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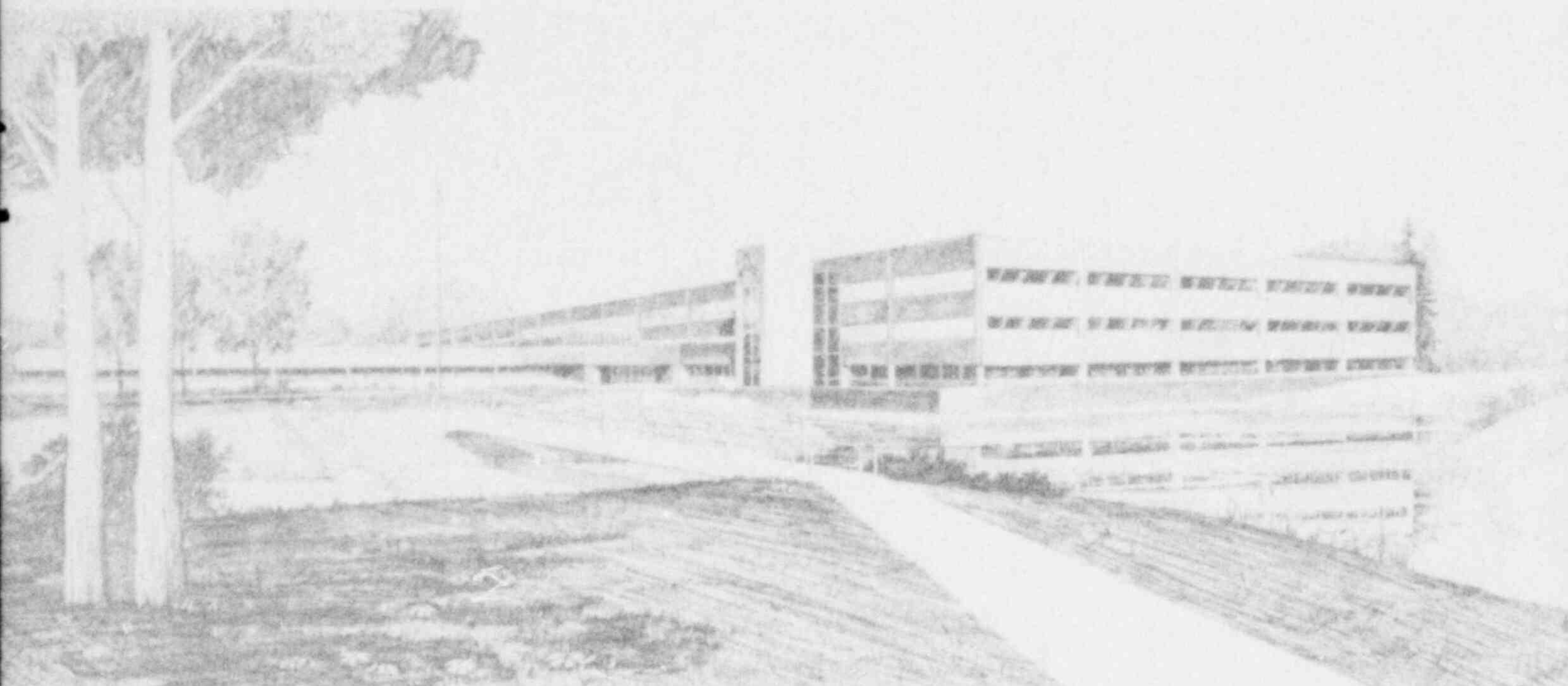

U.S. Department of Energy
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Experiment Data Report For LOFT Nuclear Small Break Experiment L3-1

Paul D. Bayless
J. Bruce Marlow
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January 1980

Prepared for the
U.S. Nuclear Regulatory Commission
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EXPERIMENT DATA REPORT FOR LOFT NUCLEAR SMALL BREAK EXPERIMENT L3-1

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ABSTRACT

Experiment L3-1 was the first small break loss of coolant experiment conducted at the Loss-of-Fluid Test (LOFT) facility with the nuclear core at power. The primary objectives of the experiment were to obtain data for analytical code assessment and to further understand the thermal-hydraulic behavior which occurs during a postulated loss-of-coolant accident in a pressurized water reactor. Other objectives of the experiment were to determine emergency core cooling system performance, determine any unexpected thresholds or events, determine how effectively typical process instrumentation indicated the true system condition, and define variations in system design or plant operation that could mitigate small break transient phenomena. The experiment successfully accomplished the objectives. The LOFT facility was configured to simulate a postulated loss-of-coolant accident caused by a small break in the primary coolant system cold leg in a commercial pressurized water reactor (~1000 MWe). The break size was equivalent to a 4-inch pipe rupture, or a 2.5% break, in a commercial plant, scaled on a break area to system volume basis. The initial conditions in the primary coolant system were: hot leg temperature, 574.0 ± 1 K; cold leg temperature, 554.0 ± 3 K; hot leg pressure, 14.85 ± 0.04 MPa; and intact loop flow, 484.0 ± 6.3 kg/s. The LOFT core was operated at 48.9 ± 1 MWt, yielding a preblowdown maximum linear heat generation rate of 51.7 ± 1 kW/m. During system depressurization, emergency core cooling water was injected into the primary coolant system cold leg. The control rods were tripped ~2 s before break initiation and the primary coolant pumps were tripped at break initiation. Recorded data for Experiment L3-1 are presented.

SUMMARY

Experiment L3-1 was performed as part of the Loss-of-Fluid Test (LOFT) Program conducted by EG&G Idaho, Inc., for the U.S. Nuclear Regulatory Commission. This experiment is part of the LOFT Small Break Experiment Series L3 which was designed to investigate the thermal-hydraulic response of LOFT reactor systems to small primary system ruptures. Experiment L3-1, conducted at 48.9 ± 1 MW (yielding a maximum linear heat generation rate of 51.7 ± 1 kW/m), had the following objectives:

1. Determine the principal variables of temperature, pressure, density, mass flow, and mass inventory as functions of time associated with the core, primary coolant system coolant, and emergency core coolant (ECC) sufficient for comparisons with and assessment of code predictions

2. Determine ECC system performance and core reflood characteristics

3. Determine the existence of thresholds and/or events not expected from review of the pretest analyses

4. Determine sequence of events during the transient and the effectiveness of typical process instruments in indicating the true conditions

5. Define operational methods and system design variations whereby specific small break transient phenomena can be made less severe.

The LOFT integral test facility has been designed to simulate the major components and system responses of a commercial four-loop pressurized water reactor (∼1000 MWe) during a loss-of-coolant accident. The LOFT facility consists of

1. A reactor vessel with a nuclear core (Core 1)

2. An intact loop with active steam generator, pressurizer, and two primary coolant pumps connected in parallel

3. A broken loop with simulated free-wheeling pump, simulated steam generator, and two quick-opening blowdown valve assemblies

4. A blowdown suppression system consisting of a blowdown header, blowdown suppression tank, and a blowdown suppression tank 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.

For the performance of Experiment L3-1, the LOFT test system was assembled to represent a postulated small break in the cold leg of a commercial PWR.

Experiment L3-1 was initiated from primary coolant system initial conditions of: hot leg temperature, 574.0 ± 1 K; cold leg temperature, 554.0 ± 3 K; hot leg pressure, 14.85 ± 0.04 MPa; and intact loop flow rate, 484.0 ± 6.3 kg/s. The preblowdown power level was 48.9 ± 1 MW, with a maximum linear heat generation rate of 51.7 ± 1 kW/m. To determine system thermal-hydraulic response, scaled ECC was directed into the primary coolant system cold leg injection line through use of an accumulator, a HPIS pump, and a LPIS pump. The accumulator initiated injection at 633.6 ± 0.5 s, and HPIS flow and LPIS flow were initiated at 4.6 ± 0.5 and 4240.0 ± 1 s after rupture, respectively.

Experiment L3-1 satisfied the specified objectives. This report presents data in the form of graphs in engineering (standard international) units. In conjunction with data obtained from direct measurement, chosen computed variables are included to facilitate the analysis of the system thermal-hydraulic behavior.

ACKNOWLEDGMENTS

Appreciation is expressed to the experimental data report group members, the personnel of the Data System branch, and the personnel of the LOFT Experimental Measurements branch. Special appreciation is expressed to C. E. Coppin for the technical editing.

CONTENTS

FIGURES

TABLES

ABBREVIATIONS AND ACRONYMS

ACC	Accumulator
BL	Broken loop
BST	Blowdown suppression tank
BSTSS	Blowdown suppression tank spray system
BWST	Borated water storage tank
CCW	Counterclockwise
CL	Cold leg
CW	Clockwise
DAVDS	Data acquisition and visual display system
DC	Downcomer
DTT	Drag disc turbine transducer
ECC	Emergency core cooling or coolant
ECCS	Emergency core coolant system
HL	Hot leg
HPIS	High-pressure injection system
IC	Initial condition
LOCA	Loss-of-coolant accident
LOCE	Loss-of-coolant experiment
LOFT	Loss-of-fluid test
LP	Lower plenum
LPIS	Low-pressure injection system
OD	Outside diameter
PNA	Pulsed neutron activation system
PORV	Power operated relief valve
PWR	Pressurized water reactor
QOBV	Quick-opening blowdown valve
RABV	Reflood assist bypass valve
SCS	Secondary coolant system
SG	Steam generator
TTF	Transit time flowmeter
XRO	Orifice

EXPERIMENT DATA REPORT FOR LOFT NUCLEAR SMALL BREAK EXPERIMENT L3-1

INTRODUCTION

The Loss-of-Fluid Test (LOFT) Program is one of several water reactor research experimental programs conducted by EG&G Idaho, Inc., for the U.S. Nuclear Regulatory Commission (NRC) and administered by the Department of Energy. The LOFT Program objectives are to

1. Provide data required to evaluate the adequacy and improve the analytical methods currently used to predict the hypothetical loss-of-coolant accident (LOCA) response of commercial (∿1000 MWe) pressurized water reactors (PWRs). The performance of engineered safety features, with particular emphasis on the emergency core cooling system (ECCS) and the quantitative margins of safety inherent in the performance of engineered safety features, is of primary interest.

2. Identify and investigate any unexpected event(s) or threshold(s) in the response of either the plant or the engineered safety features, and develop analytical techniques that adequately describe and account for such unexpected behavior.

To meet these 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. Reference 1 describes the LOFT facility in detail.

The LOFT Small Break Experiment Series (Experiment Series L3) was designed to provide large-scale blowdown system data for a PWR small break transient. Parameters varied for Experiment Series L3 include initial power level, break size and location, and primary coolant pump operation.

The specific experiment series objectives are to

1. Determine the response of the LOFT facility from break initiation through plant recovery for several types of small breaks

2. Compare actual plant conditions to information provided by typical large PWR process instruments

3. Establish initial conditions and operating conditions as close as practical to the conditions used in the audit calculations being performed by Code Assessment for the NRC and the conditions planned by Semiscale in their LOFT counterpart tests for Experiment Series L3.

Experiment L3-1 was conducted in the LOFT facility at a maximum linear heat generation rate of 51.7 ± 1 kW/m and a power of 48.9 ± 1 MW. This power level is about 98% of the LOFT rated thermal power of 50 MW. The primary objectives of Experiment L3-1 were to

1. Determine the principal variables of temperature, pressure, density, mass flow, and mass inventory as functions of time associated with the core, primary coolant system coolant, and ECC sufficient for comparisons with and assessment of code predictions

2. Determine ECC system performance and core reflood characteristics

3. Determine the existence of thresholds and/or events not expected from review of the pretest analyses

4. Determine sequence of events during the transient and the effectiveness of typical process instruments in indicating the true conditions

5. Define operational methods and system design variations whereby specific small break transient phenomena can be made less severe.

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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-coolant analysis.

Experiment L3-1 was conducted from initial temperatures in the primary coolant system intact loop of 574.0 ± 1 and 554.0 ± 3 K in the hot and cold legs, respectively, and hot leg pressure of 14.85 ± 0.04 MPa. The experiment simulated a break in the cold leg of a four-loop, commercial PWR large enough to cause system depressurization to the low-pressure injection system (LPIS) initiation pressure. The reactor was operated sufficiently long to establish a decay heat level corresponding to 40 hours of full power operation.

The purpose of this report is to present the data from Experiment L3-1 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.

The following sections describe the LOFT configuration, the LOFT instrumentation system and the methods of obtaining certain measurements, and Experiment L3-1 initial conditions and experiment procedures. The data are presented with supporting information for data interpretation. Appendix A discusses the methods used to verify the consistency and accuracy of the data.

SYSTEM CONFIGURATION

The LOFT facility has been designed to simulate the major components and system responses of a commercial PWR during a LOCA. The experiment assembly comprises five major subsystems which have been instrumented such that system variables can be measured and recorded during a loss-of-coolant experiment (LOCE). The subsystems include: (a) the reactor vessel, (b) the intact loop, (c) the broken loop, (d) the blowdown suppression system, and (e) the ECCS. The LOFT major components are shown in Figure 1, and the LOFT piping configuration is shown in Figure 2.

The LOFT reactor vessel, which simulates the reactor vessel of a commercial PWR, 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 and four triangular (corner) fuel modules, shown in Figure 3 and described in Reference 2. The center assembly is highly instrumented. Two of the corner and one of the square (15x15) 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 (U^{235}) and the density is 93% of theoretical density. 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. Cladding material is zircaloy-4. Cladding inside and outside diameters are 9.48 and 10.72 mm, respectively.

The intact loop simulates the three unbroken loops of a commercial four-loop PWR and contains a steam generator, two circulating coolant pumps in parallel, a pressurizer, a venturi flowmeter, and connecting piping. The intact loop steam generator inlet and outlet plenums contain low resistance, square-edged orifice plates.

The broken loop consists of a hot leg and a cold leg that are connected to the reactor vessel and the blowdown suppression tank 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 to maintain approximately equal loop temperatures, and are isolated from the system prior to blowdown initiation. The hot leg valves remain closed during the experiment.

The broken loop hot leg also contains a simulated steam generator and simulated pump. These simulators have hydraulic orifice plate assemblies which have similar (passive) resistances to flow as an active steam generator and a free-wheeling pump.

The blowdown suppression system simulates the containment back pressure of a commercial PWR. This system comprises the blowdown suppression tank header, the blowdown suppression tank (BST), the nitrogen pressurization system, and the blowdown suppression tank spray system. The blowdown header is connected to the suppression

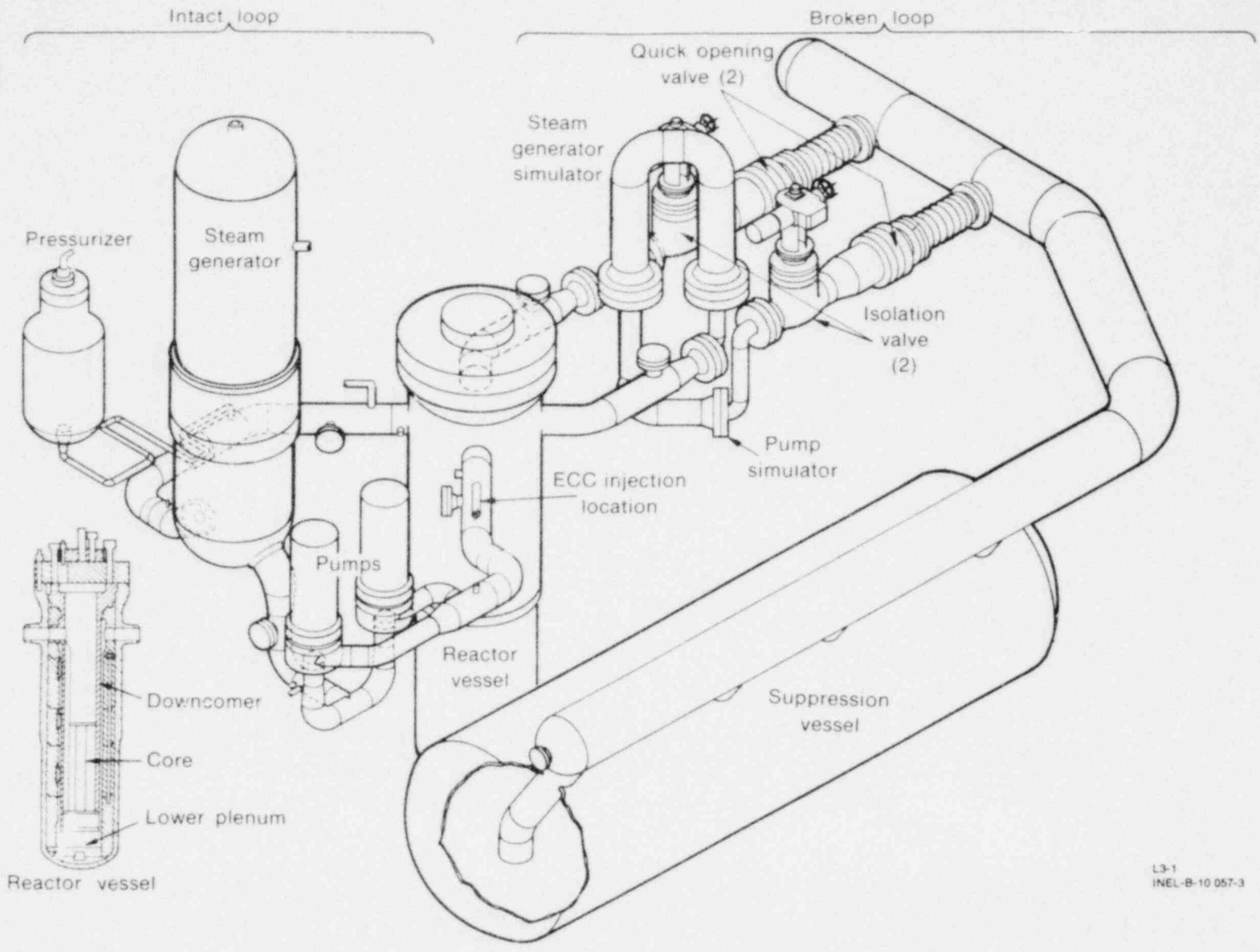

Figure 1. LOFT major components.

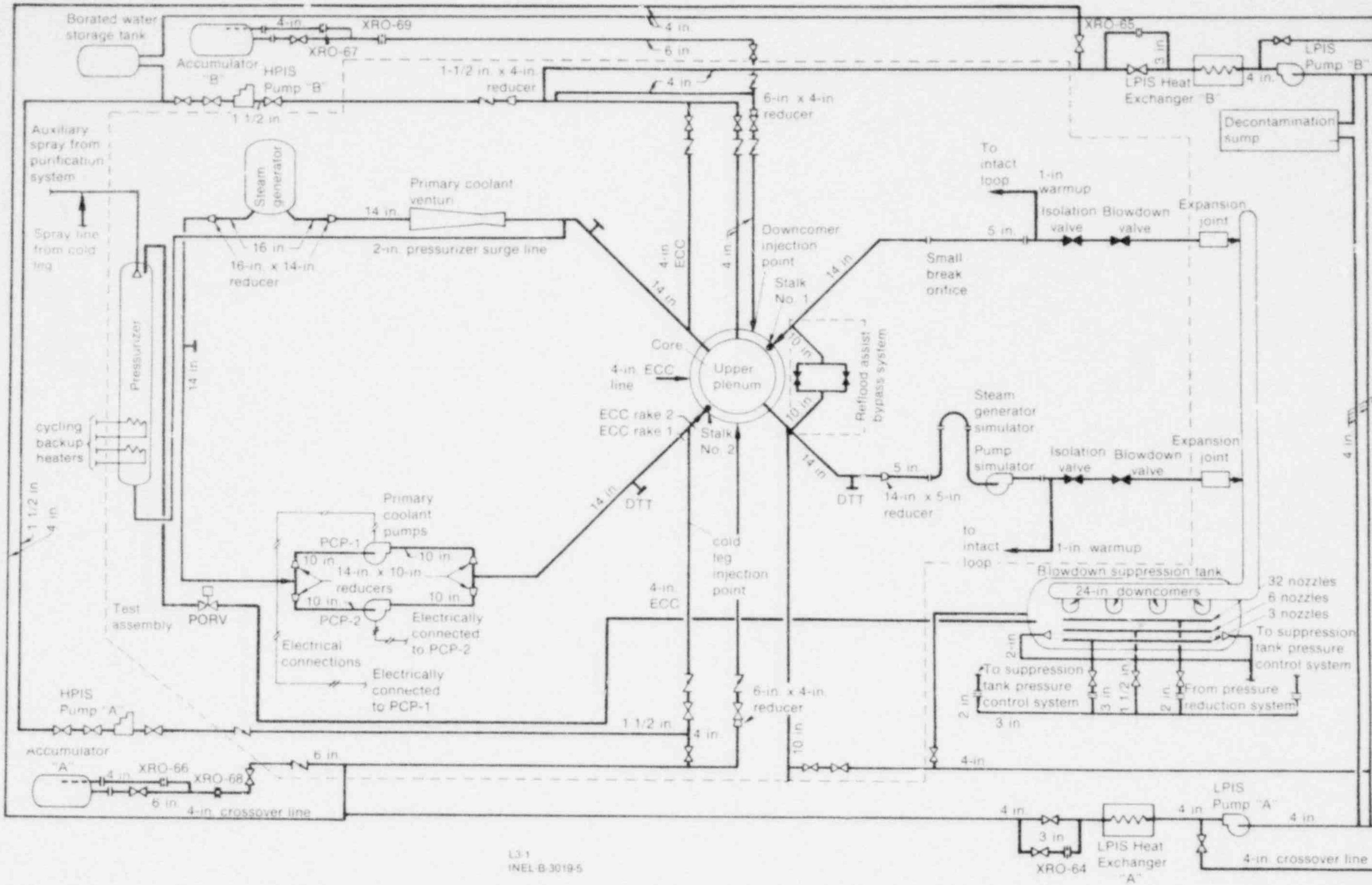

Figure 2. LOFT piping schematic.

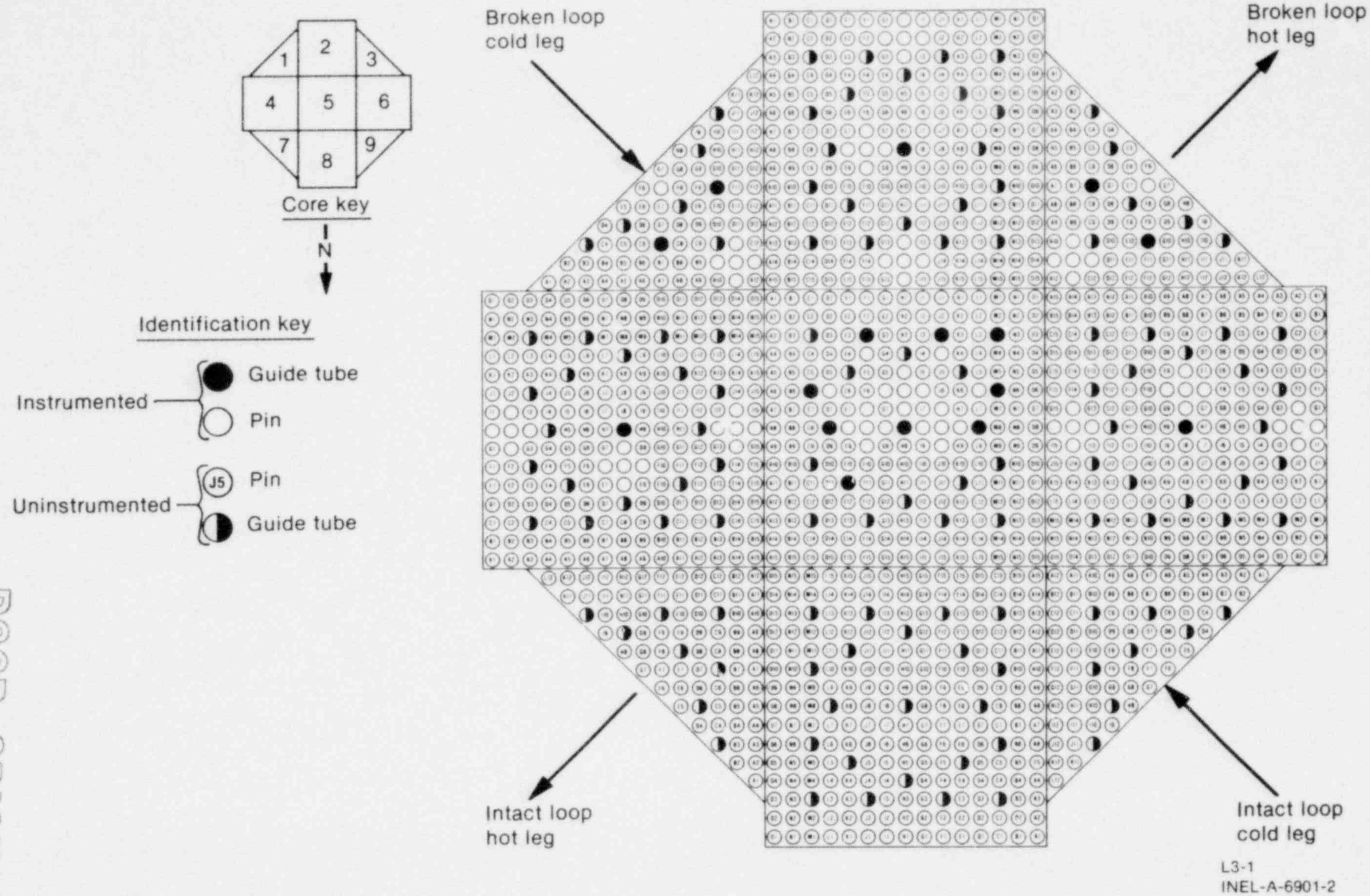

Figure 3. LOFT Core 1 configuration showing rod designations.

tank downcomers that extend inside the tank and discharge below the water level. 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 blowdown suppression tank initial pressure. The spray system consists of a centrifugal pump which 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 blowdown suppression tank 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 blowdown suppression tank along the upper centerline.

The LOFT ECCS simulates the ECCS of a commercial PWR. The accumulator, the high-pressure injection system (HPIS), and the low-pressure injection system (LPIS) were used during this experiment. Each system was arranged to inject scaled flow rates of ECC directly into the primary coolant system cold leg. To provide these scaled flow rates, Accumulator ACC-A, HPIS Pump A, and LPIS Pump A were utilized. Accumulator ACC-A was preset to inject ECC at a system pressure of 4.22 MPa. HPIS Pump A was set to initiate injection at a system pressure of 13.16 MPa. The pressure setpoint for automatic LPIS initiation was 0.98 MPa.

MEASUREMENTS AND INSTRUMENTATION

The LOFT instrumentation system was designed to measure and record the important events that occur during a LOCE.

Temperatures at all major locations in the system were obtained from thermocouples and resistance temperature detectors.

Pressure measurements were obtained with strain-gage transducers with pressure transmission lines connecting the transducers to the measurement points.

Differential pressures were measured by strain-gage transducers with double chambers. The transducers were externally located and connected to the measurement points with pressure transmission lines.

Flow velocity measurements were to be obtained by three types of instruments. A pulsed neutron activation system (PNA), shown in Figure 4, located in the intact loop hot leg measured the velocity from the time required for an activated slug of coolant to traverse the distance between the neutron sources and the detectors. A transit time flowmeter in the broken loop cold leg determined velocity from the time difference between two fast response thermocouples, located in the fluid flow, in sensing the same local thermal disturbance. The PNA failed because the detectors remained saturated throughout the experiment, and the TTF yielded data during the first 300 s and the last 350 s of the experiment. Turbine flowmeters measured the velocity directly.

Momentum flux was measured by drag discs. The data presented for fluid velocity (from the turbine flowmeters) and momentum flux are based on the following flow areas at the instrument locations.

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

Fluid density was measured by gamma densitometers, each of which consisted of a source and several detectors. Three detectors (A, B, and C) were aligned with collimated gamma ray beams passing through the pipe; the attenuation of the gamma rays varied inversely with the density of the fluid in the pipe. Each densitometer also had a detector (D) located so that it measured background radiation continuously, except for DE-PC-3, which checked the background by alternately exposing and storing the source. DE-PC-3 was a nonnuclear-hardened densitometer, had a Cs^{137} source, and was located in a vertical piping section. The rest of the densitometers were nuclear hardened, had Co^{60} sources, and were located in horizontal piping. Figure 5 shows the typical gamma densitometer configuration relative to the piping.

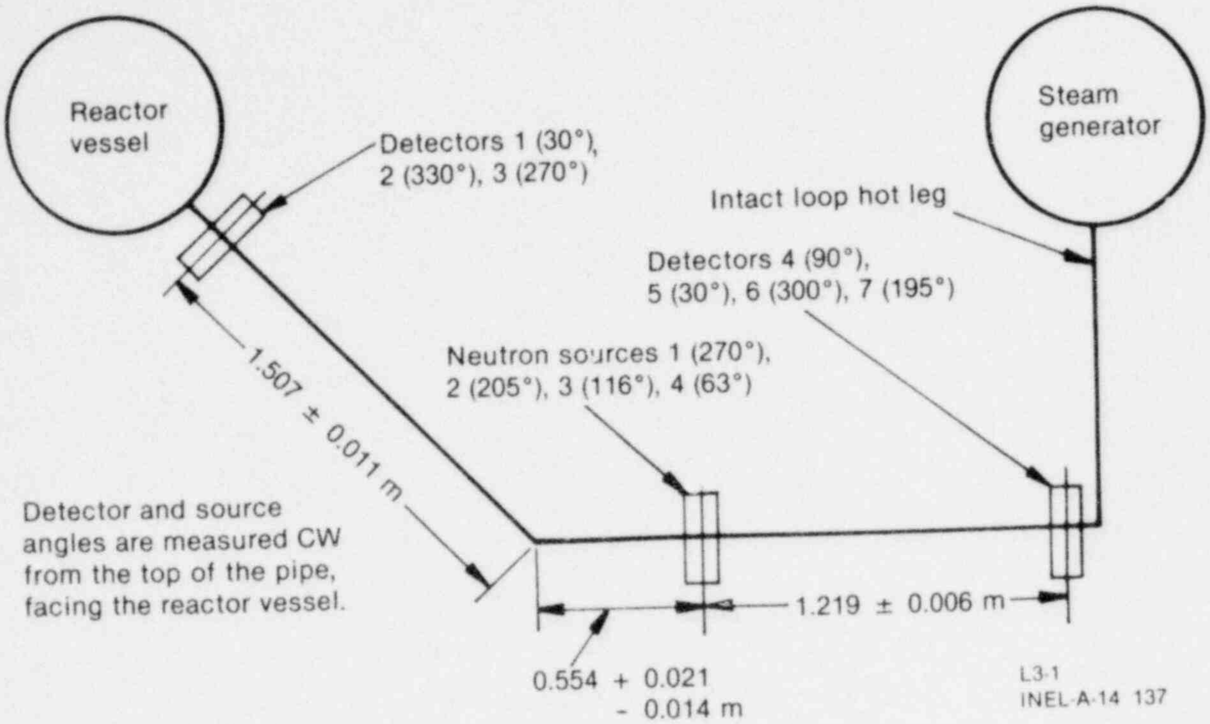

Figure 4. View of PNA sources and detectors.

Liquid levels were obtained by means of (a) differential pressure transducers in the pressurizer, accumulator, steam generator secondary side, 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.

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

Valve positions (analog indication from 0 to 100% of opening) were measured by either resistance potentiometers or differential transformers.

Mechanical pump speed was measured by an eddy current displacement transducer which used 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 was measured by a wattmeter.

The transient local linear heat generation rate was measured by self-powered neutron detectors. Each detector consists of a cylindrical Co^{59} 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.

The steady state linear heat generation rate is determined from neutron flux measurements taken with a traversing in-core probe (TIP) at four guide tube locations in the core. This instrument consists of a U-235 fission chamber attached to a flexible cable and its own data recording system. The probe is withdrawn and stored outside the core prior to blowdown initiation.

The data acquisition and visual display system (DAVDS) was used to record the measurement

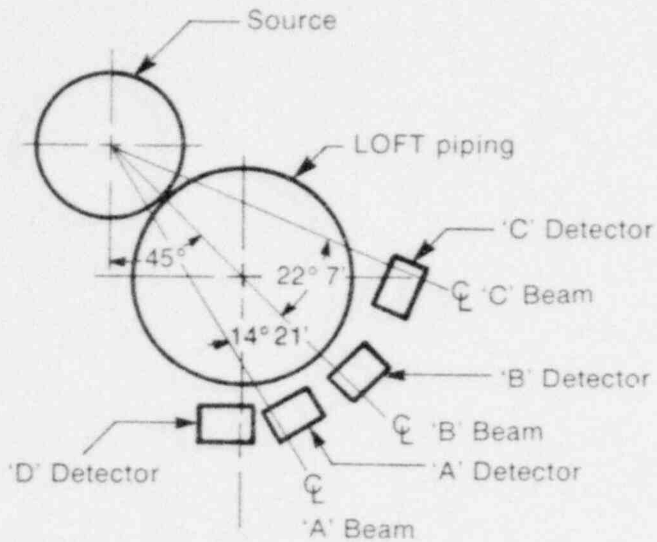

Figure 5a. Relation of source and detectors to pipe for densitometers except DE-PC-3.

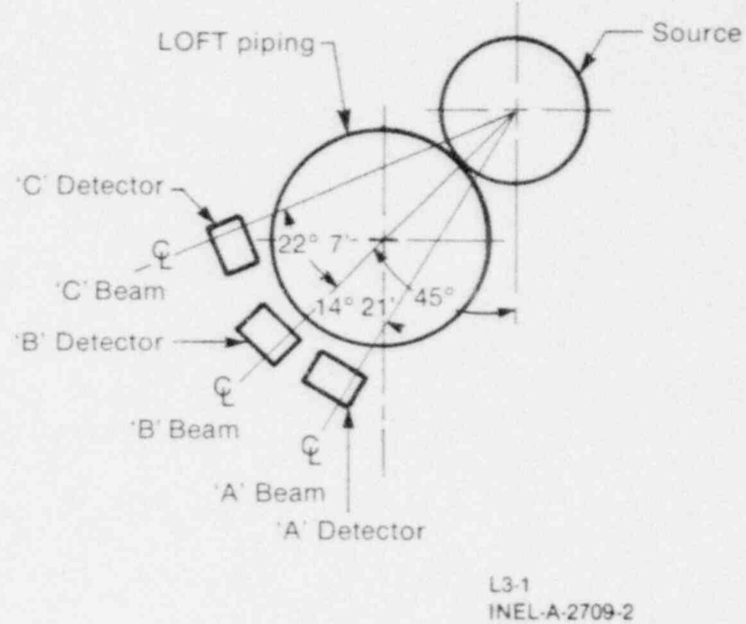

Figure 5b. Relation of source and detectors to pipe for DE-PC-3.

data from the various instrumentation systems on a combination of digital recorders and wide-band frequency modulation (FM) tape recorders, and oscillographic recorders[3]. Redundant records were made where use dictated more than one recording mode or where an extra measure of assurance was desired for critical measurements.

A digital computer was used to collect the LOCE data in a multiplex format at the LOFT facility and to perform equipment calibrations, posttest data reduction, and plotting[4]. Immediately following the test, the computer was used to reduce critical channels of the data so that a decision could be made quickly as to the success of the experiment. The recorded FM data were converted into digital form which were then demultiplexed to be compatible with the CDC CYBER 176/173 computer system.

The CDC CYBER 176/173 computer system was used to further reduce the data. Calibration factors were first applied to produce data plots in engineering units so that engineering specialists could examine each channel for discrepancies or unexpected events. Where possible, instrument channel outputs and computed variables were compared with test predictions, previous tests, corresponding parameter channels, and calculated quantities. Those measurement comparisons that were determined to be within the accuracy of the particular instrument were labeled as Qualified.

Transducers were generally calibrated under laboratory conditions prior to installation in LOFT. Verification of calibration constants was accomplished by special tests performed during heatup and by analysis of initial conditions data. In addition, post-LOCE checks were performed to pinpoint questionable data and to verify data consistency. Appendix A discusses the techniques used to perform data consistency checks.

Figure 6 shows a piping schematic with instrument locations indicated. Table 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:

Transducer location (inches from bottom of fuel rod)
Fuel assembly row
Fuel assembly column
Fuel assembly number
Transducer type

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Figures 7 and 8 show isometric views of the major system components with instrument locations indicated and Figures 9 through 19 give more specific locations for instruments located on individual components. Some of the temperature instruments shown in the figures were not recorded during the experiment. Reference 1 may be consulted if additional details of instrument design and locations are desired.

EXPERIMENT PROCEDURES AND INITIAL CONDITIONS

This section summarizes the experimental procedures, initial conditions, and the significant events recorded during the experiment.

Experiment Procedures

In preparation for Experiment L3-1, the primary coolant system was filled and vented and the specified system water chemistry was established. Prior to the primary system heatup, several tests were performed on the LOFT system. These tests included plant requalification tests, QOBV operation and seat leakage checks, pump coastdown runs, LOCE control system checks, and operational verification of newly installed instrumentation. Selected system process instrumentation was calibrated and an electrical calibration was performed on the DAVDS.

The primary coolant system 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

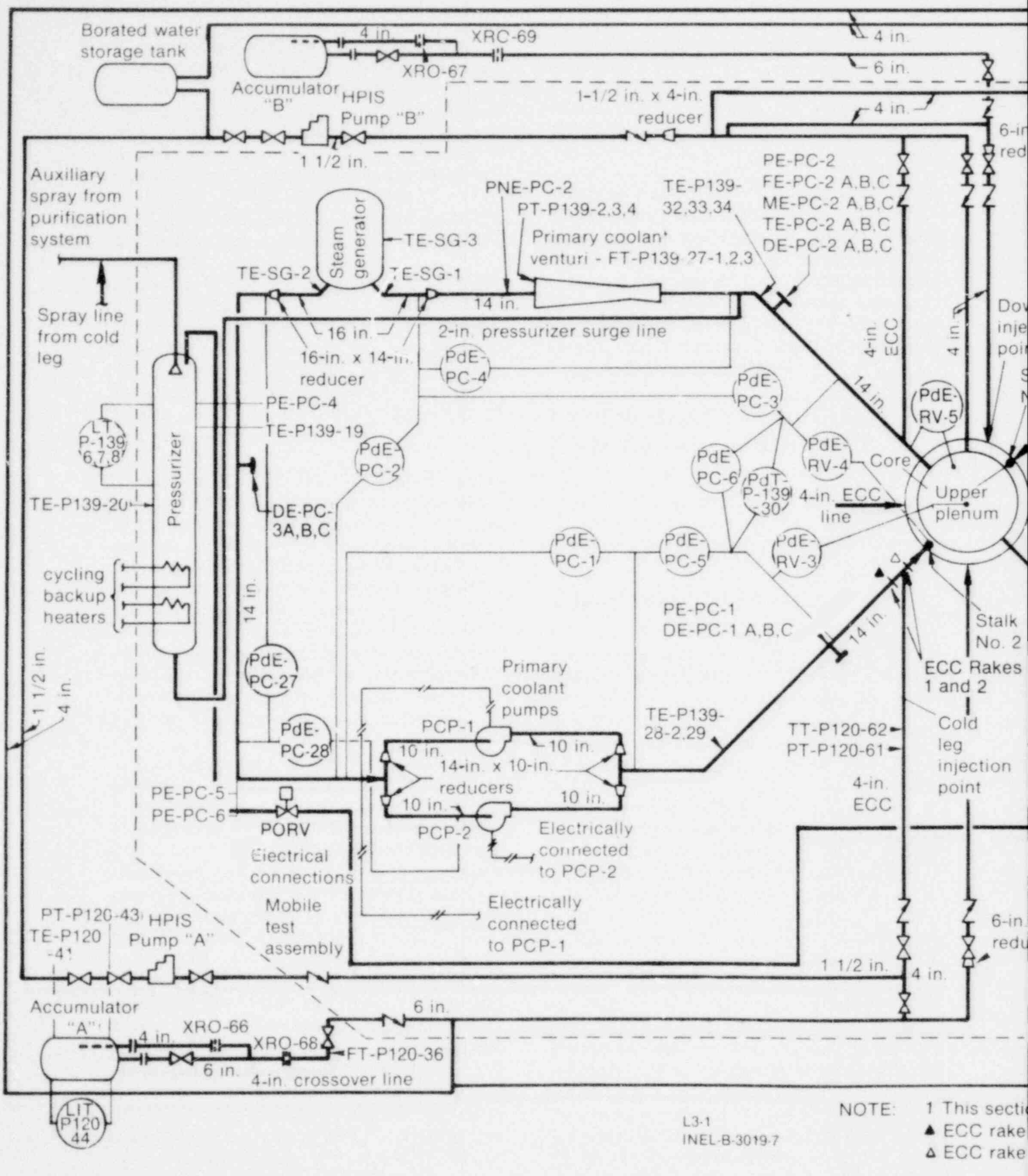
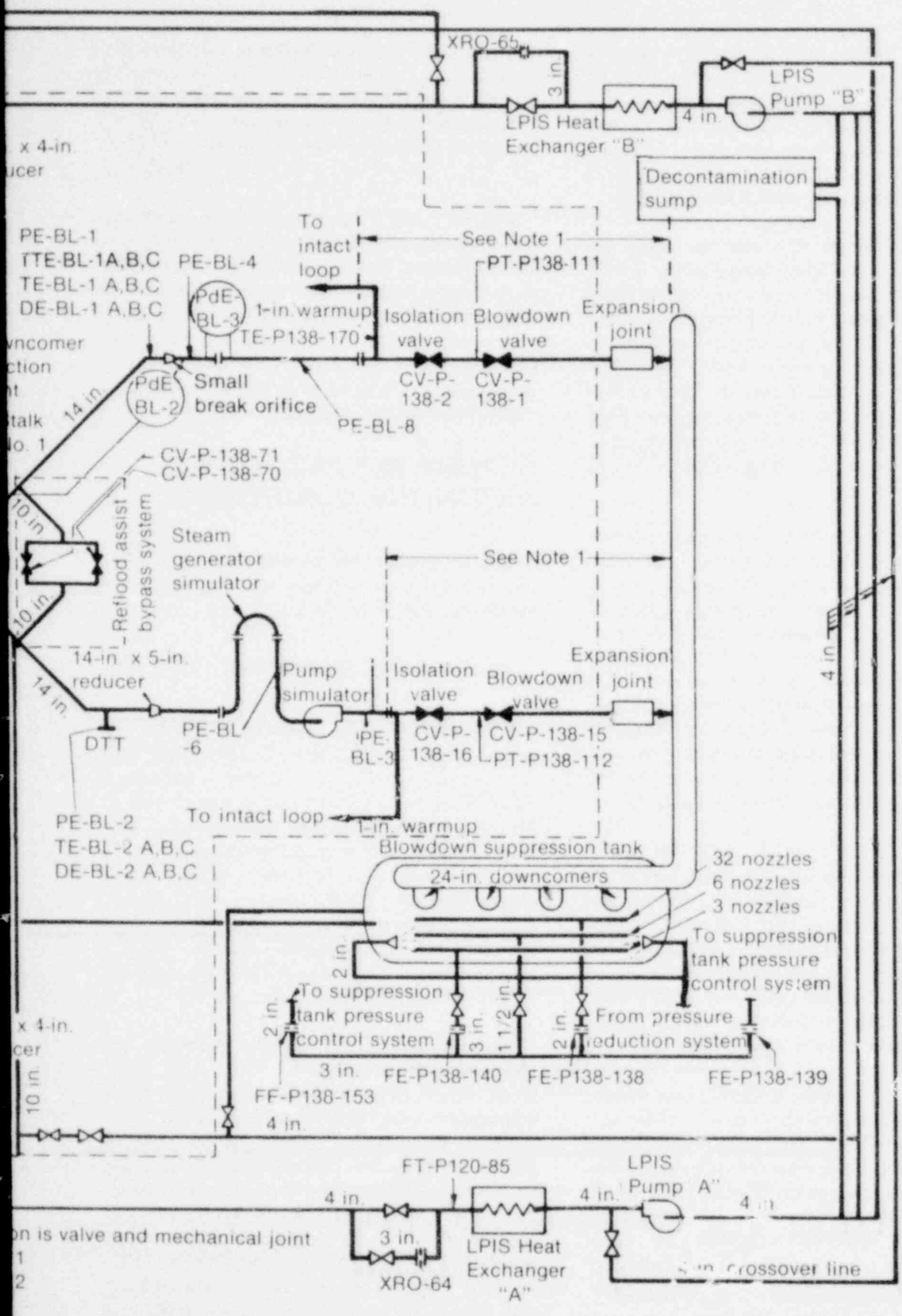


Figure 6. LOFT piping schematic with instr



on is valve and mechanical joint
1
2

umentation.

