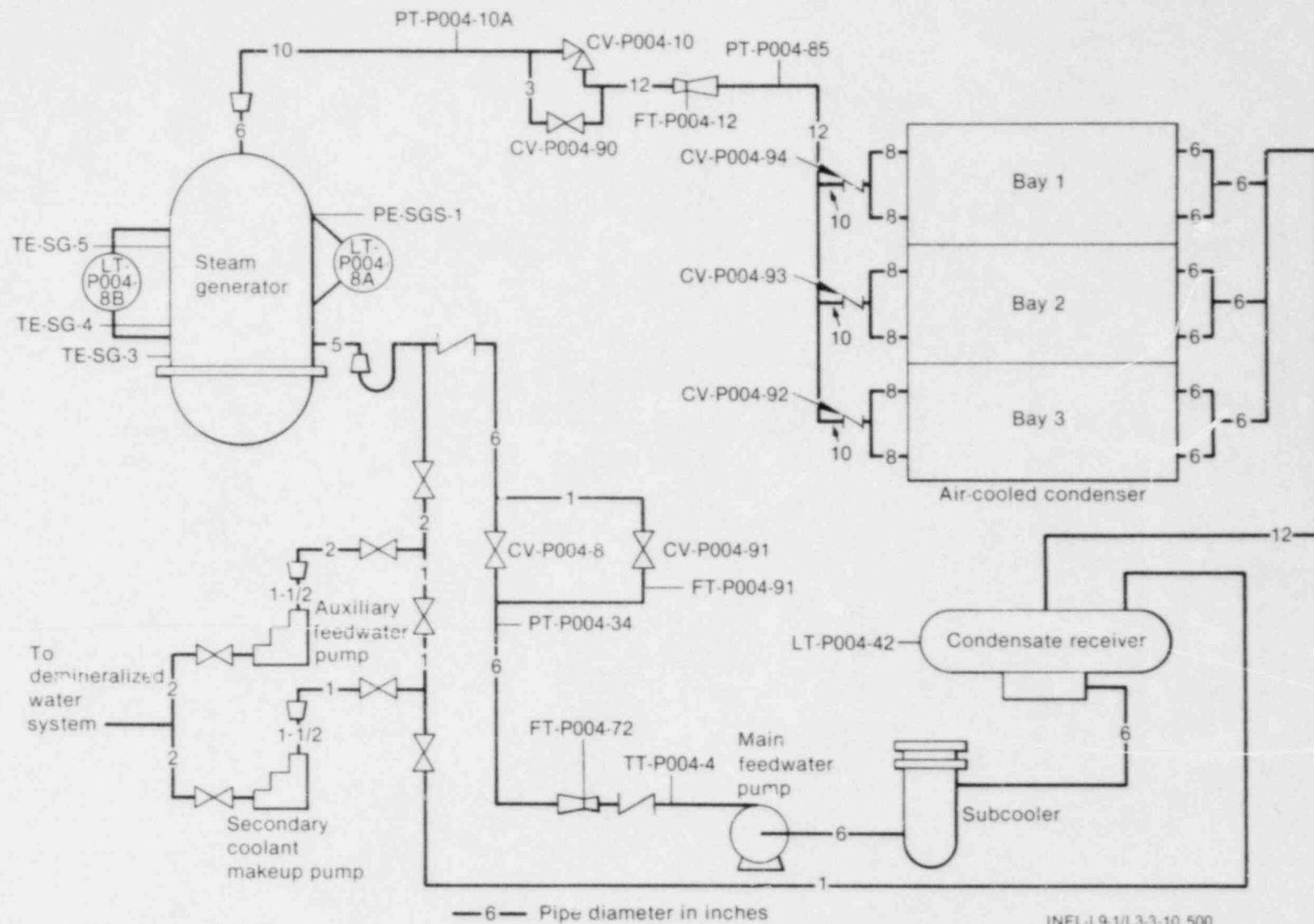


Figure B-12. LOFT steam generator instrumentation.



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Figure B-13. LOFT secondary coolant system instrumentation.

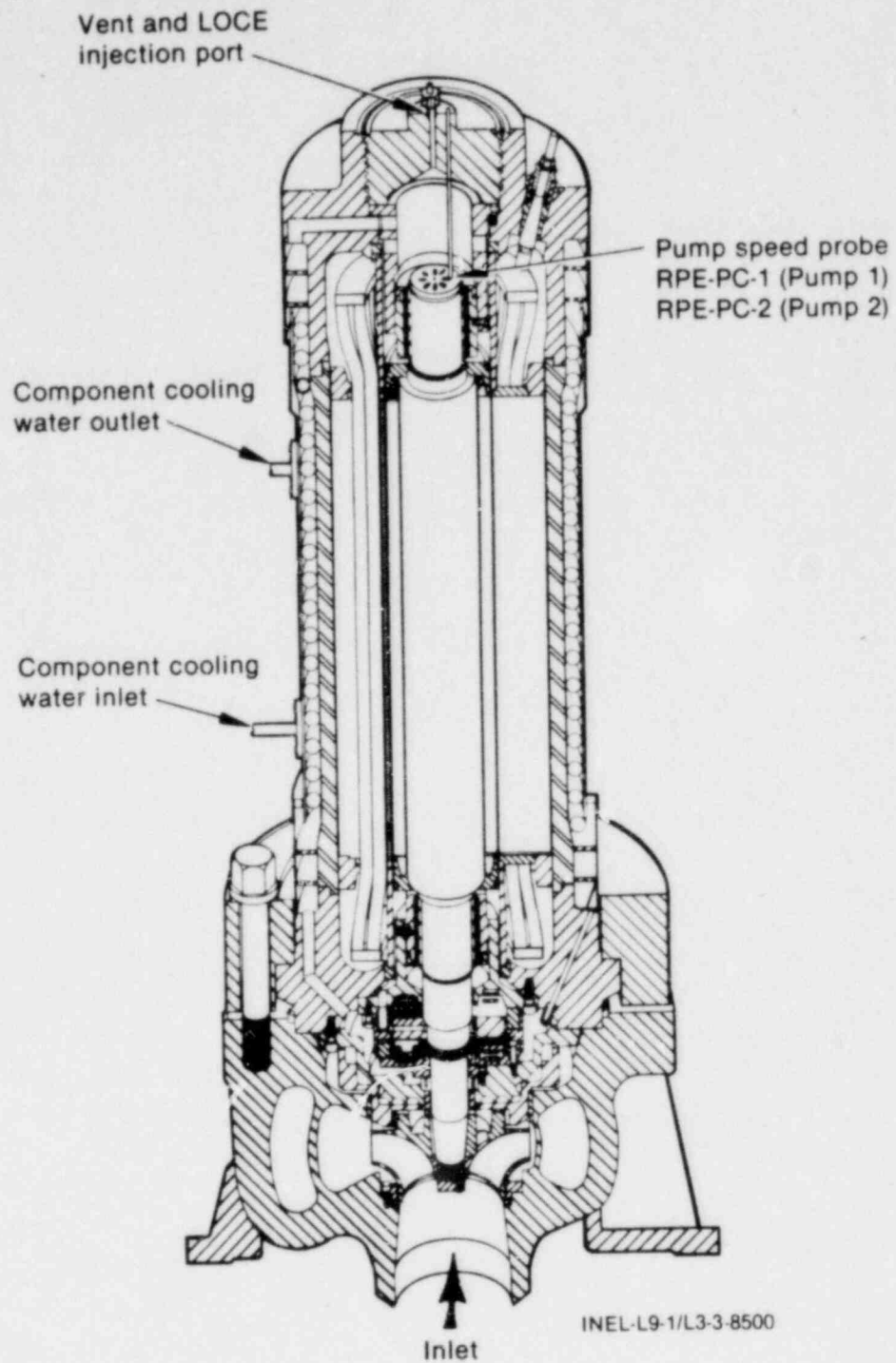


Figure B-14. LOFT primary coolant pump instrumentation.

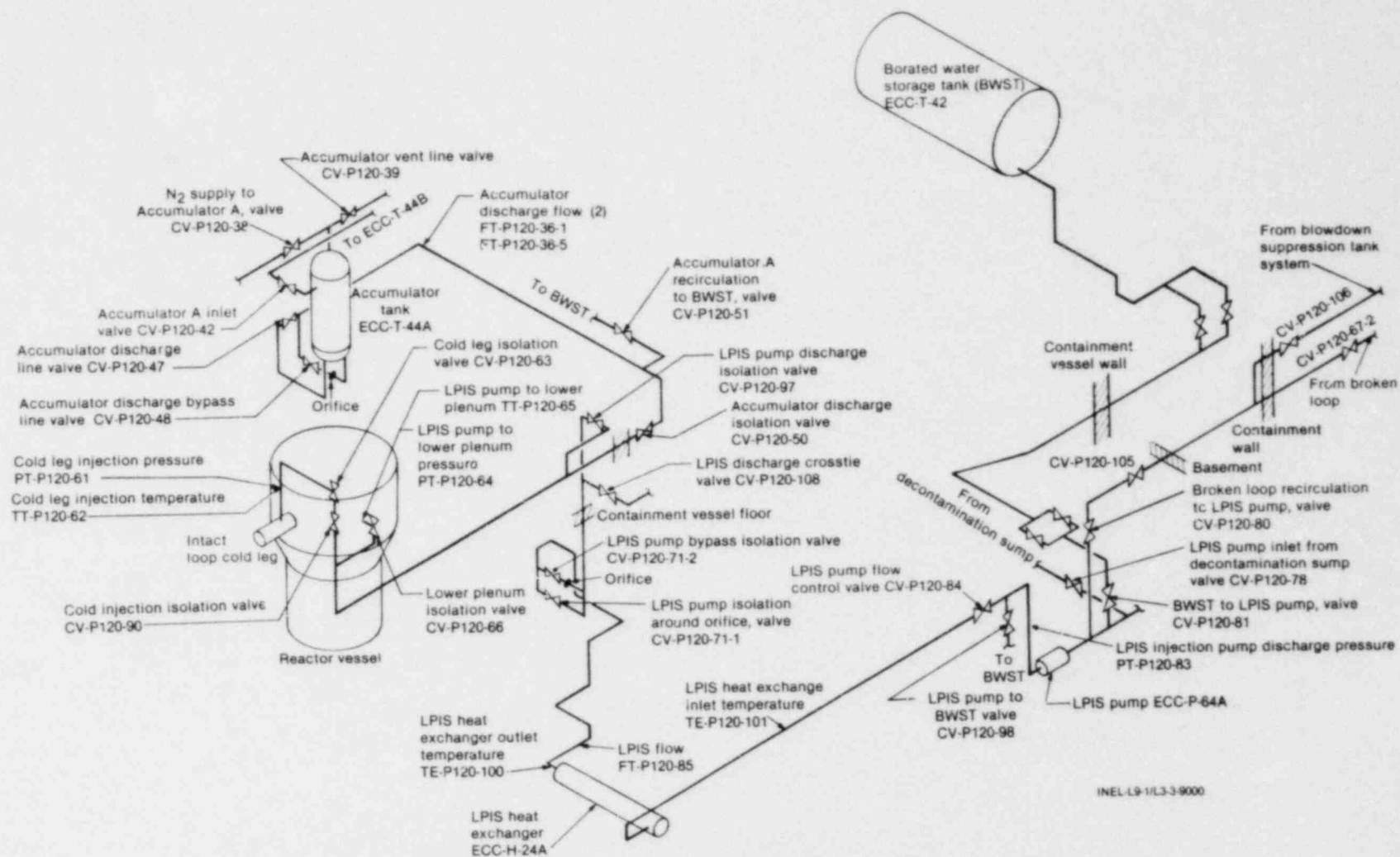
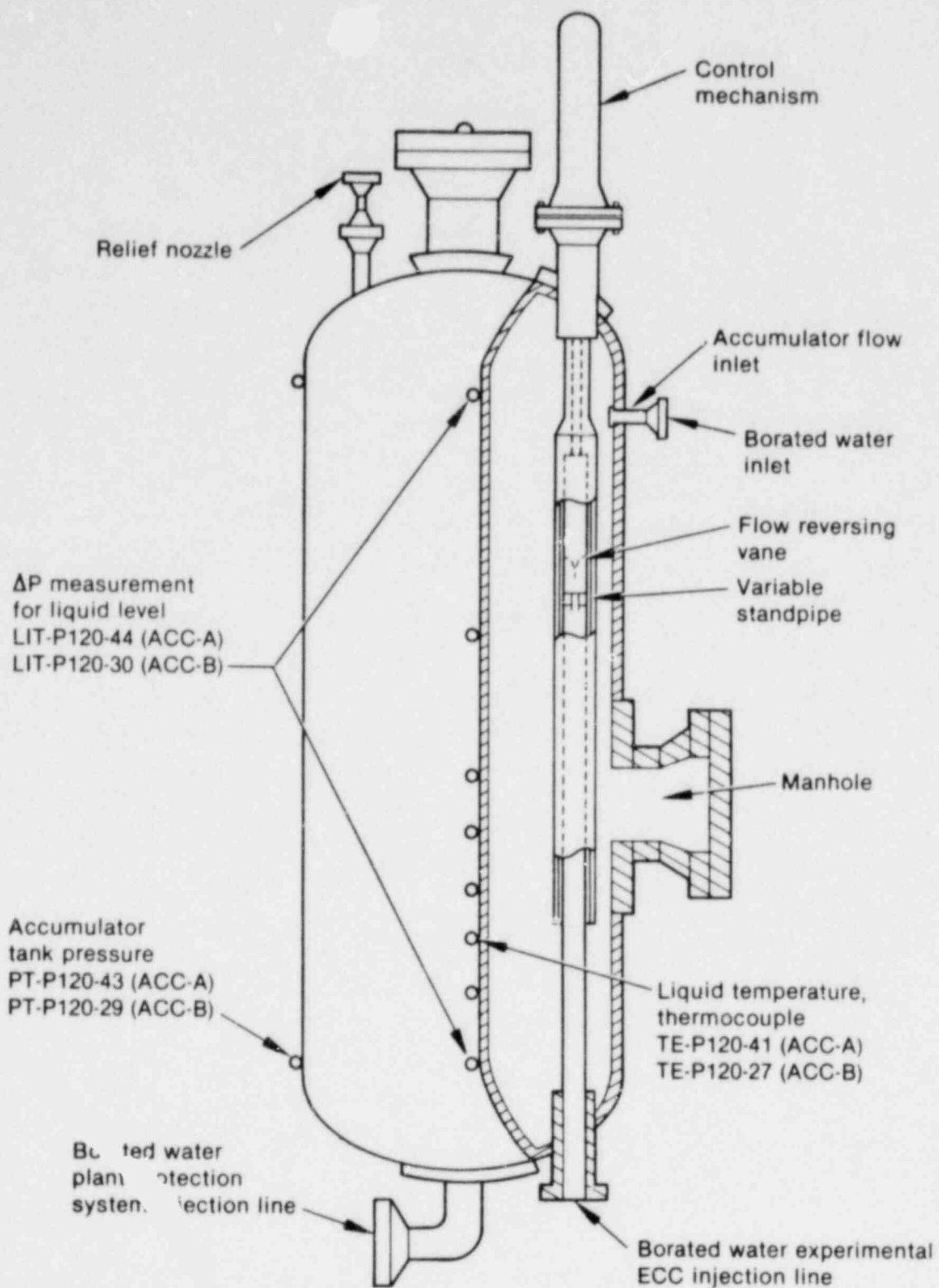