TABLE 1. NOMENCLATURE FOR LOFT INSTRUMENTATION

Designations for the different types of experimental instruments.

AE	Accelerometer
DE	Densitometer
DIE	Displacement element
FE	Coolant flow element
LE	Coolant level element
ME	Momentum flux detector
NE	Neutron detector
PCP	Primary coolant pumps
PdE	Differential pressure element
PE	Pressure element
PNE	Pulsed neutron activation system element
RPE	Pump speed element
TE	Temperature element
TTE	Transit time flowmeter element

Designations for the different experimental systems except the core.

BL	Broken loop
LP	Lower plenum
PC	Primary coolant intact loop
RV	Reactor vessel
SG	Steam generator
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 eleme
TE	Temperature element
TT	Temperature transmitter

Designations for the different systems associated with process instruments.

P4	Secondary coolant system
P120	Emergency core coolant system
P128	Primary coolant addition and control system and HPIS
P138	Broken loop and pressure suppression system
P139	Intact loop
T-87	Power range

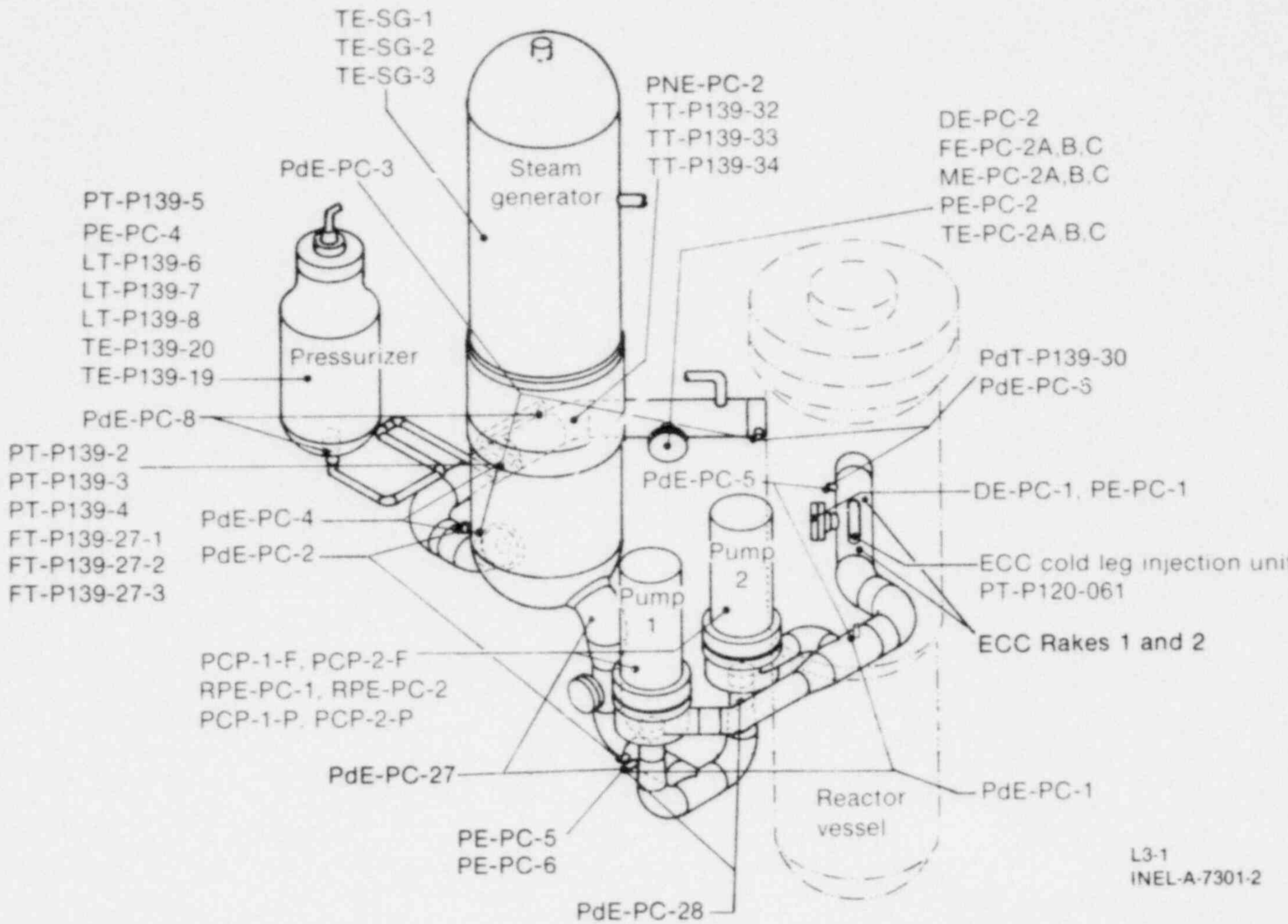


Figure 7. LOFT thermal-hydraulic instrumentation for intact loop.

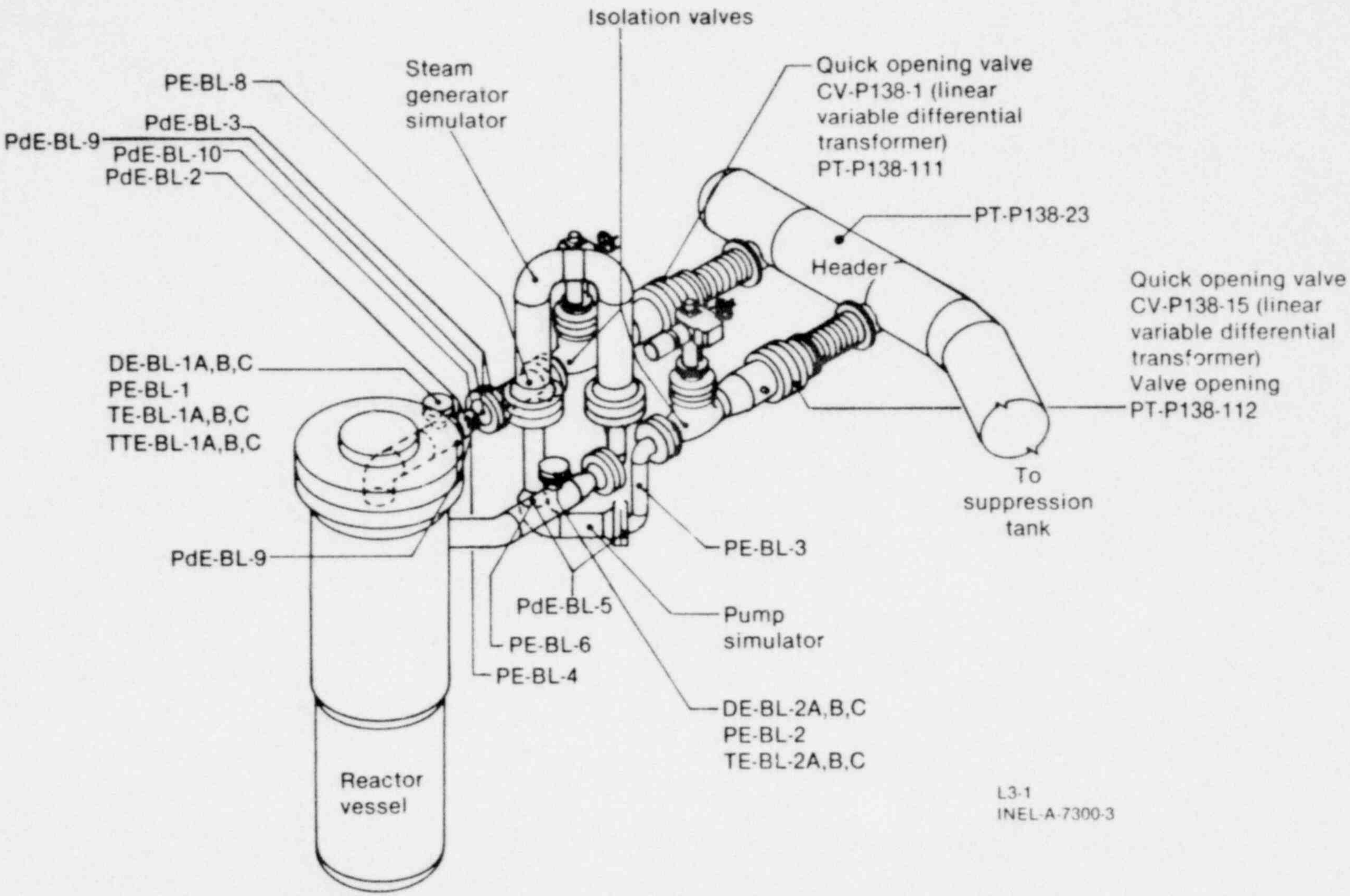


Figure 8. LOFT thermal-hydraulic instrumentation for broken loop.

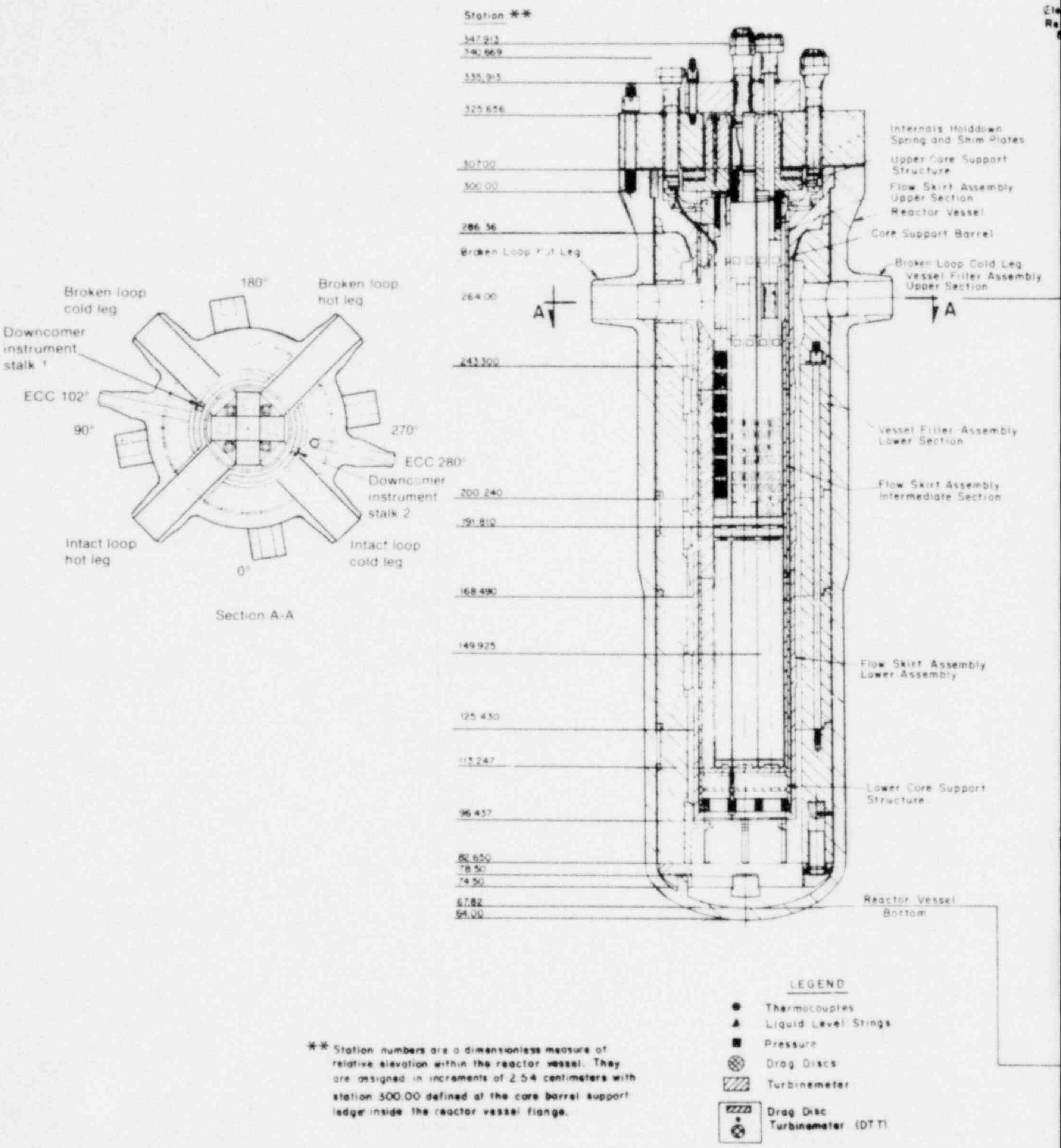


Figure 9. LOFT reactor vessel ins

rumentation.

* 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.

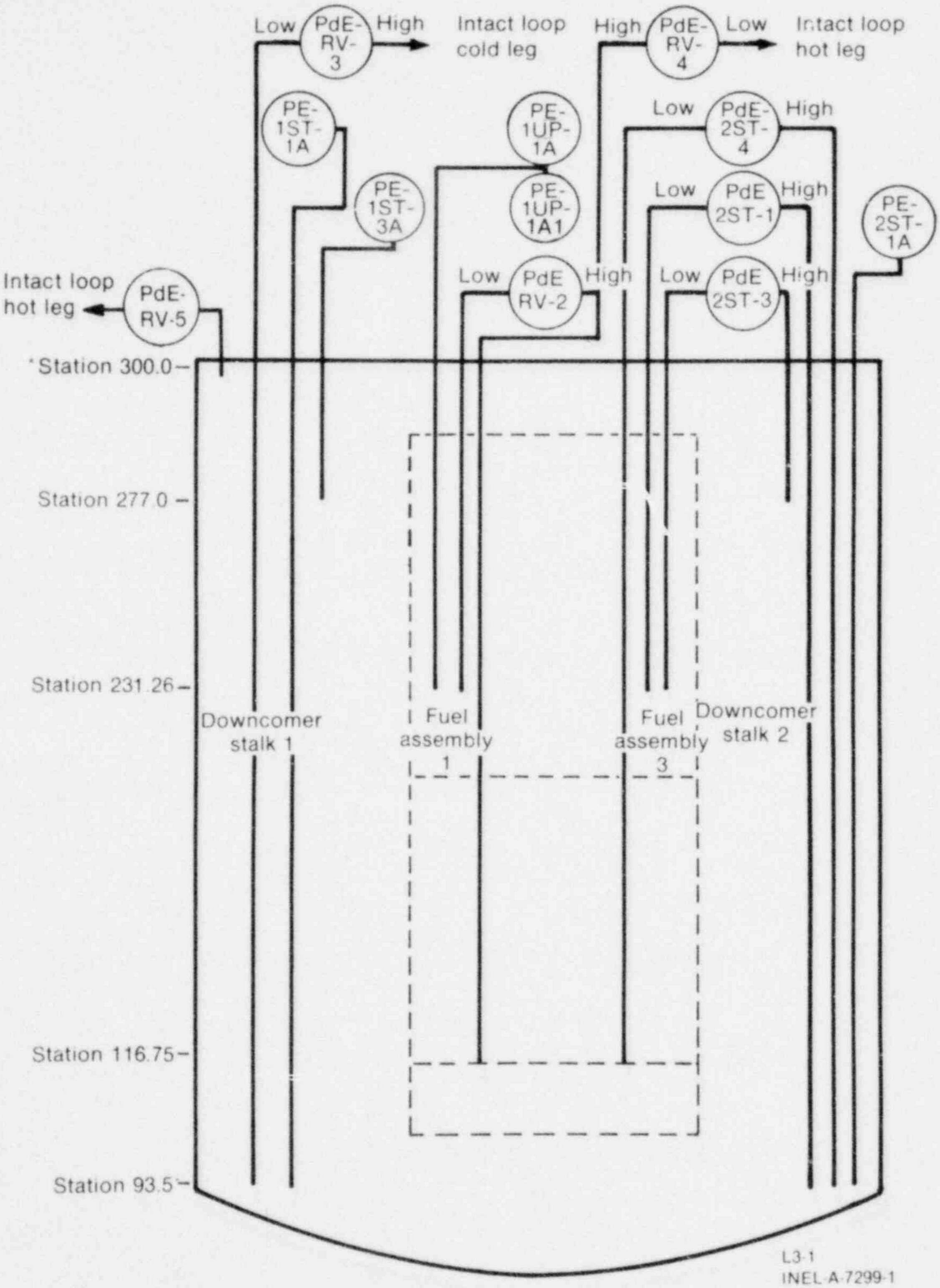
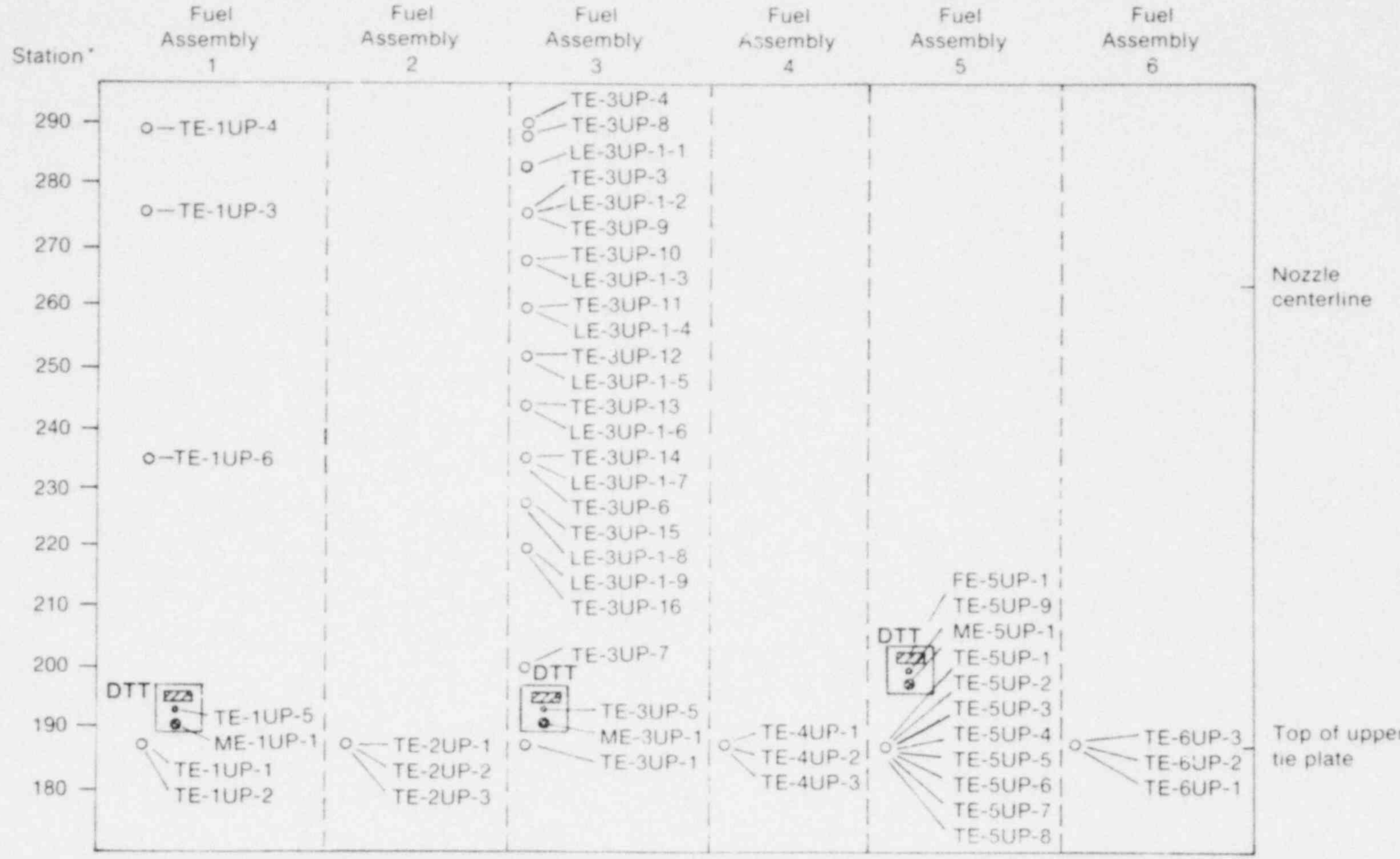


Figure 10. LOFT reactor vessel pressure and differential pressure instrumentation.



* 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 11. LOFT reactor vessel upper plenum DTT, LE, and TE elevations.

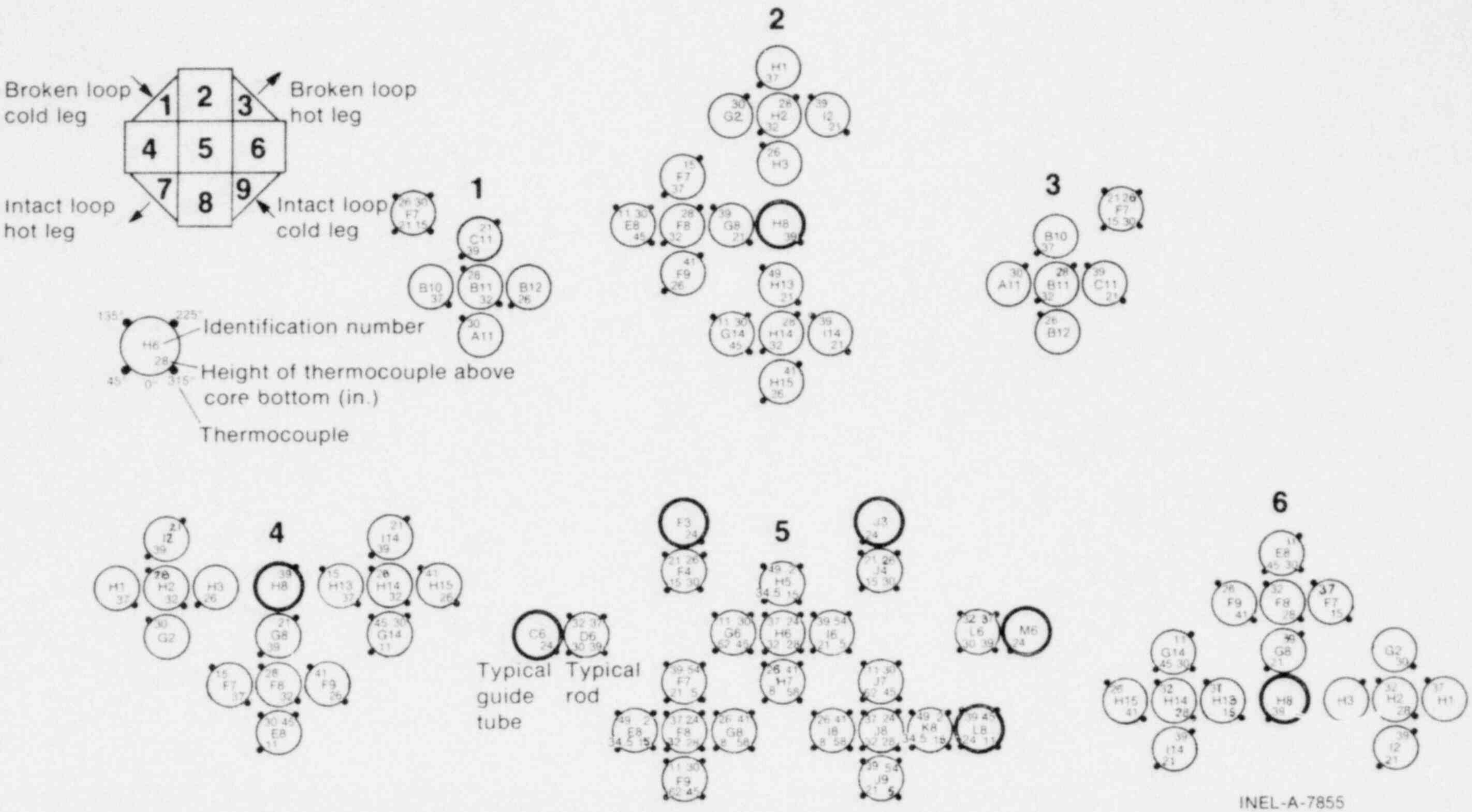


Figure 12. In-core thermocouple locations for LOFT Core 1.

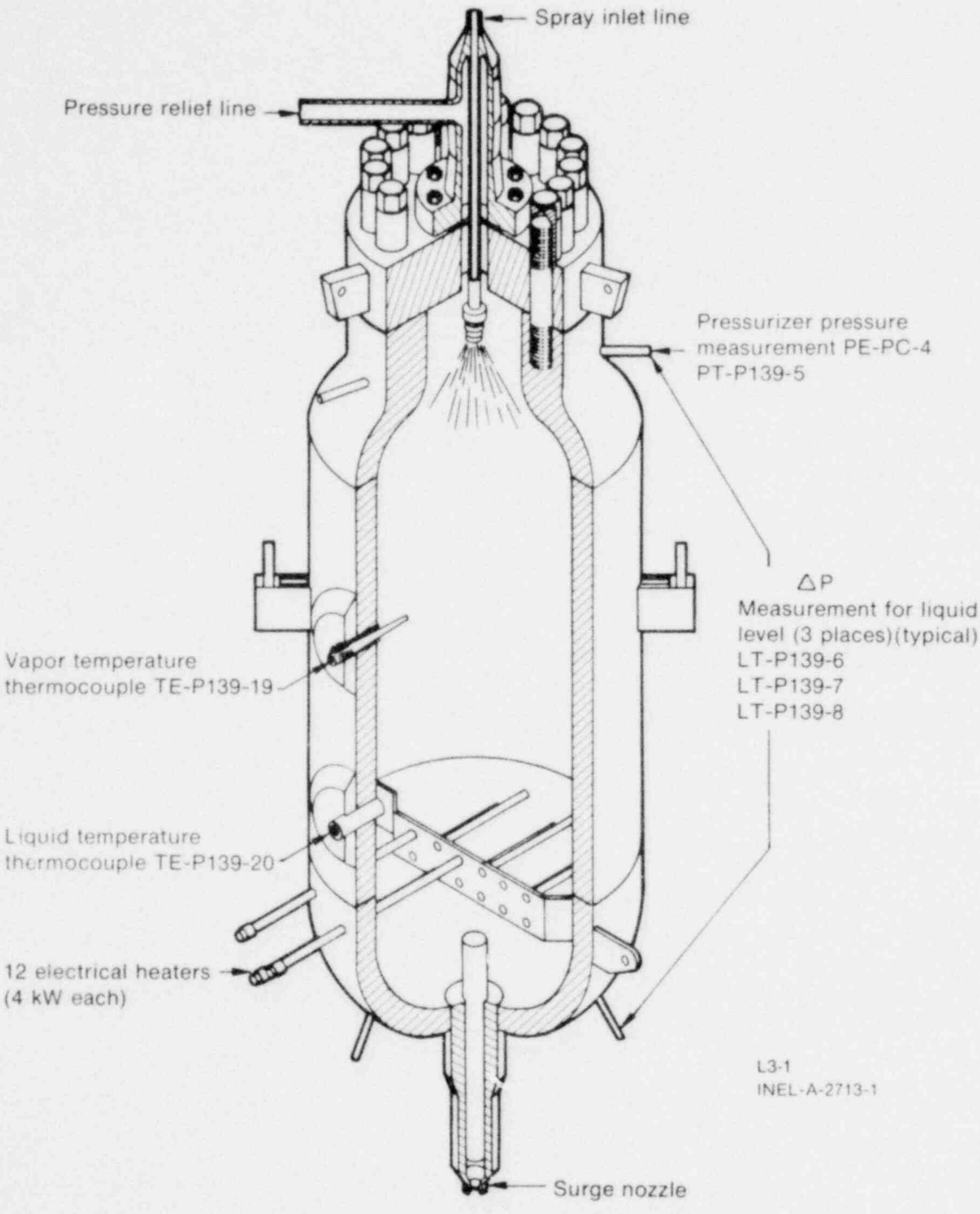


Figure 13. LOFT pressurizer instrumentation.

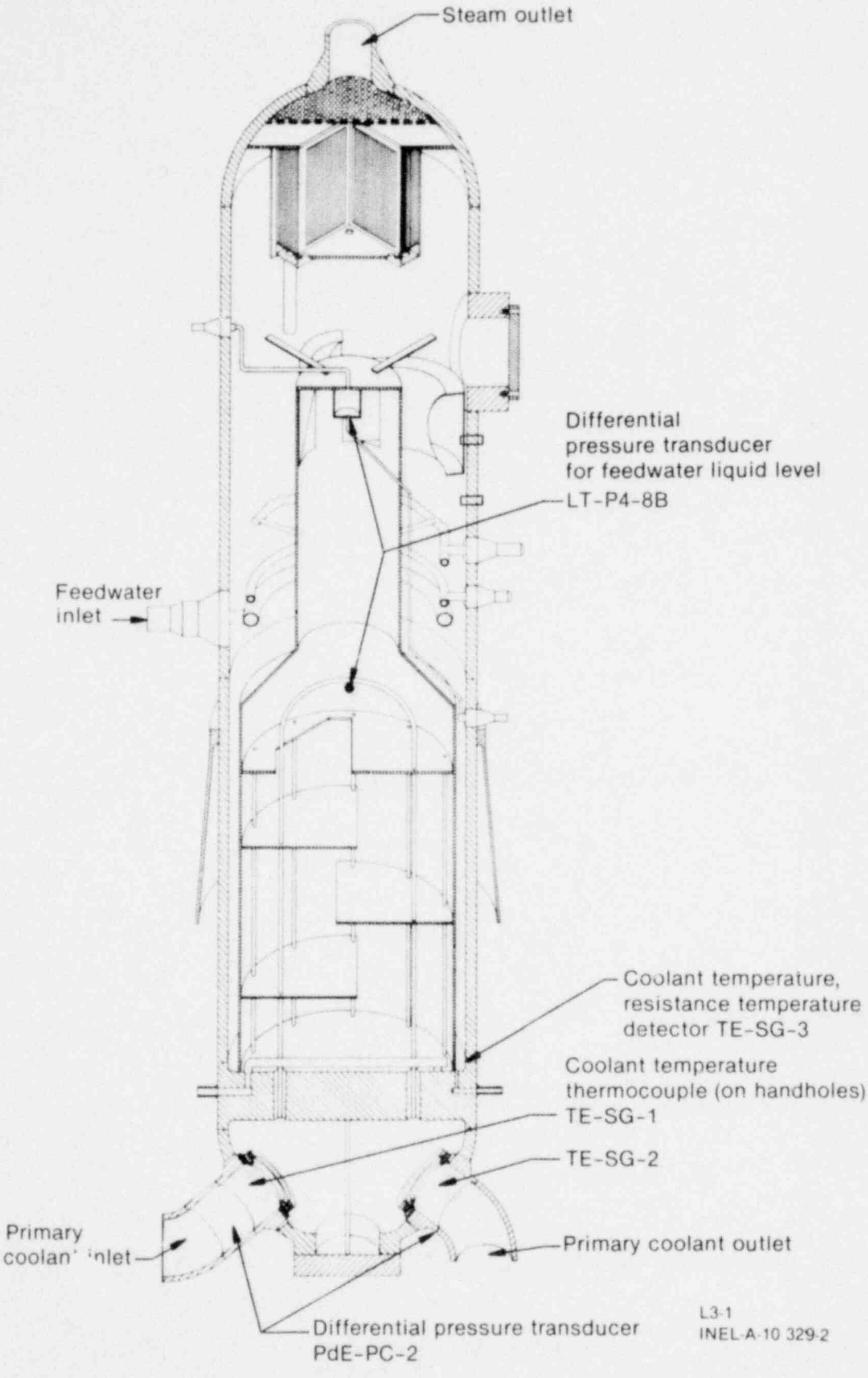


Figure 14. LOFT steam generator instrumentation.

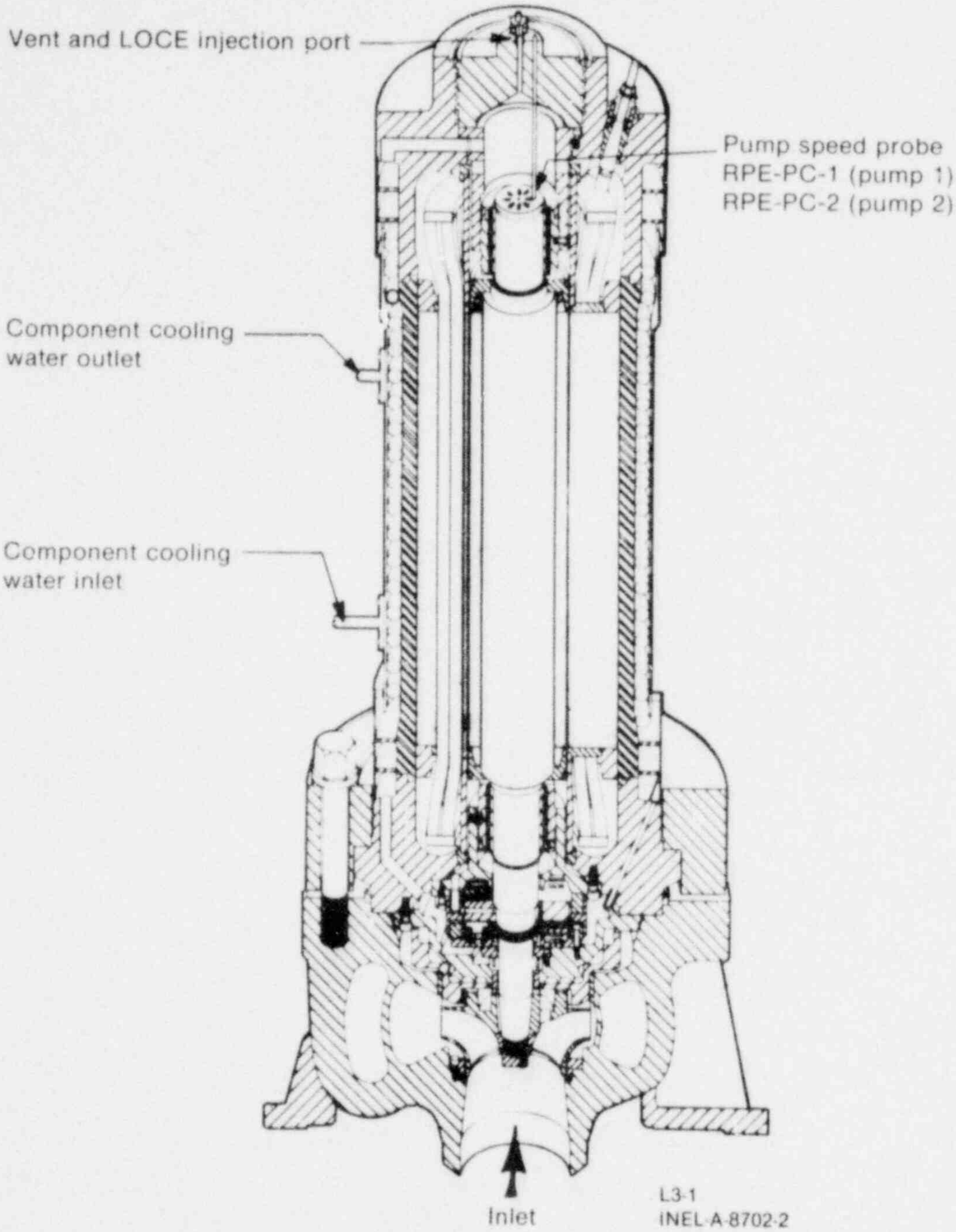


Figure 15. LOFT intact loop pump instrumentation.

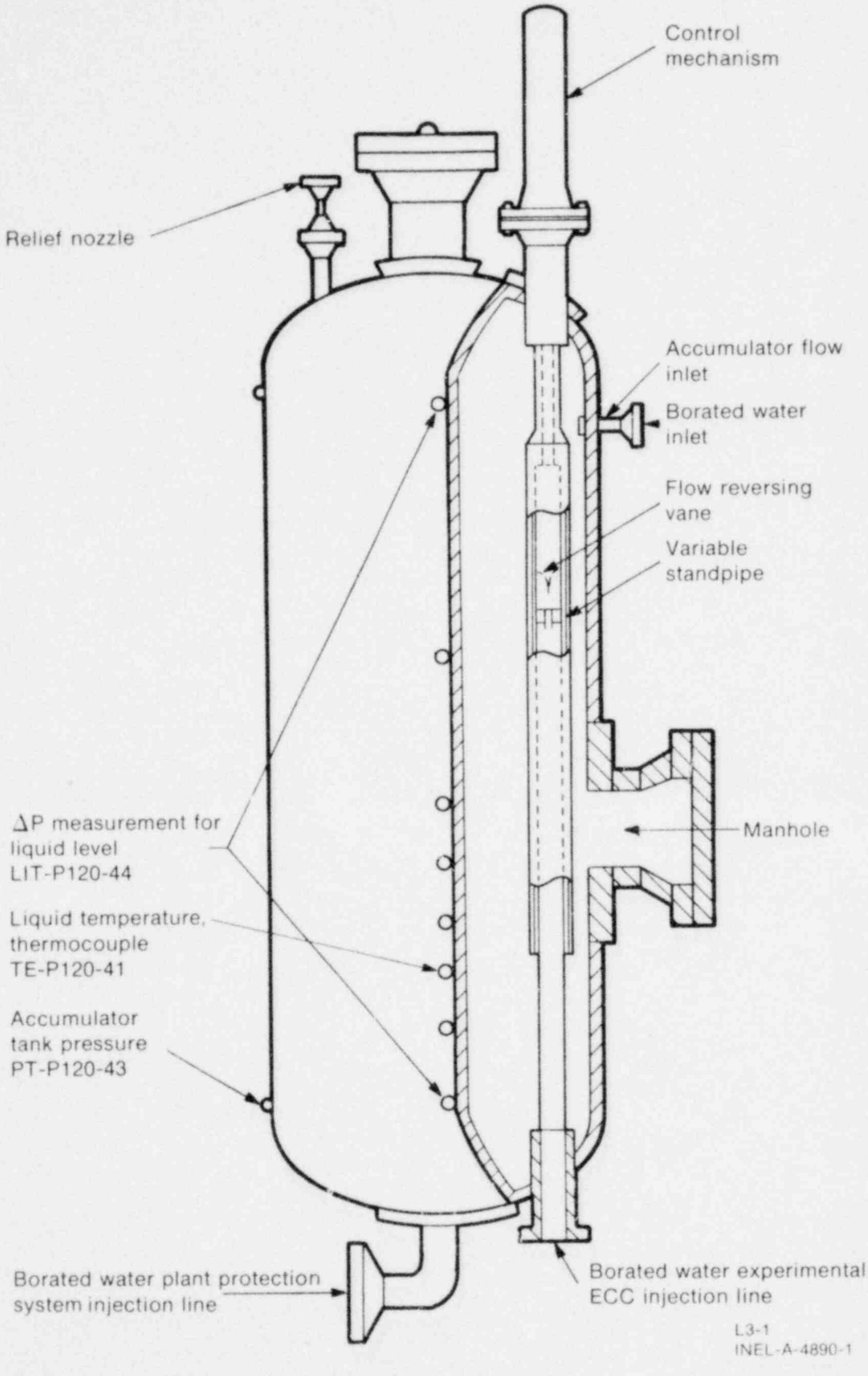


Figure 16. LOFT accumulator instrumentation.

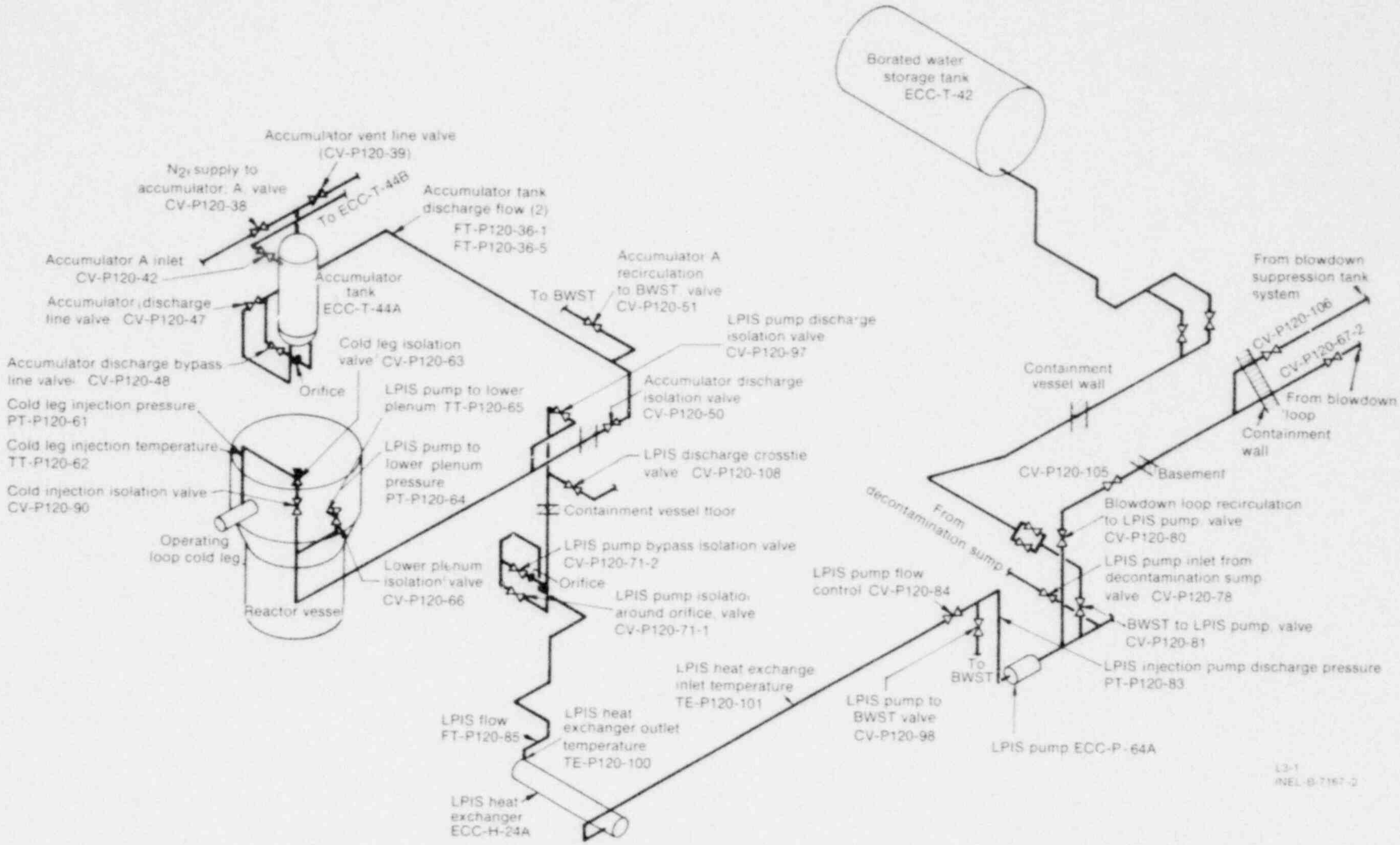


Figure 17. LOFT ECCS instrumentation.

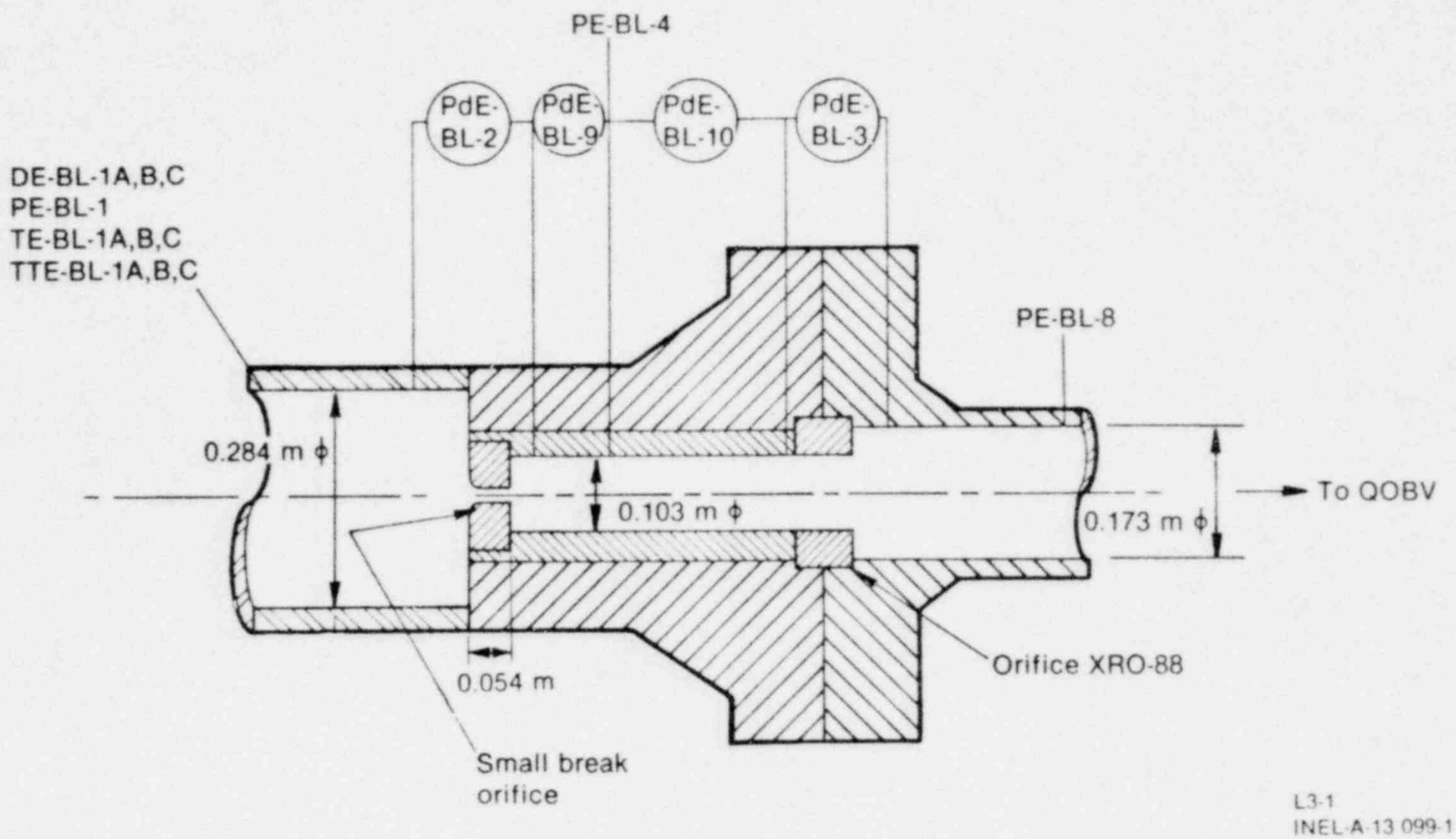


Figure 18. LOFT small break orifice area instrumentation.

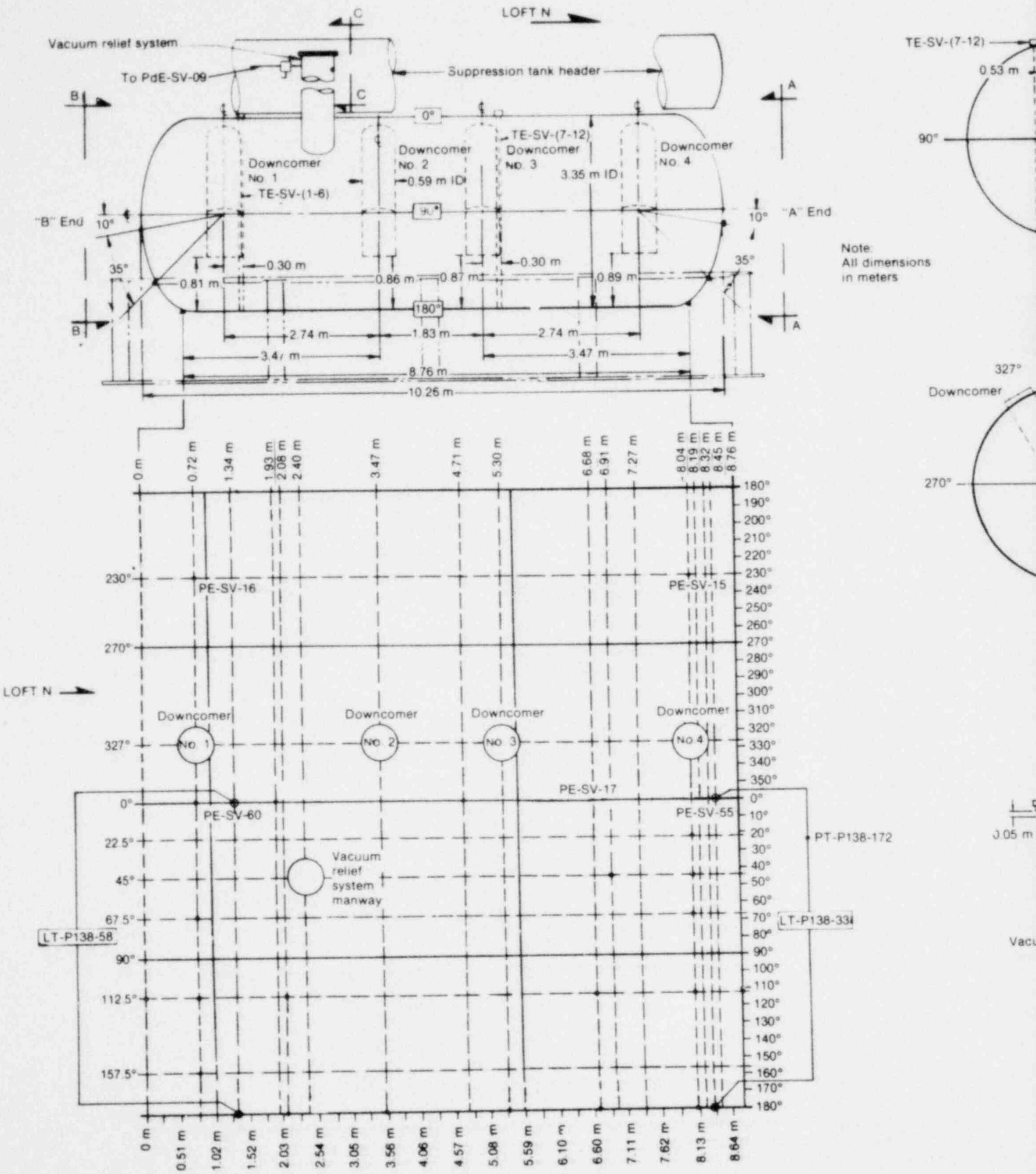
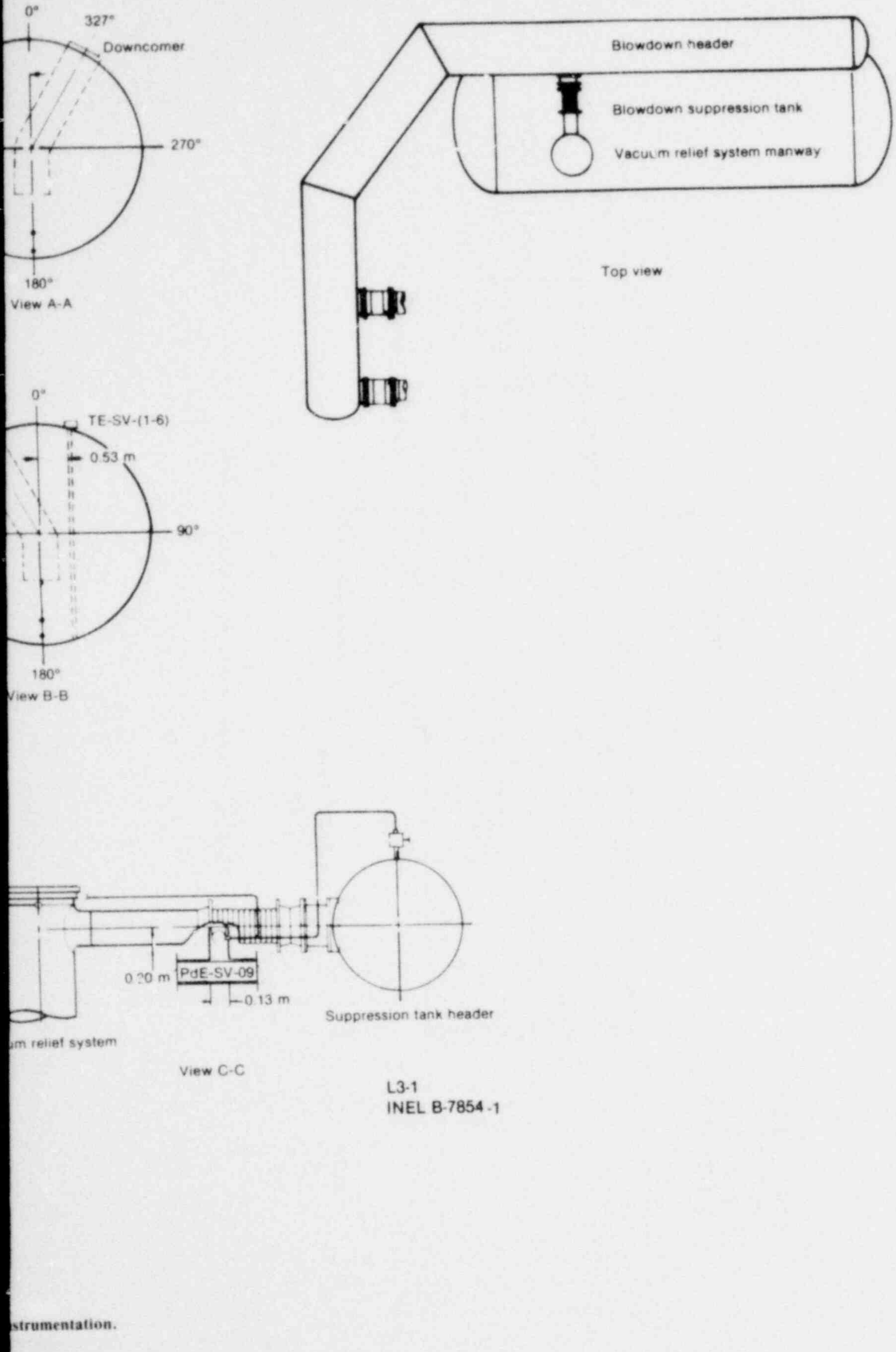


Figure 19. LOFT blowdown suppression tank i



strumentation.

appropriate initial conditions were established for the blowdown suppression tank, accumulator, and borated water storage tank.

The plant was stabilized at three different temperatures during heatup: 422, 489, and 555 K. At each of these temperatures, 20 to 30 s of data were recorded for calibration checks and to determine the degree of instrument temperature sensitivity. At the 489- and 555-K stabilization points, the pumps were stopped and 20 s of data were recorded during flow coastdown and zero flow conditions. With the pumps off at the 555-K stabilization point, 20 s of data were obtained at 14.95, 13.87, 12.50, 11.12, and 9.74 MPa in both the increasing and decreasing directions. Frequency tests were performed by varying the primary coolant pump frequency from 20 to 60 Hz in 10-Hz increments at 555-K. Before the reactor was brought critical, the DAVDS was calibrated and the boron concentration in the accumulators, blowdown suppression tank, and borated water storage tank was verified.

After reactor criticality was achieved, the power level was increased to 49 MW, which was maintained until blowdown occurred. During the power ascension, some power range tests were performed on the new center fuel module. A plot of the power level versus time for the 100-hour period prior to blowdown is given in Figure 20. Figure 21 shows the corresponding decay heat during the experiment, which was calculated using the American Nuclear Society standard 5.1. During the power ascension, measurements of power level were performed using a secondary calorimetric calculation. The flow rate was set at 478.8 ± 8.8 kg/s and adjustment of the SCS was made to maintain the experiment power level. The primary coolant system boron concentration was adjusted to establish a reactor vessel inlet temperature of 556.7 ± 2.2 K at a hot leg pressure of 14.95 ± 0.34 MPa.

Prior to blowdown, a DAVDS calibration and a data integrity check were performed. During this period, the initial-condition water samples were taken from the primary coolant system, the secondary coolant system, and the blowdown suppression tank. The intact loop conditions were checked, and adjusted as necessary, to ensure the specified conditions, 478.8 ± 8.8 kg/s flow with temperature in the cold leg and pressure in the hot leg at 556.7 ± 2.2 K and 14.95 ± 0.34 MPa, respectively, were met at blowdown initiation. The broken loop cold leg blowdown isolation valve was opened 1 minute before blowdown. Purification lines and broken loop recirculation lines to the intact loop were closed, and the pressurizer and broken loop hot leg heaters were turned off.

The DAVDS was activated and data recording was started 7 minutes prior to the blowdown. The reactor was scrammed 2 s before the blowdown. When the four rod bottom lights were on, the experiment was initiated by opening the broken loop cold leg QOBV. The break orifice area (205.9 mm^2) corresponded to the flow area of a 4-inch Schedule 160 (0.10-m OD) pipe in a commercial PWR. The sequence of events for the experiment is provided in Table 2.

Electrical power to the primary system motor generator sets was terminated at blowdown initiation and the primary coolant pumps began to coast down under the influence of a flywheel system (316.0 kg-m^2). The primary system motor generator set field breakers tripped at 17.6 ± 0.5 s as the primary coolant pumps coasted down below 12.5 Hz.

Emergency core coolant injection was directed to the intact loop cold leg during blowdown. The HPIS flow was initiated automatically 4.6 ± 0.5 s after blowdown initiation. The injection flow rate was held constant until the pressure reached 8.36 MPa, at which point the HPIS flow was increased with decreasing system pressure by operator action. Accumulator ACC-A injection at a system pressure of 4.37 ± 0.06 MPa began 633.6 ± 0.5 s after initiation of the blowdown. Nitrogen gas from the accumulator entered the system at 1741.0 ± 1 s. Initiation of the LPIS flow occurred 4240 ± 1 s after blowdown initiation. The secondary coolant system (SCS) auxiliary feed pump was operated from 75 ± 1 s to 1875 ± 1 s with a flow rate of 0.50 l/s. The SCS steam valve was opened at 3622.5 ± 1 s for 103 s to reduce the steam generator pressure and temperature.

The blowdown suppression tank pressure was not controlled because the back pressure was not expected to affect the blowdown. The BST spray system was operated throughout the transient to ensure homogeneous temperatures throughout the water volume in the BST and to ensure that the pressure limit of the pressure relief assembly would not be exceeded.

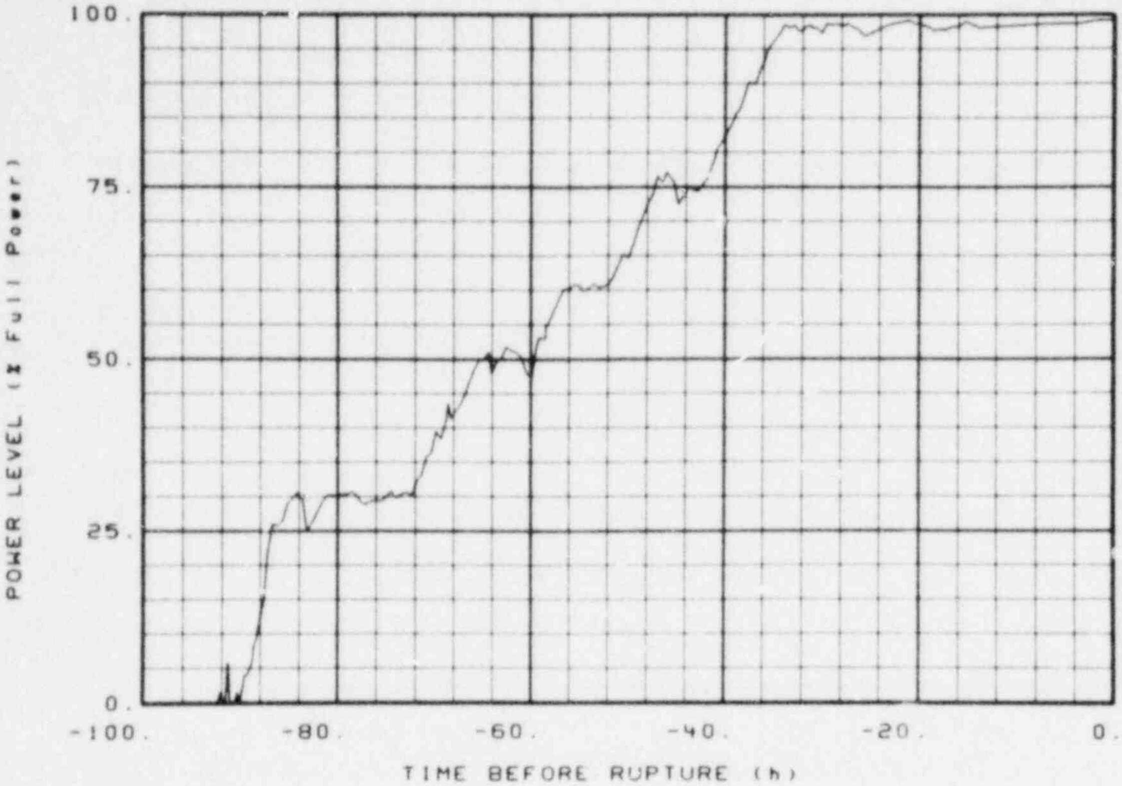


Figure 20. LOFT power history prior to Experiment L3-1 blowdown (full power = 50 MWt).

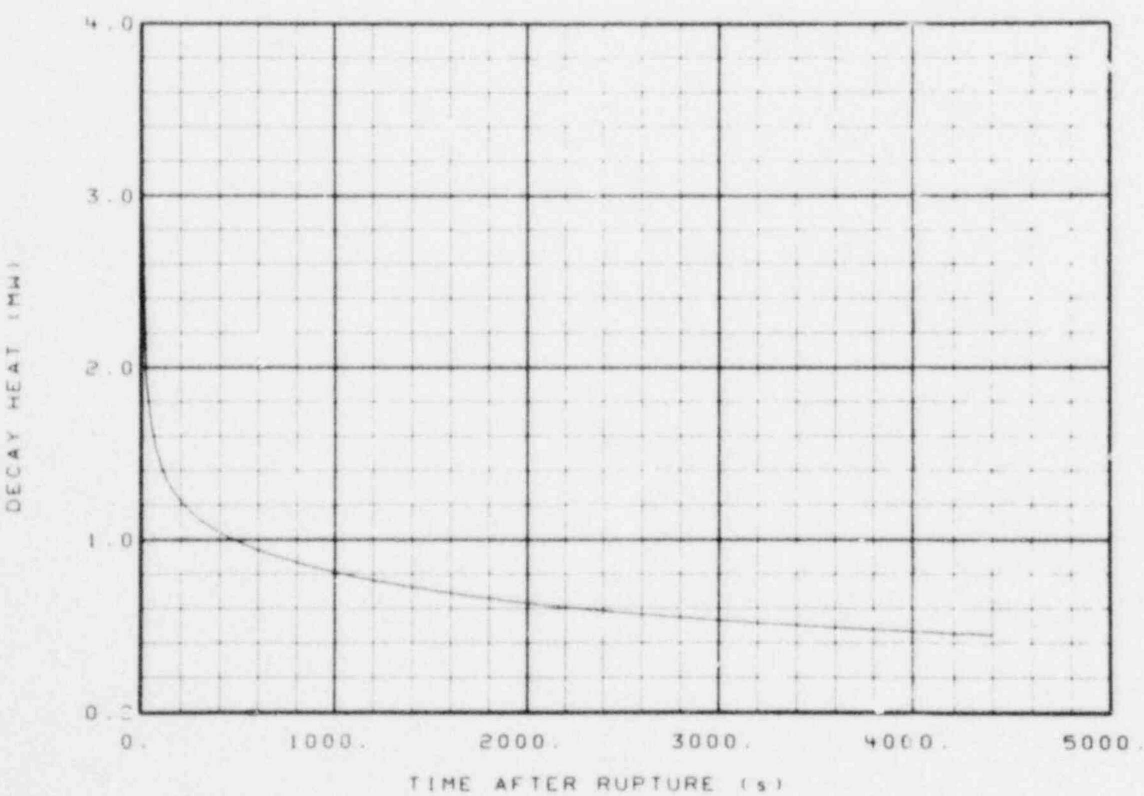


Figure 21. LOFT decay heat following Experiment L3-1 blowdown initiation.

TABLE 2. SEQUENCE OF EVENTS FOR SMALL BREAK EXPERIMENT L3-1

Event	Time After LOCE Initiation (s)
Reactor scrammed	-2.15
Control rods on bottom	-0.97
LOCE initiated	0.0
Primary coolant pumps tripped	0.04 ± 0.01
HPIS injection initiated	4.6 ± 0.5
Pressurizer emptied	17.0 ± 1
PCP coastdown completed	19.0 ± 1
Upper plenum reached saturation pressure	24.4 ± 0.5
SCS auxiliary feed pump started	75.0 ± 1
Accumulator injection initiated	633.6 ± 0.5
Accumulator liquid level below standpipe	1570.0 ± 1
Indication that ACC-A line empty of fluid	1741.0 ± 1
SCS auxiliary feed pump tripped	1875.0 ± 1
Initiate SCS steam bleed	3622.5 ± 1
LPIS injection initiated	4240.0 ± 1
Experiment completed[a]	4368.0 ± 1

a. The experiment was finished when the LPIS pumps were tripped after running for ~2 m.

The DAVDS recorded approximately 73.3 minutes of data after the simulated rupture. An electrical calibration of the DAVDS was performed following the experiment.

Initial Conditions

The initial conditions (except for the linear heat generation rate conditions) and tolerance bands for Experiment L3-1 are presented in Table 3 along with the values measured immediately prior to the blowdown initiation. Initial conditions were within specified tolerances except those indicated as out of specification in Table 3. None of the conditions that were out of specification impaired the results of the experiment. Table 4 gives the linear heat generation rate versus core height for three locations within the LOFT core prior to blowdown initiation. The data for Table 4 were obtained from the traversing in-core probe system.

TABLE 3. INITIAL CONDITIONS FOR SMALL BREAK EXPERIMENT L3-1

Parameter	Specified Value	Measured Value
Primary Coolant System		
Mass flow rate (kg/s)	478.8 ± 8.8	484.0 ± 6.3
Hot leg pressure (MPa)	14.95 ± 0.34	14.85 ± 0.04
Cold leg temperature (K)	556.7 ± 2.2	554.0 ± 3
Hot leg temperature (K)	--	574.0 ± 1
Boron concentration (ppm)	As required to maintain temperature	733 ± 15
Reactor Vessel		
Power level (MW)	50.0 ± 2	48.9 ± 1
Maximum linear heat generation rate (kW/m)	--	51.7 ± 1
Control rod position (above full-in position) (m)	1.372 ± 0.013	1.371 ± 0.01
Pressurizer		
Steam volume (m^3)	--	0.343 ± 0.008
Liquid volume (m^3)	--	0.620 ± 0.008
Water temperature (K)	--	617.0 ± 3
Pressure (MPa)	14.95 ± 0.34	14.81 ± 0.04
Level (m)	1.13 ± 0.18	1.10 ± 0.01
Broken Loop		
Cold leg temperature (K)	556.7 ± 13.9	557.3 ± 5.0
Hot leg temperature (K)	556.7 ± 13.9	562.0 ± 5.0
Steam Generator Secondary Side		
Water level (m)[a]	0.25 ± 0.05	0.20 ± 0.03
Water temperature (K)	--	536.0 ± 3.9
Pressure (MPa)	--	5.43 ± 0.11
Mass flow rate (kg/s)	--	25.0 ± 0.4
ECC Accumulator A		
Liquid level (m)[b,c]	1.85 ± 0.05	1.71 ± 0.01
Standpipe position (m)[b,c]	0.79 ± 0.03	0.48 ± 0.01
Gas Volume (m^3)	--	1.39 ± 0.03
Pressure (MPa)	4.22 ± 0.17	4.37 ± 0.06
Temperature (K)	305.4 ± 5.6	304.7 ± 3
Boron concentration (ppm)	3000	3314 ± 15
HPIS		
Initial flow rate (l/s)	0.32 ± 0.13	0.33 ± 0.02

TABLE 3. (continued)

Parameter	Specified Value	Measured Value
LPIS		
Initiation pressure (MPa)	0.98 ± 0.19	1.02 ± 0.03
Suppression Tank		
Liquid level (m)	1.27 ± 0.05	1.26 ± 0.03
Liquid volume (m^3)	--	29.2 ± 0.6
Gas volume (m^3)	--	55.8 ± 0.6
Liquid temperature (K)	--	353.5 ± 2.7
Pressure (MPa)	--	0.107 ± 0.008

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

b. Out of specification, but did not affect experiment success.

c. The total accumulator liquid volume injected, including the pipe volume, was 1.97 ± 0.03 m^3.

Table 5 gives the measured fluid temperatures of the primary coolant system immediately prior to blowdown initiation.

Table 6 specifies the required water chemistry for the primary coolant system, the blowdown suppression tank, and the secondary coolant system. In addition, the results of the water chemistry analyses for these systems are presented for pre-LOCE conditions and for the blowdown suppression tank post-LOCE conditions. The pre-LOCE Accumulator ACC-A boron concentration was 3314 ± 15 ppm.

DATA PRESENTATION

The data presented in this report include selected pertinent thermal-hydraulic and nuclear data from LOFT Experiment L3-1.

The selected data have been divided into two categories, qualified and channel failed. The qualified designation was applied to measurements that have been found to be within the uncertainty of the instrument. The absence of a comment following the "Qualified" designation indicates that the data are valid (that is, within specified uncertainty bands) over the entire time span recorded. Restrictive statements accompany data that are invalid over a portion of the recorded time span. Instrument channels were not presented if the data were in the instrument dead band or showed a similar response to nearby like instruments (such as the core thermocouples). These data are available upon special request. The checks on data consistency and instrument performance are discussed in detail in Appendix A.

The data were processed and are presented in graphical form in SI units. Measurements were combined to produce computed variables, and graphs of similar variables at several locations were overlaid to facilitate comparison. The number of data points shown for each instrument have been reduced to 2000 for ease of plotting. To

TABLE 4. LINEAR HEAT GENERATION RATE PRIOR TO EXPERIMENT L3-1 (Reading Uncertainty ± 7.6%)

Height Above Core Bottom (m)	Linear Heat Generation Rate for Core Position (kW/m) 1C7	5H8	5M3
0.152	10.23	18.32	17.96
0.305	21.65	36.83	36.81
0.406	25.63	41.74	41.78
0.460	24.76	40.34	40.37
0.508	24.99	42.50	42.49
0.559	28.65	46.67	46.71
0.660	29.77	48.50	48.54
0.762	29.57	48.17	48.21
0.838	27.92	45.48	45.52
0.891	24.65	40.15	40.18
0.940	25.40	41.37	41.41
1.067	24.09	38.17	38.65
1.219	18.64	29.52	29.90
1.270	15.98	25.31	25.64
1.303	13.24	20.97	21.24
1.372	11.67	18.48	18.72
1.524	5.23	9.45	8.87
1.626	2.64	4.78	4.49
1.676	1.73	2.89	2.71

accomplish this reduction, the data were passed through a low-pass filter and then decimated. Computed parameter data from the drag discs, the turbine flowmeters, and the gamma densitometers were filtered with a 4-Hz, low-pass filter prior to presentation.

The 2-σ confidence intervals have been determined from a knowledge of the systematic and random errors of the sensors, data system, calibration procedures, and the channel random noise during pretest calibrations. These are presented as functions of output level so that the user may determine the approximate uncertainty over each range of interest for a given variable.

Table 7 lists Experiment L3-1 instrumentation and gives the detector location, range, initial condition uncertainty, uncertainty at specific readings, and recording frequency along with the figure numbers. This table also contains a "Comments" column which gives information relative to the usability of the data.

Table 8 lists the variables that were computed from the transducer outputs and other factors, such as geometrical constants. This table also gives the equations used to compute these variables, the figure number, and comments which may reflect on the usefulness of the data.

The data are divided into three 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 L3-1 Measured Variables, Short-Term Plots (-10 to 200 s) Figures 22 through 80

2. Experiment L3-1 Measured Variables, Long-Term Plots (0 to 5000 s) Figures 81 through 166

3. Experiment L3-1 Computed Variables, Figures 167 through 171.

TABLE 5. PRIMARY COOLANT TEMPERATURES AT BLOWDOWN INITIATION

Location	Detector	Temperature (K)
Intact loop hot leg (near vessel)	TE-PC-002B	575.5 ± 3.0
Intact loop steam generator inlet	TE-SG-001	575.4 ± 3.9
Intact loop steam generator outlet	TE-SG-002	559.9 ± 3.9
Intact loop cold leg (near vessel)	TE-PC-004	558.4 ± 3.0
Reactor vessel downcomer:		
Instrument Stalk 1	TE-1ST-001	559.5 ± 5.1
Instrument Stalk 2	TE-2ST-001	560.6 ± 5.1
Reactor vessel lower plenum	TE-1LP-001	559.2 ± 5.1
Reactor vessel upper plenum	TE-1UP-001	584.1 ± 5.1
	TE-4UP-001	581.3 ± 5.1
	TE-5UP-001	587.5 ± 5.1
Broken loop hot leg (near vessel)	TE-BL-002B	562.0 ± 5.0
Broken loop cold leg (near vessel)	TE-BL-001B	557.3 ± 5.0
Intact loop pressurizer: Saturation	PE-PC-004	614.3 ± 1.3

TABLE 6. WATER CHEMISTRY RESULTS FOR EXPERIMENT L3-1

Parameter	Primary Coolant Intact Loop		Blowdown Suppression Tank			Secondary Coolant System	
	Specified	Pre-LOCE[a]	Specified	Pre-LOCE	Post-LOCE	Specified[b]	Pre-LOCE
pH (each at 298 K)	4.2 to 10.5	5.86	4.2 to 10.5	4.85	4.84	9.0 to 10.2	10.05
Conductivity (μmho/cm^3) (each at 298 K)	60 maximum	3.55	60 maximum	11.2	10.2	2 maximum	1.7[b]
Total gas (cm^3/kg)	100 maximum	55.7	--	4.6	6.9	--	--
Dissolved oxygen (ppm)	--	--	--	--	--	0.005 maximum	0
Lithium (ppm)	0.2 to 2.2	0.2	--	--	--	--	--
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	89.5
Boron (ppm)	--	733	3050	3534	3537	--	--
Fluoride (ppm)	0.1 maximum	0.02	0.1 maximum	0.02	--	--	--
Hydrogen (cm^3/kg)[c]	10 to 60	38.6	--	0	0	--	--
Total gross activity (μc/ml)	375 maximum	0.0212	--	--	6.1×10^{-5}	--	--
Gross beta and gamma (μc/ml)	--	0.0212	--	--	6.1×10^{-5}	--	--
I^{131} (μc/ml)	0.37 maximum	0	--	--	0	9×10^{-4} maximum	0
I^{135} (μc/ml)	0.76 maximum	0	--	--	0	--	0

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

b. Cation conductivity.

c. Prior to depressurization.