Figure B-15. LOFT ECCS instrumentation—A train.



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Figure B-17. LOFT accumulator instrumentation.

more specific locations for instruments located on individual components. Reference B-3 may be consulted if additional details of instrument designs and locations are desired.

Table B-2 contains a list of instruments that were available to be used for LOFT Experiment L9-1/L3-3. Included are the instrument

location, range, recording frequency, initial condition uncertainty, and uncertainty at specific readings. The "Comments" column contains information relative to the usability of the data. No entry under the "Comments" column means that the instrument was recorded, but the data were not reviewed or presented.

TABLE B-2. EXPERIMENT L9-1/L3-3 INSTRUMENTATION LIST

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
VALVE OPENING							
<u>Secondary Coolant System</u>							
CV-P004-008	Main feedwater control valve.	0 to 100%	1 Hz	3.5%	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	Qualified.
CV-P004-010	Main steam control valve.	0 to 100%	1 Hz	3.7%	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	Qualified.
CV-P004-090	Main steam bypass valve.	0 to 100%	1 Hz	--	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	
CV-P004-091	Main feedwater bypass valve.	0 to 100%	1 Hz	3.0%	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	Qualified.
<u>Broken Loop</u>							
CV-P138-001	Broken loop cold leg between break plane and suppression tank.	0 to 100%	1 Hz	--	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	
CV-P138-015	Quick-opening blowdown valve (QOBV) in hot leg.	0 to 100%	1 Hz	--	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	
CV-P138-070A	Blowdown system bypass valve.	0 to 100%	1 Hz	--	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
VALVE OPENING (continued)							
<u>Broken Loop (continued)</u>							
CV-P138-071A	Blowdown system bypass valve.	0 to 100%	1 Hz	--	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	
<u>Blowdown Suppression System</u>							
CV-P138-123	1.3-L/s spray header control valve.	0 to 100%	1 Hz	--	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	
CV-P138-124	3.8-L/s spray header control valve.	0 to 100%	1 Hz	--	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	
CV-P138-125	13.9-L/s spray header control valve.	0 to 100%	1 Hz	--	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	
CHORDAL DENSITY							
<u>Broken Loop</u>							
DE-BL-001A	Broken loop cold leg at drag disc-turbine trans- ducer (DTT) flange. Beam A is 14° 21 min from Beam B [clockwise (CW) looking toward reactor vessel (RV)].	0 to 1.0 Mg/m ³	10 Hz	--	--	0.13 Mg/m ³ b,c	Qualified after reactor scram, anomalous spikes at approximately 6000 and 6500 s.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
CHORDAL DENSITY (continued)							
<u>Broken Loop (continued)</u>							
DE-BL-001B	Broken loop cold leg at DTT flange. Beam B through centerline of pipe 45° from vertical [counterclockwise (CCW) looking toward RV].	0 to 1.0 Mg/m ³	10 Hz	--	--	0.13 Mg/m ³	Qualified after reactor scram, several anomalous spikes.
DE-BL-001C	Broken loop cold leg at DTT flange. Beam C is 22° 7 min from Beam B (CCW looking toward RV).	0 to 1.0 Mg/m ³	10 Hz	--	--	0.13 Mg/m ³	Qualified after reactor scram, several anomalous spikes.
DE-BL-002A	Broken loop hot leg at DTT flange. Beam A is 14° 21 min from Beam B (CCW looking toward RV).	0 to 1.0 Mg/m ³	10 Hz	--	--	0.13 Mg/m ³	Qualified after reactor scram.
DE-BL-002B	Broken loop hot leg at DTT flange. Beam B through centerline of pipe 45° from vertical (CW looking toward RV).	0 to 1.0 Mg/m ³	10 Hz	--	--	0.15 Mg/m ³	Qualified after reactor scram.
DE-BL-002C	Broken loop hot leg at DTT flange. Beam C is 22° 7 min from Beam B (CW looking toward RV).	0 to 1.0 Mg/m ³	10 Hz	--	--	0.17 Mg/m ³	Qualified after reactor scram.
<u>Intact Loop</u>							
DE-PC-S03A	Pressurizer relief line. Chordal density upstream of experiment power- operated relief valve (PORV).	0 to 1.0 Mg/m ³	10 Hz	0.10 Mg/m ³	--	0.10 Mg/m ³	Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
CHORDAL DENSITY (continued)							
<u>Intact Loop</u> (continued)							
DE-PC-S03B	Pressurizer relief line. Chordal density upstream of experiment PORV.	0 to 1.0 Mg/m ³	10 Hz	0.10 Mg/m ³	--	0.10 Mg/m ³	Qualified, spikes from 15 s to 1560 s.
DE-PC-001A	Intact loop cold leg at DTT flange. Beam A is 14° 21 min from Beam B (CW looking away from RV).	0 to 1.0 Mg/m ³	10 Hz	--	--	0.13 Mg/m ³	Qualified after reactor scram.
DE-PC-001B	Intact loop cold leg at DTT flange. Beam B through centerline of pipe 45° from vertical (CCW looking away from RV).	0 to 1.0 Mg/m ³	10 Hz	--	--	0.13 Mg/m ³	Qualified after reactor scram.
DE-PC-001C	Intact loop cold leg at DTT flange. Beam C is 22° 7 min from Beam B (CCW looking away from RV).	0 to 1.0 Mg/m ³	10 Hz	--	--	0.17 Mg/m ³	Qualified after reactor scram.
DE-PC-002A	Intact loop hot leg at DTT flange. Beam A is 14° 21 min from Beam B (CW looking away from RV).	0 to 1.0 Mg/m ³	10 Hz	--	--	0.13 Mg/m ³	Qualified after reactor scram, several anomalous spikes.
DE-PC-002B	Intact loop hot leg at DTT flange. Beam B through centerline of pipe 45° from vertical (CCW looking away from RV).	0 to 1.0 Mg/m ³	10 Hz	--	--	0.13 Mg/m ³	Qualified after reactor scram.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
CHORDAL DENSITY (continued)							
<u>Intact Loop (continued)</u>							
DE-PC-002C	Intact loop hot leg at DTT flange. Beam C is 22° 7 min from Beam B (CCW looking away from RV).	0 to 1.0 Mg/m ³	10 Hz	--	--	0.17 Mg/m ³	Qualified after reactor scram, anomalous spikes at 2000 s.
DE-PC-003A	Intact loop below steam generator (SG) at DTT flange. Beam A is 14° 21 min from Beam B.	0 to 1.0 Mg/m ³	1 Hz	--	--	0.13 Mg/m ³	Qualified after reactor scram.
DE-PC-003B	Intact loop below SG at DTT flange. Beam B is through centerline of pipe 45° from vertical.	0 to 1.0 Mg/m ³	1 Hz	--	--	0.13 Mg/m ³	Failed.
DE-PC-003C	Intact loop below SG at DTT flange. Beam C is 22° 7 min from Beam B.	0 to 1.0 Mg/m ³	1 Hz	--	--	0.17 Mg/m ³	Qualified after reactor scram.
FUEL ASSEMBLY DISPLACEMENT							
<u>Assembly 5</u>							
DIE-SUP-001	At top center of Fuel Assembly 5.	±12.7 mm	100 Hz	--	0 mm 6.35 mm 12.7 mm	0.3 mm ^d 0.33 mm 0.39 mm	
DIE-SUP-002	At top center of Fuel Assembly 5.	±12.7 mm	100 Hz	--	0 mm 6.35 mm 12.7 mm	0.3 mm 0.33 mm 0.39 mm	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Installation		Comments
					Reading	Uncertainty (±)	
FLUID VELOCITY							
<u>Intact Loop</u>							
FE-PC-S02	Pressurizer relief line upstream of experiment PORV.	0 to 20 m/s	1 Hz	1.0 m/s	--	1.0 m/s	Qualified.
FE-PC-002A	Hot leg DTT flange at bottom of pipe.	2 to 45 m/s	1 Hz	2 m/s	--	2 m/s ^e	Qualified to 6000 s.
FE-PC-002B	Hot leg DTT flange at middle of pipe.	2 to 45 m/s	1 Hz	2 m/s	--	2 m/s	Qualified to 6000 s.
FE-PC-002C	Hot leg DTT flange at top of pipe.	2 to 45 m/s	1 Hz	2 m/s	--	2 m/s	Qualified to 6000 s.
<u>Reactor Vessel</u>							
FE-SUP-001	Above upper end box of Fuel Assembly 5.	0.5 to 10.0 m/s	1 Hz	--	1 m/s 5 m/s 10 m/s	0.06 m/s 0.28 m/s 0.56 m/s	Failed.
FLOW RATE							
<u>Blowdown Sup- pression Tank Spray System</u>							
FE-P138-138	Blowdown suppression tank (BST) spray flow rate in the 3.79-L/s header.	0 to 6 L/s	1 Hz	--	0 L/s 4 L/s 6 L/s	0.06 L/s 0.23 L/s 0.35 L/s	
FE-P138-139	BST spray flow rate from pump discharge.	0 to 25 L/s	1 Hz	--	0 L/s 12 L/s 25 L/s	0.25 L/s 0.72 L/s 1.43 L/s	
FE-P138-140	BST spray flow rate in 13.9-L/s header.	0 to 20 L/s	1 Hz	--	0 L/s 10 L/s 18.9 L/s	0.19 L/s 0.60 L/s 1.08 L/s	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
FLOW RATE (continued)							
<u>Blowdown Sup- pression Tank Spray System (continued)</u>							
FE-P138-153	BST spray flow rate in spray pump recirculation line.	0 to 10 L/s	1 Hz	--	0 L/s 5 L/s 9.5 L/s	0.10 L/s 0.30 L/s 0.54 L/s	
<u>Secondary Coolant System</u>							
FT-P004-012	Inlet to air-cooled condenser inlet header.	0 to 40 kg/s	1 Hz	0.° kg/s	--	0.8 kg/s	Qualified, magnitude uncertain due to instrument drift.
FT-P004-72A	Main feedwater pump discharge flow.	0 to 25 kPa	10 Hz	--	--	0.17 kPa	
FT-P004-72-2	Flow out of main feed- water pump.	0 to 40 kg/s	1 Hz	--	--	0.8 kg/s	
FLUID VELOCITY							
<u>Secondary Coolant System</u>							
FT-P004-091	Main feedwater control valve bypass flow piping.	0 to 5 L/s	1 Hz	--	--	0.3 L/s	Qualified after 5000 s; only indicates presence or absence of flow; flow magnitude is not correct.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
FLOW RATE							
<u>Emergency Core Cooling System</u>							
FT-P120-31-1	Accumulator B in 6-in. line downstream of orifice.	0 to 40 L/s	1 Hz	--	--	3.5 L/s	
FT-P120-31-5	Accumulator B in 6-in. line downstream of orifice.	0 to 125 L/s	1 Hz	--	--	3.5 L/s	
FT-P120-36-1	Accumulator A in 6-in. line downstream of orifice.	0 to 125 L/s	1 Hz	--	--	3.5 L/s	
FT-P120-36-5	Accumulator A in 6-in. line downstream of orifice.	0 to 40 L/s	1 Hz	--	--	3.5 L/s	
FT-P120-085	Low-pressure injection system (LPIS) Pump A in 4-in. line between heat exchanger and orifice.	0 to 25 L/s	1 Hz	--	--	2.5 L/s	
FT-P128-085	High-pressure injection system (HPI) Pump B discharge.	0 to 2 L/s	1 Hz	--	--	0.02 L/s	
FT-P128-104	HPIS Pump A discharge.	0 to 2 L/s	1 Hz	--	--	0.02 L/s	
<u>Intact Loop</u>							
FT-P139-27-1	Intact loop hot leg venturi flowmeter (right side facing SG).	0 to 630 kg/s	1 Hz	17 kg/s	--	17 kg/s	Qualified to primary coolant pump (PCP) trip, anomalous spikes at approximately 1000 and 1700 s.
FT-P139-27-2	Intact loop hot leg venturi flowmeter (bottom of pipe).	0 to 630 kg/s	1 Hz	17 kg/s	--	17 kg/s	Qualified to PCP trip.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
FLOW RATE (continued)							
<u>Intact Loop (continued)</u>							
FT-P139-27-3	Intact loop hot leg venturi flowmeter (left side facing SG).	0 to 630 kg/s	1 Hz	17 kg/s	--	17 kg/s	Qualified to PCP trip.
<u>Primary Com- ponent Cooling System</u>							
FT-P141-022	Primary component cooling system.	0 to 22 L/s	10 Hz	--	--	0.1 L/s	
LIQUID LEVEL							
<u>Intact Loop</u>							
LD-P139-006	Pressurizer liquid level on southeast side.	0 to 1.8 m	1 Hz	--	--	0.06 m	
LD-P139-007	Pressurizer liquid level on southwest side.	0 to 1.8 m	1 Hz	--	--	0.06 m	
LD-P139-008	Pressurizer liquid level on north side.	0 to 1.8 m	1 Hz	--	--	0.06 m	
<u>Emergency Core Cooling System</u>							
LIT-P120-030	Accumulator B.	0 to 3.0 m	1 Hz	--	--	0.02 m	
LIT-P120-044	Accumulator A.	0 to 3.0 m	1 Hz	--	--	0.02 m	
<u>Secondary Coolant System</u>							
LT-P004-008A	SG (narrow range).	-1.0 to 1.5 m ^f	1 Hz	0.08 m	--	0.08 m	Qualified, not density compensated, narrow range instrument, oscillations at approximately 5000 s are not indicative of real level.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
LIQUID LEVEL (continued)							
<u>Secondary Coolant System (continued)</u>							
LT-P004-008B	SG (wide range).	-3.7 to 1.5 m ^f	1 Hz	0.08 m	--	0.08 m	Qualified after 0 s, not density compensated, oscillations at approximately 5000 s are not indicative of real level.
LT-P004-042	Condensate receiver, 1.83 m south of condensate receiver centerline	0 to 1.2 m	1 Hz	0.1 m	--	0.1 m	Qualified, magnitude uncertain.
<u>Blowdown Sup- pression Tank</u>							
LT-P138-033	BST level on north end of tank.	0 to 3.5 m	1 Hz	0.09 m	--	0.09 m	Qualified, not density compensated.
LT-P138-058	BST level on south end of tank.	0 to 3.5 m	1 Hz	0.09 m	--	0.09 m	Qualified, not density compensated.
MOMENTUM FLUX							
<u>Intact Loop</u>							
ME-PC-S02	Pressurizer relief line. Upstream of experiment PORV.	0 to 25 Mg/m·s ²	1 Hz	--	--	1.0 Mg/m·s ²	Qualified from 1575 to 4900 s.
ME-PC-002A	Hot leg DTT flange at bottom of pipe.	3 to 110 Mg/m·s ²	1 Hz	4 Mg/m·s ²	--	4 Mg/m·s ²	Qualified to pump trip.
ME-PC-002B	Hot leg DTT flange at middle of pipe.	3 to 110 Mg/m·s ²	1 Hz	4 Mg/m·s ²	--	4 Mg/m·s ²	Qualified to pump trip.
ME-PC-002C	Hot leg DTT flange at top of pipe.	3 to 110 Mg/m·s ²	1 Hz	4 Mg/m·s ²	--	4 Mg/m·s ²	Qualified to pump trip.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
MOMENTUM FLUX (continued)							
<u>Reactor Vessel</u>							
ME-1ST-001	Downcomer Stalk 1, 1.16 m above RV bottom.	0.3 to 12 Mg/m·s ²	1 Hz	--	--	0.78 Mg/m·s ²	
ME-2ST-001	Downcomer Stalk 2, 1.16 m above RV bottom.	0.3 to 12 Mg/m·s ²	1 Hz	--	--	0.78 Mg/m·s ²	
ME-3UP-001	Fuel Assembly 3 above upper end box.	0.3 to 12 Mg/m·s ²	1 Hz	--	--	0.78 Mg/m·s ²	
ME-5UP-001	Fuel Assembly 5 above upper end box.	0.3 to 12 Mg/m·s ²	1 Hz	--	--	0.78 Mg/m·s ²	
NEUTRON DETECTION							
<u>Reactor Vessel</u>							
NE-2HB-26	Neutron detector in Fuel Assembly 2.	0 to 52.5 kW/m (local)	1 Hz	2.03 kW/m	--	2.03 kW/m	Qualified, good to reactor scram.
NE-4HB-26	Neutron detector in Fuel Assembly 4.	0 to 52.5 kW/m (local)	1 Hz	2.03 kW/m	--	2.03 kW/m	Qualified, good to reactor scram.
NE-5DB-26	Neutron detector in Fuel Assembly 5.	0 to 52.5 kW/m (local)	1 Hz	--	--	2.03 kW/m	Failed.
NE-6HB-26	Neutron detector in Fuel Assembly 6.	0 to 52.5 kW/m (local)	1 Hz	--	--	2.03 kW/m	Failed.
ELECTRICAL CURRENT							
<u>Intact Loop</u>							
PCP-1-I-RMS	Primary coolant pump (PCP) 1.	0 to 1000 amps RMS	1 Hz	25 amps	100 amps 300 amps 600 amps	5 amps 15 amps 30 amps	Qualified to pump trip.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
ELECTRICAL CURRENT (continued)							
<u>Intact Loop (continued)</u>							
PCP-2-I-RMS	PCP-2.	0 to 1000 amps RMS	1 Hz	25 amps	100 amps 300 amps 600 amps	5 amps 15 amps 30 amps	Qualified to pump trip.
ELECTRICAL FREQUENCY							
<u>Intact Loop</u>							
PCP-1-F-RMS	PCP-1.	0 to 75 Hz RMS	10 Hz	0.75 Hz RMS	--	0.75 Hz ^h	Qualified to pump trip.
PCP-2-F-RMS	PCP-2.	0 to 75 Hz RMS	10 Hz	0.75 Hz RMS	--	0.75 Hz	Qualified to pump trip.
ELECTRICAL POWER							
<u>Intact Loop</u>							
PCP-1-P	PCP-1.	0 to 1 MW	10 Hz	0.05 MW	--	0.05 MW	Qualified to pump trip.
PCP-2-P	PCP-2.	0 to 1 MW	10 Hz	0.05 MW	--	0.05 MW	Qualified to pump trip.
ELECTRICAL VOLTAGE							
<u>Intact Loop</u>							
PCP-1-V-RMS	PCP-1.	0 to 600 volts RMS	1 Hz	25 volts	100 volts 300 volts 600 volts	5 volts 15 volts 30 volts	Qualified to pump trip.
PCP-2-V-RMS	PCP-2.	0 to 600 volts RMS	1 Hz	25 volts	100 volts 300 volts 600 volts	5 volts 15 volts 30 volts	Qualified to pump trip.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
DIFFERENTIAL PRESSURE							
<u>Broken Loop</u>							
PdE-BL-002	Broken loop cold leg across small break orifice.	±17.5 MPa (differential)	1 Hz	--	0 MPa 5 MPa 10 MPa 15 MPa	0.025 MPa 0.026 MPa 0.028 MPa 0.032 MPa	
PdE-BL-003	Broken loop cold leg across 5- to 8-in. expansion.	±3.5 MPa (differential)	1 Hz	--	0 MPa 2 MPa 3.5 MPa	0.009 MPa 0.010 MPa 0.010 MPa	
PdE-BL-009	Broken loop from end to middle of 5-in. pipe.	±700 kPa (differential)	1 Hz	--	0 kPa 350 kPa 700 kPa	1.7 kPa 1.7 kPa 1.9 kPa	
PdE-BL-010	Broken loop from middle to end of 5-in. pipe.	±700 kPa (differential)	1 Hz	--	0 kPa 350 kPa 700 kPa	1.7 kPa 1.7 kPa 1.9 kPa	
PdE-BL-013	SG simulator, inlet to top.	±40 kPa	1 Hz	--	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	
PdE-BL-014	SG simulator, outlet to top.	±40 kPa	1 Hz	--	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	
<u>Intact Loop</u>							
PdE-PC-S02	Pressurizer relief line across DTT spool piece.	±175 kPa (differential)	1 Hz	--	--	0.5 kPa	
PdE-PC-S03	Pressurizer relief line across experiment PORV.	±10 MPa (differential)	1 Hz	--	--	0.08 kPa	Qualified after PORV latched open.
PdE-PC-001	Intact loop cold leg across PCPs.	±700 kPa (differential)	1 Hz	1.8 kPa	0 kPa 350 kPa 700 kPa	1.7 kPa 1.7 kPa 1.9 kPa	Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
DIFFERENTIAL PRESSURE (continued)							
<u>Intact Loop (continued)</u>							
PdE-PC-002	Intact loop across SG.	±350 kPa (differential)	1 Hz	0.95 kPa	0 kPa 150 kPa 350 kPa	0.89 kPa 0.90 kPa 1.00 kPa	Qualified.
PdE-PC-003	Intact loop hot leg piping, RV to SG inlet.	±70 kPa (differential)	1 Hz	0.56 kPa	0 kPa 35 kPa 70 kPa	0.55 kPa 0.56 kPa 0.56 kPa	Qualified.
PdE-PC-005	Intact loop cold leg PCPs to RV nozzle.	±40 kPa (differential)	1 Hz	0.286 kPa	0 kPa 20 kPa 40 kPa	0.280 kPa 0.285 kPa 0.291 kPa	Qualified.
PdE-PC-008	Intact loop across pressurizer surge line.	±40 kPa (differential)	1 Hz	0.288 kPa	0 kPa 20 kPa 40 kPa	0.280 kPa 0.285 kPa 0.291 kPa	Qualified.
PdE-PC-009	Intact loop across PCP-1.	±700 kPa (differential)	1 Hz	1.6 kPa	0 kPa 350 kPa 700 kPa	1.7 kPa 1.7 kPa 1.9 kPa	Qualified.
PdE-PC-010	Intact loop across PCP-2.	±1400 kPa (differential)	1 Hz	1.8 kPa	0 kPa 350 kPa 700 kPa	1.7 kPa 1.7 kPa 1.9 kPa	Qualified.
PdE-PC-015	Pitot tube at top of emergency core coolant (ECC) Rake 1 (facing PCP).	±40 kPa (differential)	1 Hz	0.4 kPa	--	0.4 kPa	Qualified.
PdE-PC-015B	Pitot tube at top of ECC Rake 1 (facing PCP).	±12 kPa (differential)	1 Hz	--	--	0.037 kPa	
PdE-PC-016	Pitot tube next to top of ECC Rake 1 (facing PCP).	±40 kPa (differential)	1 Hz	--	--	0.4 kPa	Failed.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
DIFFERENTIAL PRESSURE (continued)							
<u>Intact Loop</u> (continued)							
PdE-PC-016B	Pitot tube next to top of ECC Rake 1 (facing PCP).	±12 kPa (differential)	1 Hz	--	--	0.037 kPa	
PdE-PC-017	Pitot tube next to bottom of ECC Rake 1 (facing PCP).	±40 kPa (differential)	1 Hz	0.4 kPa	--	0.4 kPa	Qualified.
PdE-PC-017B	Pitot tube next to bottom of ECC Rake 1 (facing PCP).	±70 kPa (differential)	1 Hz	0.56 kPa	--	0.56 kPa	Qualified.
PdE-PC-018	Pitot tube at bottom of ECC Rake 1 (facing PCP).	±40 kPa (differential)	1 Hz	0.4 kPa	--	0.4 kPa	Qualified.
PdE-PC-018B	Pitot tube at bottom of ECC Rake 1 (facing PCP).	±70 kPa (differential)	1 Hz	0.56 kPa	--	0.56 kPa	Qualified.
PdE-PC-023	Pitot tube at top of ECC Rake 2 (facing PCP).	±40 kPa (differential)	1 Hz	--	--	0.4 kPa	Failed.
PdE-PC-024	Pitot tube next to top of ECC Rake 2 (facing PCP).	±40 kPa (differential)	1 Hz	--	--	0.4 kPa	Failed.
PdE-PC-025	Pitot tube next to bottom of ECC Rake 2 (facing PCP).	±40 kPa (differential)	1 Hz	--	--	0.4 kPa	Failed.
PdE-PC-026	Pitot tube at bottom of ECC Rake 2 (facing PCP).	±40 kPa (differential)	1 Hz	--	--	0.4 kPa	Failed.
PdE-PC-027	SG outlet to pump suction (lowest point).	±40 kPa (differential)	1 Hz	0.4 kPa	--	0.4 kPa	Qualified.
PdE-PC-028	Pump suction (lowest point) to PCP-2 inlet.	±40 kPa (differential)	1 Hz	0.4 kPa	--	0.4 kPa	Qualified.