TABLE 7. MEASURED VARIABLES FOR EXPERIMENT L3-1

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
VALVE OPENING								
Intact Loop CV-P004-008	Main feedwater control valve.	0 to 100%	10 Hz	--	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	--	Channel failed.
Intact Loop CV-P004-010	Main steam control valve.	0 to 100%	1 Hz	3.0%	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	--	Not presented.[b]
Broken Loop CV-P138-001	Broken loop cold leg between break plane and suppression tank.	0 to 100%	1 Hz	3.0%	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	--	Not presented.
Broken Loop CV-P138-123	1.3 l/s spray header control valve.	0 to 100%	1 Hz	3.0%	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	--	Not presented.
Broken Loop CV-P138-124	3.8 l/s spray header control valve.	0 to 100%	1 Hz	3.0%	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	--	Not presented.
Broken Loop CV-P138-125	13.9 l/s spray header control valve.	0 to 100%	1 Hz	3.0%	0% 25% 50% 100%	3.0% 3.13% 3.47% 4.61%	--	Not presented.
CHORDAL DENSITY								
Broken Loop DE-BL-001A	Broken loop cold leg at DTT flange. Beam line 14° 21 min from -18 line (CW looking toward reactor vessel RV).	0 to 1.0 Mg/m^3	10 Hz	--	Not available		--	Channel failed.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
CHORDAL DENSITY (continued)								
Broken Loop DE-BL-001B	Broken loop cold leg at DTT flange. Beam line through ℄ of pipe 45° from vertical (CCW looking toward RV).	0 to 1.0 Mg/m^3	10 Hz	0.043 Mg/m^3	--	0.043 Mg/m^3[c]	22, 81	Qualified, second calibration point determined from intact loop liquid level during first 600 s.
Broken Loop DE-BL-001C	Broken loop cold leg at DTT flange. Beam line 22° 7 min from -1B line (CCW looking toward RV).	0 to 1.0 Mg/m^3	10 Hz	--	Not available		--	Channel failed.
Broken Loop DE-BL-002A	Broken loop hot leg at DTT flange. Beam line 14° 21 min from -2B line (CCW looking toward RV).	0 to 1.0 Mg/m^3	10 Hz	--	Not available		--	Channel failed.
Broken Loop DE-BL-002B	Broken loop hot leg at DTT flange. Beam line through ℄ of pipe 45° from vertical (CW looking toward RV).	0 to 1.0 Mg/m^3	10 Hz	--	Not available		--	Channel failed.
Intact Loop DE-PC-001A	Intact loop cold leg at DTT flange. Beam line 14° 21 min from -1B line (CW looking away from RV).	0 to 1.0 Mg/m^3	10 Hz	0.036 Mg/m^3	--	0.036 Mg/m^3	23, 82, 85	Qualified, second calibration point determined from intact loop liquid level during first 500 s.
Intact Loop DE-PC-001B	Intact loop cold leg at DTT flange. Beam line through ℄ of pipe 45° from vertical (CCW looking away from RV).	0 to 1.0 Mg/m^3	10 Hz	0.028 Mg/m^3	--	0.028 Mg/m^3	24, 83, 85	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
CHORDAL DENSITY (continued)								
Intact Loop DE-PC-001C	Intact loop cold leg at DTT flange. Beam line 22° 7 min from -1B line (CCW looking away from RV).	0 to 1.0 Mg/m^3	10 Hz	0.028 Mg/m^3	--	0.028 Mg/m^3	25, 84, 85	Qualified.
Intact Loop DE-PC-002A	Intact loop hot leg at DTT flange. Beam line 14° 21 min from -2B line (CW looking away from RV).	0 to 1.0 Mg/m^3	10 Hz	--	Not available		--	Channel failed.
Intact Loop DE-PC-002B	Intact loop hot leg at DTT flange. Beam line through ℄ of pipe 45° from vessel (CCW looking away from RV).	0 to 1.0 Mg/m^3	10 Hz	0.026 Mg/m^3	--	0.026 Mg/m^3	26, 86, 88	Qualified.
Intact Loop DE-PC-002C	Intact loop hot leg at DTT flange. Beam line 22° 7 min from -2B line (CCW looking away from RV).	0 to 1.0 Mg/m^3	10 Hz	0.028 Mg/m^3	--	0.028 Mg/m^3	27, 87, 88	Qualified, anomalous output from 2600 to 3000 s.
Intact Loop DE-PC-003B	Intact loop below steam generator at DTT flange. Beam line through ℄ of pipe.	0 to 1.0 Mg/m^3	1 Hz	--	Not available		--	Channel failed
Intact Loop DE-PC-003C	Intact loop below steam generator at DTT flange. Beam line 22° 7 min from PC-3B line.	0 to 1.0 Mg/m^3	1 Hz	--	Not available		--	Channel failed.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
FUEL ASSEMBLY DISPLACEMENT								
Assembly 5 DIE-5UP-001	At top center of Fuel Assembly 5.	±12.7 mm	100 Hz	0.3 mm	0.0 mm 6.35 mm 12.7 mm	0.3 mm[d] 0.33 mm 0.39 mm	--	Not presented.
Assembly 5 DIE-5UP-002	At top center of Fuel Assembly 5.	±12.7 mm	100 Hz	0.3 mm	0.0 mm 6.35 mm 12.7 mm	0.3 mm 0.33 mm 0.39 mm	--	Not presented.
FLUID VELOCITY								
Intact Loop FE-PC-002A	Intact loop hot leg at DTT flange on west side of pipe.	0.6 to 15.0 m/s	10 Hz	--	--	0.9 m/s[e]	--	Channel failed.
Intact Loop FE-PC-002B	Intact loop hot leg at DDT flange on middle of pipe.	0.6 to 15.0 m/s	10 Hz	0.434 m/s	--	0.9 m/s	28	Qualified, magnitude uncertain due to turbine mechanical problems, not good prior to 19 s.
Intact Loop FE-PC-002C	Intact loop hot leg at DTT flange on east side of pipe.	0.6 to 15.0 m/s	10 Hz	--	--	0.9 m/s	--	Channel failed.
Reactor Vessel FE-5UP-001	Above upper end box of Fuel Assembly 5.	0.5 to 10.0 m/s	10 Hz	2.3 m/s	--	2.3 m/s	29	Qualified.
FLOW RATE								
Blowdown Suppression Tank Spray System FE-P138-138	Suppression tank spray flow rate in the 3.79-l/s header.	0 to 6.3 l/s	1 Hz	0.1 l/s	--	0.1 l/s	--	Not presented.
Blowdown Suppression Tank Spray System FE-P138-139	Suppression tank spray flow rate from pump discharge.	0 to 25.2 l/s	1 Hz	0.36 l/s	--	0.35 l/s	89	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
FLOW RATE (continued)								
Blowdown Suppression Tank Spray System FE-P138-140	Suppression tank spray flow rate in 13.9-l/s header.	0 to 18.9 l/s	1 Hz	0.27 l/s	--	0.27 l/s	--	Not presented.
Blowdown Suppression Tank Spray System FE-P138-153	Suppression tank spray flow rate in the spray pump recirculation line.	0 to 9.5 l/s	1 Hz	0.13 l/s	--	0.13 l/s	90	Qualified.
Intact Loop FT-P004-012	Inlet to air cooled condenser inlet header.	0 to 40 kg/s	1 Hz	0.8 kg/s	--	0.8 kg/s	91	Qualified.
Intact Loop FT-P004-072A	Main feedwater pump discharge flow.	0 to 25 kPa	10 Hz	0.17 kPa	--	0.17 kPa	30	Qualified.
Intact Loop FT-P004-72-2	Flow out of main feedwater pump.	0 to 40 kg/s	1 Hz	0.8 kg/s	--	0.8 kg/s	--	Not presented.
Emergency Core Cooling System FT-P120-36-1	Accumulator A in 6-in. line downstream of orifice.	0 to 126.2 l/s	1 Hz	--	--	3.5 l/s	--	Not presented, data in instrument dead band.
Emergency Core Cooling System FT-P120-36-5	Accumulator A in 6-in. line downstream of orifice.	0 to 37.9 l/s	1 Hz	--	--	3.5 l/s	--	Not presented, data in instrument dead band.
Emergency Core Cooling System FT-P120-085	LPIS Pump A in 4-in. line between heat exchanger and orifice.	0 to 25.2 l/s	1 Hz	0.25 l/s	--	2.5 l/s	92	Qualified.
Emergency Core Cooling System FT-P128-104	HPIS Pump A discharge.	0 to 1.9 l/s	1 Hz	0.02 l/s	--	0.02 l/s	93	Qualified.
Intact Loop FT-P139-27-1	Intact loop hot leg venturi flowmeter (right side facing steam generator).	0 to 630.0 kg/s	10 Hz	7 kg/s	--	17 kg/s	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
FLOW RATE (continued)								
Intact Loop FT-P139-27-2	Intact loop hot leg venturi flowmeter (bottom of pipe).	0 to 630.0 kg/s	10 Hz	7 kg/s	--	17 kg/s	--	Not presented.
Intact Loop FT-P139-27-3	Intact loop hot leg venturi flowmeter (left side facing steam generator).	0 to 630.0 kg/s	10 Hz	7 kg/s	--	17 kg/s	--	Not presented.
LIQUID LEVEL								
Emergency Core Cooling System LIT-P120-044	Accumulator A.	0 to 3.0 m	10 Hz	0.01 m	--	0.02 m	94	Qualified.
Secondary Coolant System LT-P004-008B	Steam generator feed-water level (wide range).	-3.6 to 1.4 m[f]	1 Hz	0.03 m	--	0.05 m	95	Qualified, does not indicate correct level during transient.
Blowdown Suppression Tank LT-P138-033	Blowdown suppression tank level on north end of tank.	0 to 3.8 m	1 Hz	0.03 m	--	0.06 m	96	Qualified.
Blowdown Suppression Tank LT-P138-058	Blowdown suppression tank level on south end of tank.	0 to 3.4 m	1 Hz	0.03 m	--	0.06 m	97	Qualified.
Intact Loop LT-P139-006	Pressurizer level on southeast side.	0 to 1.9 m	1 Hz	0.02 m	--	0.04 m	--	Not presented.
Intact Loop LT-P139-007	Pressurizer level on southwest side.	0 to 1.9 m	1 Hz	0.02 m	--	0.04 m	31	Qualified.
Intact Loop LT-P139-008	Pressurizer level on north side.	0 to 1.9 m	1 Hz	0.02 m	--	0.04 m	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
MOMENTUM FLUX								
Intact Loop ME-PC-002B	Intact loop hot leg on DTT flange at middle of pipe.	1 to 21 $Mg/m \cdot s^2$	1 Hz	11.36 $Mg/m \cdot s^2$	--	11.36 $Mg/m \cdot s^2$	--	Not presented.
Intact Loop ME-PC-002C	Intact loop hot leg on DTT flange on east side of pipe.	1 to 21 $Mg/m \cdot s^2$	1 Hz	11.36 $Mg/m \cdot s^2$	--	11.36 $Mg/m \cdot s^2$	--	Not presented.
Reactor Vessel ME-1ST-001	Downcomer Stalk 1, 1.16 m above RV bottom.	0.3 to 5.2 $Mg/m \cdot s^2$	10 Hz	0.74 $Mg/m \cdot s^2$	--	0.78 $Mg/m \cdot s^2$	--	Not presented.
Reactor Vessel ME-2ST-001	Downcomer Stalk 2, 1.16 m above RV bottom.	0.3 to 5.2 $Mg/m \cdot s^2$	10 Hz	0.74 $Mg/m \cdot s^2$	--	0.78 $Mg/m \cdot s^2$	--	Not presented.
Reactor Vessel ME-1UP-001	Fuel Assembly 1 above upper end box.	0.3 to 5.2 $Mg/m \cdot s^2$	10 Hz	0.74 $Mg/m \cdot s^2$	--	0.78 $Mg/m \cdot s^2$	--	Not presented.
Reactor Vessel ME-3UP-001	Fuel Assembly 3 above upper end box.	0.3 to 5.2 $Mg/m \cdot s^2$	10 Hz	0.74 $Mg/m \cdot s^2$	--	0.78 $Mg/m \cdot s^2$	--	Not presented.
Reactor Vessel ME-5UP-001	Fuel Assembly 5 above upper end box.	0.3 to 5.2 $Mg/m \cdot s^2$	10 Hz	0.74 $Mg/m \cdot s^2$	--	0.78 $Mg/m \cdot s^2$	32	Qualified.
NEUTRON DETECTION								
Reactor Vessel NE-2H8-26	Neutron detector in Fuel Assembly 2.	0 to 52.5 Local kW/m	1 Hz	2.03 kW/m	--	2.03 kW/m[a]	--	Not presented.
Reactor Vessel NE-4H8-26	Neutron detector in Fuel Assembly 4.	0 to 52.5 Local kW/m	1 Hz	2.03 kW/m	--	2.03 kW/m	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
NEUTRON DETECTION (continued)								
Reactor Vessel NE-5D8-26	Neutron detector in Fuel Assembly 5.	0 to 52.5 Local kW/m	1 Hz	2.03 kW/m	--	2.03 kW/m	--	Qualified, good for initial conditions only. Not presented.
Reactor Vessel NE-6H8-26	Neutron detector in Fuel Assembly 6.	0 to 52.5 Local kW/m	1 Hz	2.03 kW/m	--	2.03 kW/m	--	Qualified, good for initial conditions only. Not presented.
ELECTRICAL FREQUENCY								
Intact Loop PCP-1-F	Intact loop Pump 1.	0 to 75 Hz	10 Hz	0.75 Hz	--	0.75 Hz[h]	--	Not presented.
Intact Loop PCP-2-F	Intact loop Pump 2.	0 to 75 Hz	10 Hz	0.75 Hz	--	0.75 Hz	--	Not presented.
ELECTRICAL POWER								
Intact Loop PCP-1-P	Intact loop Pump 1.	0 to 1 MW	10 Hz	0.05 MW	--	0.05 MW	--	Not presented.
Intact Loop PCP-2-P	Intact loop Pump 2.	0 to 1 MW	10 Hz	0.05 MW	--	0.05 MW	--	Not presented.
DIFFERENTIAL PRESSURE								
Broken Loop PDE-BL-0G2	Broken loop cold leg across small break orifice.	±17.5 MPa (differential)	1 Hz	0.0247 MPa	0 MPa 5 MPa 10 MPa 15 MPa	0.0247 MPa 0.0255 MPa 0.0279 MPa 0.0315 MPa	33, 98	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
DIFFERENTIAL PRESSURE (continued)								
Broken Loop PDE-BL-003	Broken loop cold leg across 5- to 8-inch expansion.	±3.5 MPa (differential)	1 Hz	0.000 88 MPa	0 MPa 5 MPa 10 MPa	0.000 88 MPa 0.01 MPa 0.01 MPa	--	Channel failed.
Broken Loop PDE-BL-009	Broken loop from end to middle of 5-inch pipe.	±0.7 MPa (differential)	1 Hz	--	0.0 MPa 0.35 MPa 0.70 MPa	0.0017 MPa 0.0017 MPa 0.0019 MPa	--	Channel failed.
Broken Loop PDE-BL-010	Broken loop from middle to end of 5-inch pipe.	±0.7 MPa (differential)	1 Hz	0.000 88 MPa	0.0 MPa 0.35 MPa 0.70 MPa	0.0017 MPa 0.0017 MPa 0.0019 MPa	--	Channel failed.
Intact Loop PDE-PC-001	Intact loop cold leg across primary coolant pumps.	±0.7 MPa (differential)	1 Hz	0.0017 MPa	0.0 MPa 0.35 MPa 0.70 MPa	0.0017 MPa 0.0017 MPa 0.0019 MPa	34	Qualified.
Intact Loop PDE-PC-002	Intact loop across SG.	±0.35 MPa (differential)	1 Hz	0.000 88 MPa	0.0 MPa 0.15 MPa 0.30 MPa	0.000 88 MPa 0.0009 MPa 0.0009 MPa	35	Qualified.
Intact Loop PDE-PC-003	Intact loop hot leg piping, RV to SG inlet.	±0.1 MPa (differential)	1 Hz	0.000 49 MPa	0.0 MPa 0.05 MPa 0.10 MPa	0.000 49 MPa 0.000 50 MPa 0.000 52 MPa	36	Qualified.
Intact Loop PDE-PC-004	Intact loop hot leg piping, surge line junction to SG inlet.	±0.1 MPa (differential)	1 Hz	0.000 49 MPa	0.0 MPa 0.05 MPa 0.10 MPa	0.000 49 MPa 0.000 50 MPa 0.000 52 MPa	37	Qualified.
Intact Loop PDE-PC-005	Intact loop cold leg primary coolant pumps to RV nozzle.	±0.1 MPa (differential)	1 Hz	0.000 49 MPa	0.0 MPa 0.05 MPa 0.10 MPa	0.000 49 MPa 0.000 50 MPa 0.000 52 MPa	38	Qualified.
Intact Loop PDE-PC-006	Intact loop reactor vessel outlet to inlet.	±0.1 MPa (differential)	1 Hz	0.000 49 MPa	0.0 MPa 0.05 MPa 0.10 MPa	0.000 49 MPa 0.000 50 MPa 0.000 52 MPa	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
DIFFERENTIAL PRESSURE (continued)								
Intact Loop PDE-PC-008	Intact loop across pressurizer surge line.	±10.34 MPa (differential)	1 Hz	0.025 MPa	0 MPa 5 MPa 10 MPa	0.025 MPa 0.0258 MPa 0.028 MPa	39	Qualified, flow into pressurizer reads positive.
Intact Loop PDE-PC-011	Pitot tube at top of ECC Rake 1 (facing reactor vessel).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	--	Not presented.
Intact Loop PDE-PC-012	Pitot tube at next to top of ECC Rake 1 (facing reactor vessel).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	--	Not presented.
Intact Loop PDE-PC-013	Pitot tube at next to bottom of ECC Rake 1 (facing reactor vessel).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	--	Not presented.
Intact Loop PDE-PC-014	Pitot tube at bottom of ECC Rake 1 (facing reactor vessel).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	40	Qualified.
Intact Loop PDE-PC-015	Pitot tube at top of ECC Rake 1 (facing pump).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	--	Not presented.
Intact Loop PDE-PC-016	Pitot tube at next to top of ECC Rake 1 (facing pump).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	--	Not presented.
Intact Loop PDE-PC-017	Pitot tube at next to bottom of ECC Rake 1 (facing pump).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	--	Not presented.
Intact Loop PDE-PC-018	Pitot tube at bottom of ECC Rake 1 (facing pump).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	41	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
DIFFERENTIAL PRESSURE (continued)								
Intact Loop PDE-PC-019	Pitot tube at top of ECC Rake 2 (facing reactor vessel).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	--	Not presented.
Intact Loop PDE-PC-020	Pitot tube at next to top of ECC Rake 2 (facing reactor vessel).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	--	Not presented.
Intact Loop PDE-PC-021	Pitot tube at next to bottom of ECC Rake 2 (facing reactor vessel).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	--	Not presented.
Intact Loop PDE-PC-022	Pitot tube at bottom of ECC Rake 2 (facing reactor vessel).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	--	Not presented.
Intact Loop PDE-PC-023	Pitot tube at top of ECC Rake 2 (facing pump).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	--	Not presented.
Intact Loop PDE-PC-024	Pitot tube at next to top of ECC Rake 2 (facing pump).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	--	Not presented.
Intact Loop PDE-PC-025	Pitot tube at next to bottom of ECC Rake 2 (facing pump).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	--	Not presented.
Intact Loop PDE-PC-026	Pitot tube at bottom of ECC Rake 2 (facing pump).	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	42, 99	Qualified.
Intact Loop PDE-PC-027	Steam generator outlet to pump suction, lowest point.	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	43, 100	Qualified, minimum forced to 7.23 kPa, voiding of the pipe increases the differential pressure.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
DIFFERENTIAL PRESSURE (continued)								
Intact Loop PDE-PC-028	Pump suction, lowest point to Pump 2 outlet.	± 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa 40 kPa	0.28 kPa 0.285 kPa 0.291 kPa	44, 101	Qualified forced to -5.6 kPa at zero flow (~60 s).
Reactor Vessel PDE-RV-002	Fuel Assembly 1 from lower end box to upper end box.	±172 kPa (differential)	1 Hz	1.2 kPa	0 kPa 100 kPa 170 kPa	1.2 kPa 0.23 kPa 0.391 kPa	--	Not presented.
Reactor Vessel PDE-RV-003	Intact loop cold leg inlet to bottom of downcomer.	±0.1 MPa (differential)	1 Hz	0.000 49 MPa	0.0 MPa 0.05 MPa 0.10 MPa	0.000 49 MPa 0.000 50 MPa 0.000 52 MPa	--	Not presented.
Reactor Vessel PDE-RV-004	Fuel Assembly 1 lower end box to the RV outlet nozzle in the intact loop hot leg.	±0.2 MPa (differential)	1 Hz	0.0012 MPa	0.0 MPa 0.1 MPa 0.2 MPa	0.0012 MPa 0.001 22 MPa 0.001 26 MPa	--	Not presented.
Reactor Vessel PDE-RV-005	Top of reactor vessel to intact loop hot leg.	0 to 40 kPa (differential)	1 Hz	0.28 kPa	0 kPa 20 kPa	0.28 kPa 0.285 kPa	45, 102	Qualified, minimum forced to 14.5 kPa, use caution when converting to level.
Blowdown Suppression Tank PDE-SV-009	Suppression tank across the vacuum breaker line.	±69.0 kPa (differential)	10 Hz	0.49 kPa	0 kPa 30 kPa 69 kPa	0.49 kPa 0.492 kPa 0.502 kPa	--	Not presented.
Reactor Vessel PDE-2ST-001	Bottom of 2ST to Fuel Assembly 3 upper end box.	±69 kPa (differential)	1 Hz	0.49 kPa	0 kPa 30 kPa 69 kPa	0.49 kPa 0.492 kPa 0.502 kPa	--	Not presented.
Reactor Vessel PDE-2ST-004	Bottom of downcomer Stalk 2, to Fuel Assembly 3 lower end box.	±69 kPa (differential)	1 Hz	0.49 kPa	0 kPa 30 kPa 69 kPa	0.49 kPa 0.492 kPa 0.502 kPa	--	Not presented.
Intact Loop PDT-P139-27-1	Intact loop venturi, Channel A.	0 to 0.199 MPa (differential)	10 Hz	0.002 MPa	--	0.002 MPa	46	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
DIFFERENTIAL PRESSURE (continued)								
Intact Loop PDT-P139-27-2	Intact loop venturi, Channel B.	0 to 0.199 MPa (differential)	10 Hz	0.002 MPa	--	0.002 MPa	47	Qualified.
Intact Loop PDT-P139-27-3	Intact loop venturi, Channel C.	0 to 0.199 MPa (differential)	10 Hz	0.002 MPa	--	0.002 MPa	48	Qualified.
Intact Loop PDT-P139-030	Across RV just beyond intact loop inlet and and outlet nozzles.	0 to 0.3 MPa (differential)	10 Hz	0.003 MPa	--	0.003 MPa	49	Qualified.
PRESSURE[i]								
Broken Loop PE-BL-001	Broken loop cold leg at DTT flange.	0.1 to 20.8 MPa[i]	1 Hz	0.036 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	50, 103	Qualified.
Broken Loop PE-BL-002	Broken loop hot leg at DTT flange.	0.1 to 20.8 MPa	1 Hz	0.036 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	51, 104	Qualified.
Broken Loop PE-BL-003	Broken loop hot leg nstream of pump mulator.	0.1 to 20.8 MPa	1 Hz	--	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	--	Channel failed.
Broken Loop PE-BL-004	roken loop cold leg t inlet of spool piece.	0.1 to 20.8 MPa	1 Hz	--	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	--	Channel failed.
Broken Loop PE-BL-006	Broken loop hot leg at outlet of SG simulator.	0.1 to 20.8 MPa	1 Hz	--	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	--	Channel failed.
Broken Loop PE-BL-008	Broken loop cold leg at center of spool piece.	0.1 to 20.8 MPa	1 Hz	0.036 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	52, 105	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
PRESSURE (continued)								
Intact Loop PE-PC-001	Intact loop cold leg at DTT flange.	0.1 to 20.8 MPa	1 Hz	0.036 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	53, 106	Qualified.
Intact Loop PE-PC-002	Intact loop hot leg at DTT flange.	0.1 to 20.8 MPa	1 Hz	0.036 MPa	0 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	54, 107	Qualified.
Intact Loop PE-PC-004	Intact loop pressurizer vapor space.	0.1 to 20.8 MPa	1 Hz	0.036 MPa	0.1 MPa 10 MPa 20 MPa	0.199 MPa 0.223 MPa 0.282 MPa	55, 108	Quali[illegible]
Intact Loop PE-PC-005	Intact loop reference pressure.	0.1 to 17.0 MPa	1 Hz	0.002 MPa	--	0.028 MPa	56	Qualified.
Intact Loop PE-PC-006	Intact loop reference pressure.	0.1 to 17.0 MPa	1 Hz	0.002 MPa	--	0.028 MPa	109	Qualified.
Blowdown Suppression System PE-SV-015	Blowdown suppression tank across from Downcomer 4, 230° from top vertical (CW looking north).	0.1 to 0.7 MPa	1 Hz	0.008 MPa	--	0.008 MPa	110	Qualified.
Blowdown Suppression System PE-SV-016	Blowdown suppression tank across from Downcomer 1, 230° from top vertical (CW looking north).	0.1 to 0.7 MPa	1 Hz	0.008 MPa	--	0.008 MPa	111	Qualified.
Blowdown Suppression System PE-SV-017	Blowdown suppression tank, 1.38 m north of Downcomer 3 $\mathcal{C}_L$, 327° from top vertical (CW looking north).	0.1 to 0.7 MPa	1 Hz	0.008 MPa	--	0.008 MPa	--	Not presented.
Blowdown Suppression System PE-SV-055	Blowdown su[illegible]ssion tank top, [illegible] m north of Downcomer 4 $\mathcal{C}_L$.	0.1 to 0.[illegible] MPa	1 Hz	0.008 MPa	--	0.008 MPa	112	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
PRESSURE (continued)								
Blowdown Suppression System PE-SV-060	Blowdown suppression tank top above Downcomer 1.	0.1 to 0.7 MPa	1 Hz	0.008 MPa	--	0.008 MPa	113	Qualified.
Reactor Vessel PE-1ST-001A	Downcomer Stalk 1, 0.62 m above RV bottom, wide range (0 to 20.8 MPa).	0.1 to 20.8 MPa	1 Hz	0.036 MPa	0.1 MPa 10.0 MPa 20.5 MPa	0.199 MPa 0.199 MPa 0.200 MPa	57	Qualified.
Reactor Vessel PE-1ST-003A	Downcomer Stalk 1, 5.32 m above RV bottom, wide range (0 to 20.8 MPa).	0.1 to 20.8 MPa	1 Hz	0.03 MPa	0.1 MPa 10 MPa 20 MPa	0.2 MPa 0.22 MPa 0.28 MPa	114	Qualified.
Reactor Vessel PE-1UP-001A	Above Fuel Assembly 1 upper end box, high range.	0.1 to 20.8 MPa	1 Hz	0.03 MPa	0.1 MPa 10 MPa 20 MPa	0.2 MPa 0.22 MPa 0.28 MPa	58	Qualified.
Reactor Vessel PE-1UP-001A1	Above Fuel Assembly 1 upper end box, high range.	0 to 21.0 MPa	1 Hz	0.03 MPa	0.1 MPa 10 MPa 20 MPa	0.2 MPa 0.22 MPa 0.28 MPa	116	Qualified.
Reactor Vessel PE-2ST-001A	Downcomer Stalk 2, 0.62 m above RV bottom, wide range (0 to 20.8 MPa).	0.1 to 20.8 MPa	1 Hz	0.03 MPa	0.1 MPa 10 MPa 20 MPa	0.2 MPa 0.22 MPa 0.28 MPa	115	Qualified.
Secondary Coolant System PT-P004-010A	In 10-in. line from steam generator.	0.1 to 8.4 MPa	1 Hz	0.110 MPa	--	0.110 MPa	117	Qualified.
Secondary Coolant System PT-P004-034	Downstream of main feedwater pump.	0 to 10.3 MPa	10 Hz	0.07 MPa	--	0.07 MPa	--	Not presented.
Secondary Coolant System PT-P004-085	Upstream of inlet to air-cooled condenser header.	0 to 2.8 MPa	1 Hz	0.075 MPa	--	0.075 MPa	118	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
PRESSURE (continued)								
Emergency Core Cooling System PT-P120-043	Accumulator A, 0.69 m above water outlet.	0.1 to 7.0 MPa	1 Hz	0.055 MPa	--	0.055 MPa	119	Qualified.
Emergency Core Cooling System PT-P120-061	Emergency core cooling injection.	0.1 to 20.8 MPa	1 Hz	0.158 MPa	--	0.158 MPa	--	Not presented.
Emergency Core Cooling System PT-P120-083	LPIS Pump A discharge.	0.1 to 7.0 MPa	1 Hz	0.04 MPa	--	0.04 MPa	--	Qualified, not presented.
Broken Loop PT-P138-023	Blowdown header.	0.1 to 1.4 MPa	10 Hz	0.007 MPa	--	0.007 MPa	--	Not presented.
Broken Loop PT-P138-111	Broken loop cold leg QOBV inlet between isolation valve and QOBV.	0.1 to 13.9 MPa	100 Hz	--	--	0.20 MPa	--	Not presented.
Broken Loop PT-P138-112	Broken loop hot leg QOBV inlet between isolation valve and QOBV.	0.1 to 13.9 MPa	100 Hz	--	--	0.20 MPa	--	Not presented.
Intact Loop PT-P139-002	Intact loop hot leg at venturi on bottom.	0.1 to 20.8 MPa	1 Hz	0.25 MPa	--	0.25 MPa	--	Not presented.
Intact Loop PT-P.39-003	Intact loop hot leg at venturi on left side when looking toward SG.	0.1 to 20.8 MPa	1 Hz	0.25 MPa	--	0.25 MPa	--	Not presented.
Intact Loop PT-P139-004	Intact loop hot leg at venturi on right side when looking toward SG.	0.1 to 20.8 MPa	1 Hz	0.25 MPa	--	0.25 MPa	120	Qualified.
Intact Loop PT-P139-005	1.86 m above pressurizer bottom (vapor space).	10.3 to 17.2 MPa	1 Hz	0.12 MPa	--	0.12 MPa	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
PUMP SPEED								
Intact Loop RPE-PC-001	Intact loop Pump 1.	0 to 10 000 rpm	1 Hz	8.825 rpm	1000 rpm 2000 rpm 3000 rpm 4000 rpm	7.65 rpm 8.825 rpm 10.10 rpm 11.66 rpm	59	Qualified.
Intact Loop RPE-PC-002	Intact loop Pump 2.	0 to 10 000 rpm	1 Hz	8.825 rpm	1000 rpm 2000 rpm 3000 rpm 4000 rpm	7.65 rpm 8.825 rpm 10.10 rpm 11.66 rpm	60	Qualified.
REACTIVITY								
Reactor Vessel RE-TRM-86-5	Transient reactivity meter in shield tank.	±0.145 Rho	10 Hz	0.01 Rho	--	0.01 Rho	--	Not presented.
Reactor Vessel RE-TRM-86-6	Transient reactivity meter in shield tank.	±0.145 Rho	10 Hz	0.01 Rho	--	0.01 Rho	--	Not presented.
Reactor Vessel RE-T-77-1A2	Power range Channel A-level.	0 to 100% power	10 Hz	3%	--	3%	--	Not presented.
Reactor Vessel RE-T-77-2A2	Power range Channel B-level.	0 to 100% power	10 Hz	3%	--	3%	--	Not presented.
Reactor Vessel RE-T-77-3A2	Power range Channel C-level.	0 to 100% power	10 Hz	3%	--	3%	--	Not presented.
Reactor Vessel RE-T-87-4A2	Power range Channel D-level.	0 to 100% power	10 Hz	3%	--	3%	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE								
Broken Loop TE-BL-001B	Broken loop cold leg at DTT rake center.	255.2 to 588.6 K	1 Hz	5.0 K	400 K 450 K 500 K 550 K	5.6 K 6.3 K 4.6 K 5.0 K	61, 121	Qualified.
Broken Loop TE-BL-002B	Broken loop hot leg at middle of DTT flange.	255.2 to 588.6 K	1 Hz	5.0 K	400 K 450 K 500 K 550 K	5.6 K 6.3 K 4.6 K 5.0 K	122	Qualified.
Intact Loop TE-PC-002A	Intact loop hot leg at DTT flange on west side of pipe.	255 to 980 K	1 Hz	--	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	--	Channel failed.
Intact Loop TE-PC-002B	Intact loop hot leg at DTT flange at middle of pipe.	255 to 980 K	1 Hz	3 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	62, 123	Qualified.
Intact Loop TE-PC-002C	Intact loop hot leg at DTT flange on east side of pipe.	255 to 980 K	1 Hz	3 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Intact Loop TE-PC-004	Bottom of ECC Rake 1 (between PDE-PC-14 and PDE-PC-18).	270 to 1530 K	1 Hz	3 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	63, 124	Qualified.
Intact Loop TE-PC-005	Next to bottom of ECC Rake 1 (between PDE-PC-13 and PDE-PC-17).	270 to 1530 K	10 Hz	3 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	63, 125	Qualified.
Intact Loop TE-PC-006	Next to top of ECC Rake 1 (between PDE-PC-12 and PDE-PC-16).	270 to 1530 K	1 Hz	3 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	63, 126	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Intact Loop TE-PC-007	Top of ECC Rake 1 (between PDE-PC-11 and PDE-PC-15).	270 to 1530 K	10 Hz	3 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	63, 127	Qualified.
Intact Loop TE-PC-008	Bottom of ECC Rake 2 (between PDE-PC-22 and PDE-PC-26).	270 to 1530 K	10 Hz	3 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	128	Qualified.
Intact Loop TE-PC-009	Next to bottom of ECC Rake 2 (between PDE-PC-21 and PDE-PC-25).	270 to 1530 K	10 Hz	3 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	129	Qualified.
Intact Loop TE-PC-010	Next to top of ECC Rake 2 (between PDE-PC-20 and PDE-PC-24).	270 to 1530 K	10 Hz	3 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	130	Qualified.
Intact Loop TE-PC-011	Top of ECC Rake 2 (between PDE-PC-19 and PDE-PC-23).	270 to 1530 K	10 Hz	3 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	64, 131	Qualified.
Emergency Core Cooling System TE-P120-041	Accumulator A temperature	255.2 to 366.3 K	1 Hz	0.7 K	--	0.7 K	132	Qualified.
Blowdown Suppression Tank TE-P138-137	Outlet of suppression tank spray system heat exchanger.	250 to 420 K	1 Hz	1.3 K	--	1.3 K	--	Not presented.
Blowdown Suppression Tank Spray System TE-P138-141	Temperature of spray in the 3.79-l/s header.	255.2 to 420 K	1 Hz	4 K	--	5.2 K	133	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_0 Reading	After T_0 Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Blowdown Suppression Tank Spray System TE-P138-142	Temperature of spray pump discharge.	255.2 to 420 K	1 Hz	--	--	5.2 K	--	Channel failed.
Blowdown Suppression Tank Spray System TE-P138-143	Temperature of spray in 13.88-l/s header.	255.2 to 420 K	1 Hz	4 K	--	5.2 K	133	Qualified.
Intact Loop TE-P139-019	Pressurizer vapor space, 0.86 m above the heater rods.	588.6 to 644.1 K	1 Hz	0.5 K	--	0.5 K	--	Not presented.
Intact Loop TE-P139-020	Pressurizer liquid volume, 0.36 m above heater rods.	283 to 644.1 K	1 Hz	4.55 K	--	4.8 K	--	Qualified, good for initial conditions only. Not presented.
Intact Loop TE-P139-028-2	Intact loop cold leg.	530 to 620 K	1 Hz	3 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	--	Qualified, good for initial conditions only. Not presented.
Intact Loop TE-P139-029	Intact loop cold leg.	280 to 620 K	1 Hz	3 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	--	Qualified, good for initial conditions only. Not presented.
Intact Loop TE-SG-001	Intact loop cold leg SG outlet.	255.4 to 977.4 K	1 Hz	3.9 K	400 K 450 K 500 K 550 K	3.9 K 4.3 K 4.8 K 5.2 K	65, 134	Qualified, possibly experiencing hot wall effects after ~375 s.
Intact Loop TE-SG-002	Intact loop hot leg SG inlet.	255.4 to 977.4 K	1 Hz	3.9 K	400 K 450 K 500 K 550 K	3.9 K 4.3 K 4.8 K 5.2 K	66, 134	Qualified, possibly experiencing hot wall effects after ~800 s.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Secondary Coolant System TE-SG-003	SG secondary side.	253.4 to 588.6 K	1 Hz	3.9 K	500 K 550 K	4.8 K 5.2 K	135	Qualified.
Blowdown Suppression System TE-SV-002	Blowdown suppression tank, 0.3 m north of Downcomer 1, 0.53 m east of tank ℄, 2.36 m from tank bottom.	253.2 to 477.4 K	1 Hz	2.7 K	300 K 350 K 400 K	2.7 K 3.1 K 3.5 K	136	Qualified.
Blowdown Suppression System TE-SV-004	Blowdown suppression tank, 0.3 m north of Downcomer 1, 0.53 m east of tank ℄, 1.45 m from tank bottom.	253.2 to 477.4 K	1 Hz	2.7 K	300 K 350 K 400 K	2.7 K 3.1 K 3.5 K	137	Qualified.
Blowdown Suppression System TE-SV-005	Blowdown suppression tank, 0.3 m north of Downcomer 1, 0.53 m east of tank ℄, 0.99 m from tank bottom.	253.2 to 477.4 K	1 Hz	--	300 K 350 K 400 K	2.7 K 3.1 K 3.5 K	--	Channel failed.
Blowdown Suppression System TE-SV-006	Blowdown suppression tank, 0.3 m north of Downcomer 1, 0.53 m east of tank ℄, 0.37 m from tank bottom.	253.2 to 477.4 K	1 Hz	2.7 K	300 K 350 K 400 K	2.7 K 3.1 K 3.5 K	138	Qualified.
Blowdown Suppression System TE-SV-007	Blowdown suppression tank, 0.3 m north of Downcomer 3, 0.53 m east of tank ℄, 2.72 m from tank bottom.	253.2 to 477.4 K	1 Hz	2.7 K	300 K 350 K 400 K	2.7 K 3.1 K 3.5 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Blowdown Suppression System TE-SV-008	Blowdown suppression tank, 0.3 m north of Downcomer 3, 0.53 m east of tank ℄, 2.36 m from tank bottom.	253.2 to 477.4 K	1 Hz	2.7 K	300 K 350 K 400 K	2.7 K 3.1 K 3.5 K	136	Qualified.
Blowdown Suppression System TE-SV-010	Blowdown suppression tank, 0.3 m north of Downcomer 3, 0.53 m east of tank ℄, 1.45 m from tank bottom.	253.2 to 477.4 K	1 Hz	2.7 K	300 K 350 K 400 K	2.7 K 3.1 K 3.5 K	137	Qualified.
Blowdown Suppression System TE-SV-011	Blowdown suppression tank, 0.3 m north of Downcomer 3, 0.53 m east of tank ℄, 0.99 m from tank bottom.	253.2 to 477.4 K	1 Hz	2.7 K	300 K 350 K 400 K	2.7 K 3.1 K 3.5 K	139	Qualified.
Blowdown Suppression System TE-SV-012	Blowdown suppression tank, 0.3 m north of Downcomer 3, 0.53 m east of tank ℄, 0.37 m from tank bottom.	253.2 to 477.4 K	1 Hz	2.7 K	300 K 350 K 400 K	2.7 K 3.1 K 3.5 K	139	Qualified.
Reactor Vessel TE-1B12-026	Fuel Assembly 1, Row B, Column 12, 0.660 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-1C11-039	Fuel Assembly 1, Row C, Column 11, 0.991 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-1F7-015	Fuel Assembly 1, Row F, Column 7, 0.381 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	74, 154	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-1F7-021	Fuel Assembly 1, Row F, Column 7, 0.533 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	74, 154	Qualified.
Reactor Vessel TE-1F7-026	Fuel Assembly 1, Row F, Column 7, 0.660 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	74, 154	Qualified.
Reactor Vessel TE-1F7-030	Fuel Assembly 1, Row F, Column 7, 0.762 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	74, 154	Qualified.
Reactor Vessel TE-1LP-001	Fuel Assembly 1 lower end box.	310 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	67, 144	Qualified.
Reactor Vessel TE-1ST-001	Downcomer Stalk 1, 4.8 m from RV bottom.	253.2 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	140	Qualified.
Reactor Vessel TE-1ST-002	Downcomer Stalk 1, 4.2 m from RV bottom.	253.2 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	140	Qualified.
Reactor Vessel TE-1ST-005	Downcomer Stalk 1, 2.37 m from RV bottom.	253.2 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	140	Qualified.
Reactor Vessel TE-1ST-009	Downcomer Stalk 1, 0.64 m from RV bottom.	253.2 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	141	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-1ST-013	Downcomer Stalk 1, 0.24 m from RV bottom.	253.2 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	141	Qualified.
Reactor Vessel TE-1ST-014	Downcomer Stalk 1, 1.17 m from RV bottom (inside of DTT).	253.2 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	141	Qualified.
Reactor Vessel TE-1UP-001	Fuel Assembly 1 upper end box.	310 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	68, 145	Qualified.
Reactor Vessel TE-1UP-002	Fuel Assembly 1 upper end box.	310 to 977.4 K	10 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-1UP-003	Fuel Assembly 1 support column above reactor vessel.	310 to 977.4 K	10 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-1UP-004	Fuel Assembly 1 support column above reactor vessel.	310 to 977.4 K	10 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-1UP-005	DTT FE-1UP-1 above Fuel Assembly 1.	310 to 977.4 K	10 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-1UP-006	Fuel Assembly 1 support column.	310 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	 Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-2E8-045	Cladding on Fuel Assembly 2, Row E, Column 8 at 1.14 m above bottom of fuel rod.	422 to 1533 K	10 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-2G14-011	Cladding on Fuel Assembly 2, Row G, Column 14 at 0.28 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-2G14-030	Cladding on Fuel Assembly 2, Row G, Column 14 at 0.76 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-2G14-045	Cladding on Fuel Assembly 2, Row G, Column 14 at 1.14 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	75, 155	Qualified.
Reactor Vessel TE-2H01-037	Cladding on Fuel Assembly 2, Row H, Column 1 at 0.94 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	76, 156	Qualified.
Reactor Vessel TE-2H02-028	Cladding on Fuel Assembly 2, Row H, Column 2 at 0.71 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	76, 156	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-2H02-032	Cladding on Fuel Assembly 2, Row H, Column 2 at 0.81 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	76, 156	Qualified.
Reactor Vessel TE-2H08-039	Guide tube for Fuel Assembly 2, Row H, Column 8 at 0.99 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-2LP-001	Fuel Assembly 2 lower end box.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.5 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-2LP-003	Fuel Assembly 2 lower end box.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.5 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-2ST-001	Downcomer Stalk 2, 4.8 m from RV bottom.	253.2 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	142	Qualified.
Reactor Vessel TE-2ST-005	Downcomer Stalk 2, 2.37 m from RV bottom.	253.2 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	143	Qualified.
Reactor Vessel TE-2ST-009	Downcomer Stalk 2, 0.64 m from RV bottom.	253.2 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 F 550 K	5.6 K 6.4 K 4.6 K 5.1 K	143	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-2ST-013	Downcomer Stalk 2, 0.24 m from RV bottom.	253.2 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	143	Qualified.
Reactor Vessel TE-2ST-014	Downcomer Stalk 2, 1.17 m from RV bottom.	253.2 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	143	Qualified.
Reactor Vessel TE-2UP-001	Fuel Assembly 2 upper end box.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	69, 146	Qualified.
Reactor Vessel TE-2UP-002	Fuel Assembly 2 upper end box.	311 to 977.4 K	10 Hz	5.1 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-2UP-003	Fuel Assembly 2 upper end box.	311 to 977.4 K	10 Hz	5.1 K	400 K 450 K 500 K 550 K	5.6 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-3B12-026	Cladding on Fuel Assembly 3, Row B, Column 12 at 0.66 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-3C11-039	Cladding on Fuel Assembly 3, Row C, Column 11 at 0.99 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	77, 157	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	 Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-3F7-015	Cladding on Fuel Assembly 3, Row F, Column 7 at 0.38 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-3F7-021	Cladding on Fuel Assembly 3, Row F, Column 7 at 0.53 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-3F7-026	Cladding on Fuel Assembly 3, Row F, Column 7 at 0.66 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-3F7-030	Cladding on Fuel Assembly 3, Row F, Column 7 at 0.76 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-3LP-001	Fuel Assembly 3 lower end box.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-3UP-001	Fuel Assembly 3 upper end box.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	70, 147	Qualified.
Reactor Vessel TE-3UP-003	Fuel Assembly 3 support column above RV nozzle.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	147	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-3UP-004	Fuel Assembly 3 support column above RV nozzle.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-3UP-005	DTT FE-3UP-1 above Fuel Assembly 3.	311 to 977.4 K	1 Hz	--	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Channel failed.
Reactor Vessel TE-3UP-006	Support column.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-3UP-007	Support column.	311 to 977.4 K	1 Hz	--	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Channel failed.
Reactor Vessel TE-3UP-008	Liquid level transducer above Fuel Assembly 3.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-3UP-009	Liquid level transducer above Fuel Assembly 3.	311 to 977.4 K	1 Hz	--	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Channel failed.
Reactor Vessel TE-3UP-010	Liquid level transducer above Fuel Assembly 3.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-3UP-011	Liquid level transducer above Fuel Assembly 3.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	148	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-3UP-012	Liquid level transducer above Fuel Assembly 3.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-3UP-013	Liquid level transducer above Fuel Assembly 3.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	148	Qualified.
Reactor Vessel TE-3UP-014	Liquid level transducer above Fuel Assembly 3.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-3UP-015	Liquid level transducer above Fuel Assembly 3.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	148	Qualified.
Reactor Vessel TE-3UP-016	Liquid level transducer above Fuel Assembly 3.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-4G14-011	Cladding on Fuel Assembly 4, Rod G, Column 14 at 0.28 m above bottom of fuel rod.	422 to 1533 K	1 Hz	--	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Channel failed.
Reactor Vessel TE-4G14-030	Cladding on Fuel Assembly 4, Row G, Column 14 at 0.76 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-4G14-045	Cladding on Fuel Assembly 4, Row G, Column 14 at 1.14 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	78, 158	Qualified.
Reactor Vessel TE-4H01-037	Cladding on Fuel Assembly 4, Row H, Column 1 at 0.94 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-4H02-028	Cladding on Fuel Assembly 4, Row H, Column 2 at 0.71 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-4H02-032	Cladding on Fuel Assembly 4, Row H, Column 2 at 0.81 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-4H08-039	Cladding on Fuel Assembly 4, Row H Column 8 at 0.99 m above bottom of fuel rod.	422 to 1533 K	10 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-4LP-001	Fuel Assembly 4 lower end box.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-4LP-003	Fuel Assembly 4 lower end box.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	71, 149	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-4UP-001	Fuel Assembly 4 upper end box.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	150	Qualified.
Reactor Vessel TE-4UP-002	Fuel Assembly 4 upper end box.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-4UP-003	Fuel Assembly 4 upper end box.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-5C6-024	Guide tube for Fuel Assembly 5, Row C, Column 6 at 0.61 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5D6-030	Cladding on Fuel Assembly 5, Row D, Column 6 at 0.76 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	159	Qualified.
Reactor Vessel TE-5D6-032	Cladding on Fuel Assembly 5, Row D, Column 6 at 0.81 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	159	Qualified.
Reactor Vessel TE-5D6-037	Cladding on Fuel Assembly 5, Row D, Column 6 at 0.94 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.[illegible] 6.6 K 8.2	159	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5D6-039	Cladding on Fuel Assembly 5, Row D, Column 6 at 0.99 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	159	Qualified.
Reactor Vessel TE-5E8-002	Cladding on Fuel Assembly 5, Row E, Column 8 at 0.05 m above bottom of fuel rod.	422 to 1533 K	1 Hz	--	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Channel failed.
Reactor Vessel 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	5.0 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel 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	5.0 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5E8-049	Cladding on Fuel Assembly 5, Row E, Column 8 at 1.24 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5F3-024	Cladding on Fuel Assembly 5, Row F, Column 3 at 0.61 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5F4-015	Cladding on Fuel Assembly 5, Row F, Column 4 at 0.38 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5F4-021	Cladding on Fuel Assembly 5, Row F, Column 4 at 0.53 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5F4-026	Cladding on Fuel Assembly 5, Row F, Column 4 at 0.66 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5F4-030	Cladding on Fuel Assembly 5, Row F, Column 4 at 0.76 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5F7-005	Cladding on Fuel Assembly 5, Row F, Column 7 at 0.13 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.[illegible] K 8.2 K	--	Not presented.
Reactor Vessel TE-5F7-021	Cladding on Fuel Assembly 5, Row F, Column 7 at 0.53 m above bottom of fuel rod.	420 to 1810 K	1 Hz	--	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Channel failed.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5F7-039	Cladding on Fuel Assembly 5, Row F, Column 7 at 0.99 m above bottom of fuel rod.	420 to 1810 K	1 Hz	5.0 K	400 K 600 K 800 K 1000 K	5.6 K 5.3 K 6.6 K 8.2 K	160	Qualified.
Reactor Vessel TE-5F7-054	Cladding on Fuel Assembly 5, Row F, Column 7 at 1.37 m above bottom of fuel rod.	422 to 1533 K	1 Hz	--	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Channel failed.
Reactor Vessel 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	5.0 K	400 K 600 K 800 K 1000 K	5.6 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel 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	5.0 K	400 K 600 K 800 K 1000 K	5.6 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel 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	5.0 K	400 K 600 K 800 K 1000 K	5.6 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5F8-037	Cladding on Fuel Assembly 5, Row F, Column 8 at 0.94 m above bottom of fuel rod.	420 to 1810 K	1 Hz	--	400 K 600 K 800 K 1000 K	5.6 K 5.3 K 6.6 K 8.2 K	--	Channel failed.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5F9-011	Cladding on Fuel Assembly 5, Row F, Column 9 at 0.28 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel 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	5.0 K	400 K 600 K 800 K 1000 K	5.6 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5F9-045	Cladding on Fuel Assembly 5, Row F, Column 9 at 1.14 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	161	Qualified.
Reactor Vessel TE-5F9-062	Cladding on Fuel Assembly 5, Row F, Column 9 at 1.57 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	161	Qualified.
Reactor Vessel TE-5G6-011	Cladding on Fuel Assembly 5, Row G, Column 6 at 0.28 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5G6-030	Cladding on Fuel Assembly 5, Rod G, Column 6 at 0.76 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5G6-045	Cladding on Fuel Assembly 5, Row G, Column 6 at 1.14 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	162	Qualified.
Reactor Vessel TE-5G6-062	Cladding on Fuel Assembly 5, Row G, Column 6 at 1.57 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5G8-008	Cladding on Fuel Assembly 5, Row G, Column 8 at 0.20 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel 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	5.0 K	400 K 600 K 800 K 1000 K	5.6 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5G8-041	Cladding on Fuel Assembly 5, Row G, Column 8 at 1.04 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5G8-058	Cladding on Fuel Assembly 5, Row G, Column 8 at 1.47 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	163	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5H5-002	Cladding on Fuel Assembly 5, Row H, Column 5 at 0.05 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5H5-015	Cladding on Fuel Assembly 5, Row H, Column 5 at 0.38 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5H5-034.5	Cladding on Fuel Assembly 5, Row H, Column 5 at 0.88 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5H5-049	Cladding on Fuel Assembly 5, Row H, Column 5 at 1.24 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5H6-024	Cladding on Fuel Assembly 5, Row H, Column 6 at 0.61 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5H6-028	Cladding on Fuel Assembly 5, Row H, Column 6 at 0.71 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5H6-032	Cladding on Fuel Assembly 5, Row H, Column 6 at 0.81 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5H6-037	Cladding on Fuel Assembly 5, Row H, Column 6 at 0.94 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5H7-008	Cladding on Fuel Assembly 5, Row H, Column 7 at 0.20 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5H7-026	Cladding on Fuel Assembly 5, Row H, Column 7 at 0.66 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5H7-041	Cladding on Fuel Assembly 5, Row H, Column 7 at 1.04 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5H7-058	Cladding on Fuel Assembly 5, Row H, Column 7 at 1.47 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5I6-005	Cladding on Fuel Assembly 5, Row I, Column 6 at 0.13 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5I6-021	Cladding on Fuel Assembly 5, Row I, Column 6 at 0.53 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5I6-039	Cladding on Fuel Assembly 5, Row I, Column 6 at 0.99 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5I6-054	Cladding on Fuel Assembly 5, Row I, Column 6 at 1.37 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5I8-008	Cladding on Fuel Assembly 5, Row I Column 8 at 0.20 m above bottom of fue. rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	164	Qualified.
Reactor Vessel TE-5I8-026	Cladding on Fuel Assembly 5, Row I, Column 8 at 0.66 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	164	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5I8-041	Cladding on Fuel Assembly 5, Row I, Column 8 at 1.04 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	164	Qualified.
Reactor Vessel TE-5I8-058	Cladding on Fuel Assembly 5, Row I, Column 8 at 1.47 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	164	Qualified.
Reactor Vessel TE-5J3-024	Cladding on Fuel Assembly 5, Row J, Column 3 at 0.61 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5J4-015	Cladding on Fuel Assembly 5, Row J, Column 4 at 0.38 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5J4-021	Cladding on Fuel Assembly 5, Row J, Column 4 at 0.53 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5J4-026	Cladding on Fuel Assembly 5, Row J, Column 4 at 0.66 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5J4-030	Cladding on Fuel Assembly 5, Row J, Column 4 at 0.76 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5J7-011	Cladding on Fuel Assembly 5, Row J, Column 7 at 0.28 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5J7-030	Cladding on Fuel Assembly 5, Row J, Column 7 at 0.76 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5J7-045	Cladding on Fuel Assembly 5, Row J, Column 7 at 1.14 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5J7-062	Cladding on Fuel Assembly 5, Row J, Column 7 at 1.57 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5J8-024	Cladding on Fuel Assembly 5, Row J, Column 8 at 0.61 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5J8-028	Cladding on Fuel Assembly 5, Row J, Column 8 at 0.71 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5J8-032	Cladding on Fuel Assembly 5, Row J, Column 8 at 0.81 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5J8-037	Cladding on Fuel Assembly 5, Row J, Column 8 at 0.94 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5J9-005	Cladding on Fuel Assembly 5, Row J, Column 9 at 0.13 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5J9-021	Cladding on Fuel Assembly 5, Row J, Column 9 at 0.53 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5J9-039	Cladding on Fuel Assembly 5, Row J, Column 9 at 0.99 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_0 Reading	After T_0 Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5J9-054	Cladding on Fuel Assembly 5, Row J, Column 9 at 1.37 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5K8-002	Cladding on Fuel Assembly 5, Row K, Column 8 at 0.05 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5K8-015	Cladding on Fuel Assembly 5, Row K, Column 8 at 0.38 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5K8-034.5	Cladding on Fuel Assembly 5, Row K, Column 8 at 0.88 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5K8-049	Cladding on Fuel Assembly 5, Row K, Column 8 at 1.24 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5LP-001	Fuel Assembly 5 lower end box.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-5LP-002	Fuel Assembly 5 lower end box.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5LP-003	Fuel Assembly 5 lower end box.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-5LP-004	Fuel Assembly 5 lower end box.	311 to 977.4 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-5L6-030	Cladding on Fuel Assembly 5, Row L, Column 6 at 0.76 m above bottom of fuel rod.	422 to 1533 K	1 K	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5L6-032	Cladding on Fuel Assembly 5, Row L, Column 6 at 0.81 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5L6-037	Cladding on Fuel Assembly 5, Row L, Column 6 at 0.94 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5L6-039	Cladding on Fuel Assembly 5, Row L, Column 6 at 0.99 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5L8-011	Guide tube for Fuel Assembly 5, Row L, Column 8 at 0.28 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5L8-024	Guide tube for Fuel Assembly 5, Row L, Column 8 at 0.61 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5L8-039	Guide tube for Fuel Assembly 5, Row L, Column 8 at 0.99 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5L8-045	Guide tube for Fuel Assembly 5, Row L, Column 8 at 1.14 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5M6-024	Guide tube for Fuel Assembly 5, Row M, Column 6 at 0.61 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-5UP-001	Fuel Assembly 5, upper end box.	311 to 978 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.3 K 4.6 K 5.1 K	72, 151	Qualified.
Reactor Vessel TE-5UP-002	Fuel Assembly 5, upper end box.	311 to 978 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	151	Qualified.
Reactor Vessel TE-5UP-003	Fuel Assembly 5, upper end box.	311 to 978 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	151	Qualified.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-5UP-004	Fuel Assembly 5, upper end box.	311 to 978 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	151	Qualified.
Reactor Vessel TE-5UP-005	Fuel Assembly 5, upper end box.	311 to 978 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	152	Qualified.
Reactor Vessel TE-5UP-006	Fuel Assembly 5, upper end box.	311 to 978 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	152	Qualified.
Reactor Vessel TE-5UP-007	Fuel Assembly 5, upper end box.	311 to 978 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	152	Qualified.
Reactor Vessel TE-5UP-008	Fuel Assembly 5, upper end box.	311 to 978 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	152	Qualified.
Reactor Vessel TE-5UP-009	Fuel Assembly 5, upper end box.	311 to 978 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-6E8-045	Cladding on Fuel Assembly 6, Row E, Column 8 at 1.14 m above bottom of fuel rod.	422 to 1533 K	10 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-6G14-011	Cladding on Fuel Assembly 6, Row G, Column 14 at 0.28 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-6G14-030	Cladding on Fuel Assembly 6, Row G, Column 14 at 0.76 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	79, 165	Qualified.
Reactor Vessel TE-6G14-045	Cladding on Fuel Assembly 6, Row G, Column 14 at 1.14 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-6H01-037	Cladding on Fuel Assembly 6, Row H, Column 1 at 0.94 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-6H02-028	Cladding on Fuel Assembly 6, Row H, Column 2 at 0.71 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-6H02-032	Cladding on Fuel Assembly 6, Row H, Column 2 at 0.81 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Reactor Vessel TE-6H08-039	Cladding on Fuel Assembly 6, Row H, Column 8 at 0.99 m above bottom of fuel rod.	422 to 1533 K	1 Hz	5.2 K	400 K 600 K 800 K 1000 K	5.8 K 5.3 K 6.6 K 8.2 K	--	Not presented.
Reactor Vessel TE-6LP-001	Fuel Assembly 6 lower end box.	311 to 978 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-6LP-003	Fuel Assembly 6 lower end box.	311 to 978 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	--	Not presented.
Reactor Vessel TE-6UP-001	Fuel Assembly 6 upper end box.	311 to 978 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	73, 153	Qualified.
Reactor Vessel TE-6UP-003	Fuel Assembly 6 upper end box.	311 to 978 K	1 Hz	5.1 K	400 K 450 K 500 K 550 K	5.7 K 6.4 K 4.6 K 5.1 K	153	Qualified.
Secondary Coolant System TT-P004-004	Secondary coolant system feedwater.	366 to 505 K	1 Hz	0.9 K	--	0.9 K	--	Not presented.
Emergency Core Cooling System 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	--	2.1 K	--	Not presented.