TABLE B-2. (continued)

Variable, System, and Device	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
DIFFERENTIAL PRESSURE (continued)							
<u>Reactor Vessel</u>							
PdE-RV-002	Fuel Assembly 1 from lower end box to upper end box.	±175 kPa (differential)	1 Hz	--	0 kPa 100 kPa 175 kPa	1.3 kPa 1.3 kPa 1.4 kPa	
PdE-RV-003	Intact loop cold leg inlet to bottom of downcomer.	±100 kPa (differential)	1 Hz	--	1 kPa 50 kPa 100 kPa	0.49 kPa 0.50 kPa 0.52 kPa	
PdE-RV-005	Top of RV to intact loop hot leg.	±40 kPa (differential)	1 Hz	--	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	Failed.
<u>Blowdown Sup- pression Tank</u>							
PdE-SV-001	BST.	-25 to 0 kPa	1 Hz	--	0 kPa 12 kPa 25 kPa	0.039 kPa 0.043 kPa 0.055 kPa	Failed.
PdE-SV-002	BST.	-15 to 0 kPa	1 Hz	--	0 kPa 12 kPa 25 kPa	0.039 kPa 0.043 kPa 0.055 kPa	Failed.
PdE-SV-009	BST across the vacuum breaker line.	±70 kPa (differential)	10 Hz	--	0 kPa 30 kPa 70 kPa	0.55 kPa 0.56 kPa 0.56 kPa	
<u>Pressurizer</u>							
PdT-P139-006	Pressurizer on south- east side.	0.0 to 17.5 kPa	1 Hz	0.18 kPa	--	0.18 kPa	Qualified.
PdT-P139-007	Pressurizer on south- west side.	0.0 to 17.5 kPa	1 Hz	0.18 kPa	--	0.18 kPa	Qualified.
PdT-P139-008	Pressurizer on north side.	0.0 to 17.5 kPa	1 Hz	--	--	0.18 kPa	Failed.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
DIFFERENTIAL PRESSURE (continued)							
<u>Intact Loop</u>							
PdT-P139-27-1	Intact loop venturi, Channel A.	0 to 200 kPa (differential)	1 Hz	2 kPa	--	2 kPa	Qualified.
PdT-P139-27-2	Intact loop venturi, Channel B.	0 to 200 kPa (differential)	1 Hz	2 kPa	--	2 kPa	Qualified.
PdT-P139-27-3	Intact loop venturi, Channel C.	0 to 200 kPa (differential)	1 Hz	2 kPa	--	2 kPa	Qualified.
PdT-P139-030	Across RV just beyond intact loop inlet and outlet nozzles.	0 to 350 kPa (differential)	1 Hz	3 kPa	--	3 kPa	Qualified.
PRESSURE ¹							
<u>Broken Loop</u>							
PE-BL-001	Broken loop cold leg at DTT flange.	0.1 to 21 MPa ¹	1 Hz	0.253 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	Qualified.
PE-BL-002	Broken loop hot leg at DTT flange.	0.1 to 21 MPa	1 Hz	0.253 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	Qualified.
PE-BL-003	Broken loop hot leg downstream of pump simulator.	0.1 to 21 MPa	1 Hz	--	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	
PE-BL-008	Broken loop cold leg in 8-in. pipe.	0.1 to 21 MPa	1 Hz	--	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
PRESSURE ¹ (continued)							
<u>Intact Loop</u>							
PE-PC-S05	Pressurizer relief line between DTT and experi- ment PORV.	0.1 to 17.5 MPa	1 Hz	0.282 MPa	--	0.282 MPa	Qualified.
PE-PC-S06	Pressurizer relief line upstream of DTT.	0.1 to 17.5 MPa	1 Hz	0.282 MPa	--	0.282 MPa	Qualified.
PE-PC-S07	Pressurizer relief line downstream of experiment PORV.	0.1 to 17.5 MPa	1 Hz	0.282 MPa	--	0.282 MPa	Qualified.
PE-PC-001	Intact loop cold leg at DTT flange.	0.1 to 21 MPa	1 Hz	0.252 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	Qualified.
PE-PC-002	Intact loop hot leg at DTT flange.	0.1 to 21 MPa	1 Hz	0.252 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	Qualified.
PE-PC-004	Intact loop pressurizer vapor space.	0.1 to 21 MPa	1 Hz	0.252 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	Qualified.
PE-PC-005	Intact loop reference pressure between SG outlet and PCP inlet.	0.1 to 17.5 MPa	1 Hz	0.282 MPa	--	0.282 MPa	Qualified.
PE-PC-006	Intact loop reference pressure between SG outlet and PCP inlet.	0.1 to 17.5 MPa	1 Hz	0.282 MPa	--	0.232 MPa	Qualified.
<u>Secondary Coolant System</u>							
PE-SGS-001	SG dome pressure.	0.1 to 7.0 MPa	1 Hz	0.12 MPa	--	0.12 MPa	Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
PRESSURE ¹ (continued)							
<u>Blowdown Sup- pression System</u>							
PE-SV-003	BST across from Downcomer 1 (south end), 157.5° from top vertical (CW looking north).	85 to 700 kPa	1 Hz	--	--	8 kPa	
PE-SV-014	BST header above Downcomer 4, 327° from top vertical (CW looking north).	85 to 700 kPa	1 Hz	--	--	8 kPa	
PE-SV-016	BST across from Downcomer 1, 230° from top vertical (CW looking north).	85 to 700 kPa	1 Hz	8 kPa	--	8 kPa	Qualified.
PE-SV-017	BST, 1.38 m north of Downcomer 3 centerline, 0° from top vertical (CW looking north).	85 to 700 kPa	1 Hz	--	--	8 kPa	
PE-SV-018	BST header above Downcomer 1.	85 to 700 kPa	1 Hz	--	--	8 kPa	
PE-SV-044	BST bottom under Downcomer 3.	85 to 700 kPa	1 Hz	--	--	8 kPa	
PE-SV-055	BST top, 0.15 m north of Downcomer 4 centerline.	85 to 700 kPa	1 Hz	--	--	8 kPa	
PE-SV-060	BST top above Down- comer 1.	85 to 700 kPa	1 Hz	8 kPa	--	8 kPa	Qualified.
<u>Reactor Vessel</u>							
PE-1ST-001A	Downcomer Stalk 1, 0.62 m above RV bottom.	0.1 to 21 MPa	1 Hz	0.253 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.287 MPa	Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
<u>PRESSURE¹</u> (continued)							
<u>Reactor Vessel</u> (continued)							
PE-1ST-003A	Downcomer Stalk 1, 5.32 m above RV bottom.	0.1 to 21 MPa	1 Hz	0.253 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	Qualified.
PE-1UP-001A	Above Fuel Assembly 1 upper end box.	0.1 to 21 MPa	1 Hz	0.253 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	Qualified.
PE-1UP-001A1	Above Fuel Assembly 1 upper end box.	0.1 to 21 MPa	1 Hz	0.253 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	Qualified.
PE-2ST-001A	Downcomer Stalk 2, 0.62 m above RV bottom.	0.1 to 21 MPa	1 Hz	0.253 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	Qualified.
<u>Secondary Coolant System</u>							
PT-P004-010A	In 10-in. line from SG.	0.1 to 8.3 MPa	1 Hz	0.11 MPa	--	0.11 MPa	Qualified.
PT-P004-034	Downstream of main feedwater pump.	0.1 to 10.3 MPa	10 Hz	--	--	0.07 MPa	
PT-P004-085	Upstream of inlet to air-cooled condenser header.	0.1 to 2.8 MPa	1 Hz	--	--	0.075 MPa	
<u>Emergency Core Cooling System</u>							
PT-P120-029	Accumulator B.	0.1 to 7.0 MPa	1 Hz	--	--	0.055 MPa	
PT-P120-043	Accumulator A.	0.1 to 7.0 MPa	1 Hz	--	--	0.055 MPa	
PT-P120-061	ECC injection.	0.1 to 21 MPa	1 Hz	--	--	0.158 MPa	
PT-P120-074	LPIS Pump B discharge.	0.1 to 7.0 MPa	1 Hz	--	--	0.055 MPa	
PT-P120-083	LPIS Pump A discharge.	0.1 to 7.0 MPa	1 Hz	--	--	0.04 MPa	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
PRESSURE ¹ (continued)							
<u>Intact Loop</u>							
PT-P139-002	Intact loop hot leg at venturi on bottom.	0.1 to 21 MPa	1 Hz	0.25 MPa	--	0.25 MPa	Qualified.
PT-P139-003	Intact loop hot leg at venturi on left side when looking toward SG.	0.1 to 21 MPa	1 Hz	0.25 MPa	--	0.25 MPa	Qualified.
PT-P139-004	Intact loop hot leg at venturi on right side when looking toward SG.	0.1 to 21 MPa	1 Hz	0.25 MPa	--	0.25 MPa	Qualified.
PT-P139-05-1	Pressurizer, 1.88 m above bottom (vapor space).	0.1 to 17.5 MPa	1 Hz	0.34 MPa	--	0.34 MPa	Qualified.
PUMP SPEED							
<u>Intact Loop</u>							
RPE-PC-001	PCP-1.	0 to 4500 rpm	1 Hz	10.4 rpm	1000 rpm 2000 rpm 3000 rpm 4000 rpm	7.65 rpm 8.825 rpm 10.10 rpm 11.66 rpm	Qualified.
RPE-PC-002	PCP-2.	0 to 4500 rpm	1 Hz	10.4 rpm	1000 rpm 2000 rpm 3000 rpm 4000 rpm	7.65 rpm 8.825 rpm 10.10 rpm 11.66 rpm	Qualified.
REACTIVITY							
<u>Reactor Vessel</u>							
RE-TRM-86-5	Transient reactivity meter in shield tank.	±0.145 Rho	10 Hz	--	--	0.01 Rho	
RE-TRM-86-6	Transient reactivity meter in shield tank.	±0.145 Rho	10 Hz	--	--	0.01 Rho	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
REACTIVITY (continued)							
<u>Reactor Vessel (continued)</u>							
RE-T-77-1A2	Power range, Channel A level.	0 to 62.5 kW/m	1 Hz	2.0 kW/m	--	2.0 kW/m	Qualified.
RE-T-77-2A2	Power range, Channel B level.	0 to 62.5 kW/m	1 Hz	2.0 kW/m	--	2.0 kW/m	Qualified.
RE-T-77-3A2	Power range, Channel C level.	0 to 62.5 kW/m	1 Hz	2.0 kW/m	--	2.0 kW/m	Qualified.
RE-T-87-4A2	Power range, Channel D level.	0 to 125% power	10 Hz	--	--	3% power	
TEMPERATURE							
<u>Broken Loop</u>							
TE-BL-001B	Broken loop cold leg at DTT rake center.	255 to 590 K	1 Hz	2.6 K	350 K	2.4 K	Qualified.
					450 K	2.5 K	
					550 K	2.5 K	
					600 K	2.9 K	
TE-BL-002B	Broken loop hot leg at middle of DTT flange.	255 to 590 K	1 Hz	2.6 K	350 K	2.4 K	Qualified.
					450 K	2.5 K	
					550 K	2.5 K	
					600 K	2.9 K	
<u>Intact Loop</u>							
TE-PC-S03	Pressurizer relief line in DTT spool piece.	255 to 980 K	1 Hz	--	350 K	2.4 K	Failed.
					450 K	2.5 K	
					550 K	2.5 K	
					600 K	2.9 K	
TE-PC-S04	Pressurizer relief line in DTT spool piece.	255 to 980 K	1 Hz	2.5 K	350 K	2.4 K	Qualified.
					450 K	2.5 K	
					550 K	2.5 K	
					600 K	2.9 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Intact Loop (continued)</u>							
TE-PC-S05	Pressurizer relief line downstream of experiment PORV.	255 to 980 K	1 Hz	2.5 K	350 K	2.4 K	Qualified.
					450 K	2.5 K	
					550 K	2.5 K	
					600 K	2.9 K	
TE-PC-S06	Pressurizer relief line downstream of experiment PORV.	255 to 980 K	1 Hz	--	350 K	2.1 K	Failed.
					450 K	2.5 K	
					550 K	2.5 K	
					600 K	2.9 K	
TE-PC-002A	Intact loop hot leg DTT flange at bottom of pipe.	255 to 980 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-PC-002B	Intact loop hot leg DTT flange at middle of pipe.	255 to 980 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-PC-002C	Intact loop hot leg DTT flange at top of pipe.	255 to 980 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-PC-004	Bottom of ECC Rake 1 (between PdE-PC-014 and PdE-PC-018).	255 to 590 K	1 Hz	--	350 K	2.8 K	Failed.
					450 K	2.9 K	
					550 K	3.0 K	
					650 K	3.6 K	
TE-PC-005	Next to bottom of ECC Rake 1 (between PdE-PC-013 and PdE-PC-017).	255 to 590 K	1 Hz	3.1 K	350 K	2.8 K	Qualified.
					450 K	2.9 K	
					550 K	3.0 K	
					650 K	3.6 K	
TE-PC-006	Next to top of ECC Rake 1 (between PdE-PC-012 and PdE-PC-016).	255 to 590 K	1 Hz	3.1 K	350 K	2.8 K	Qualified.
					450 K	2.9 K	
					550 K	3.0 K	
					650 K	3.6 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Intact Loop (continued)</u>							
TE-PC-007	Top of ECC Rake 1 (between PdE-PC-011 and PdE-PC-015).	255 to 590 K	1 Hz	3.1 K	350 K	2.8 K	Qualified.
					450 K	2.9 K	
					550 K	3.0 K	
					650 K	3.6 K	
TE-PC-009	Next to bottom of ECC Rake 2 (between PdE-PC-021 and PdE-PC-025).	255 to 590 K	1 Hz	3.1 K	350 K	2.8 K	Qualified.
					450 K	2.9 K	
					550 K	3.0 K	
					650 K	3.6 K	
TE-PC-010	Next to top of ECC Rake 2 (between PdE-PC-020 and PdE-PC-024).	255 to 590 K	1 Hz	3.1 K	350 K	2.8 K	Qualified.
					450 K	2.9 K	
					550 K	3.0 K	
					650 K	3.6 K	
TE-PC-011	Top of ECC Rake 2 (between PdE-PC-019 and PdE-PC-023).	255 to 590 K	1 Hz	3.1 K	350 K	2.8 K	Qualified.
					450 K	2.9 K	
					550 K	3.0 K	
					650 K	3.6 K	
<u>Secondary Coolant System</u>							
TE-P004-054	Condensate receiver tank.	250 to 500 K	1 Hz	--	--	2.5 K	
<u>Emergency Core Cooling System</u>							
TE-P120-027	Accumulator B temperature.	250 to 370 K	1 Hz	--	--	0.7 K	
TE-P120-041	Accumulator A temperature.	250 to 370 K	1 Hz	--	--	0.7 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Blowdown Sup- pression Tank Spray System</u>							
TE-P138-137	Outlet of BST spray system heat exchanger.	250 to 420 K	1 Hz	--	--	0.7 K	
TE-P138-141	Spray in 3.79-L/s header.	250 to 420 K	1 Hz	--	--	1.3 K	
TE-P138-142	Spray pump discharge.	250 to 420 K	1 Hz	--	--	1.3 K	
TE-P138-143	Spray in 13.88-L/s header.	250 to 420 K	1 Hz	--	--	1.3 K	
<u>Broken Loop</u>							
TE-P138-170	Hot leg warmup line.	73 to 622 K	1 Hz	--	--	2.1 K	
TE-P138-171	Cold leg warmup line.	172 to 672 K	1 Hz	--	--	0.8 K	
<u>Intact Loop</u>							
TE-P139-019	Pressurizer vapor space, 0.86 m above heater rods.	280 to 640 K	1 Hz	3.0 K	--	3.0 K	Qualified.
TE-P139-020	Pressurizer liquid volume, 0.36 m above heater rods.	280 to 640 K	1 Hz	3.0 K	--	3.0 K	Qualified.
TE-P139-20-1	Pressurizer liquid volume.	280 to 640 K	1 Hz	--	--	3.0 K	Failed.
TE-P139-28-2	Intact loop cold leg.	530 to 620 K	1 Hz	1.6 K	--	1.6 K	Qualified, response and range limited.
TE-P139-029	Intact loop cold leg.	280 to 620 K	1 Hz	--	--	1.6 K	
TE-P139-32-1	Intact loop hot leg.	280 to 620 K	1 Hz	1.7 K	--	1.7 K	Qualified, response limited.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Primary Com- ponent Cooling System</u>							
TE-P141-094	Downstream from primary component cooling system heat exchanger.	275 to 350 K	10 Hz	--	--	0.3 K	
TE-P141-095	Upstream from primary component cooling system heat exchanger.	275 to 350 K	10 Hz	--	--	0.3 K	
<u>Intact Loop</u>							
TE-SG-001	Intact loop hot leg SG inlet.	255 to 980 K	1 Hz	--	350 K	2.5 K	Failed.
					450 K	2.6 K	
					550 K	2.7 K	
					600 K	2.9 K	
TE-SG-002	Intact loop cold leg SG outlet.	255 to 980 K	1 Hz	2.7 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					600 K	2.9 K	
<u>Secondary Coolant System</u>							
TE-SG-003	SG secondary side down- comer, 0.25 m above top of tube sheet.	255 to 590 K	1 Hz	--	--	3.0 K	Failed.
TE-SG-004	SG secondary side down- comer, 2.12 m above top of tube sheet.	255 to 590 K	1 Hz	3.0 K	--	3.0 K	Qualified.
TE-SG-005	SG secondary side down- comer, 2.92 m above top of tube sheet.	255 to 590 K	1 Hz	3.0 K	--	3.0 K	Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Blowdown Sup- pression System</u>							
TE-SV-001	BST, 0.3 m north of Downcomer 1, 0.53 m east of tank centerline, 2.72 m from tank bottom.	255 to 480 K	1 Hz	1.1 K	300 K 350 K 400 K	0.9 K 1.0 K 1.3 K	Qualified, anomalous spike at approximately 7000 s.
TE-SV-002	BST, 0.3 m north of Downcomer 1, 0.53 m east of tank centerline, 2.36 m from tank bottom.	255 to 480 K	1 Hz	1.1 K	300 K 350 K 400 K	0.9 K 1.0 K 1.3 K	Qualified.
TE-SV-003	BST, 0.3 m north of Downcomer 1, 0.53 m east of tank centerline, 1.90 m from tank bottom.	255 to 480 K	1 Hz	--	300 K 350 K 400 K	0.9 K 1.0 K 1.3 K	
TE-SV-004	BST, 0.3 m north of Downcomer 1, 0.53 m east of tank centerline, 1.45 m from tank bottom.	255 to 480 K	1 Hz	1.1 K	300 K 350 K 400 K	0.9 K 1.0 K 1.3 K	Qualified.
TE-SV-006	BST, 0.3 m north of Downcomer 1, 0.53 m east of tank centerline, 0.37 m from tank bottom.	255 to 480 K	1 Hz	1.1 K	300 K 350 K 400 K	0.9 K 1.0 K 1.3 K	Qualified.
TE-SV-007	BST, 0.3 m north of Downcomer 3, 0.53 m east of tank centerline, 2.72 m from tank bottom.	255 to 480 K	1 Hz	1.1 K	300 K 350 K 400 K	0.9 K 1.0 K 1.3 K	Qualified.
TE-SV-008	BST, 0.3 m north of Downcomer 3, 0.53 m east of tank centerline, 2.36 m from tank bottom.	255 to 480 K	1 Hz	1.1 K	300 K 350 K 400 K	0.9 K 1.0 K 1.3 K	Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Blowdown Sup- pression System</u> (continued)							
TE-SV-009	BST, 0.3 m north of Downcomer 3, 0.53 m east of tank centerline, 1.90 m from tank bottom.	255 to 480 K	1 Hz	1.1 K	300 K 350 K 400 K	0.9 K 1.0 K 1.3 K	Qualified.
TE-SV-010	BST, 0.3 m north of Downcomer 3, 0.53 m east of tank centerline, 1.45 m from tank bottom.	255 to 480 K	1 Hz	1.1 K	300 K 350 K 400 K	0.9 K 1.0 K 1.3 K	Qualified.
TE-SV-011	BST, 0.3 m north of Downcomer 3, 0.53 m east of tank centerline, 0.99 m from tank bottom.	255 to 480 K	1 Hz	1.1 K	300 K 350 K 400 K	0.9 K 1.0 K 1.3 K	Qualified.
TE-SV-012	BST, 0.3 m north of Downcomer 3, 0.53 m east of tank centerline, 0.37 m from tank bottom.	255 to 480 K	1 Hz	1.1 K	300 K 350 K 400 K	0.9 K 1.0 K 1.3 K	Qualified.
<u>Reactor Vessel</u>							
TE-1A11-030	Fuel Assembly 1, Row A, Column 11, 0.762 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	
TE-1B10-037	Fuel Assembly 1, Row B, Column 10, 0.940 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	
TE-1B12-026	Fuel Assembly 1, Row B, Column 12, 0.660 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^d	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-1C11-021	Fuel Assembly 1, Row C, Column 11, 0.533 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	
TE-1C11-039	Fuel Assembly 1, Row C, Column 11, 0.991 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	
TE-1F7-015	Fuel Assembly 1, Row F, Column 7, 0.38 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-1F7-021	Fuel Assembly 1, Row F, Column 7, 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-1F7-026	Fuel Assembly 1, Row F, Column 7, 0.66 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-1F7-030	Fuel Assembly 1, Row F, Column 7, 0.76 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-1LP-001	Fuel Assembly 1 lower end box.	310 to 980 K	1 Hz	2.7 K	350 K 450 K 550 K 650 K	2.5 K 2.6 K 2.6 K 3.3 K	Qualified.
TE-1LP-002	Fuel Assembly 1 lower end box.	310 to 980 K	1 Hz	2.7 K	350 K 450 K 550 K 650 K	2.5 K 2.6 K 2.6 K 3.3 K	Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-1ST-001	Downcomer Stalk 1, 4.8 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	
TE-1ST-002	Downcomer Stalk 1, 4.2 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	
TE-1ST-003	Downcomer Stalk 1, 3.59 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	
TE-1ST-004	Downcomer Stalk 1, 2.98 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	
TE-1ST-005	Downcomer Stalk 1, 2.37 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	
TE-1ST-006	Downcomer Stalk 1, 1.76 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	
TE-1ST-007	Downcomer Stalk 1, 0.74 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	
TE-1ST-009	Downcomer Stalk 1, 0.64 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Reactor Vessel</u> <u>(continued)</u>							
TE-1ST-011	Downcomer Stalk 1, 0.44 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	
TE-1ST-012	Downcomer Stalk 1, 0.34 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	
TE-1ST-013	Downcomer Stalk 1, 0.24 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	
TE-1UP-001	Fuel Assembly 1 upper end box.	310 to 980 K	1 Hz	2.9 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-1UP-002	Fuel Assembly 1 upper end box.	310 to 980 K	1 Hz	2.9 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-1UP-004	Fuel Assembly 1 support column above RV nozzle.	310 to 980 K	10 Hz	--	350 K	2.5 K	
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-1UP-005	DTT FE-1UP-1 above Fuel Assembly 1.	310 to 980 K	1 Hz	--	350 K	2.5 K	
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-1UP-006	Fuel Assembly 1 support column.	310 to 980 K	1 Hz	--	350 K	2.5 K	
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Reactor Vessel</u> <u>(continued)</u>							
TE-2E8-045	Cladding on Fuel Assembly 2, Row E, Column 8 at 1.14 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2F7-037	Cladding on Fuel Assembly 2, Row F, Column 7 at 0.94 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K	2.8 K	
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2F8-028	Cladding on Fuel Assembly 2, Row F, Column 8 at 0.71 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2F8-032	Cladding on Fuel Assembly 2, Row F, Column 8 at 0.81 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2F9-026	Cladding on Fuel Assembly 2, Row F, Column 9 at 0.66 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2F9-041	Cladding on Fuel Assembly 2, Row F, Column 9 at 1.04 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2G02-030	Cladding on Fuel Assembly 2, Row G, Column 2 at 0.76 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-2608-021	Cladding on Fuel Assembly 2, Row G, Column 8 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2608-039	Cladding on Fuel Assembly 2, Row G, Column 8 at 0.99 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2614-011	Cladding on Fuel Assembly 2, Row G, Column 14 at 0.28 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2614-030	Cladding on Fuel Assembly 2, Row G, Column 14 at 0.76 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2614-045	Cladding on Fuel Assembly 2, Row G, Column 14 at 1.14 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2H01-037	Cladding on Fuel Assembly 2, Row H, Column 1 at 0.94 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	400 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2H02-032	Cladding on Fuel Assembly 2, Row H, Column 2 at 0.81 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	400 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-2H23-026	Cladding on Fuel Assembly 2, Row H, Column 3 at 0.66 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	400 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2H08-039	Guide tube for Fuel Assembly 2, Row H, Column 8 at 0.99 m above bottom of guide tube.	420 to 1530 K	1 Hz	3.1 K	400 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2H13-021	Cladding on Fuel Assembly 2, Row H, Column 13 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2H13-049	Cladding on Fuel Assembly 2, Row H, Column 13 at 1.24 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2H14-028	Cladding on Fuel Assembly 2, Row H, Column 14 at 0.71 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2H14-032	Cladding on Fuel Assembly 2, Row H, Column 14 at 0.81 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2H15-026	Cladding on Fuel Assembly 2, Row H, Column 15 at 0.66 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-2H15-041	Cladding on Fuel Assembly 2, Row H, Column 15 at 1.04 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2102-021	Cladding on Fuel Assembly 2, Row I, Column 2 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2102-039	Cladding on Fuel Assembly 2, Row I, Column 2 at 0.99 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2114-021	Cladding on Fuel Assembly 2, Row I, Column 14 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.7 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-2LP-001	Fuel Assembly 2 lower end box.	310 to 980 K	1 Hz	2.7 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-2LP-002	Fuel Assembly 2 lower end box.	310 to 980 K	1 Hz	2.7 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-2LP-003	Fuel Assembly 2 lower end box.	310 to 980 K	1 Hz	2.7 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-2ST-001	Downcomer Stalk 2, 4.8 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Reactor Vessel</u> (continued)							
TE-2ST-002	Downcomer Stalk 2, 4.20 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	
TE-2ST-005	Downcomer Stalk 2, 2.37 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.5 K	
					550 K	2.7 K	
					650 K	3.3 K	
TE-2ST-009	Downcomer Stalk 2, 0.64 m from RV bottom.	255 to 980 K	1 Hz	--	350 K	2.5 K	Failed.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	
TE-2ST-013	Downcomer Stalk 2, 0.24 m from RV bottom.	255 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.7 K	
					650 K	3.3 K	
TE-2UP-001	Fuel Assembly 2 upper end box.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-2UP-002	Fuel Assembly 2 upper end box.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-2UP-003	Fuel Assembly 2 upper end box.	310 to 980 K	1 Hz	2.9 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-3B12-026	Cladding on Fuel Assembly 3, Row B, Column 12 at 0.60 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K	2.8 K	
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (\pm)	After Experiment Initiation	
					Reading	Uncertainty (\pm)
TEMPERATURE (continued)						
Reactor Vessel (continued)						
TE-3C11-021	Cladding on Fuel Assembly 3, Row C, Column 11 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K
TE-3C11-039	Cladding on Fuel Assembly 3, Row C, Column 11 at 0.99 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K Qualified.
TE-3F7-015	Cladding on Fuel Assembly 3, Row F, Column 7 at 0.38 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K Qualified.
TE-3F7-021	Cladding on Fuel Assembly 3, Row F, Column 7 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K Qualified.
TE-3F7-026	Cladding on Fuel Assembly 3, Row F, Column 7 at 0.66 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K Qualified.
TE-3F7-030	Cladding on Fuel Assembly 3, Row F, Column 7 at 0.76 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K Qualified.
TE-3LP-001	Fuel Assembly 3 lower end box.	310 to 980 K	1 Hz	--	350 K 450 K 550 K 650 K	2.5 K 2.6 K 2.6 K 3.3 K
TE-3LP-002	Fuel Assembly 3 lower end box.	310 to 980 K	1 Hz	2.7 K	350 K 450 K 550 K 650 K	2.5 K 2.6 K 2.6 K 3.3 K Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Reactor Vessel</u> (continued)							
TE-3UP-004	Fuel Assembly 3 support column above RV nozzle.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-3UP-006	Fuel Assembly 3 support column.	310 to 980 K	1 Hz	2.6 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-3UP-008	Liquid level transducer above Fuel Assembly 3.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-3UP-010	Liquid level transducer above Fuel Assembly 3.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-3UP-011	Liquid level transducer above Fuel Assembly 3.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-3UP-012	Liquid level transducer above Fuel Assembly 3.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-3UP-013	Liquid level transducer above Fuel Assembly 3.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-3UP-014	Liquid level transducer above Fuel Assembly 3.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (\pm)	After Experiment Initiation	
					Reading	Uncertainty (\pm)
TEMPERATURE (continued)						
Reactor Vessel (continued)						
TE-3UP-015	Liquid level transducer above Fuel Assembly 3.	310 to 980 K	1 Hz	2.8 K	350 K 450 K 550 K 650 K	2.5 K 2.6 K 2.6 K 3.3 K Qualified.
TE-3UP-016	Liquid level transducer above Fuel Assembly 3.	310 to 980 K	1 Hz	2.8 K	350 K 450 K 550 K 650 K	2.5 K 2.6 K 2.6 K 3.3 K Qualified.
TE-4EB-045	Cladding on Fuel Assembly 4, Row E, Column 8 at 1.14 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K Qualified.
TE-4F7-037	Cladding on Fuel Assembly 4, Row F, Column 7 at 0.94 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K Qualified.
TE-4F8-028	Cladding on Fuel Assembly 4, Row F, Column 8 at 0.71 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K Qualified.
TE-4F8-032	Cladding on Fuel Assembly 4, Row F, Column 8 at 0.81 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K Qualified.
TE-4F9-026	Cladding on Fuel Assembly 4, Row F, Column 9 at 0.66 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K Qualified.
TE-4F9-041	Cladding on Fuel Assembly 4, Row F, Column 9 at 1.04 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-4G02-030	Cladding on Fuel Assembly 4, Row G, Column 2 at 0.76 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-4G08-021	Cladding on Fuel Assembly 4, Row G, Column 8 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-4G08-039	Cladding on Fuel Assembly 4, Row G, Column 8 at 0.99 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K	2.8 K	
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-4G14-030	Cladding on Fuel Assembly 4, Row G, Column 14 at 0.76 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K	2.8 K	