TABLE 7. (continued)

VARIABLE System Detector	Location	Measurement Range	Recording Frequency[a]	Initial Condition Uncertainty (±)	After T_o Reading	After T_o Uncertainty (±)	Figure	Comments
TEMPERATURE (continued)								
Intact Loop TT-P139-032	Intact loop hot leg primary coolant, Channel A.	533 to 616 K	1 Hz	0.5 K	--	0.5 K	80, 166	Qualified, high range instrument, not valid below 535 K.
Intact Loop TT-P139-033	Intact loop hot leg primary coolant, Channel A.	533 to 616 K	1 Hz	0.5 K	--	0.5 K	--	Not presented.
Intact Loop TT-P139-034	Intact loop hot leg primary coolant, Channel A.	533 to 616 K	1 Hz	0.5 K	--	0.5 K	--	Not presented.

a. Recording Frequency is the measurement channel bandwidth at the ± 3 db level.

b. Instrument channels were "not presented" if the data were in the instrument dead band or showed a similar response to nearby like instruments (such as the core thermocouples). These data are available upon special request.

c. Reference 5.

d. Reference 6.

e. Reference 7.

f. The steam gene[illegible]r level is defined as 0.0 at 2.95 m above the top of the tube sheet.

g. Reference 8.

h. Reference 9.

i. Pressure measurements are presented as absolute values.

TABLE 8. COMPUTED VARIABLES FOR EXPERIMENT L3-1

Variable Location Detectors	Units	Uncertainty	Calculation Method	Figure	Comments
DENSITY, AVERAGE	Mg/m^3	a	Density, average:		The individual beam densities were filtered with a 4-Hz filter prior to being used in the average calculation.
Intact Loop Cold Leg DE-PC-1A (ρ_A) DE-PL-1E (ρ_B) } DE-BL-105 DE-PL-1C (ρ_C)	Mg/m^3	± 0.03 Mg/m^3	Except where the density distribution reduces to an average directly, the following method is used to determine the average density: (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. (2) The least squares curve fits are compared to determine the optimum assumed density profile to fit the data. (3) The best profile is area averaged to give average density by $\bar{\rho} = 1/A \int \rho\ (\bar{r})dA$ where A = cross-sectional area of the pipe $\rho(\bar{r})$ = chordal profile.	167	Qualified, second calibration point of one input determined from intact loop liquid level during first 600 s.

TABLE 8. (continued)

Variable Location Detectors	Units	Uncertainty	Calculation Method	Figure	Comments
DENSITY, AVERAGE (continued)			The assumed profiles are as follows: (1) For homogeneous flow the average results directly in $\bar{\rho} = \frac{(\rho_A + \rho_B + \rho_C)}{3}$ where ρ_A, ρ_B, and ρ_C, = density along gamma densitometer beam lines A, B, and C. (2) For tilted stratified flow, $\rho(\bar{r}) = \rho_\ell - \frac{\rho_\ell - \rho_g}{1 + \exp -4a(x-b)}$ where a and b = two adjustable parameters ρ_g and ρ_ℓ = gas and liquid densities x = position in maximum density gradient direction. (3) For annular distribution, $(\bar{r}) = \begin{matrix} \rho_c \text{ for } r < R-D \\ \rho_\ell \text{ for } r > R-D \end{matrix}$ where ρ_c and D are two adjustable parameters.		

TABLE 8. (continued)

Variable Location Detectors	Units	Uncertainty	Calculation Method	Figure	Comments
DENSITY, AVERAGE (continued)			(4) Eccentric annular is the same as annular, except that the core region may be vertically displaced from the pipe center.		
			(5) For 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. $\bar{\rho} = 0.34485\ \rho_A + 0.40034\ \rho_B + 0.25481\ \rho_C$.		
FLUID VELOCITY	m/s				
Intact Loop Hot Leg PNE-PC-2	m/s	Not available	The outputs from the detectors at each location are algebraically summed to give one plot of counts versus time for each pulsing of the neutron sources for each location. A peak appears in the downstream detectors output, and its location (which corresponds to the time after the source pulsing) is determined. The distance between the sources and detectors (see Figure 4) is divided by this time, giving the fluid velocity.	--	Channel failed.

TABLE 8. (continued)

Variable Location Detectors		Units	Uncertainty	Calculation Method	Figure	Comments
FLUID VELOCITY (continued)						
Broken Loop Cold Leg				The A, B, and C measurement positions are located vertically in the pipe. At the A and C locations there are three axially positioned thermocouples. To analyze the data, two pairs of thermocouples (each consisting of the middle and one end thermocouple) are examined. The two end thermocouples are separated from the middle one by 25.4 and 50.8 mm. At each location, a cross correlation technique is used on each thermocouple pair to determine the fluid transit time. The two pairs at each location are compared, and the one with the greater signal-to-noise ratio is used, together with the separation distance, to determine the fluid velocity. At the B location there are two thermocouples (and hence only one thermocouple pair) separated by 76.2 mm. Again the cross correlation technique is used to determine the transit time, which is used to calculate the fluid velocity.		
TTE-BL-1A-1 TTE-BL-1A-2 TTE-BL-1A-3	TTE-BL-1A	m/s	Not available		--	Not presented, limited amount of data available.
TTE-BL-1B-1 TTE-BL-1B-3	TTE-BL-1B	m/s	Not available		--	Channel failed.
TTE-BL-1C-1 TTE-BL-1C-2 TTE-BL-1C-3	TTE-BL-1C	m/s	Not available		--	Channel failed.

TABLE 8. (continued)

Variable Location Detectors	Units	Uncertainty	Calculation Method	Figure	Comments
LIQUID LEVEL			The liquid distribution was interpreted from the voltage output of the conductivity probes using the following criteria.		
Downcomer and Lower Plenum					
LE-1ST-1 and -2	m	b	(1) A response time of 550 ms during dryout was assumed.	168	Qualified.
LE-2ST-1 and -2	m			--	Not presented.
Upper Plenum					
LE-3UP-1	m	b	(2) The void fraction is assumed to vary linearly with the voltage. The maximum voltage measured during the test from each probe is an indication of 100% void.	169	Qualified.
Core					
LE-1F10	m	b	(3) An X indicates void fractions less than 10%, an O indicates void fractions between 10 and 90%, and a blank indicates void fractions greater than 90%.	--	Core liquid levels not presented.
LE-3F10	m				
LE-5E11	m				
			Engineering judgement was required at times on each conductivity probe in order to best satisfy the preceding criteria.		

TABLE 8. (continued)

Variable Location Detectors	Units	Uncertainty	Calculation Method	Figure	Comments
LIQUID LEVEL (continued)					
			Caution should be exercised in applying the in-core liquid level data to the core as a whole because the in-core liquid level stings are located at "cold spots" (that is, along guide tubes rather than fuel rods) in the core. Prior to the first rewet these liquid level plots indicate more fluid than is present at the surrounding hotter fuel rods due to the effects of a strong radial temperature profile.		
MASS FLOW RATE	kg/s		The first 300 s of data are calculated from the equation		
Broken Loop Cold Leg		$\pm$ 15%	Mass flow rate = $C\ \overline{\rho}\ A\ V$ where: C = 1000 kg/Mg $\overline{\rho}$ = fluid density from DE-BL-001B A = flow area = 0.06342 m^2 V = fluid velocity from TTE-BL-1B	170	Qualified.

TABLE 8. (continued)

Variable Location Detectors	Units	Uncertainty	Calculation Method	Figure	Comments
MASS FLOW RATE (continued)					
			The remainder of the data is based on the BST level. The integrated level change was multiplied by the fluid density to yield an integrated mass increase in the tank. A 7th order curve fit to these data was found, and then differentiated to give a mass flow rate.		
FLUID SUBCOOLING	K				
Upper Plenum		± 5 K	The subcooling is defined as $T_{sat}-T$. The saturation temperature is calculated from the pressure reading of PE-1UP-001A1 using the following curve fits of steam table data: for $P < 1.4$ MPa, $T_{sat} = 348.225 + 290.13P - 399.543P^2 + 298.730P^3 - 84.1936P^4$ for $1.4 \text{ MPa} \leq P \leq 12$ MPa, $T_{sat} = 419.024 + 42.6705P - 5.63957P^2 + 0.433108P^3 - 0.0130329P^4$ for $P > 12$ MPa, $T_{sat} = 508.252 + 8.84806P - 0.114572P^2$. The measured temperature is from TE-5UP-001.	171	Qualified.

a. Reference 10.

b. The uncertainty in each conductivity probe for (a) LE-1ST-1 and LE-2ST-1 is ± 4.5% of range, (b) LE-1ST-2 and LE-2ST-2 is ± 7.1% of range, and (c) LE-1F10, LE-3F10, LE-5E11 and LE-3UP-1 is ± 2.9% of range. All conductivity probes have a response time of 340 ms.

SHORT-TERM PLOTS
(-10 to 200 seconds)

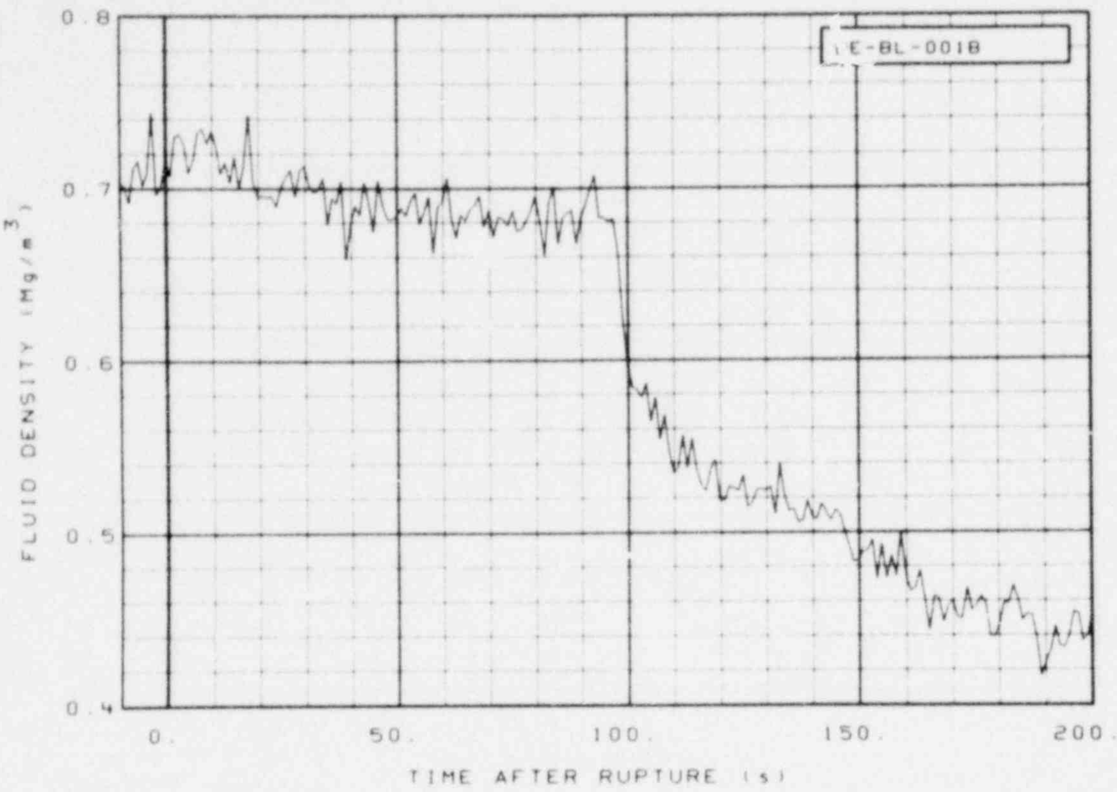


Figure 22. Fluid density in broken loop cold leg, chordal density (DE-BL-001B) (Qualified, second calibration point determined from intact loop liquid level during first 600 s).

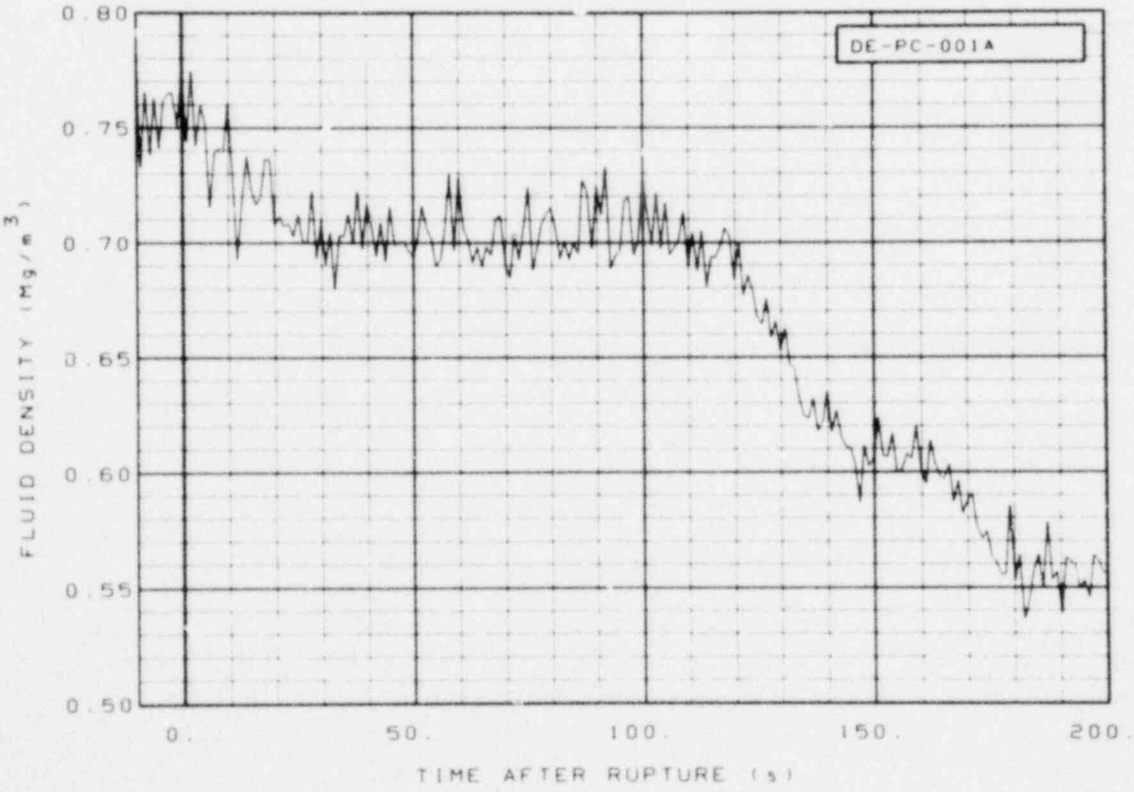


Figure 23. Fluid density in intact loop cold leg, chordal density (DE-PC-001A) (Qualified, second calibration point determined from intact loop liquid level during first 600 s).

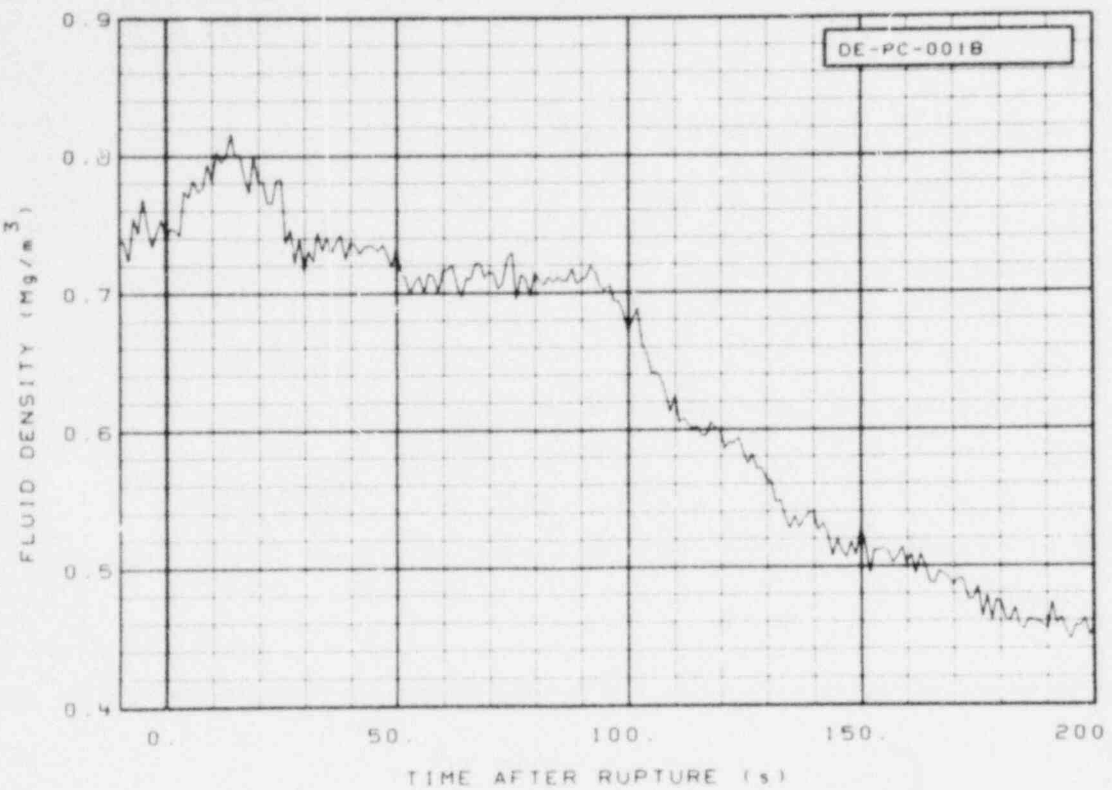


Figure 24. Fluid density in intact loop cold leg, chordal density (DE-PC-001B) (Qualified).

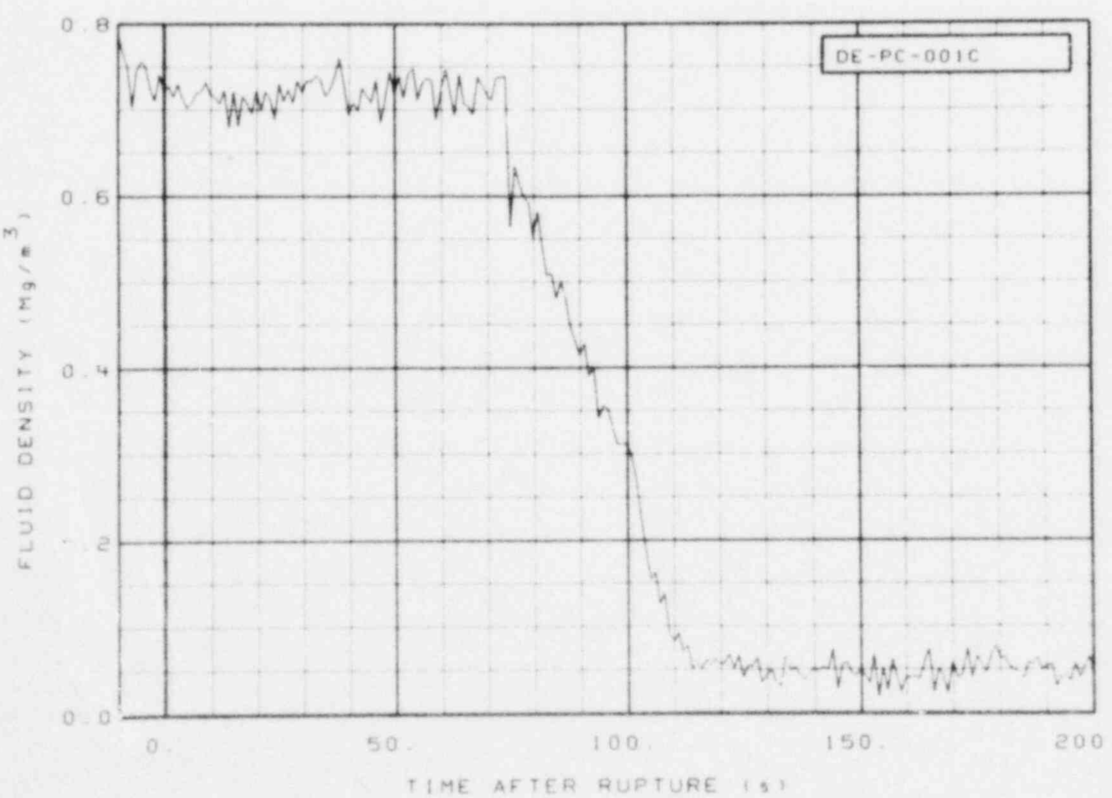


Figure 25. Fluid density in intact loop cold leg, chordal density (DE-PC-001C) (Qualified).

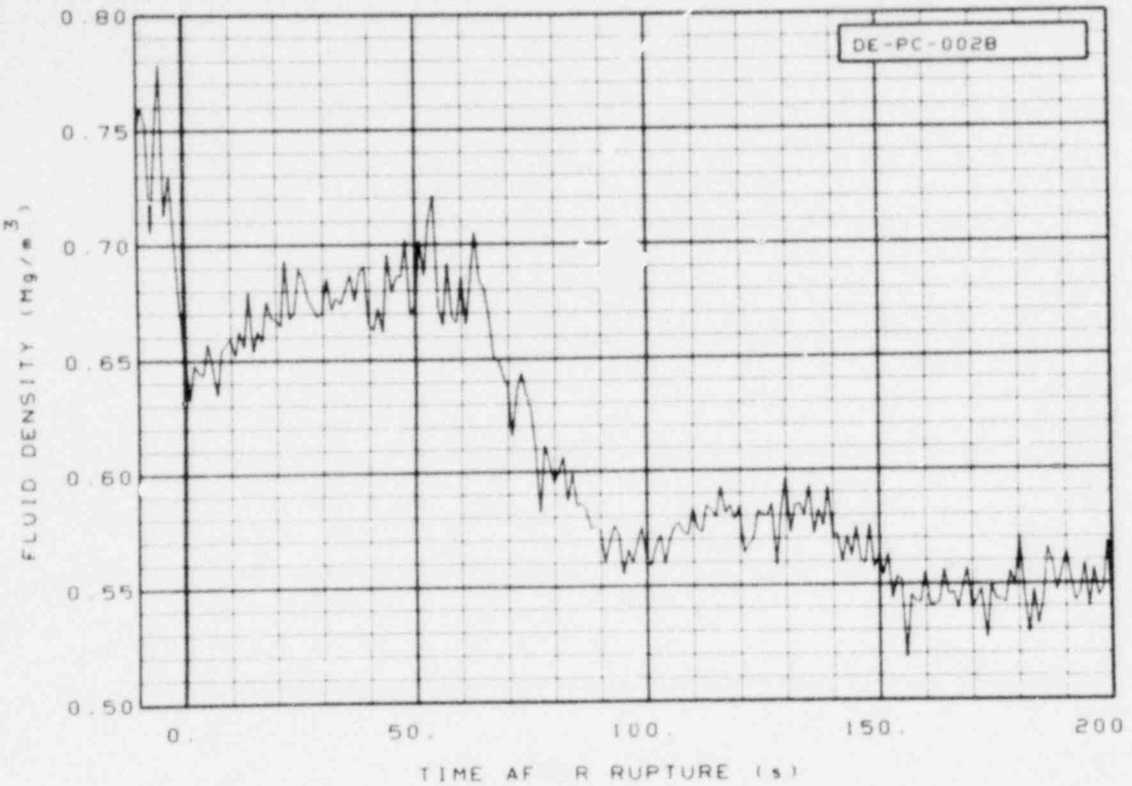


Figure 26. Fluid density in intact loop hot leg, chordal density (DE-PC-002B) (Qualified).

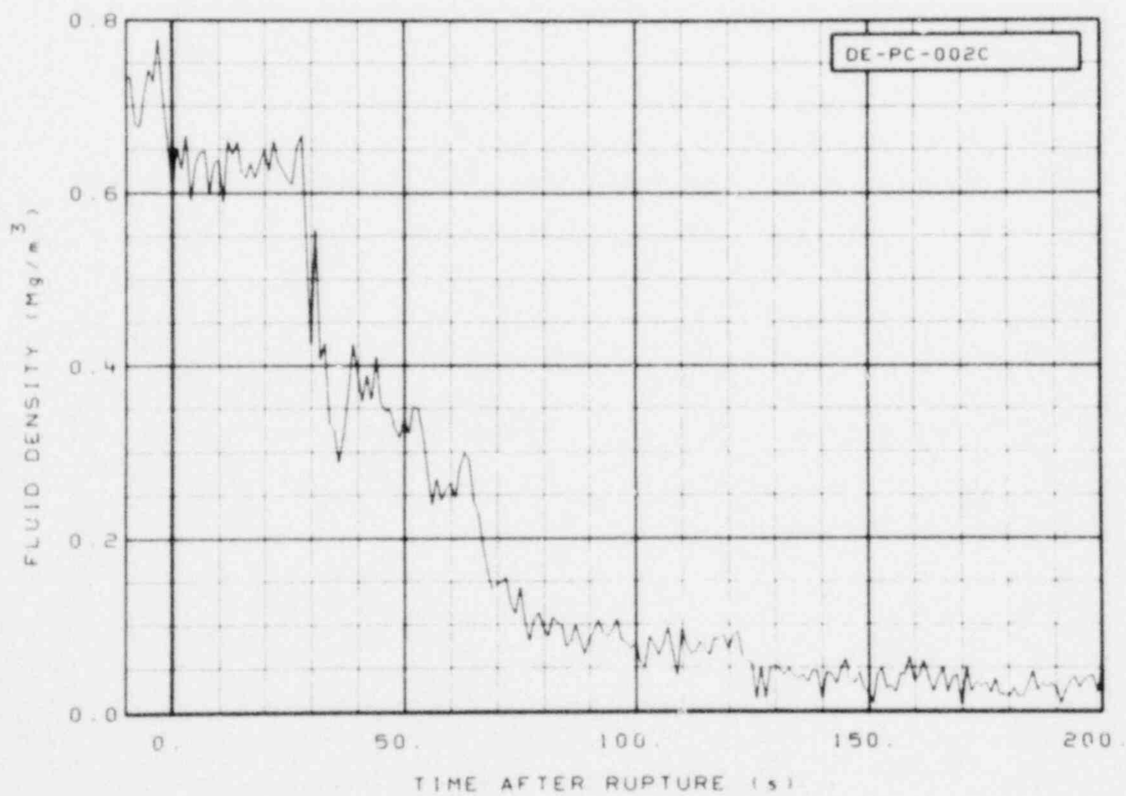


Figure 27. Fluid density in intact loop hot leg, chordal density (DE-PC-002C) (Qualified, anomalous output from 2600 to 3000 s).

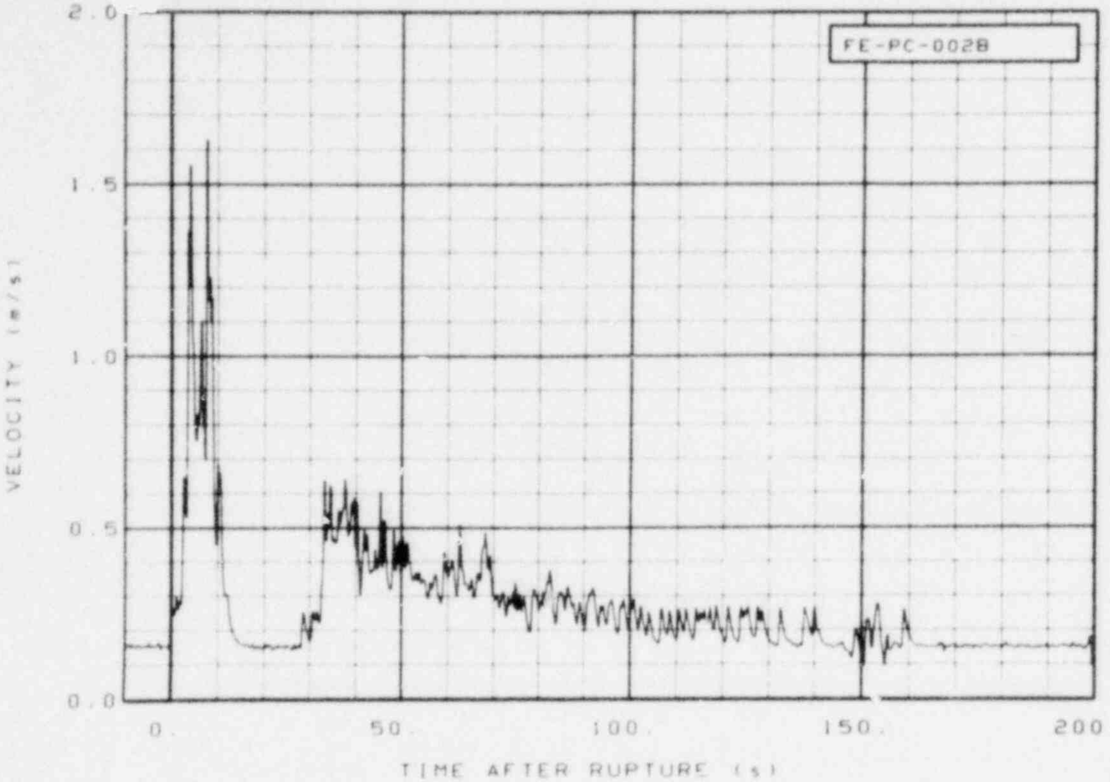


Figure 28. Fluid velocity in intact loop hot leg in middle of pipe (FE-PC-002B) (Qualified, magnitude uncertain due to turbine mechanical problems, not good prior to 10 s).

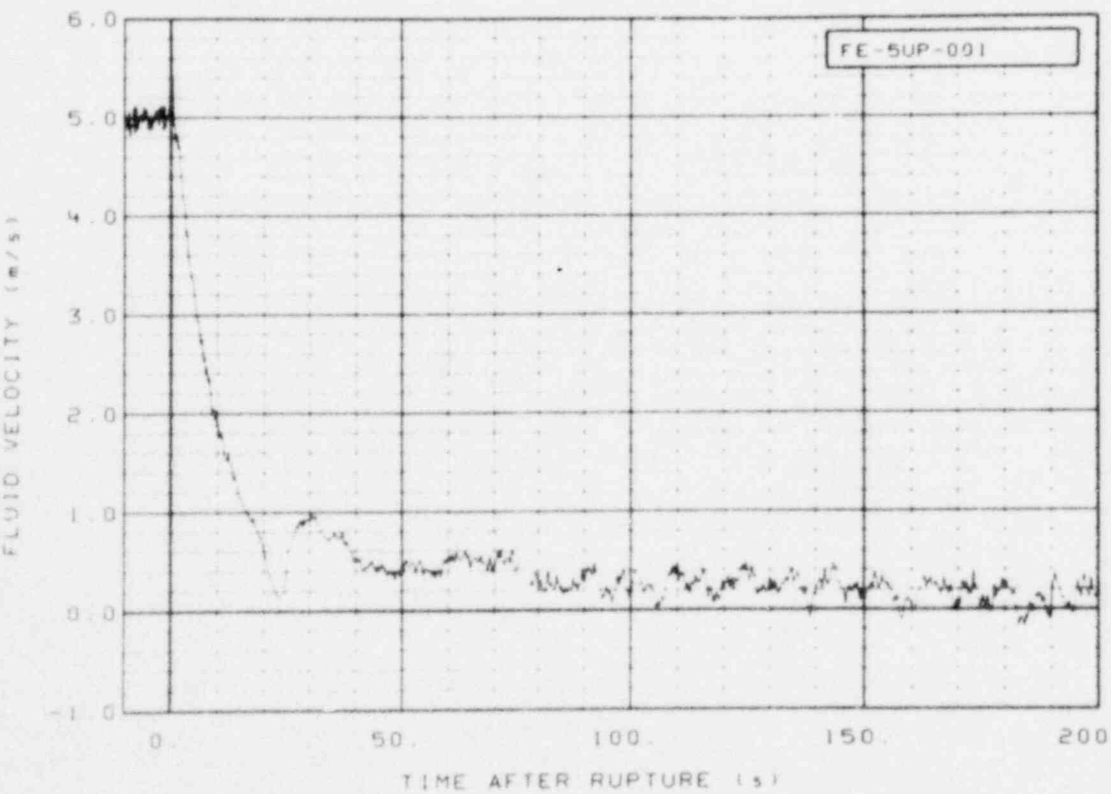


Figure 29. Fluid velocity above upper end box of Fuel Assembly 5 (FE-5UP-001) (Qualified).