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-4G14-045	Cladding on Fuel Assembly 4, Row G, Column 14 at 1.14 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-4H01-037	Cladding on Fuel Assembly 4, Row H, Column 1 at 0.94 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-4H02-032	Cladding on Fuel Assembly 4, Row H, Column 2 at 0.81 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-4H13-032	Cladding on Fuel Assembly 4, Row H, Column 13 at 0.94 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-4H14-028	Cladding on Fuel Assembly 4, Row H, Column 14 at 0.71 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-4H14-032	Cladding on Fuel Assembly 4, Row H, Column 14 at 0.81 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-4H15-026	Cladding on Fuel Assembly 4, Row H, Column 15 at 0.66 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-4H15-041	Cladding on Fuel Assembly 4, Row H, Column 15 at 1.04 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-4I02-021	Cladding on Fuel Assembly 4, Row I, Column 2 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-4I02-039	Cladding on Fuel Assembly 4, Row I, Column 2 at 0.99 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Reactor Vessel</u> (continued)							
TE-4I14-021	Cladding on Fuel Assembly 4, Row 1, Column 14 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-4I14-039	Cladding on Fuel Assembly 4, Row 1, Column 14 at 0.99 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-4LP-001	Fuel Assembly 4 lower end box.	310 to 980 K	1 Hz	2.7 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-4LP-002	Fuel Assembly 4 lower end box.	310 to 980 K	1 Hz	--	350 K	2.5 K	
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-4LP-003	Fuel Assembly 4 lower end box.	310 to 980 K	1 Hz	--	350 K	2.5 K	
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-4UP-001	Fuel Assembly 4 upper end box.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-4UP-002	Fuel Assembly 4 upper end box.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-4UP-003	Fuel Assembly 4 upper end box.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-4UP-004	Fuel Assembly 4 support column.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-4UP-005	Fuel Assembly 4 support column.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-506-024	Guide tube for Fuel Assembly 5, Row C, Column 6 at 0.61 m above bottom of guide tube.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					900 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-506-030	Cladding on Fuel Assembly 5, Row D, Column 6 at 0.76 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-506-032	Cladding on Fuel Assembly 5, Row D, Column 6 at 0.81 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-506-037	Cladding on Fuel Assembly 5, Row D, Column 6 at 0.94 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-506-039	Cladding on Fuel Assembly 5, Row D, Column 6 at 0.99 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Reactor Vessel</u> (continued)							
TE-5E8-015	Cladding on Fuel Assembly 5, Row E, Column 8 at 0.38 m above bottom of fuel rod.	420 to 1810 K	1 Hz	4.2 K	450 K 600 K 800 K 1000 K	3.8 K 4.2 K 5.2 K 6.7 K	Qualified.
TE-5E8-034.5	Cladding on Fuel Assembly 5, Row E, Column 8 at 0.88 m above bottom of fuel rod.	420 to 1810 K	1 Hz	4.2 K	450 K 600 K 800 K 1000 K	3.8 K 4.2 K 5.2 K 6.7 K	Qualified.
TE-5E8-049	Cladding on Fuel Assembly 5, Row E, Column 8 at 1.24 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5F3-024	Guide tube for Fuel Assembly 5, Row F, Column 3 at 0.61 m above bottom of guide tube.	420 to 1530 K	1 Hz	3.1 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5F4-015	Cladding on Fuel Assembly 5, Row F, Column 4 at 0.38 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5F4-021	Cladding on Fuel Assembly 5, Row F, Column 4 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5F4-026	Cladding on Fuel Assembly 5, Row F, Column 4 at 0.66 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5F4-030	Cladding on Fuel Assembly 5, Row F, Column 4 at 0.76 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-5F7-005	Cladding on Fuel Assembly 5, Row F, Column 7 at 0.13 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5F8-024	Cladding on Fuel Assembly 5, Row F, Column 8 at 0.61 m above bottom of fuel rod.	420 to 1810 K	1 Hz	4.2 K	450 K	3.8 K	Qualified.
					600 K	4.2 K	
					800 K	5.2 K	
					1000 K	6.7 K	
TE-5F8-028	Cladding on Fuel Assembly 5, Row F, Column 8 at 0.71 m above bottom of fuel rod.	420 to 1810 K	1 Hz	4.2 K	450 K	3.8 K	Qualified.
					600 K	4.2 K	
					800 K	5.2 K	
					1000 K	6.7 K	
TE-5F8-032	Cladding on Fuel Assembly 5, Row F, Column 8 at 0.81 m above bottom of fuel rod.	420 to 1810 K	1 Hz	4.2 K	450 K	3.8 K	Qualified.
					600 K	4.2 K	
					800 K	5.2 K	
					1000 K	6.7 K	
TE-5F9-011	Cladding on Fuel Assembly 5, Row F, Column 9 at 0.28 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5F9-030	Cladding on Fuel Assembly 5, Row F, Column 9 at 0.76 m above bottom of fuel rod.	420 to 1810 K	1 Hz	4.2 K	450 K	3.8 K	Qualified.
					600 K	4.2 K	
					800 K	5.2 K	
					1000 K	6.7 K	
TE-5F9-045	Cladding on Fuel Assembly 5, Row F, Column 9 at 1.14 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.	
					800 K	4.7	
					1000 K	6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Reactor Vessel</u> (continued)							
TE-5F9-062	Cladding on Fuel Assembly 5, Row F, Column 9 at 1.57 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5G6-011	Cladding on Fuel Assembly 5, Row G, Column 6 at 0.28 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5G6-030	Cladding on Fuel Assembly 5, Row G, Column 6 at 0.76 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5G6-045	Cladding on Fuel Assembly 5, Row G, Column 6 at 1.14 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5G6-062	Cladding on Fuel Assembly 5, Row G, Column 6 at 1.57 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5G8-008	Cladding on Fuel Assembly 5, Row G, Column 8 at 0.20 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5G8-026	Cladding on Fuel Assembly 5, Row G, Column 8 at 0.66 m above bottom of fuel rod.	410 to 1820 K	1 Hz	4.2 K	450 K 600 K 800 K 1000 K	3.8 K 4.2 K 5.2 K 6.7 K	Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-5G8-041	Cladding on Fuel Assembly 5, Row G, Column 8 at 1.04 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5G8-058	Cladding on Fuel Assembly 5, Row G, Column 8 at 1.47 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5H5-002	Cladding on Fuel Assembly 5, Row H, Column 5 at 0.05 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5H5-015	Cladding on Fuel Assembly 5, Row H, Column 5 at 0.38 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5H5-034.6	Cladding on Fuel Assembly 5, Row H, Column 5 at 0.88 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5H5-049	Cladding on Fuel Assembly 5, Row H, Column 5 at 1.24 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K	2.8 K	
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5H6-024	Cladding on Fuel Assembly 5, Row H, Column 6 at 0.61 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5H6-028	Cladding on Fuel Assembly 5, Row H, Column 6 at 0.71 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-5H6-032	Cladding on Fuel Assembly 5, Row H, Column 6 at 0.81 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5H6-037	Cladding on Fuel Assembly 5, Row H, Column 6 at 0.94 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5H7-008	Cladding on Fuel Assembly 5, Row H, Column 7 at 0.20 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5H7-026	Cladding on Fuel Assembly 5, Row H, Column 7 at 0.66 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5H7-041	Cladding on Fuel Assembly 5, Row H, Column 7 at 1.04 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5H7-058	Cladding on Fuel Assembly 5, Row H, Column 7 at 1.47 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5I6-005	Cladding on Fuel Assembly 5, Row I, Column 6 at 0.13 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K	2.8 K	Failed.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5I6-021	Cladding on Fuel Assembly 5, Row I, Column 6 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Reactor Vessel</u> (continued)							
TE-516-039	Cladding on Fuel Assembly 5, Row I, Column 6 at 0.99 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-516-054	Cladding on Fuel Assembly 5, Row I, Column 6 at 1.37 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-518-008	Cladding on Fuel Assembly 5, Row I, Column 8 at 0.20 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-518-026	Cladding on Fuel Assembly 5, Row I, Column 8 at 0.66 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-518-041	Cladding on Fuel Assembly 5, Row I, Column 8 at 1.04 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-518-058	Cladding on Fuel Assembly 5, Row I, Column 8 at 1.47 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-533-024	Guide tube for Fuel Assembly 5, Row J, Column 3 at 0.61 m above bottom of guide tube.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Reactor Vessel</u> (continued)							
TE-5J4-015	Cladding on Fuel Assembly 5, Row J, Column 4 at 0.38 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5J4-030	Cladding on Fuel Assembly 5, Row J, Column 4 at 0.76 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5J7-011	Cladding on Fuel Assembly 5, Row J, Column 7 at 0.28 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5J7-030	Cladding on Fuel Assembly 5, Row J, Column 7 at 0.76 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5J7-045	Cladding on Fuel Assembly 5, Row J, Column 7 at 1.14 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5J7-062	Cladding on Fuel Assembly 5, Row J, Column 7 at 1.57 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5J8-024	Cladding on Fuel Assembly 5, Row J, Column 8 at 0.61 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-5JB-028	Cladding on Fuel Assembly 5, Row J, Column 8 at 0.71 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5JB-032	Cladding on Fuel Assembly 5, Row J, Column 8 at 0.81 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5JB-037	Cladding on Fuel Assembly 5, Row J, Column 8 at 0.94 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5J9-005	Cladding on Fuel Assembly 5, Row J, Column 9 at 0.13 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5J9-021	Cladding on Fuel Assembly 5, Row J, Column 9 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5J9-039	Cladding on Fuel Assembly 5, Row J, Column 9 at 0.99 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5J9-054	Cladding on Fuel Assembly 5, Row J, Column 9 at 1.37 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5KB-002	Cladding on Fuel Assembly 5, Row K, Column 8 at 0.05 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-SK8-015	Cladding on Fuel Assembly 5, Row K, Column 8 at 0.38 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	
TE-SK8-034.5	Cladding on Fuel Assembly 5, Row K, Column 8 at 0.88 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-SK8-049	Cladding on Fuel Assembly 5, Row K, Column 8 at 1.24 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.
TE-5LP-001	Fuel Assembly 5 lower end box.	310 to 980 K	1 Hz	2.7 K	350 K 450 K 550 K 650 K	2.5 K 2.6 K 2.6 K 3.3 K	Qualified.
TE-5LP-002	Fuel Assembly 5 lower end box.	310 to 980 K	1 Hz	2.7 K	350 K 450 K 550 K 650 K	2.5 K 2.6 K 2.6 K 3.3 K	Qualified.
TE-5LP-003	Fuel Assembly 5 lower end box.	310 to 980 K	1 Hz	2.7 K	350 K 450 K 550 K 650 K	2.5 K 2.6 K 2.6 K 3.3 K	Qualified.
TE-5LP-004	Fuel Assembly 5 lower end box.	310 to 980 K	1 Hz	2.7 K	350 K 450 K 550 K 650 K	2.5 K 2.6 K 2.6 K 3.3 K	Qualified.
TE-5L6-030	Cladding on Fuel Assembly 5, Row L, Column 6 at 0.76 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K 600 K 800 K 1000 K	2.8 K 3.2 K 4.7 K 6.2 K	Qualified.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Reactor Vessel</u> (continued)							
TE-5L6-032	Cladding on Fuel Assembly 5, Row L, Column 6 at 0.81 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5L6-037	Cladding on Fuel Assembly 5, Row L, Column 6 at 0.94 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5L6-039	Cladding on Fuel Assembly 5, Row L, Column 6 at 0.99 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5L8-011	Guide tube for Fuel Assembly 5, Row L, Column 8 at 0.28 m above bottom of guide tube.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5L8-024	Guide tube for Fuel Assembly 5, Row L, Column 8 at 0.61 m above bottom of guide tube.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5L8-039	Guide tube for Fuel Assembly 5, Row L, Column 8 at 0.99 m above bottom of guide tube.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-5M6-024	Guide tube for Fuel Assembly 5, Row M, Column 6 at 0.61 m above bottom of guide tube.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Reactor Vessel</u> (continued)							
TE-5UP-001	Fuel Assembly 5 upper end box.	310 to 980 K	1 Hz	2.9 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-5UP-002	Fuel Assembly 5 upper end box.	310 to 980 K	1 Hz	2.9 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-5UP-003	Fuel Assembly 5 upper end box.	310 to 980 K	1 Hz	2.9 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-5UP-004	Fuel Assembly 5 upper end box.	310 to 980 K	1 Hz	2.9 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-5UP-005	Fuel Assembly 5 upper end box.	310 to 980 K	1 Hz	2.9 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-5UP-006	Fuel Assembly 5 upper end box.	310 to 980 K	1 Hz	2.9 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-5UP-007	Fuel Assembly 5 upper end box.	310 to 980 K	1 Hz	2.9 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	