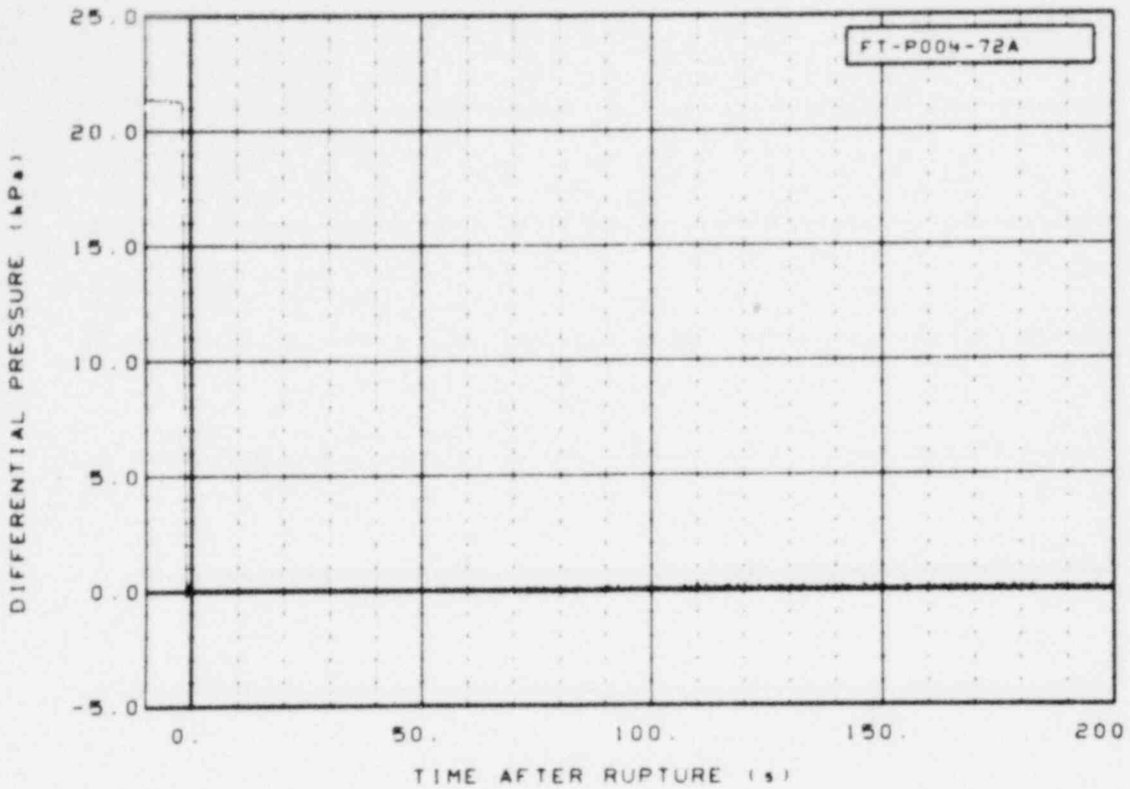


Figure 30. Differential pressure in secondary coolant system feedwater line (FT-P004-072A) (Qualified).

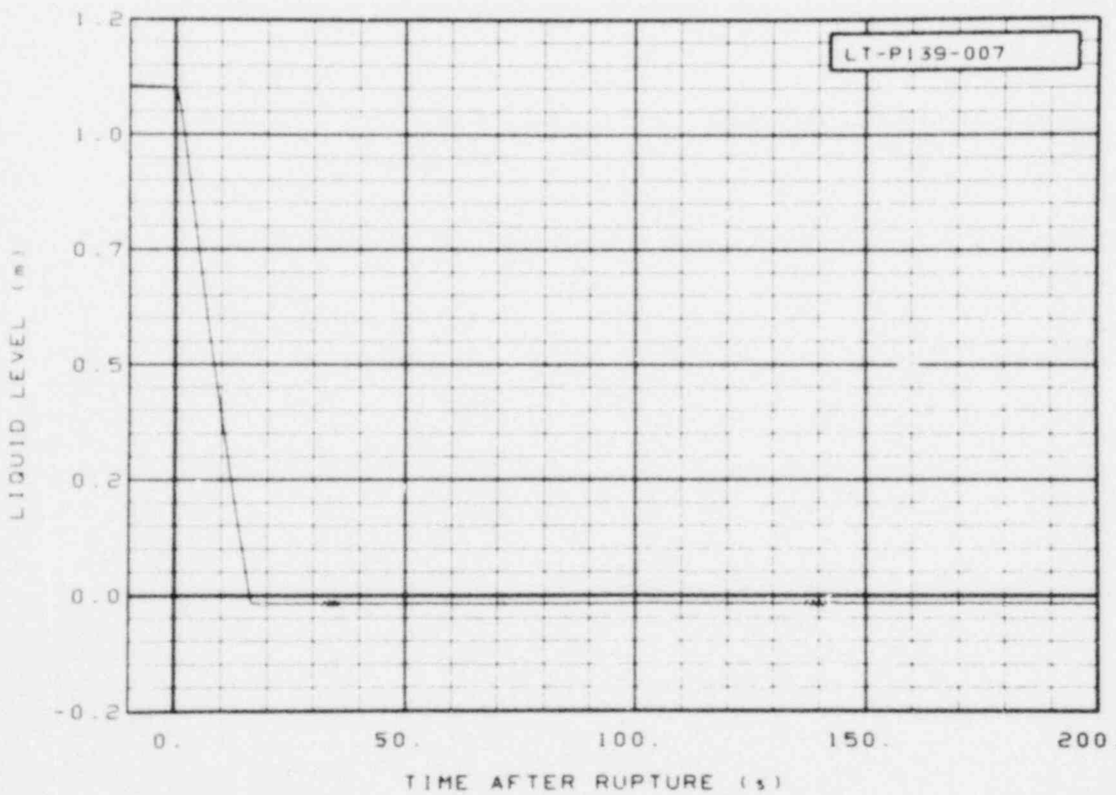


Figure 31. Liquid level in pressurizer (LT-P139-007) (Qualified).

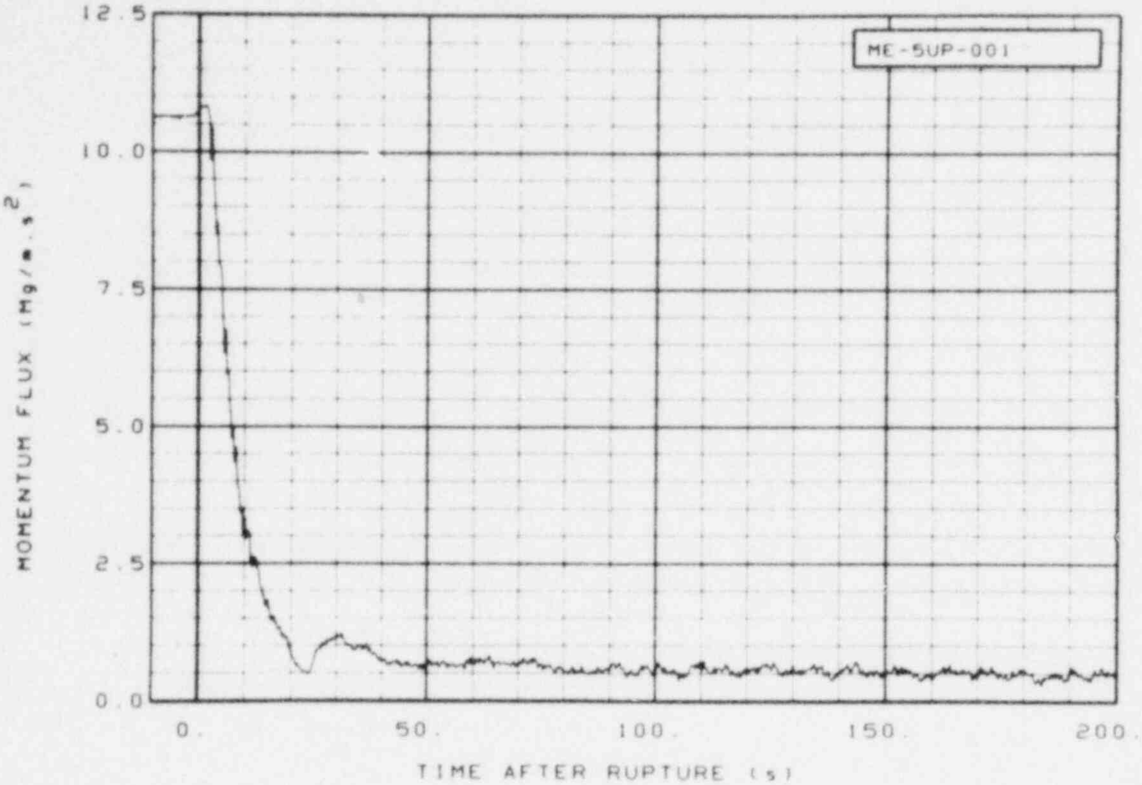


Figure 32. Momentum ›. above upper end box of Fuel Assembly 5 (ME-5UP-001) (Qualified).

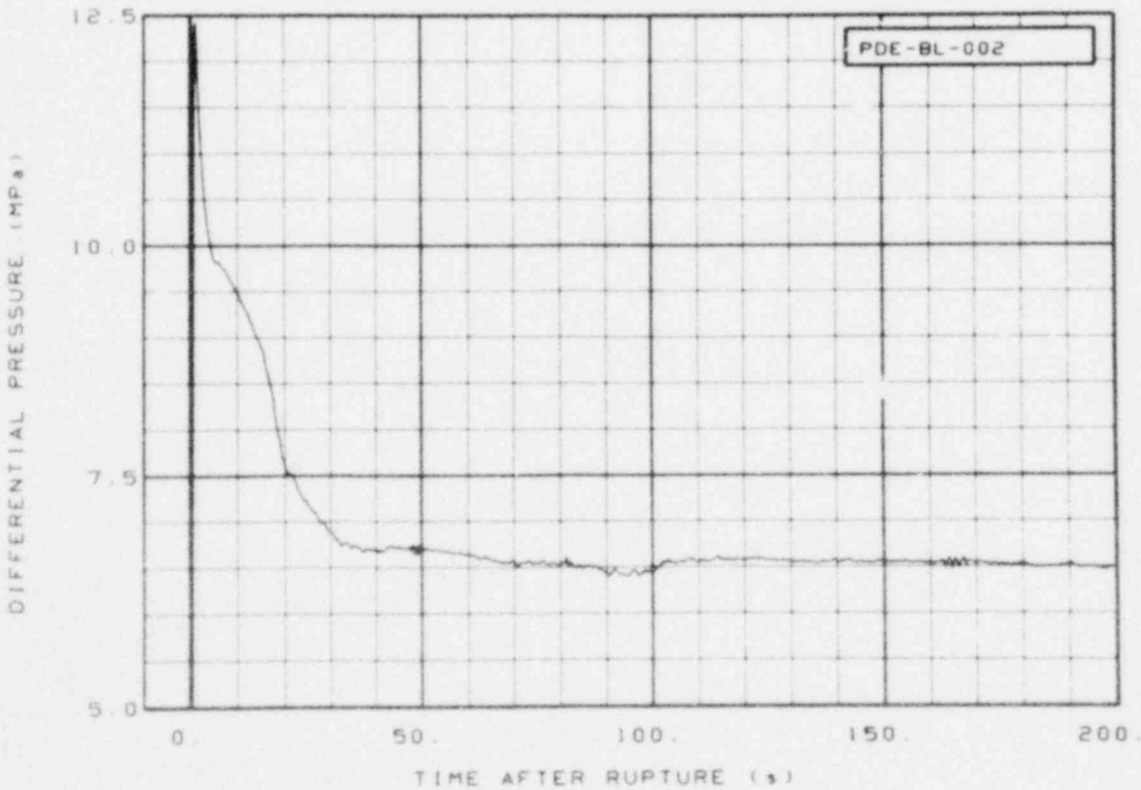


Figure 33. Differential pressure in broken loop cold leg across small break orifice (PDE-BL-002) (Qualified, IC = 0.0 kPa).

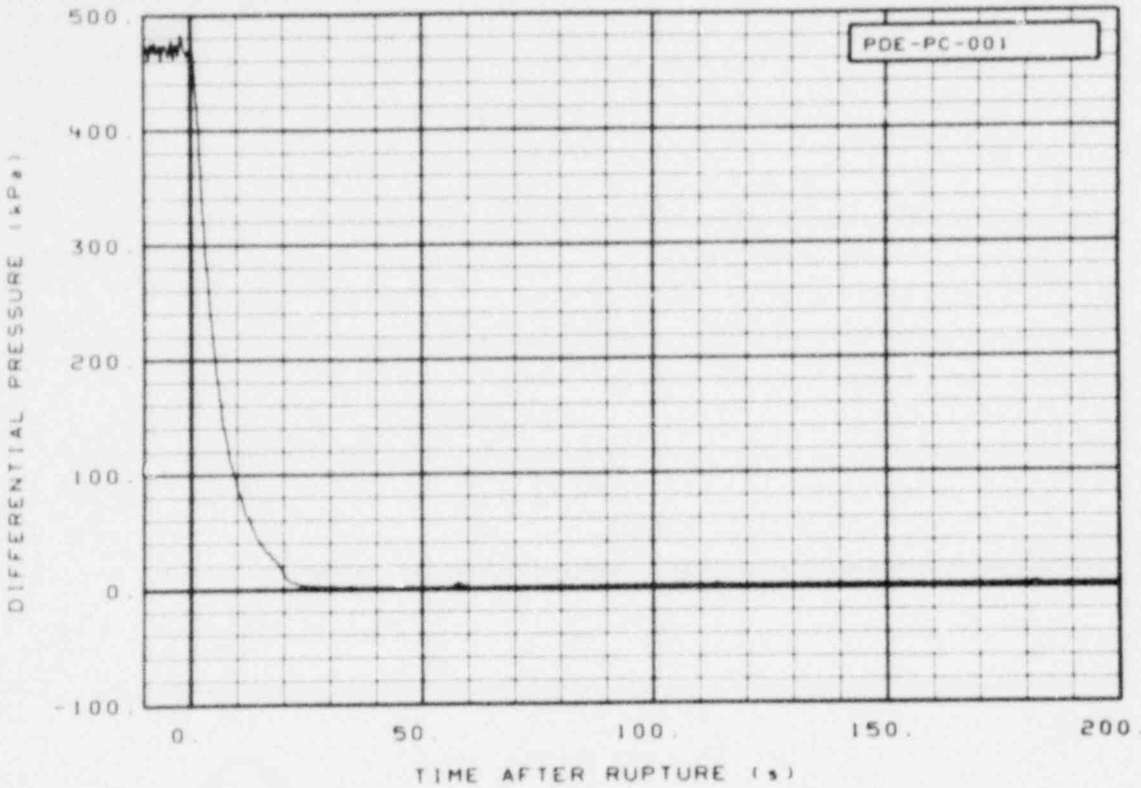


Figure 34. Differential pressure in intact loop cold leg across primary coolant Pumps 1 and 2 (PDE-PC-001) (Qualified).

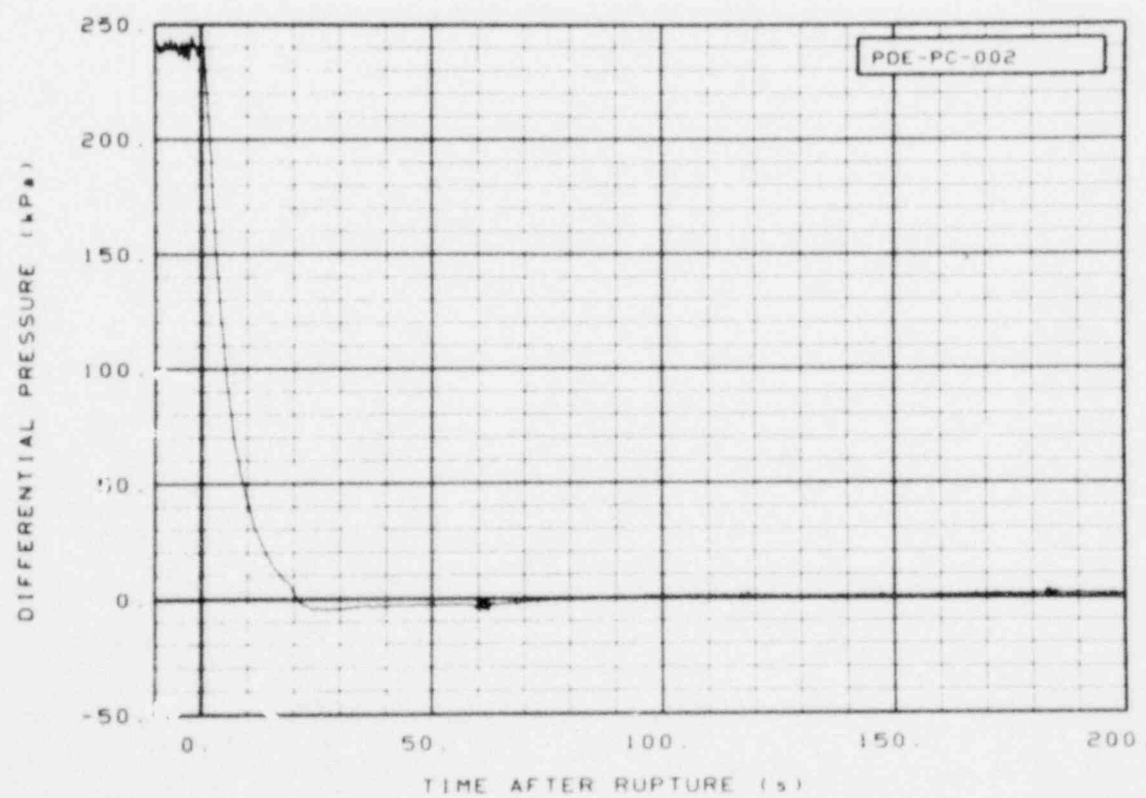


Figure 35. Differential pressure in intact loop across the steam generator (PDE-PC-002) (Qualified).

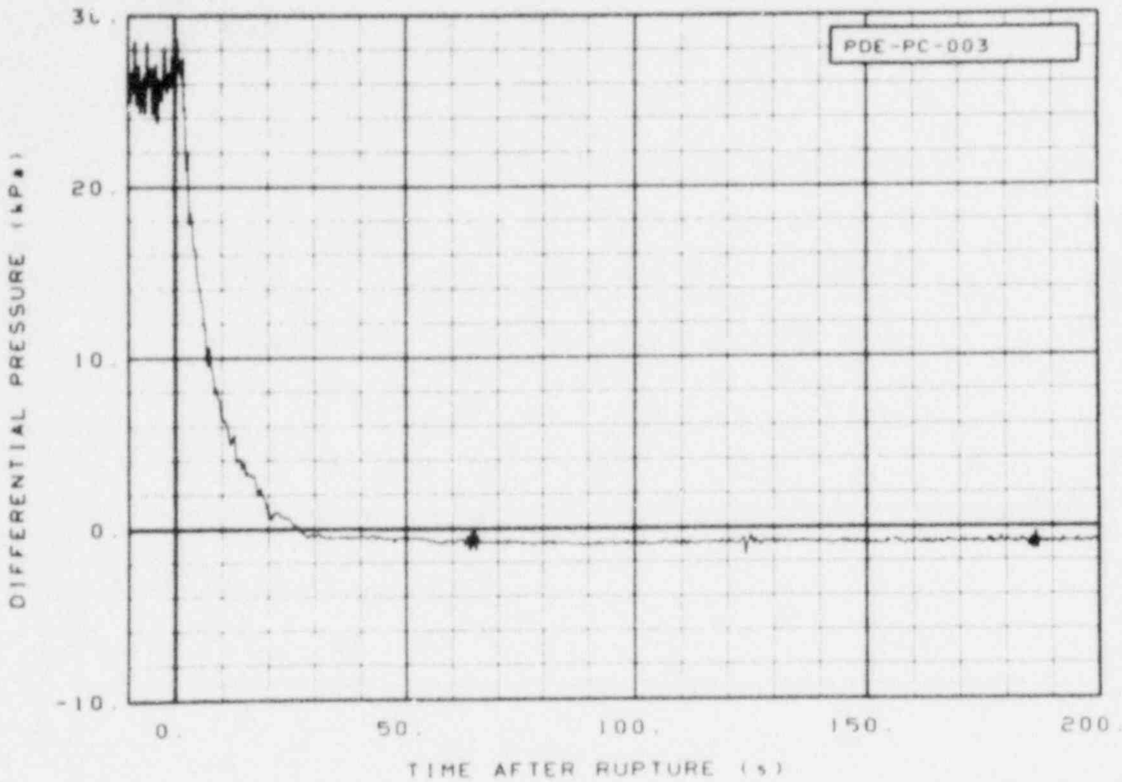


Figure 36. Differential pressure in intact loop hot leg from reactor vessel outlet to steam generator inlet (PDE-PC-003) (Qualified).

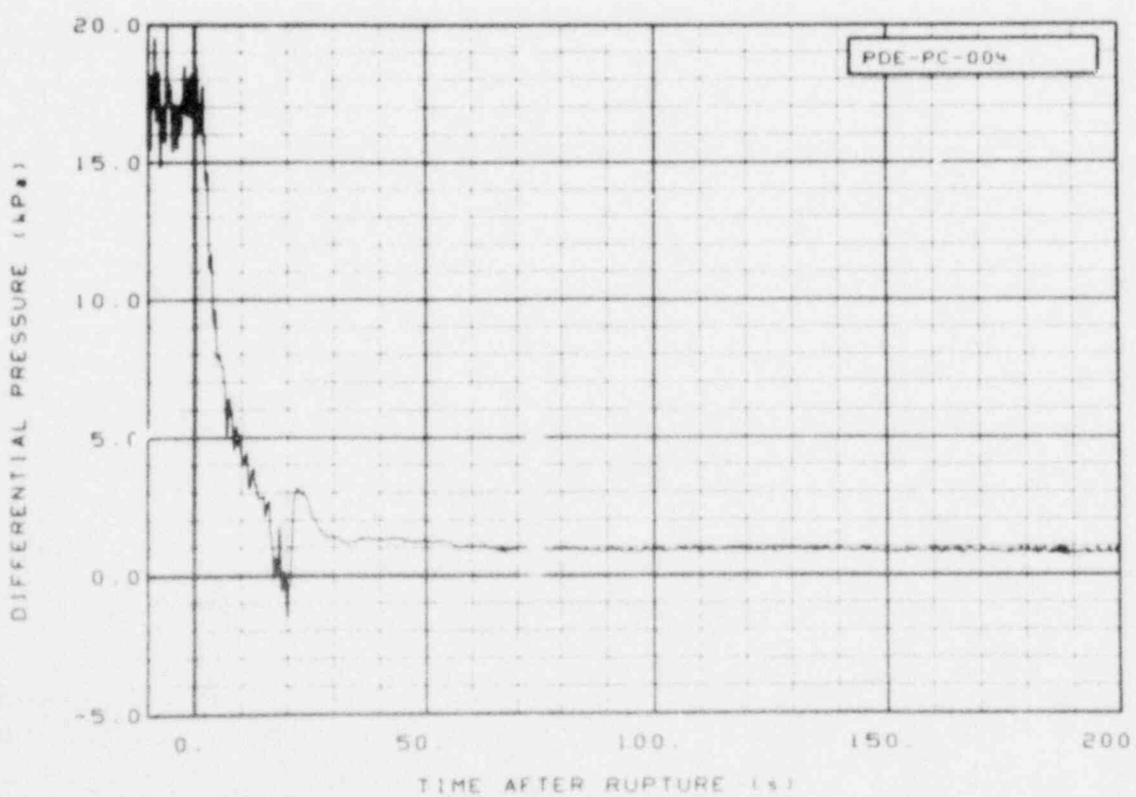


Figure 37. Differential pressure in intact loop hot leg from pressurizer surge line junction to steam generator inlet (PDE-PC-004) (Qualified).

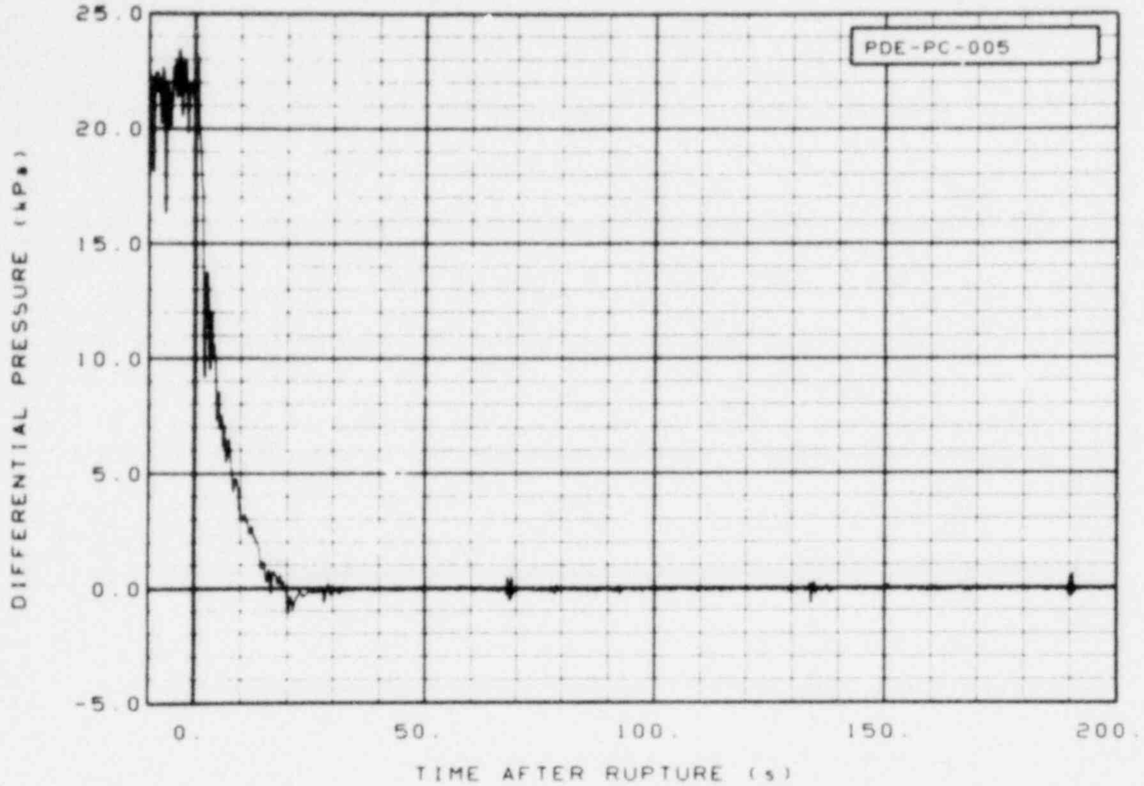


Figure 38. Differential pressure in intact loop cold leg from primary coolant pump discharge to reactor vessel inlet (PDE-PC-005) (Qualified).

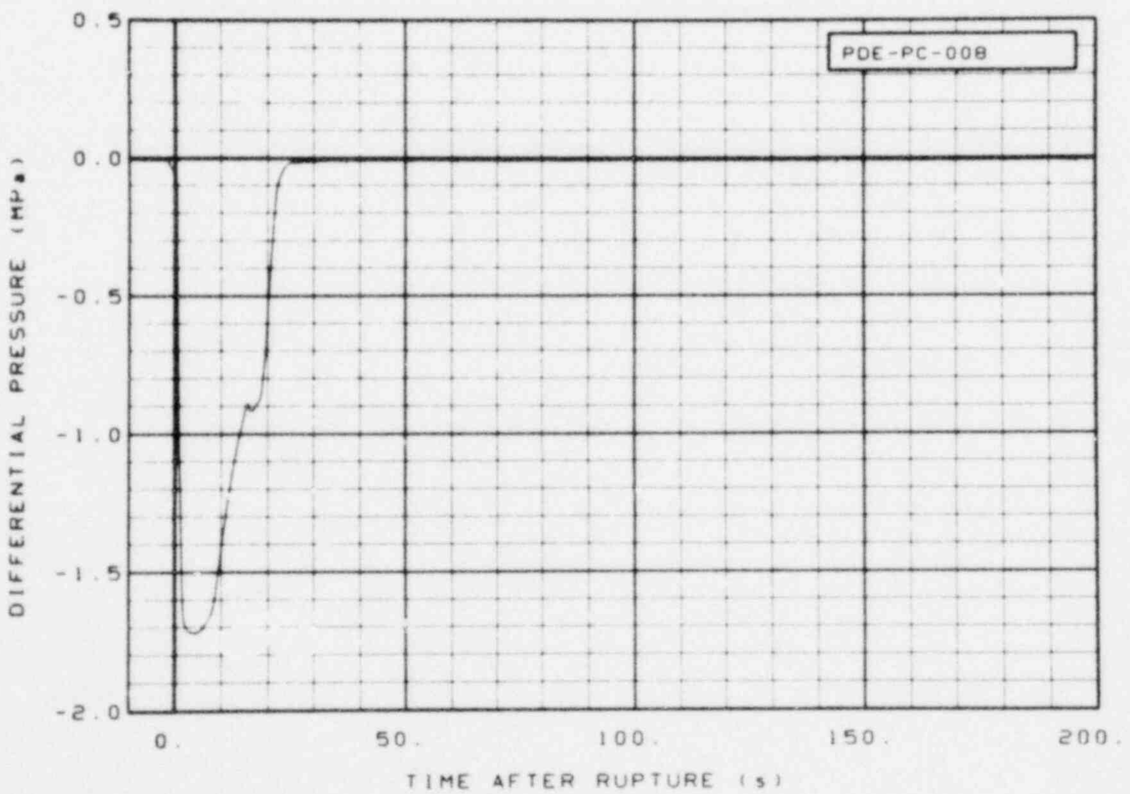


Figure 39. Differential pressure in intact loop across pressurizer surge line (PDE-PC-008) (Qualified, flow into pressurizer reads positive).

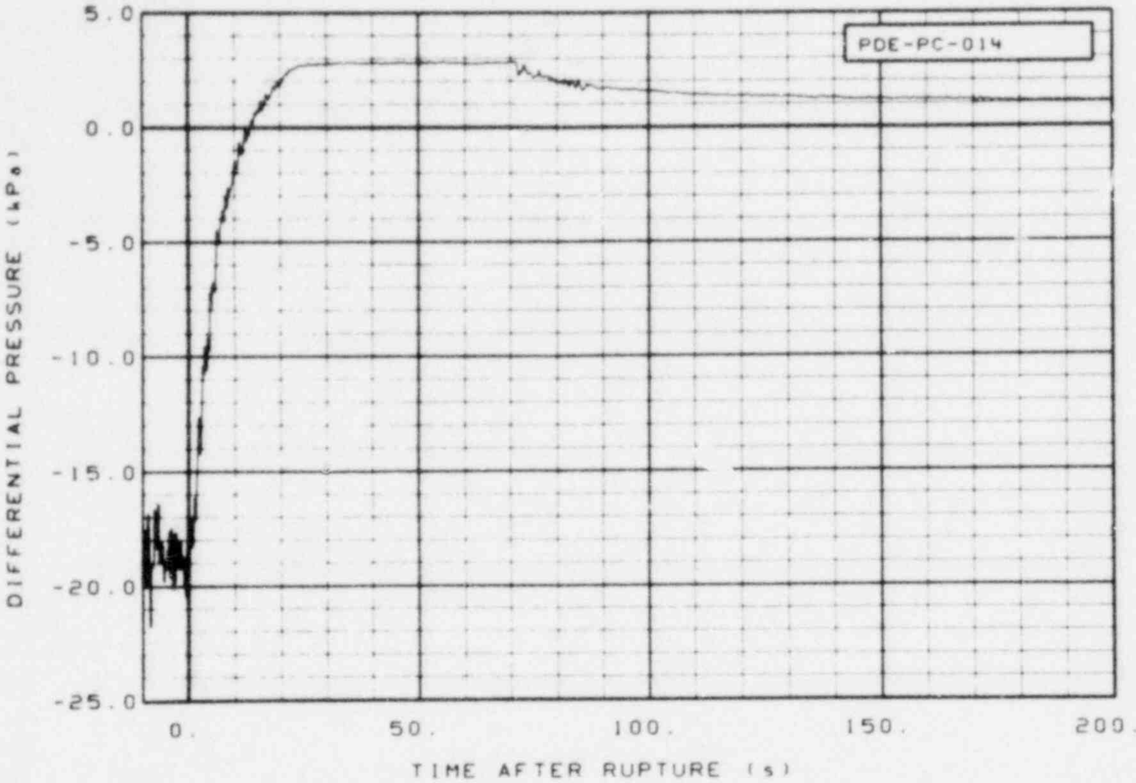


Figure 40. Differential pressure in intact loop cold leg across ECC Rake 1 bottom pitot tube facing reactor vessel (PDE-PC-014) (Qualified).

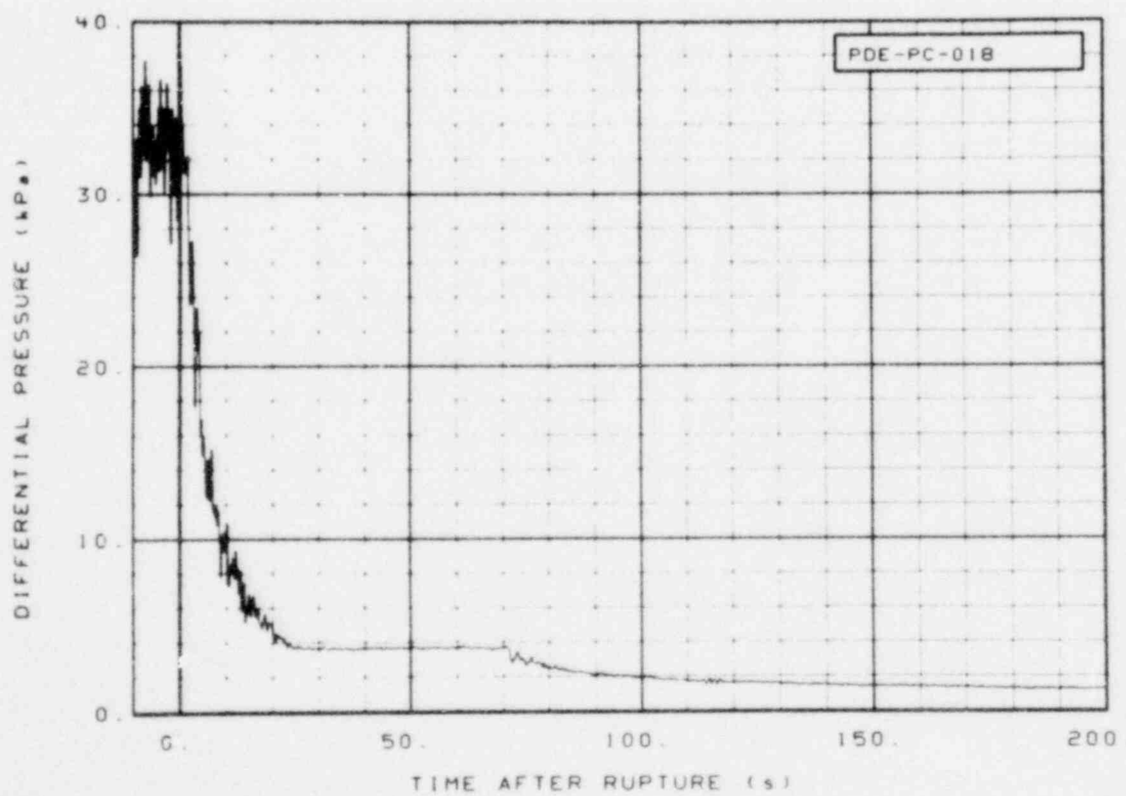


Figure 41. Differential pressure in intact loop cold leg across ECC Rake 1 bottom pitot tube facing pumps (PDE-PC-018) (Qualified).

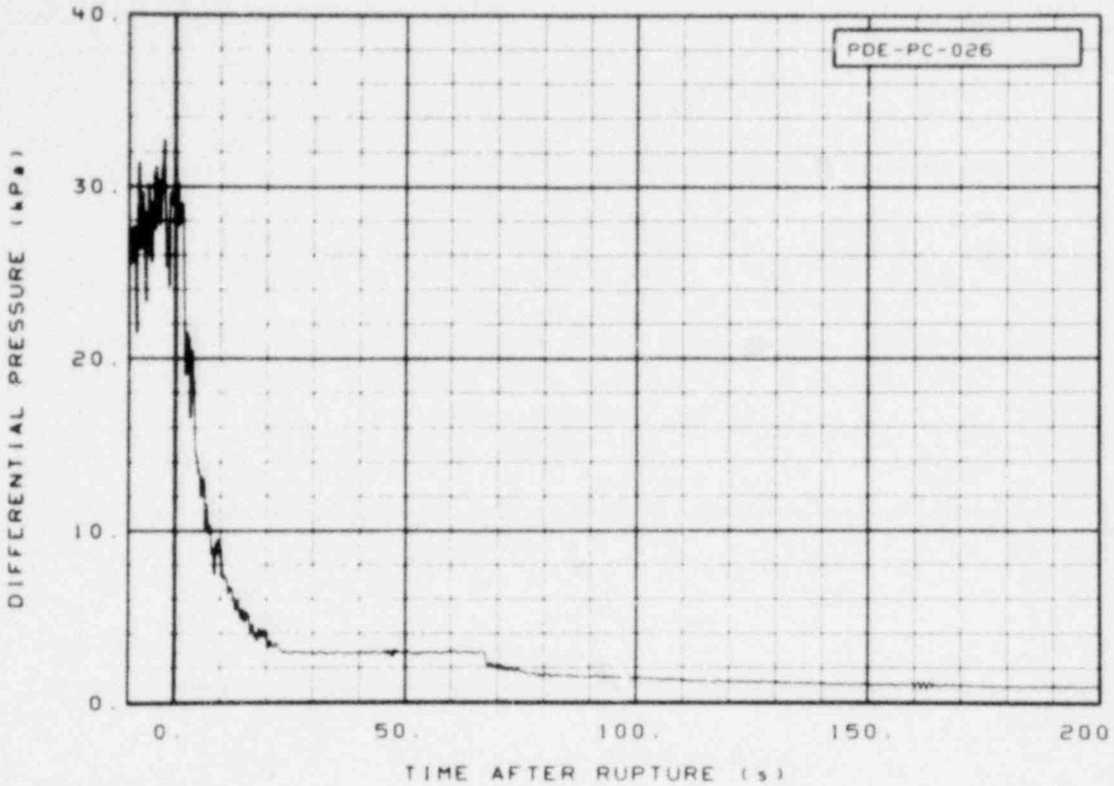


Figure 42. Differential pressure in intact loop cold leg across ECC Rake 2 bottom pitot tube facing pumps (PDE-PC-026) (Qualified).

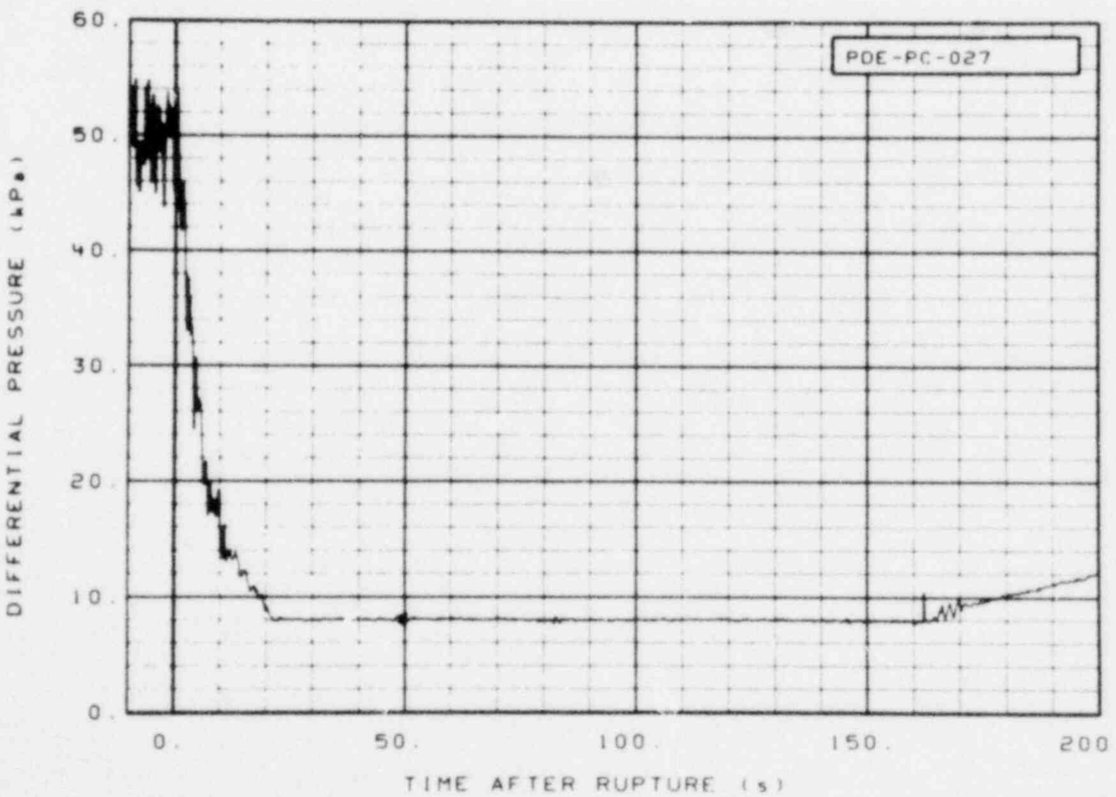


Figure 43. Differential pressure in intact loop from steam generator outlet to bottom of loop seal (PDE-PC-027) (Qualified, minimum forced to 7.23 kPa, voiding of the pipe increases the differential pressure).

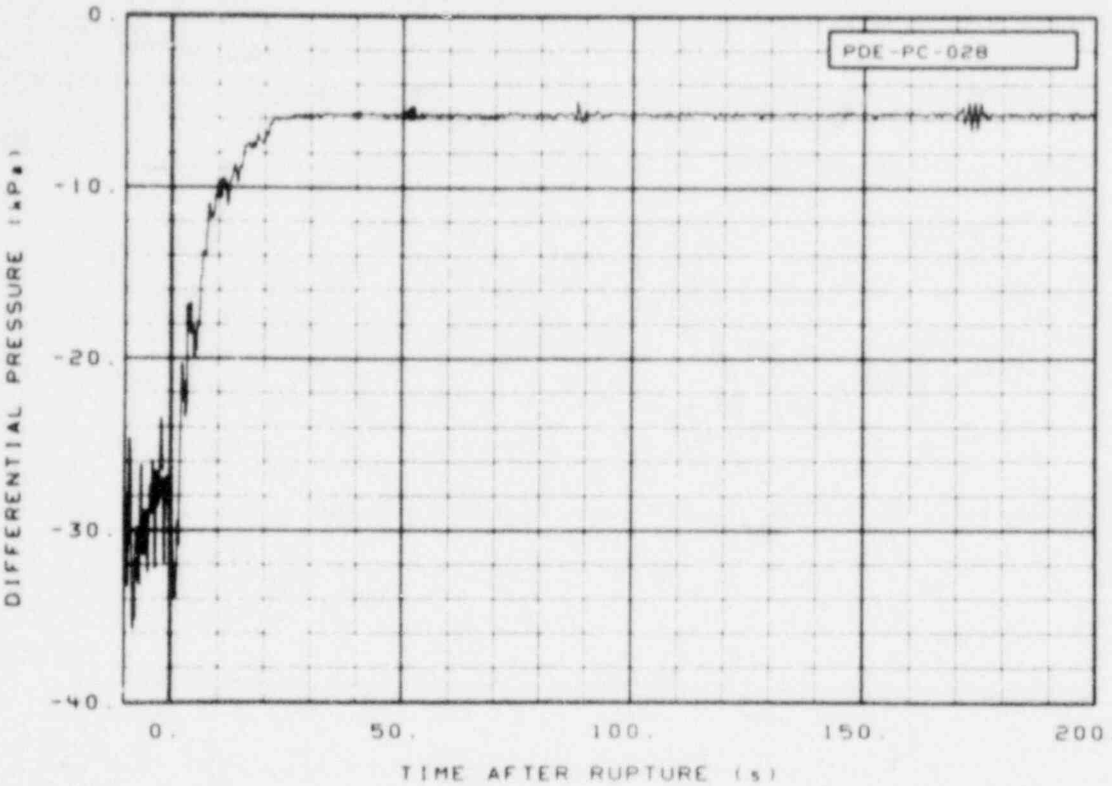


Figure 44. Differential pressure in intact loop from bottom of loop seal to primary coolant Pump 2 inlet (PDE-PC-028) [Qual forced to -5.6 kPa at zero flow (about 60 s), voiding of the pipe increases the differential pressure].

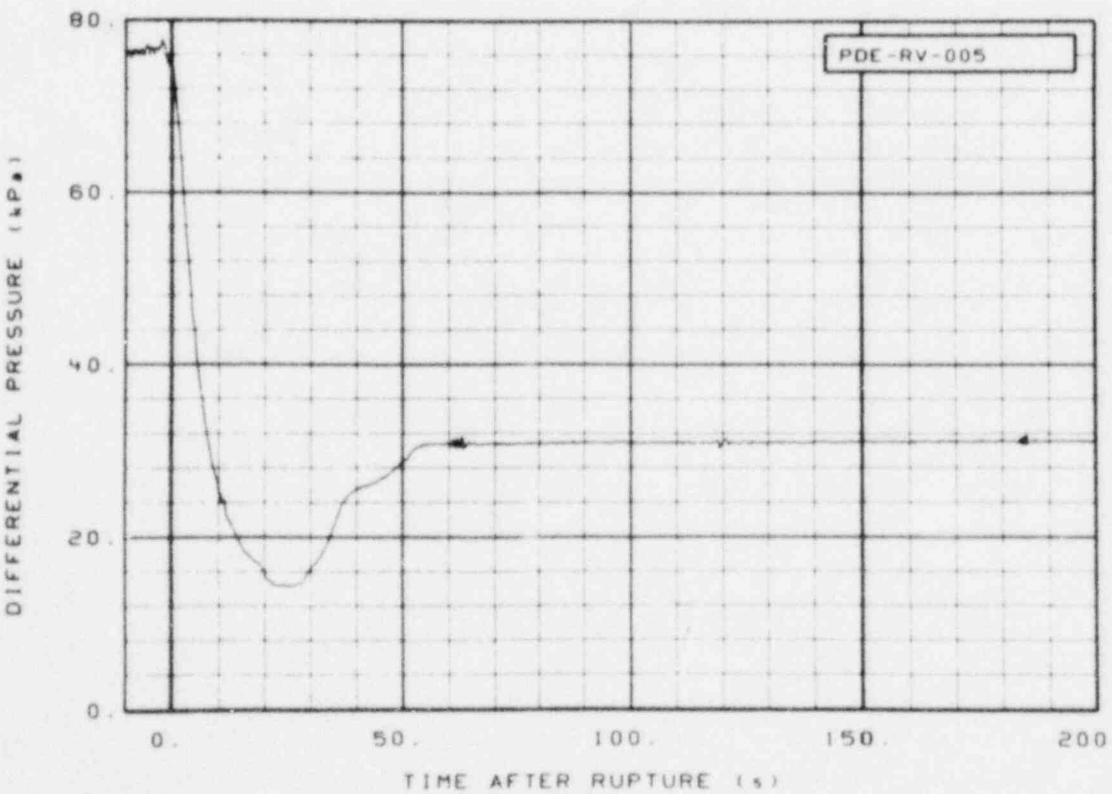


Figure 45. Differential pressure in reactor vessel from vessel top to intact loop hot leg outlet (PDE-RV-005) (Qualified, minimum forced to 14.5 kPa, use caution when converting to level).

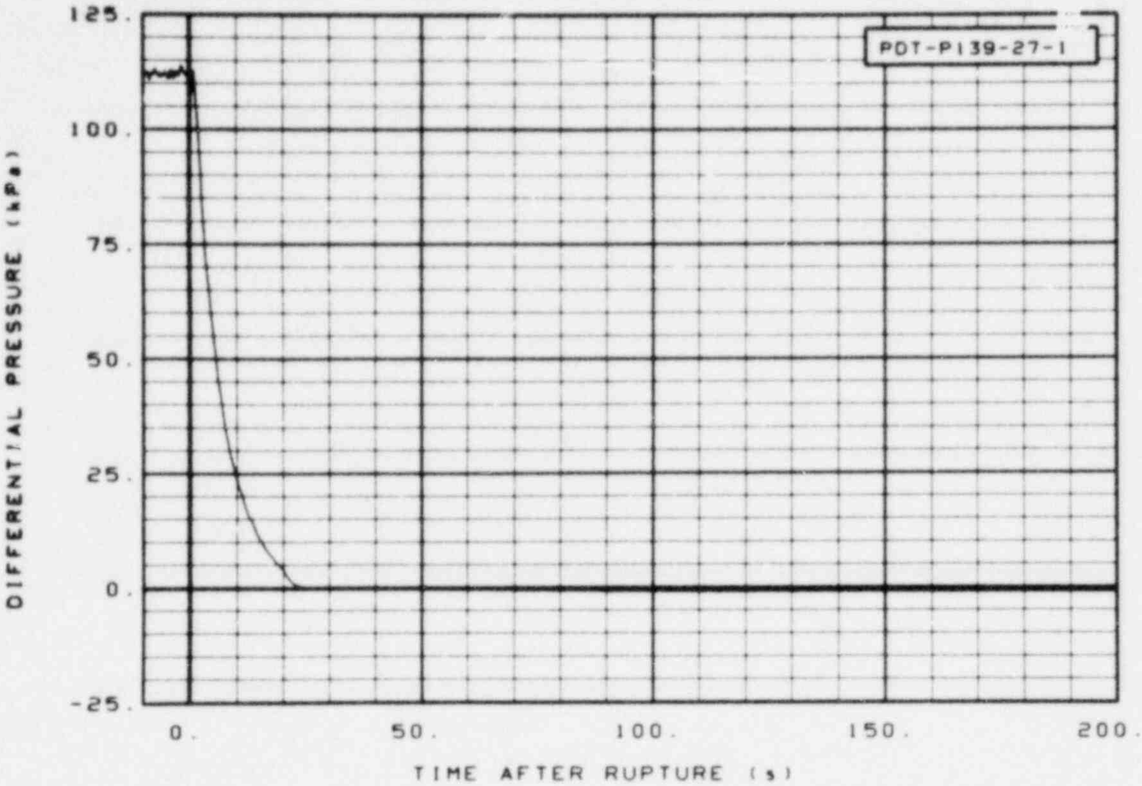


Figure 46. Differential pressure for primary coolant flow Channel A (PDT-P139-27-1) (Qualified).

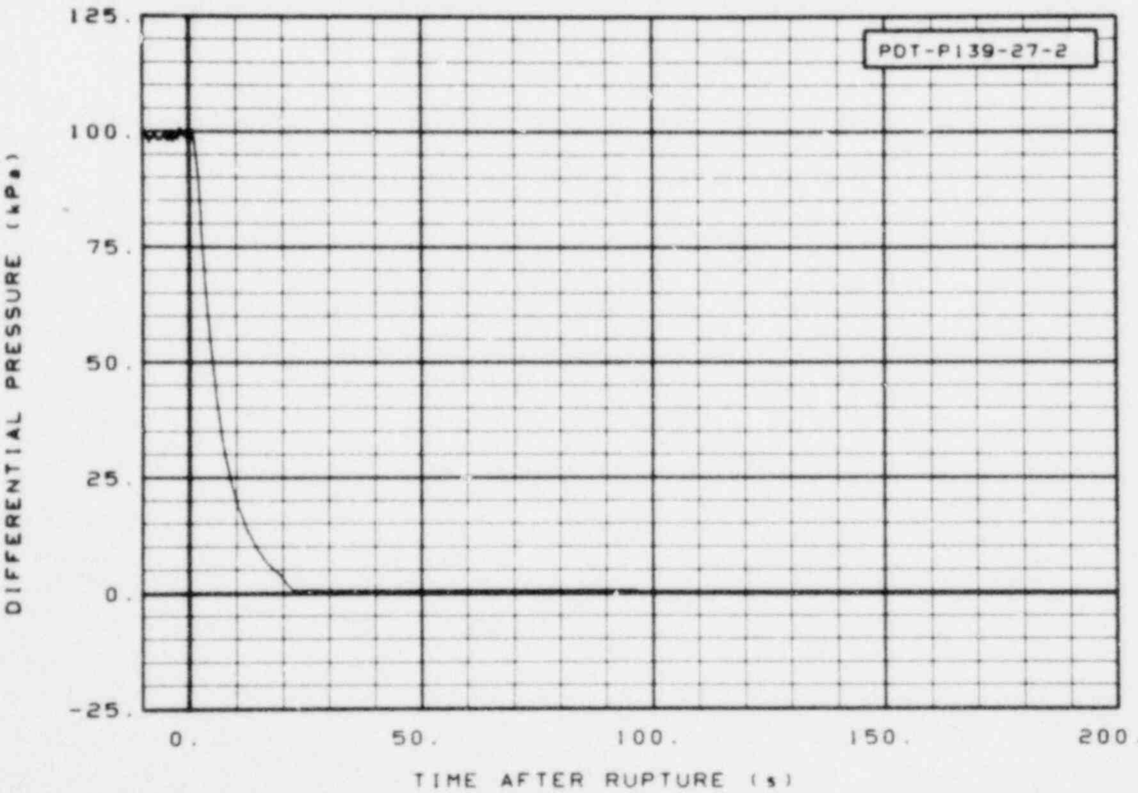


Figure 47. Differential pressure for primary coolant flow Channel B (PDT-P139-27-2) (Qualified).

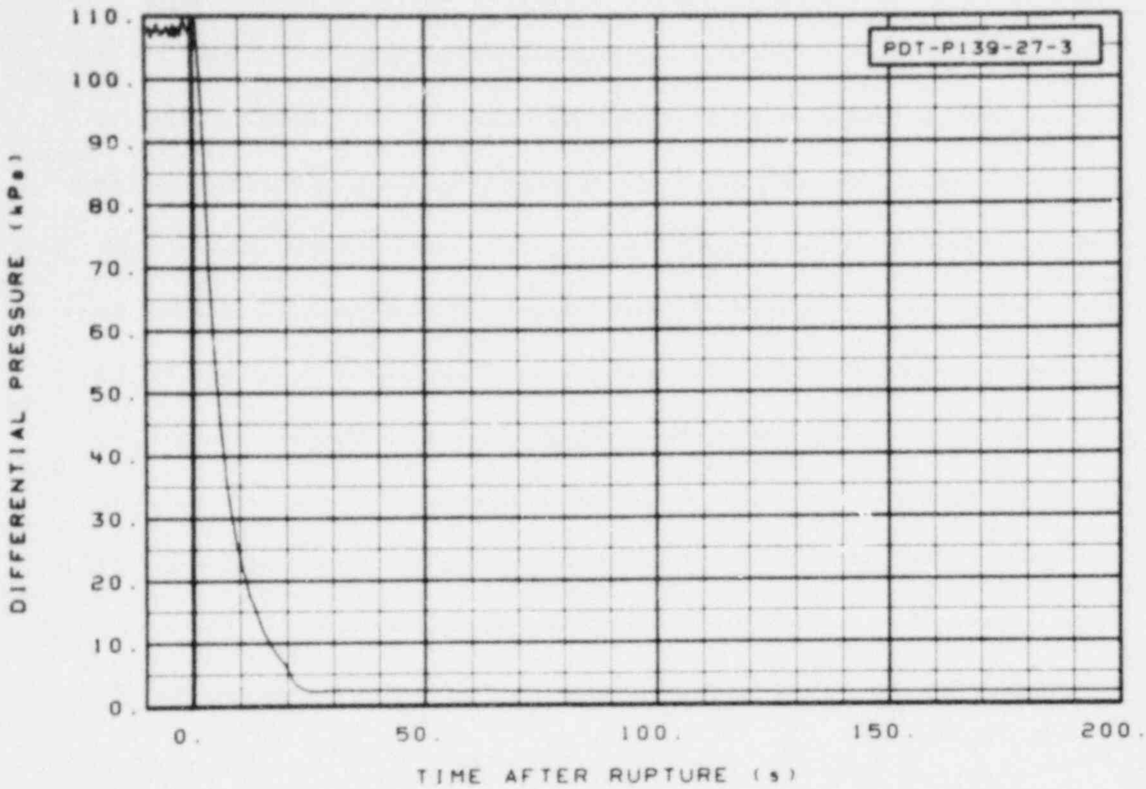


Figure 48. Differential pressure for primary coolant flow Channel C (PDT-P139-27-3) (Qualified).

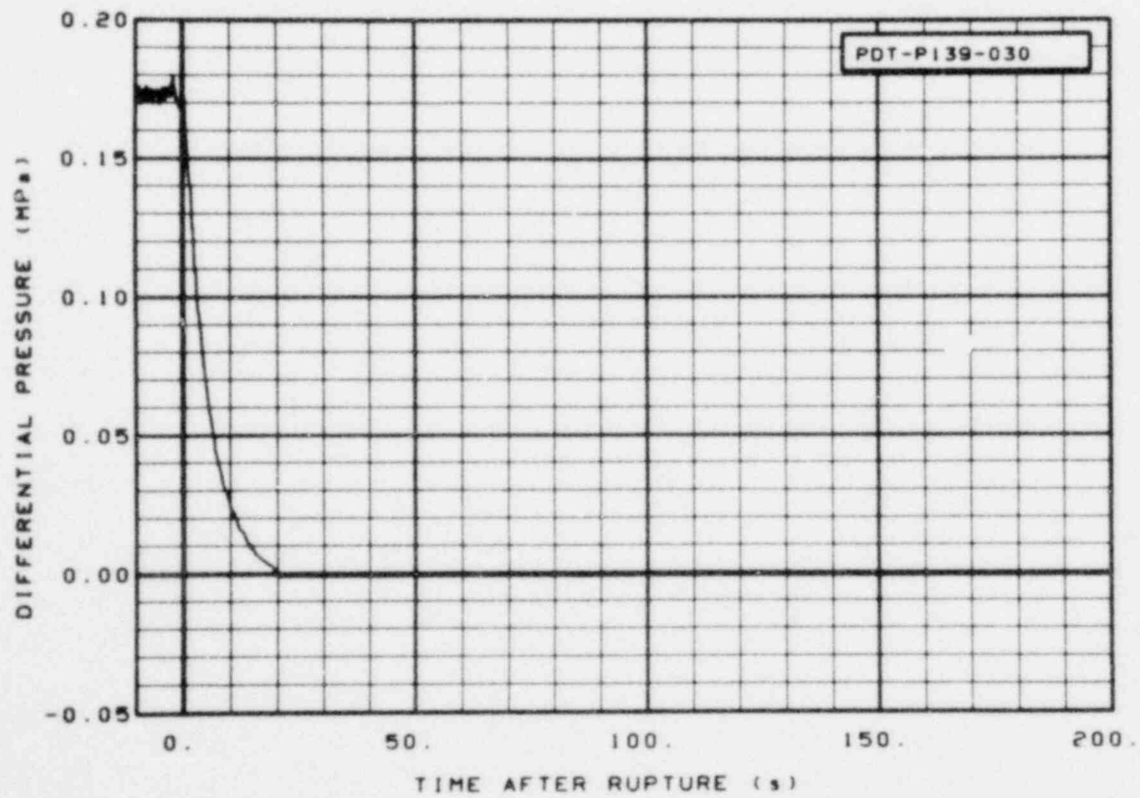


Figure 49. Differential pressure in intact loop across reactor vessel (PDT-P139-030) (Qualified).

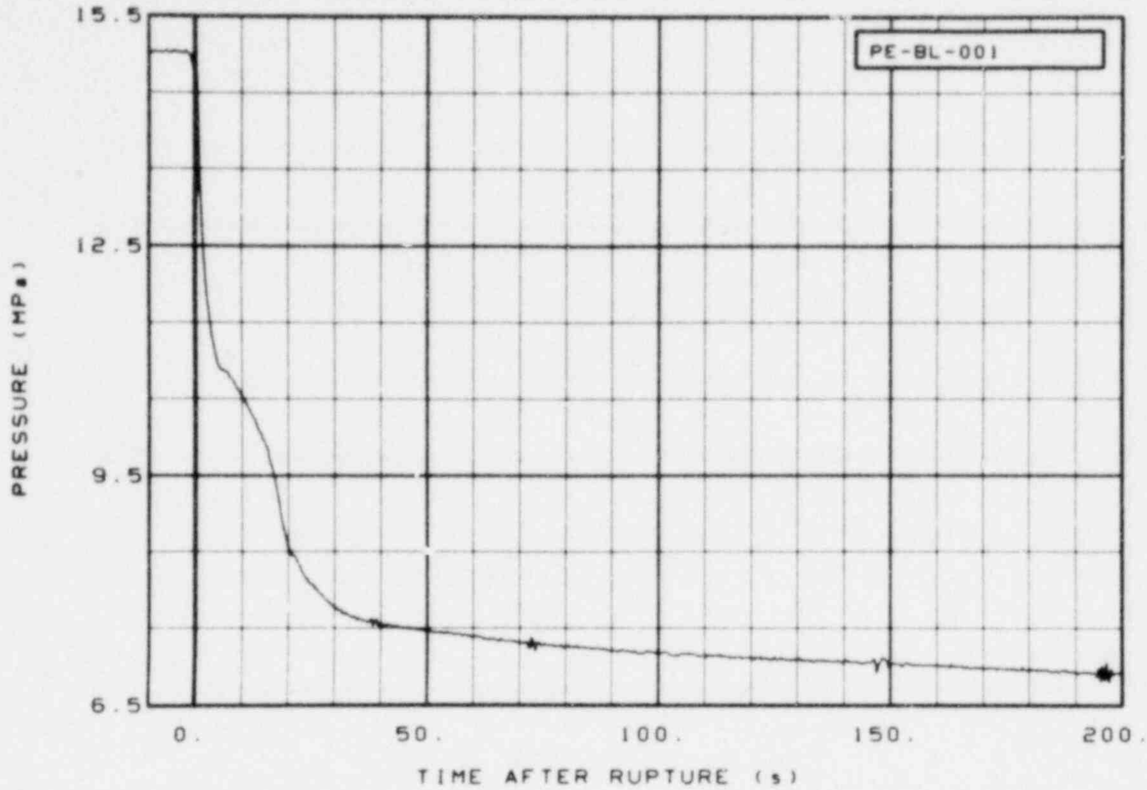


Figure 50. Pressure in broken loop cold leg (PE-BL-001) (Qualified).

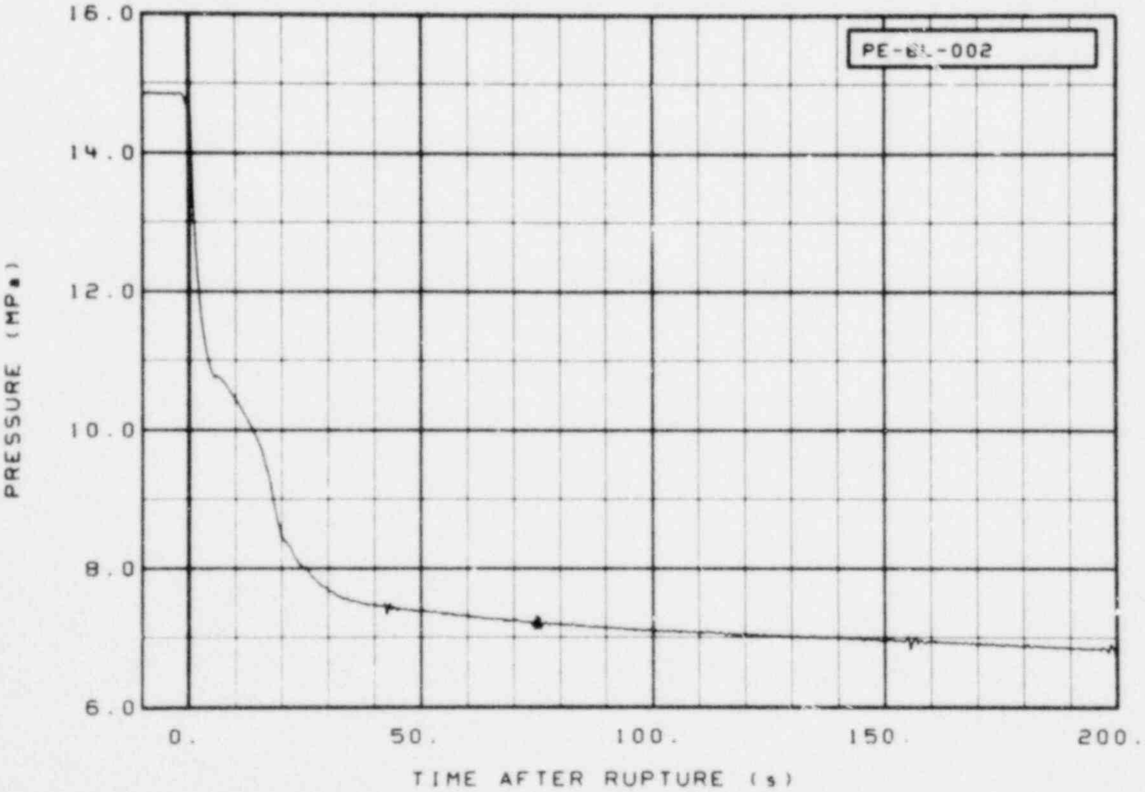


Figure 51. Pressure in broken loop hot leg (PE-BL-002) (Qualified).

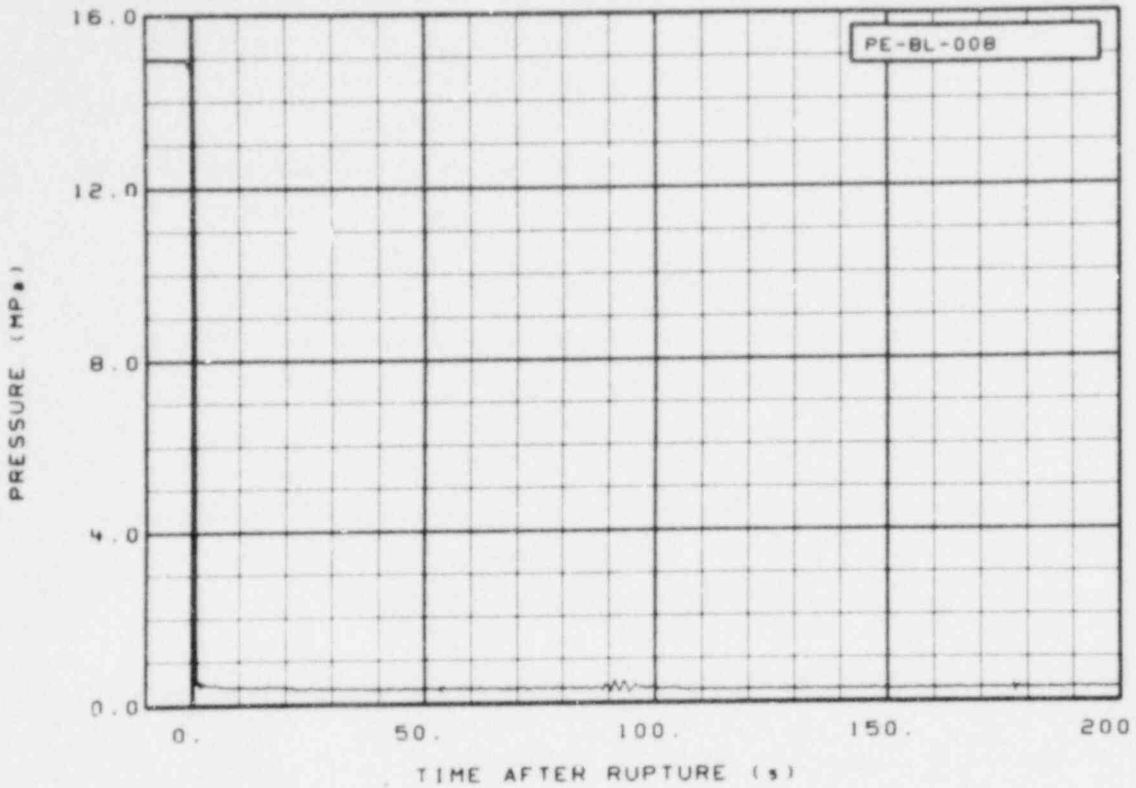


Figure 52. Pressure in broken loop cold leg 8-inch pipe (PE-BL-008) (Qualified).

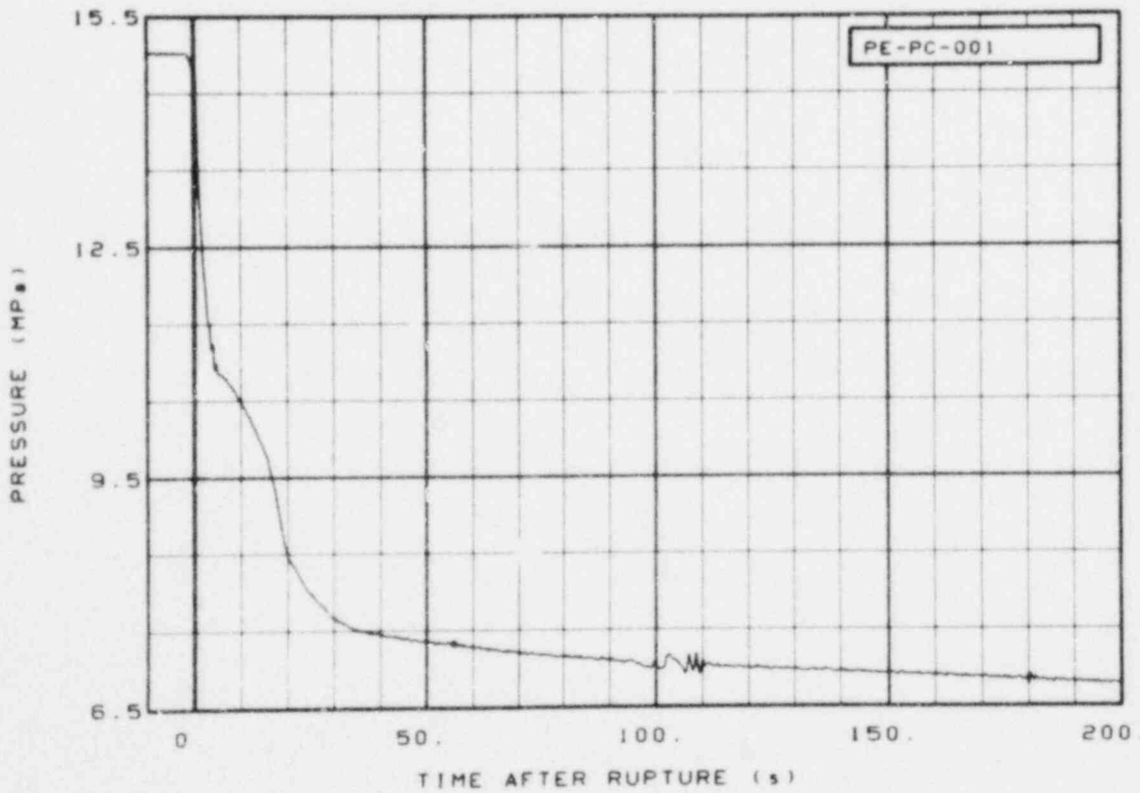


Figure 53. Pressure in intact loop cold leg (PE-PC-001) (Qualified).

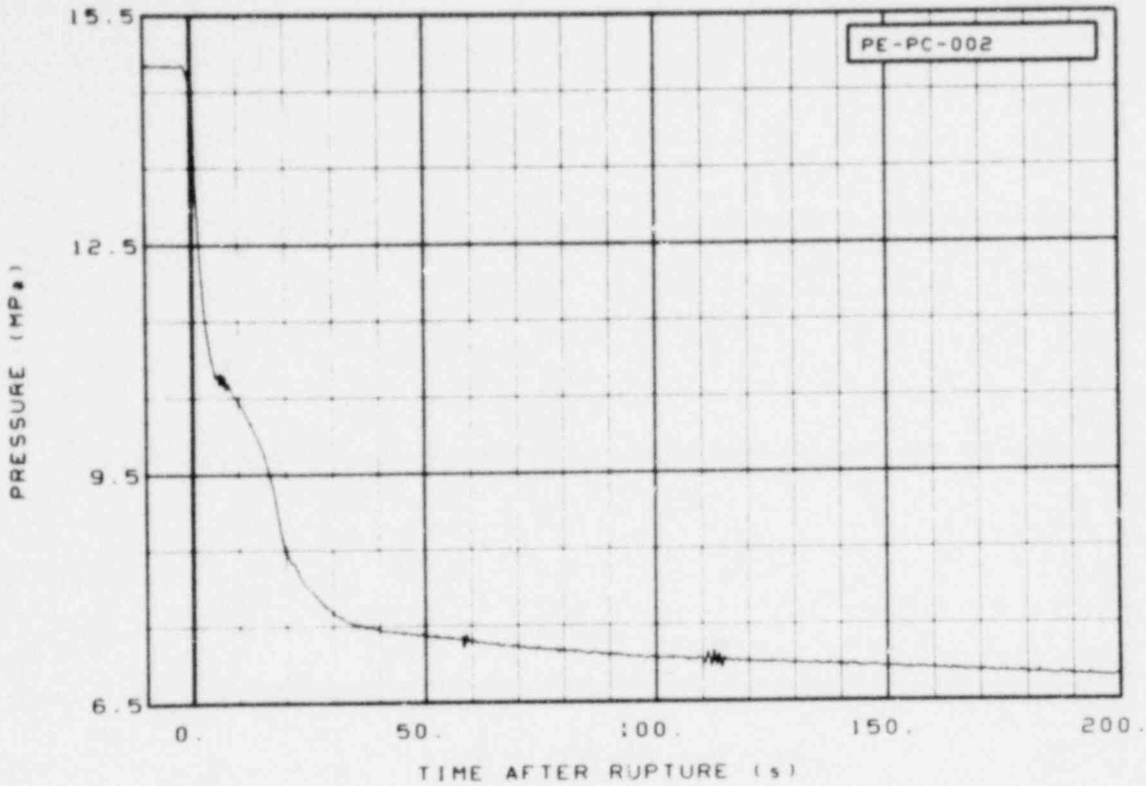


Figure 54. Pressure in intact loop hot leg (PE-PC-002) (Qualified).

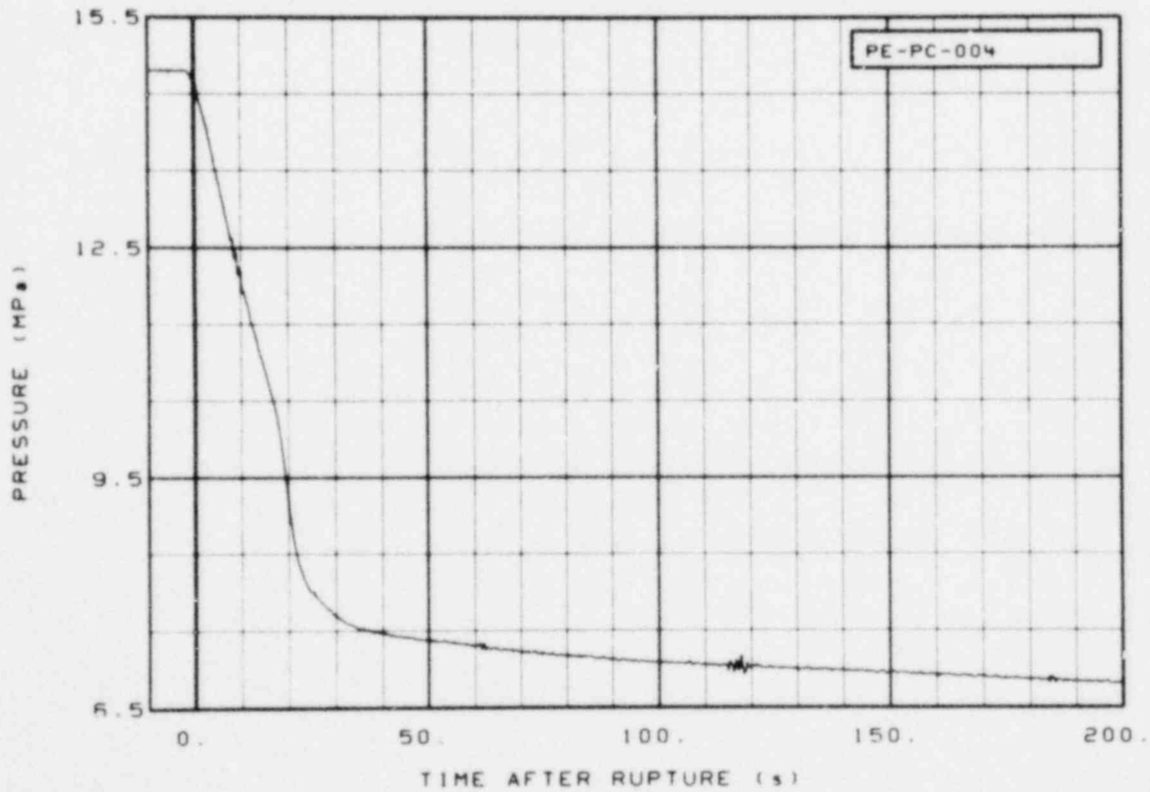


Figure 55. Pressure in pressurizer (PE-PC-004) (Qualified).

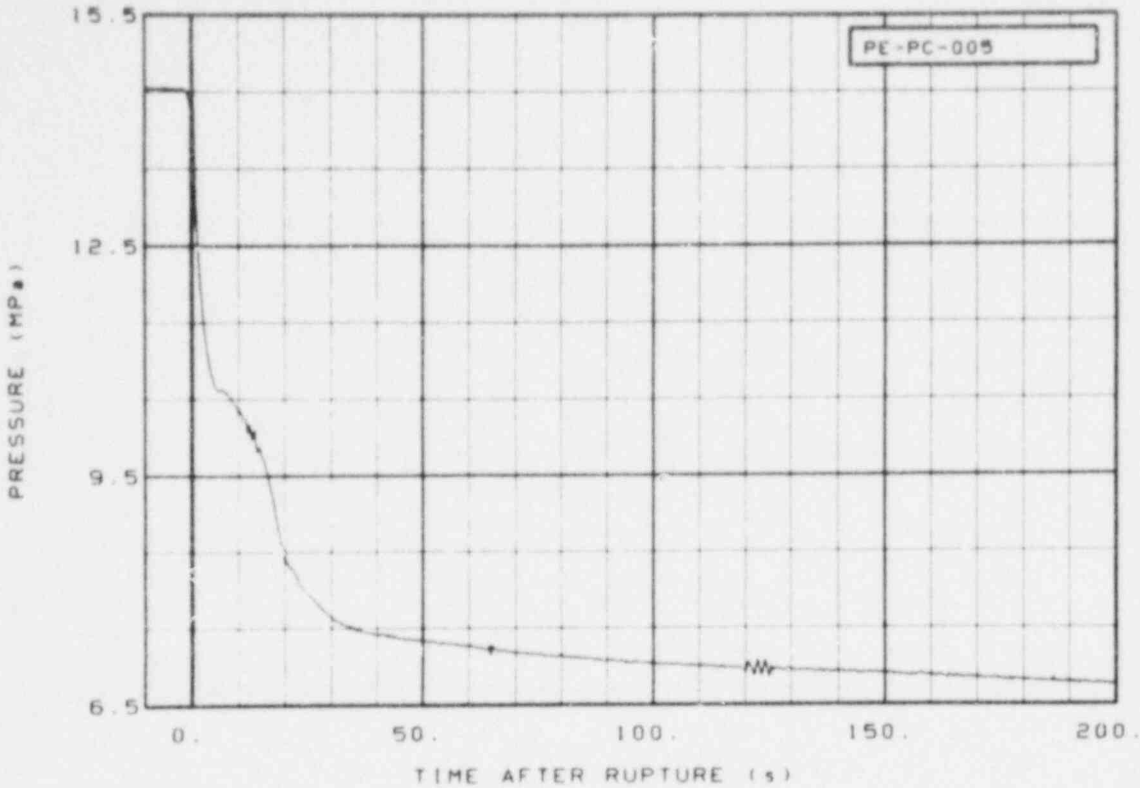


Figure 56. Reference pressure in intact loop (PE-PC-005) (Qualified).

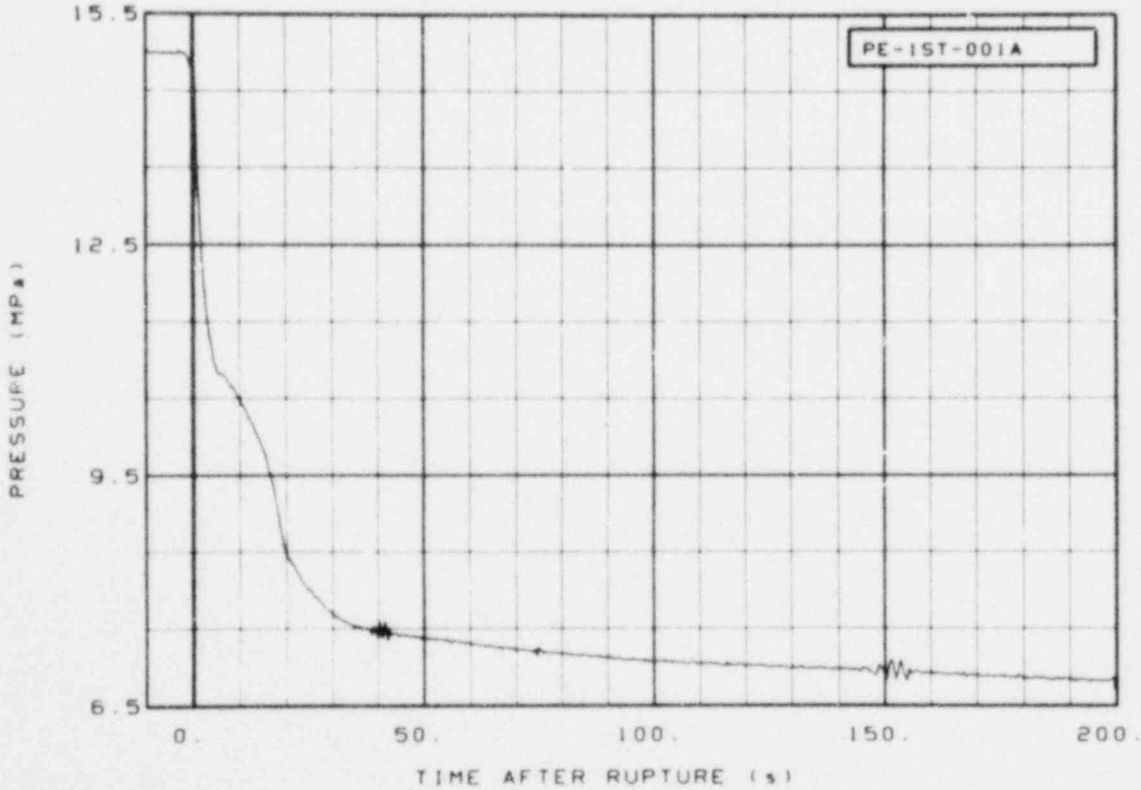


Figure 57. Pressure in reactor vessel Downcomer Stalk 1 (PE-1ST-001A) (Qualified).

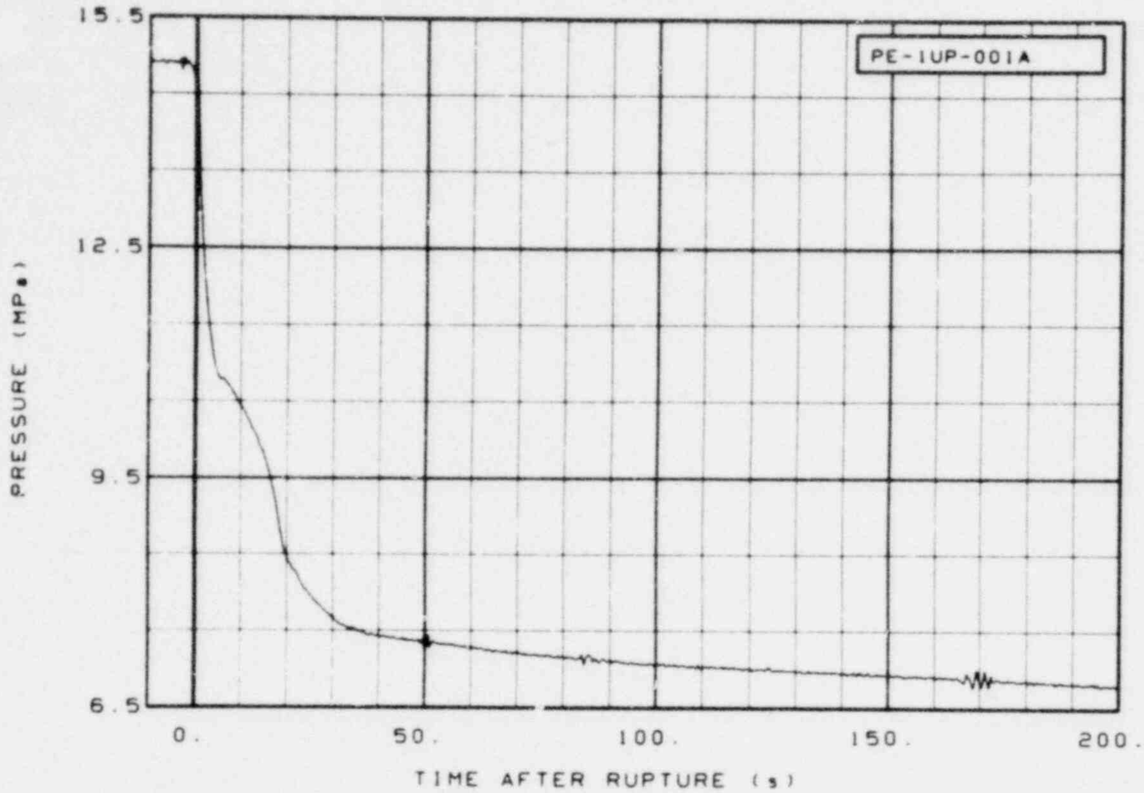


Figure 58. Pressure in reactor vessel above upper end box of Fuel Assembly 1 (PE-1UP-001A) (Qualified).