Table B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-5UP-008	Fuel Assembly 5 upper end box.	310 to 980 K	1 Hz	--	350 K	2.5 K	
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-5UP-009	Fuel Assembly 5 upper end box.	310 to 980 K	1 Hz	2.9 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-6E8-045	Cladding on Fuel Assembly 6, Row E, Column 8 at 1.14 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6F9-041	Cladding on Fuel Assembly 6, Row F, Column 9 at 1.04 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6G02-030	Cladding on Fuel Assembly 6, Row G, Column 2 at 0.76 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6G08-021	Cladding on Fuel Assembly 6, Row G, Column 8 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6G08-039	Cladding on Fuel Assembly 6, Row G, Column 8 at 0.99 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
Reactor Vessel (continued)							
TE-6G14-011	Cladding on Fuel Assembly 6, Row G, Column 14 at 0.28 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K	2.8 K	
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6G14-030	Cladding on Fuel Assembly 6, Row G, Column 14 at 0.76 m above bottom of fuel rod.	420 to 1530 K	1 Hz	--	450 K	2.8 K	
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6G14-045	Cladding on Fuel Assembly 6, Row G, Column 14 at 1.14 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6H01-037	Cladding on Fuel Assembly 6, Row H, Column 1 at 0.94 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6H02-028	Cladding on Fuel Assembly 6, Row H, Column 2 at 0.71 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6H02-032	Cladding on Fuel Assembly 6, Row H, Column 2 at 0.81 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6H03-026	Cladding on Fuel Assembly 6, Row H, Column 3 at 0.66 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6H08-039	Cladding on Fuel Assembly 6, Row H, Column 8 at 0.99 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Reactor Vessel</u> (continued)							
TE-6H13-015	Cladding on Fuel Assembly 6, Row H, Column 13 at 0.38 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6H13-037	Cladding on Fuel Assembly 6, Row H, Column 13 at 0.94 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6H14-028	Cladding on Fuel Assembly 6, Row H, Column 14 at 0.71 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.2 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6H14-032	Cladding on Fuel Assembly 6, Row H, Column 14 at 0.81 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6H15-026	Cladding on Fuel Assembly 6, Row H, Column 15 at 0.66 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6H15-041	Cladding on Fuel Assembly 6, Row H, Column 15 at 1.04 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Reactor Vessel</u> (continued)							
TE-6102-021	Cladding on Fuel Assembly 6, Row 1, Column 2 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.1 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6114-021	Cladding on Fuel Assembly 6, Row 1, Column 14 at 0.53 m above bottom of fuel rod.	420 to 1530 K	1 Hz	3.3 K	450 K	2.8 K	Qualified.
					600 K	3.2 K	
					800 K	4.7 K	
					1000 K	6.2 K	
TE-6LP-001	Fuel Assembly 6 lower end box.	310 to 980 K	1 Hz	2.7 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-6LP-002	Fuel Assembly 6 lower end box.	310 to 980 K	1 Hz	2.7 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-6LP-003	Fuel Assembly 6 lower end box.	310 to 980 K	1 Hz	2.7 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-6UP-001	Fuel Assembly 6 upper end box.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-6UP-002	Fuel Assembly 6 upper end box.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Reactor Vessel (continued)</u>							
TE-6UP-003	Fuel Assembly 6 upper end box.	310 to 980 K	1 Hz	2.9 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-6UP-004	Fuel Assembly 6 support column.	310 to 980 K	1 Hz	2.8 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
TE-6UP-005	Fuel Assembly 6 support column.	310 to 980 K	1 Hz	2.7 K	350 K	2.5 K	Qualified.
					450 K	2.6 K	
					550 K	2.6 K	
					650 K	3.3 K	
<u>Secondary Coolant System</u>							
TT-P004-004	Secondary coolant system feedwater.	370 to 505 K	1 Hz	--	--	0.9 K	
<u>Emergency Core Cooling System</u>							
TT-P120-062	Cold leg injection in 4-in. line upstream of cold leg injection point.	280 to 620 K	1 Hz	--	--	2.1 K	
<u>Intact Loop</u>							
TT-P139-032	Intact loop hot leg primary coolant, Channel A.	535 to 620 K	1 Hz	1.7 K	--	1.7 K	Qualified, response limited.
TT-P139-033	Intact loop hot leg primary coolant, Channel B.	535 to 620 K	1 Hz	1.7 K	--	1.7 K	Qualified, response limited.

TABLE B-2. (continued)

Variable, System, and Detector	Location	Measurement Range	Recording Frequency ^a	Initial Condition Uncertainty (±)	After Experiment Initiation		Comments
					Reading	Uncertainty (±)	
TEMPERATURE (continued)							
<u>Intact Loop (continued)</u>							
TT-P139-034	Intact loop hot leg primary coolant, Channel C.	535 to 620 K	1 Hz	1.7 K	--	1.7 K	Qualified, response limited.

- a. Recording frequency is the measurement channel bandwidth at the ± 3 -dB level.
- b. Reference B-4.
- c. Reference B-5.
- d. Reference B-6.
- e. Reference B-7.
- f. The steam generator liquid level is defined as 0 at 2.95 m above the top of the tube sheet.
- g. Reference B-8.
- h. Reference B-9.
- i. Pressure measurements are presented as absolute values.

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APPENDIX C

PREEXPERIMENT PROCEDURES AND DATA CONSISTENCY CHECKS

APPENDIX C

PREEXPERIMENT PROCEDURES AND DATA CONSISTENCY CHECKS

In preparation for Experiment L9-1/L3-3, the primary coolant system (PCS) was filled and vented, and the specified system water chemistry was established. Prior to the primary system heatup, several tests were performed on the Loss-of-Fluid Test (LOFT) system. These tests included plant requalification tests, accumulator blowdowns through the pressurizer relief line, pump coastdown runs, experiment control system checks, and operational verification of newly installed instrumentation. Selected system process instruments were calibrated and an electrical calibration was performed on the data acquisition and visual display system (DAVDS).^{C-1}

The PCS pressure was hydrostatically increased to 1.46, 3.53, 6.98, 10.43, 13.87, and 15.60 MPa at cold plant temperature and zero flow conditions. The DAVDS recorded 20 s of data at each pressure plateau in both the increasing and decreasing directions to determine the degree of sensitivity of the pressure sensing instruments. The system was concurrently inspected for leakage at the various test pressures. The pumps were operated at 15, 20, 30, 40, 50, and 60 Hz with 20 s of data taken at each frequency. During heatup of the plant, the appropriate initial conditions were established for the blowdown suppression tank (BST), accumulator, and borated water storage tank (BWST).

The plant was stabilized at 422, 489, and 555 K during heatup. At each of these temperatures, 20 s of data were recorded for calibration checks and to determine the degree of instrument temperature sensitivity. In addition, the pump speeds were increased to 15, 20, 30, 40, 50, and 60 Hz and then decreased through the same frequency steps, with 20 s of data taken at each frequency in both the increasing and decreasing directions. At the 422-K stabilization point, with the pumps off, 20 s of data were taken at system pressure plateaus of 1.46, 3.53, 6.98, 9.74, and 11.12 MPa in both the increasing and decreasing directions. At the 489- and 555-K stabilization points, the pumps were stopped, and 20 s of data were recorded during pump coastdown and zero flow conditions. With the pumps off at the 489-K stabilization

point, 20 s of data were taken at system pressure plateaus of 12.49, 11.12, 9.74, 6.98, and 3.53 MPa in both the decreasing and increasing directions. With the pumps off at the 555-K stabilization point, the PCS pressure was decreased and then increased through 14.95, 13.87, 12.50, 11.12, and 9.74 MPa and 20 s of data were obtained at each step. Before the reactor was brought critical, the DAVDS was calibrated and the boron concentration in the accumulators, BST, and BWST was verified.

The following discussion describes several techniques used to perform consistency checks on the data presented in this report. The purpose of these checks is to establish data integrity and to evaluate the performance of a given transducer.

1. CHECKS OF PREEXPERIMENT DATA

Prior to the experiment, static pressure, steady state flow, zero flow, pump coastdown, isothermal, and accumulator blowdown tests were conducted on the LOFT system at various temperatures, pressures, and flow rates. Using the data from these tests, the following checks were performed.

1.1 Absolute Pressure Data

During the approach to initial conditions, a series of static pressure tests was performed. After each test, the absolute pressure measurements were compared with two reference pressures (PE-PC-005 and -006). The pressure tests were used to evaluate the slope coefficient of the calibration equations and to evaluate the pressure sensitivity of the transducers.

Prior to the experiment, the BST was vented to the atmosphere and the BST pressure readings were checked against atmospheric pressure.

The steam generator pressures were compared to each other and checked against the temperature

in the steam generator by comparing the pressure obtained from the steam tables, using the steam generator temperature, with the pressure transducer readings.

When the accumulator was pressurized, both accumulator pressure transducer readings were checked by comparing one with the other.

1.2 Flow Data

Measurements of fluid flow included pump speed, differential pressure, venturi, turbine, and drag disc. The measurements were analyzed primarily to check the zero offset. Turbine and drag disc measurements were also analyzed to check slope coefficient (gain) changes.

1.2.1 Pump Speed Data. The reference measurement for all intact loop flow measurements was primary coolant pump speed, because it is the most accurate and stable of the flow measurements. The pump speed measurement was adjusted using a square wave generator to calibrate the digital-to-analog conversion.

During heatup the zero reading was checked at every zero flow point, and during flow tests the pump speed was checked against pump frequency. Pump speed measurements were checked for consistency by comparison with pump speed as calculated from the primary system motor generator frequencies. This check was valid prior to and during the experiment until the primary system motor generator field breakers were opened. Prior to the experiment, the pump speed was further checked by reviewing the agreement with previous LOFT experiments. Pump operating voltages and currents were evaluated prior to the experiment by calculating the pump electrical horsepower input, the pump water power, and finally the combined pump efficiency. These calculated efficiencies were then compared with previously recorded efficiencies determined during pump requalification tests.

1.2.2 Differential Pressure Data. Zero offsets were determined from flow data, static pressure tests, and temperature sensitivity data derived during the heatup. Steady state flow conditions for the PCS were then established, and selected PCS pressure drops were compared with predicted values. At various flow conditions, intact loop flow resistance coefficients were calculated and

verified to remain essentially constant and to agree with previously tabulated data. Further consistency checks were performed on the intact loop differential pressure measurements by plotting the square root of the differential pressure against pump speed using data from the pump frequency tests. The results of the curve fits performed on those plots were then used to confirm zero offsets. Both prior to and during the experiment, differential pressure measurements were compared with the differential pressure computed by subtracting appropriate absolute pressure measurements. Pressure closure was calculated for the PCS intact loop.

1.2.3 Venturi Data. Consistency checks were performed by comparing the venturi mass flow rates with each other and venturi mass flow rates from previous LOFT experiments (with the same loop resistance). A comparison of the venturi with the pump speed consisted of performing a least squares fit of the venturi data versus the pump data (derived from the pump speed frequency test). The results were used to correct any zero offset in the venturi. The corrected venturi data were then used to calculate the average fluid velocity and momentum flux of the intact loop. The computed velocity was compared to the differential pressure measured across the pumps, the steam generator, and the reactor vessel.

1.2.4 Drag Disc-Turbine (DTT) Data. Reactor vessel and piping drag disc measurements were compared with values calculated from venturi mass flow, assuming the full flow area. Slope coefficients were calculated, and the effect of temperature on the calibration coefficients was determined.

After the slope coefficients had been verified, the data for a given transducer were plotted against pump speed and a least squares fit performed. The zero offset from this curve fit was used to modify the zero offset of the transducers.

As an independent check, the turbine flowmeter and drag disc data were used to calculate fluid density. These values were then compared to the known single-phase density prior to the experiment. This analysis was performed on all the turbine flowmeter and drag disc measurements with the exception of those that failed.

Accumulator blowdowns through the pressurizer relief line were performed to verify the

slope coefficients for the break line DTT. The calculated mass flow from the DTT was compared with the mass flow rate from the accumulator and the mass flow rate into the BST.

1.3 Gamma Densitometer Data

To evaluate the PCS average fluid densities, calculations were performed using the gamma densitometers. The densitometers were checked for normal operation by recording and examining data tapes approximately 1 day before the experiment and by observing spectra, count rate data, and live-time data on the densitometer system display console during and immediately before the experiment.

1.4 Level Measurement Data

Six system level measurements were evaluated: (a) BST liquid level, (b) pressurizer coolant level, (c) pump suction liquid level, (d) reactor vessel coolant level, (e) steam generator simulator liquid level, and (f) steam generator secondary side liquid level. BST liquid level measurements were qualified by comparing the four available measurements. In addition, a site glass measurement was made both prior to and following the experiment. Similarly, pressurizer and steam generator liquid levels were reviewed by redundant level measurements. The pump suction and steam generator simulator liquid levels were checked at zero flow conditions with the plant full of water. The reactor vessel liquid level probes were verified by performing preexperiment conductivity calibrations with the vessel full, under cold and hot plant conditions.

1.5 Thermocouple Data

Temperature measurements were analyzed by comparing them with other temperature data obtained during the isothermal tests. Resistance temperature measurements were used for reference, where they existed. If saturation conditions existed, the temperature was compared with the temperature from the steam tables using pressure measurements as the reference. Temperature measurements outside the primary coolant were compared with any known temperature in the same area.

2. CHECKS DURING AND AFTER THE EXPERIMENT

The purpose of these checks was to further establish the data integrity. For each type of measurement, comparable data channels were evaluated and the determination of data consistency was identified. The following is a brief summary of those checks.

2.1 Absolute Pressure Data

Immediately prior to experiment initiation, pressures were compared to the reference pressures (PE-PC-005 and -006). During the experiment, pressure measurements situated in nearby measurement locations were compared. When saturation conditions existed, measured pressures were compared to saturation pressures calculated from the saturated steam table using temperature data.

2.2 Flow Data

Immediately prior to the experiment, flow data were again compared for consistency. In addition, experiment data were compared with previous similar experiments. A summary of the consistency checks for the pump and flow transducer measurements follows.

2.2.1 Pump Speed Data. The field breakers for the primary coolant pump motor generator sets were opened at the end of pump coastdown. Pump speed measurements were compared during pump coastdown.

2.2.2 Differential Pressure Data. Immediately prior to the experiment, when steady state operating conditions had been established, the differential pressure measurements around the intact loop were summed and compared with the differential pressure across the primary coolant pumps.

2.2.3 Venturi Data. The initial conditions data from the venturi were checked for data consistency by comparing them with preexperiment flow test data. The flow venturi was used only for steady state initial conditions information.

2.2.4 Drag Disc-Turbine (DTT) Data. Initial conditions data were checked by calculating momentum flux from the venturi mass flow rate and from the known density for those DTTs that were not overranged. These values were then compared with the measured values from the DTT.

Experiment data were checked by comparing data from previous experiments. An additional check was made by comparing the basic shape of the velocity or momentum flux curves with a differential pressure close to the DTT.

2.3 Gamma Densitometer Data

Checks of the calibration constants were obtained from the all-liquid readings a few seconds prior to the experiment and in addition for the pressurizer relief line densitometer an all-steam condition was obtained later in the transient. The fluid densities for the all-liquid and all-steam conditions were determined from the steam tables using temperature and pressure measurements.

2.4 Liquid Level Data

The BST liquid level was evaluated by comparing four independent level measurements

(LT-P138-33 and -58 and LEPdE-SV-1 and -2). Similarly, the steam generator and pressurizer liquid levels were reviewed by redundant level measurements. The steam generator simulator and upper plenum liquid levels were checked for consistency by comparison with liquid levels generated from the gamma densitometers in the intact and broken loop hot legs. This check was made during the interval when the primary coolant level was at the level of the nozzles. The reactor vessel liquid level measurements were compared to vessel thermocouple data (that is, when the liquid level dropped below a given thermocouple, the measured temperature increased).

2.5 Temperature Data

The temperatures during the experiment were compared with saturation temperatures from the steam tables using pressure data and with previous experimental data. Initial conditions were also checked by comparing all primary coolant thermocouple and resistance thermometer detector measurements. Suppression tank thermocouple measurements were compared in a like manner.

3. REFERENCES

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