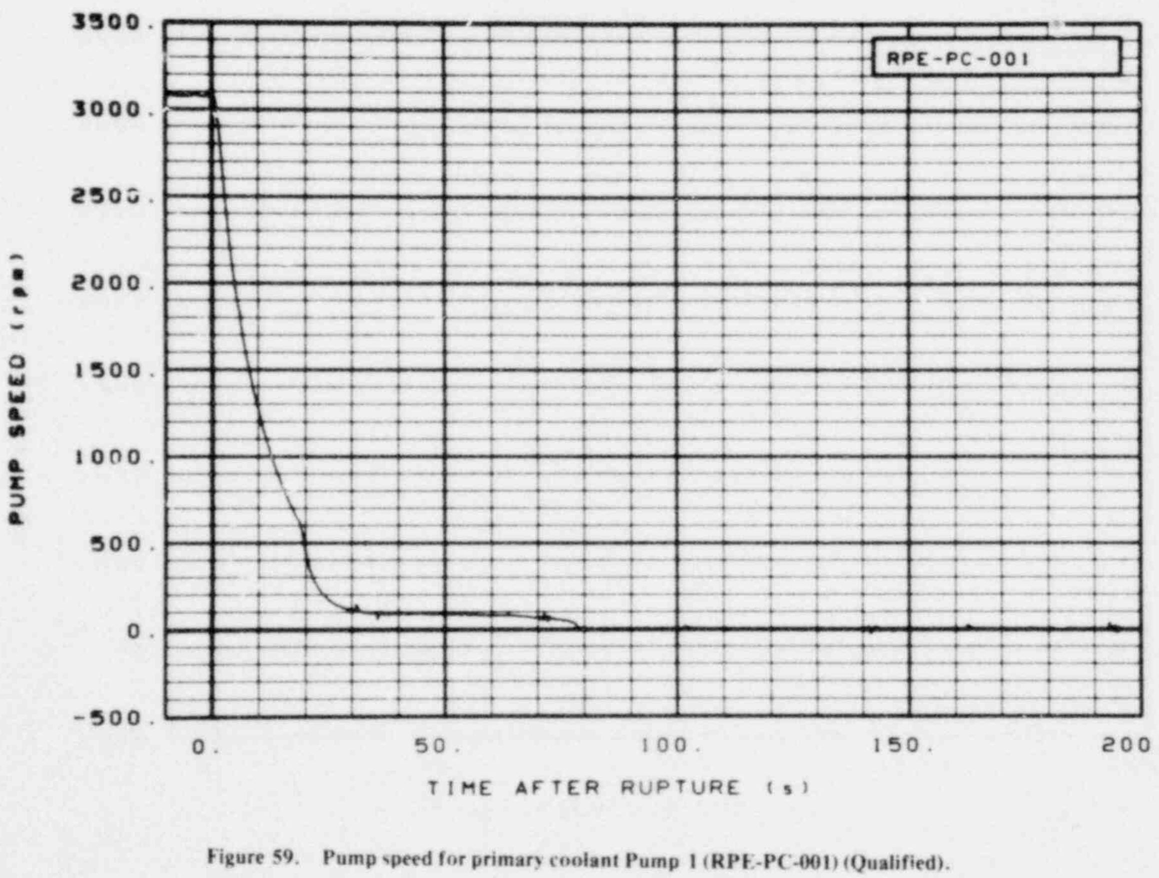


Figure 59. Pump speed for primary coolant Pump 1 (RPE-PC-001) (Qualified).

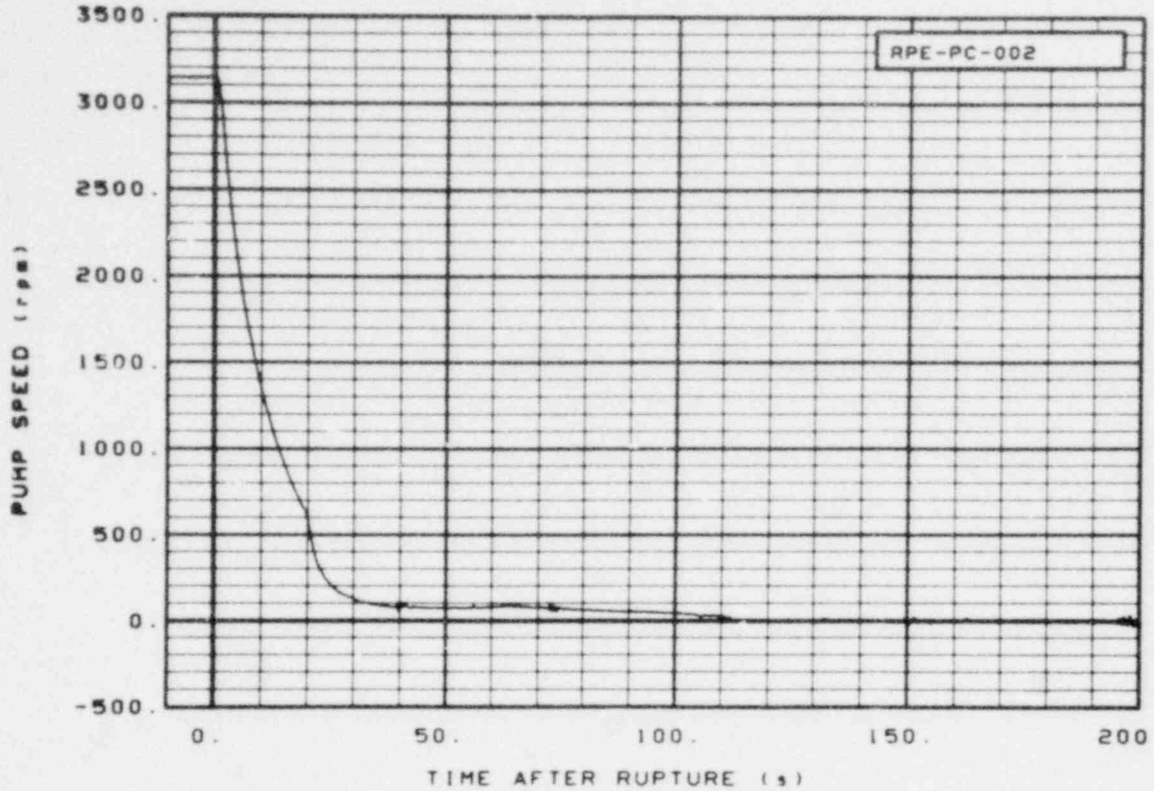


Figure 60. Pump speed for primary coolant Pump 2 (RPE-PC-002) (Qualified).

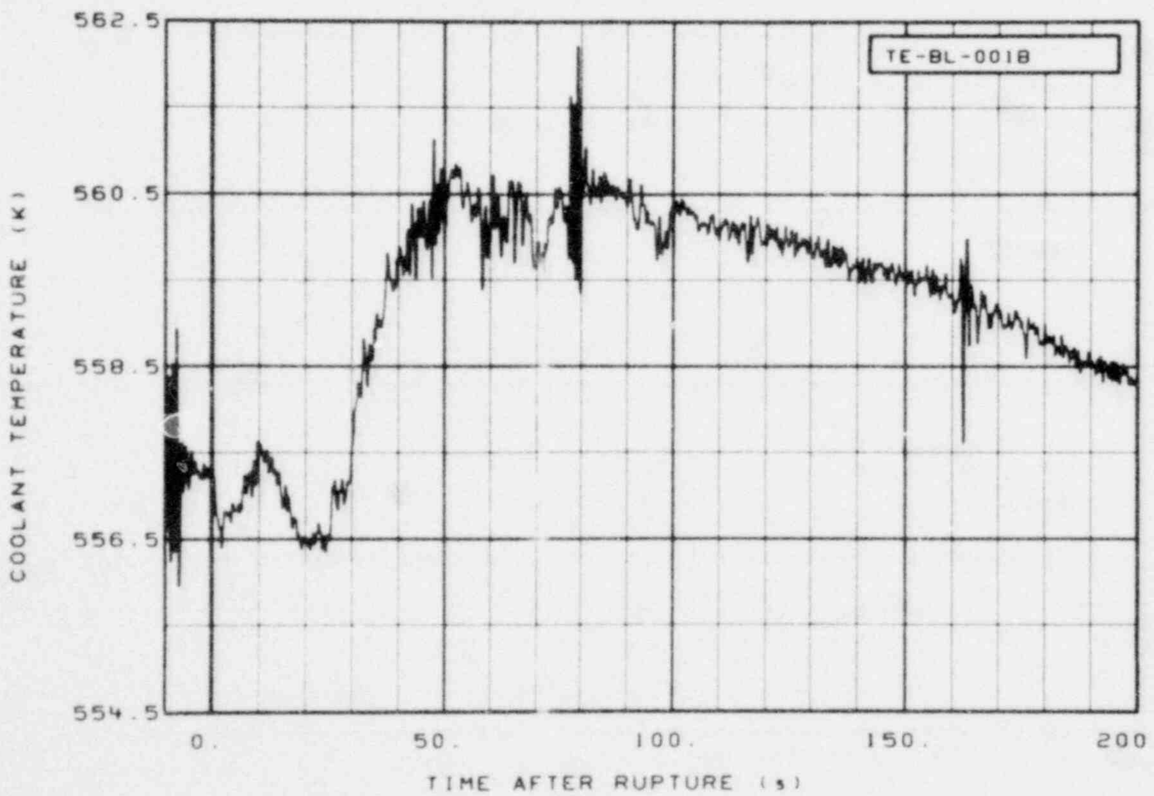


Figure 61. Coolant temperature in broken loop cold leg (TE-BL-001B) (Qualified).

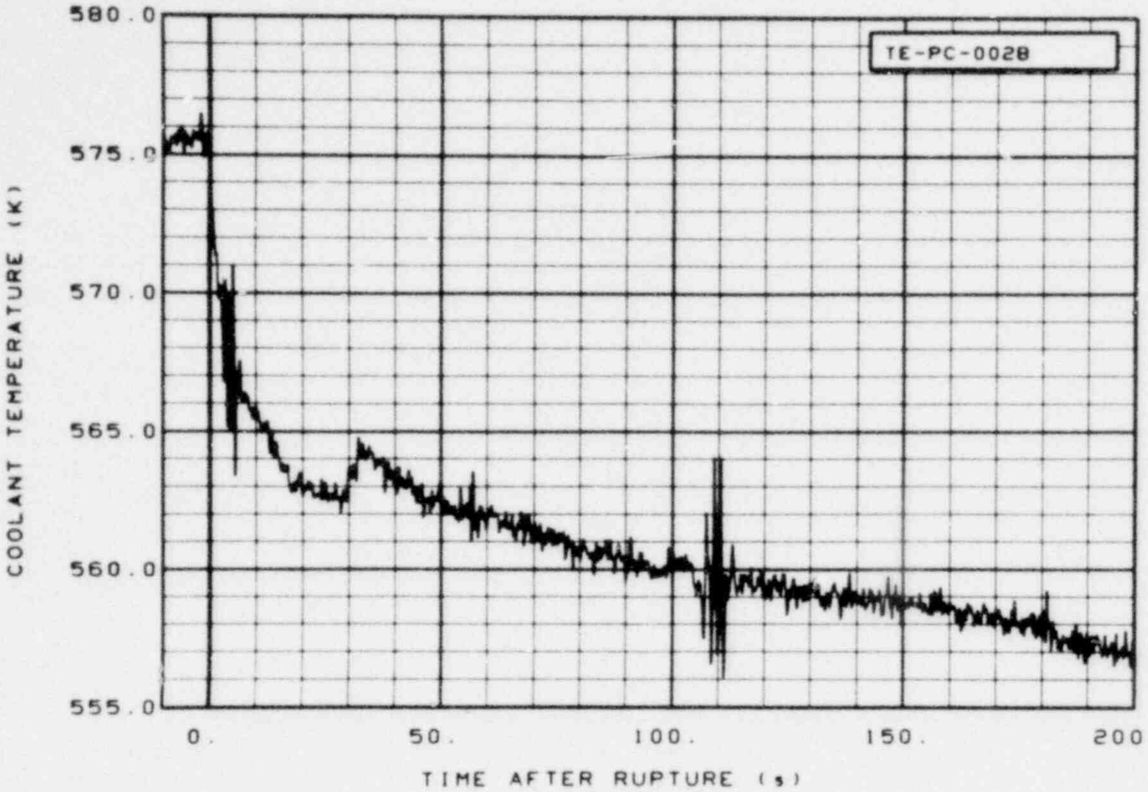


Figure 62. Coolant temperature in intact loop hot leg in middle of pipe (TE-PC-002B) (Qualified).

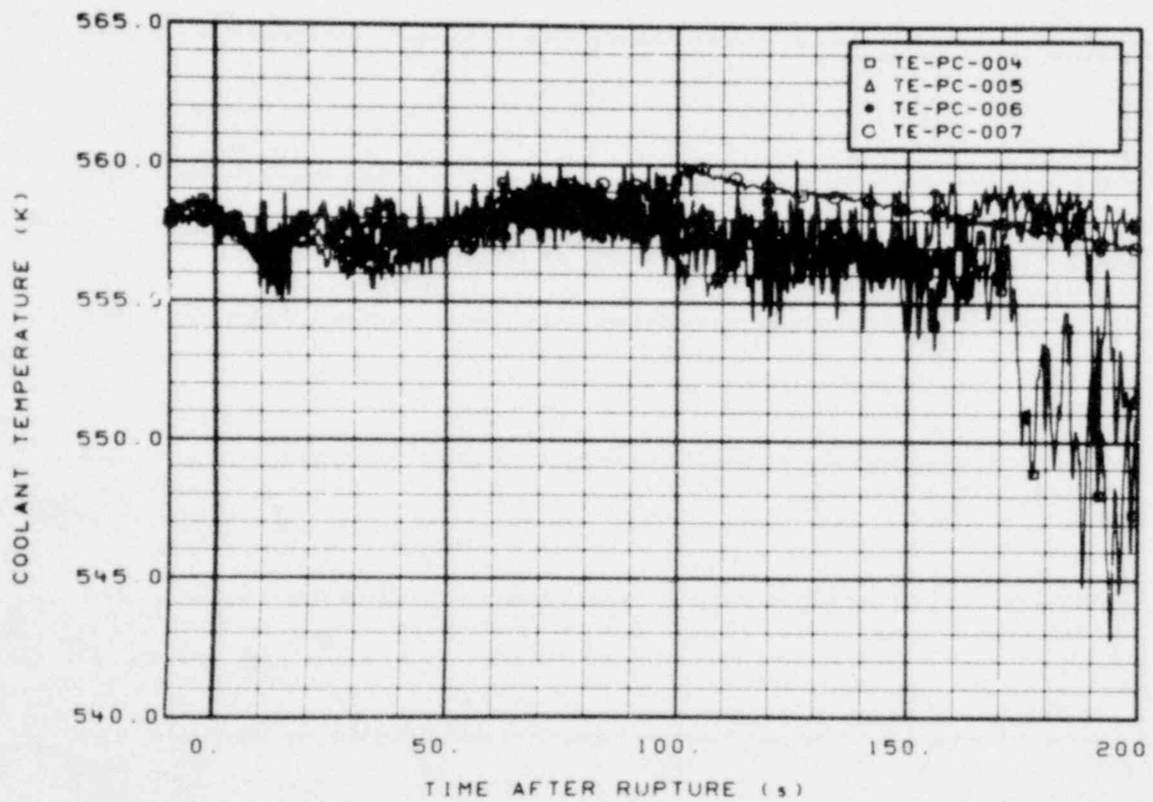


Figure 63. Coolant temperature in intact loop cold leg at ECC Rake 1 (TE-PC-004, -005, -006, and -007) (Qualified).

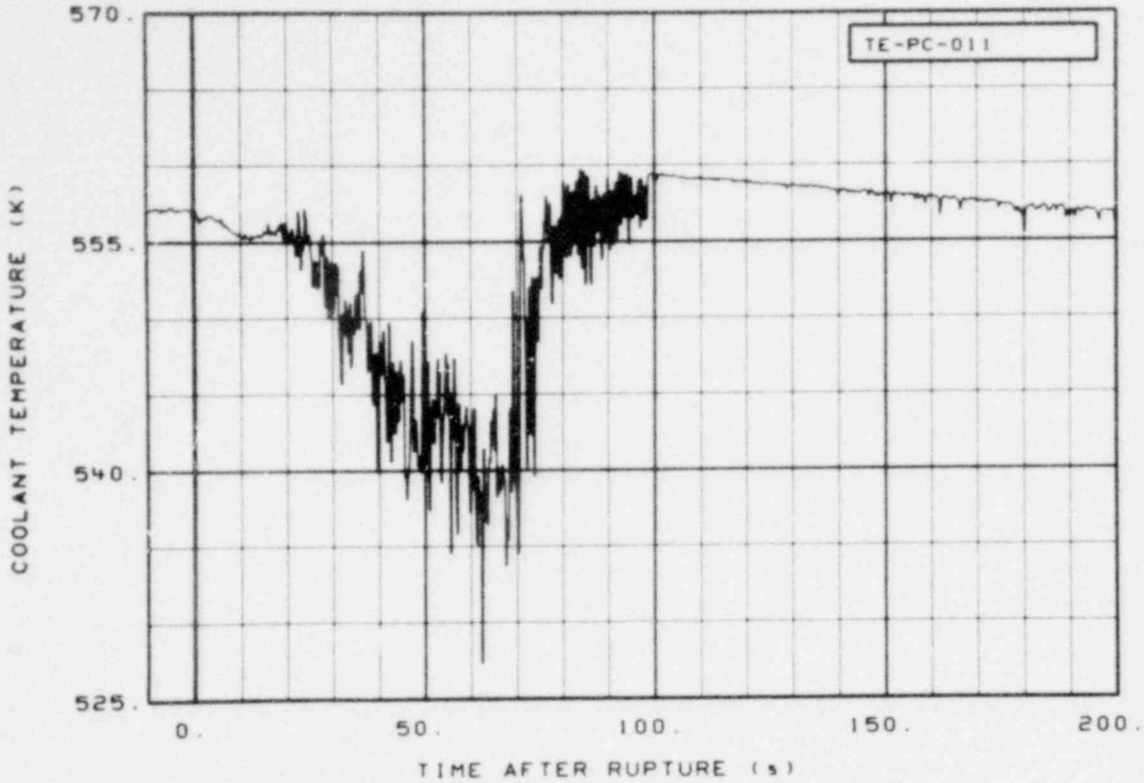


Figure 64. Coolant temperature in intact loop cold leg at top of ECC Rake 2 (TE-PC-011) (Qualified).

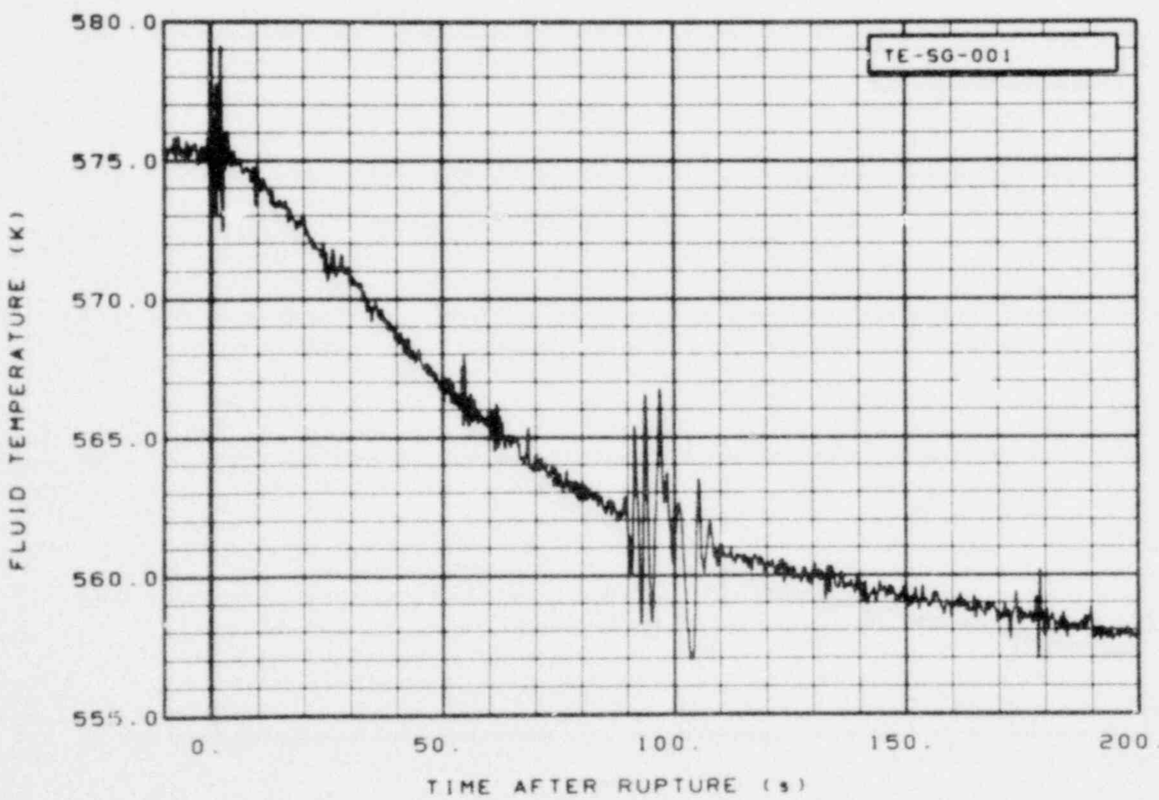


Figure 65. Fluid temperature in intact loop steam generator inlet plenum (TE-SG-001) (Qualified, possibly experiencing hot wall effects after about 375 s).

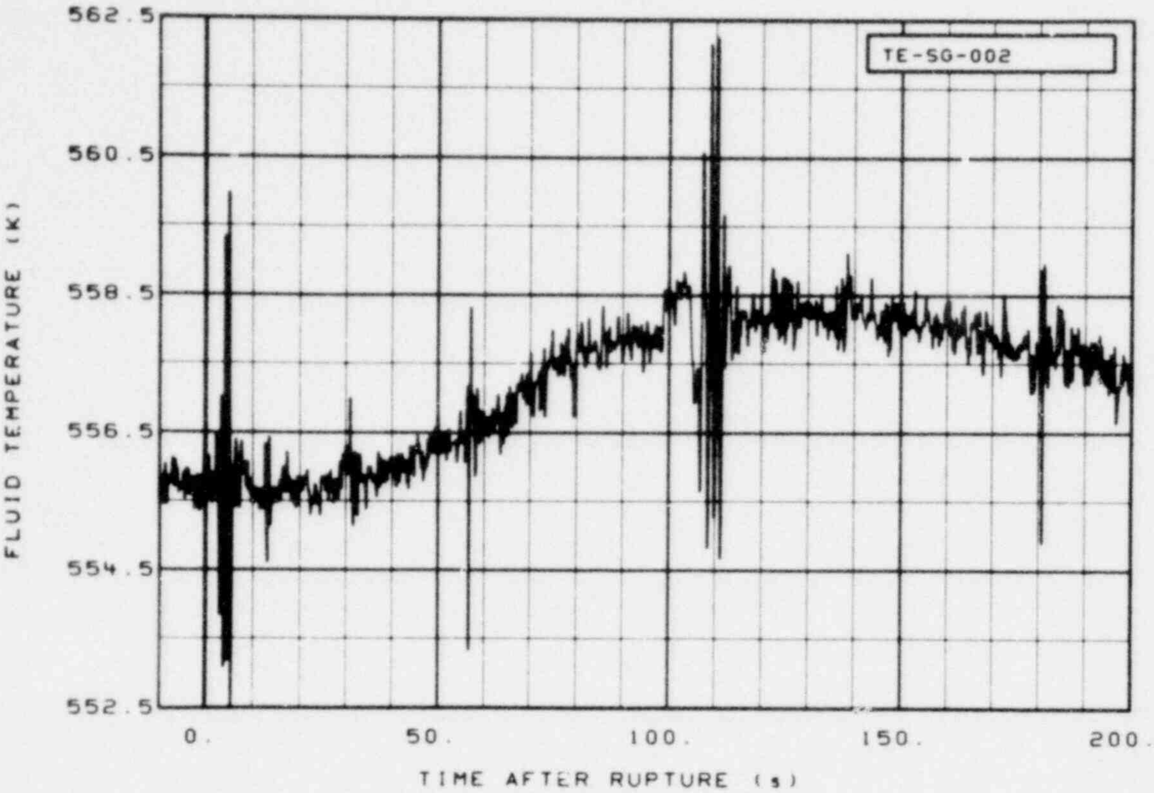


Figure 66. Fluid temperature in intact loop steam generator outlet plenum (TE-SG-002) (Qualified, possibly experiencing hot wall effects after about 800 s).

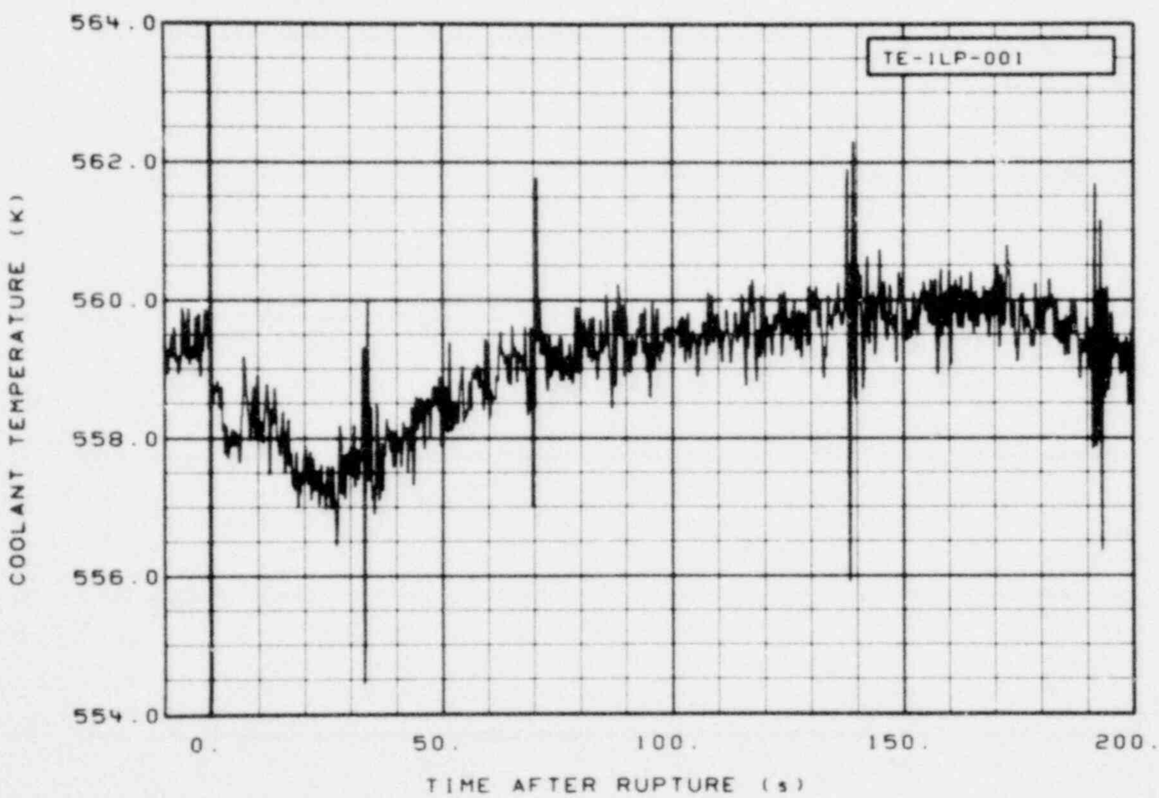


Figure 67. Coolant temperature in reactor vessel at lower end box of Fuel Assembly 1 (TE-1LP-001) (Qualified).

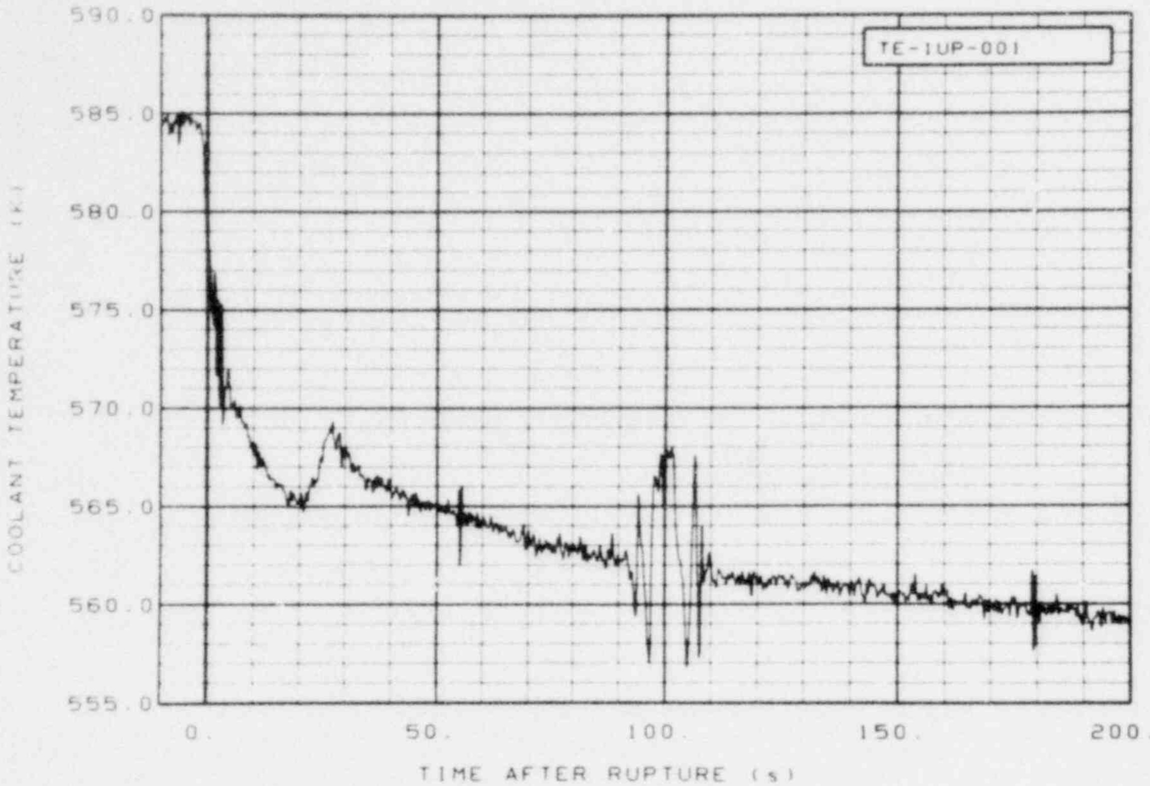


Figure 68. Coolant temperature in reactor vessel at upper end box of Fuel Assembly 1 (TE-1UP-001) (Qualified).

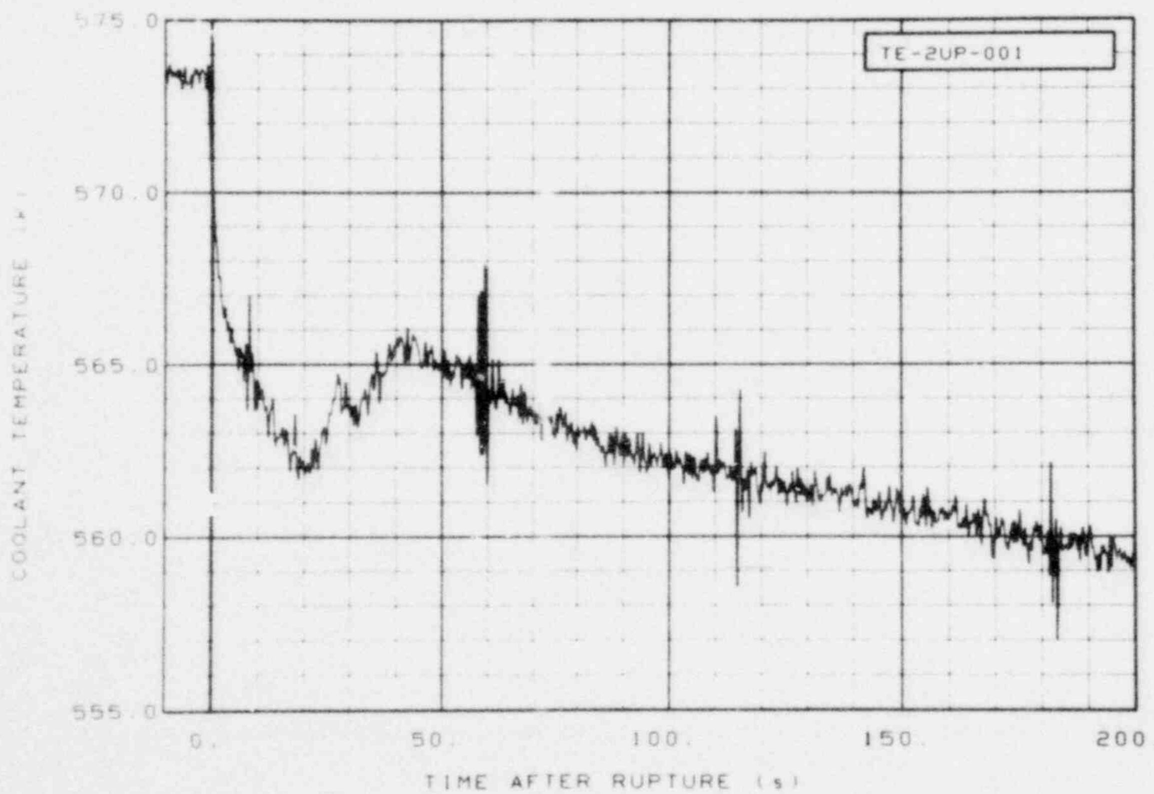


Figure 69. Coolant temperature in reactor vessel at upper end box of Fuel Assembly 2 (TE-2UP-001) (Qualified).

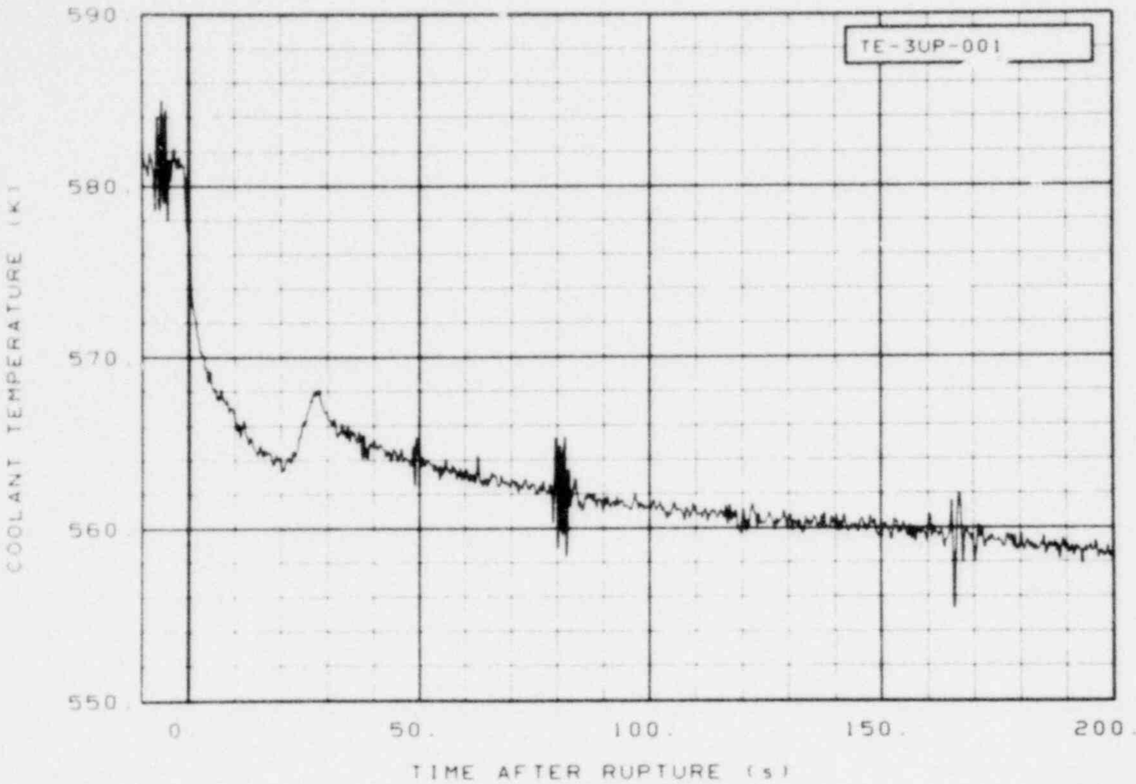


Figure 70. Coolant temperature in reactor vessel at upper end box of Fuel Assembly 3 (TE-3UP-001) (Qualified).

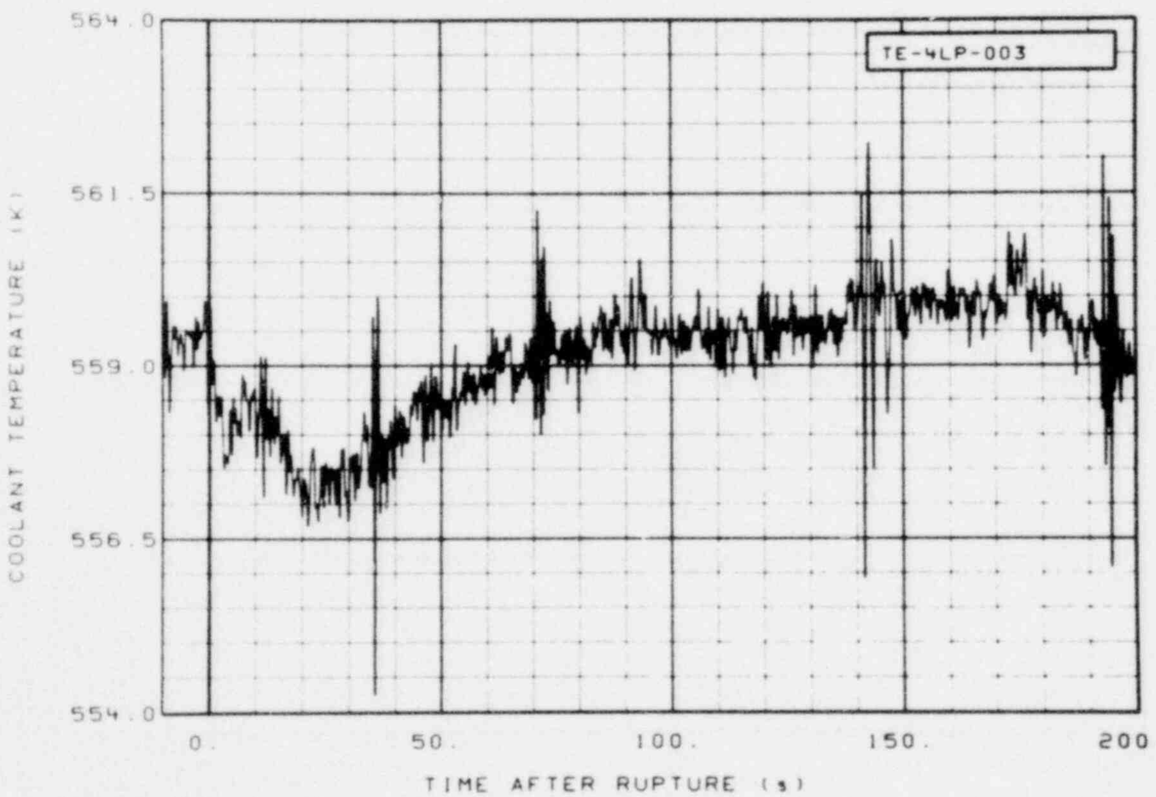


Figure 71. Coolant temperature in reactor vessel at lower end box of ıel Assembly 4 (TE-4LP-003) (Qualified).

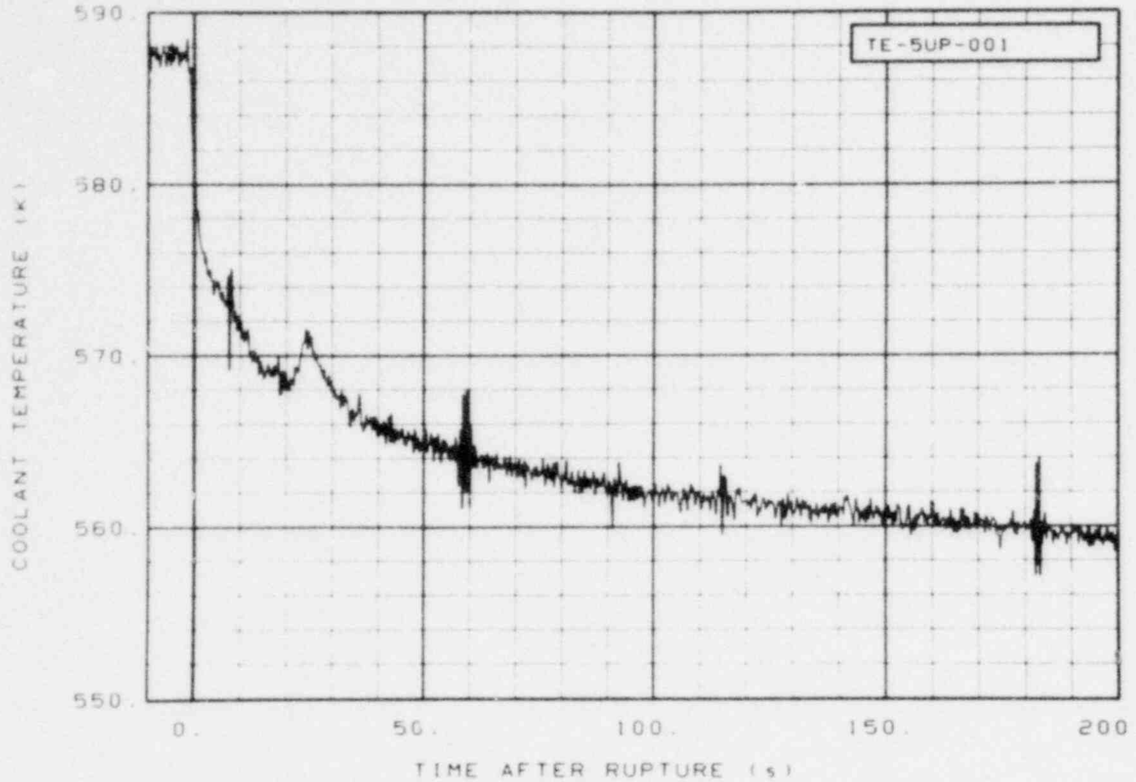


Figure 72. Coolant temperature in reactor vessel at upper end box of Fuel Assembly 5 (TE-5UP-001) (Qualified).

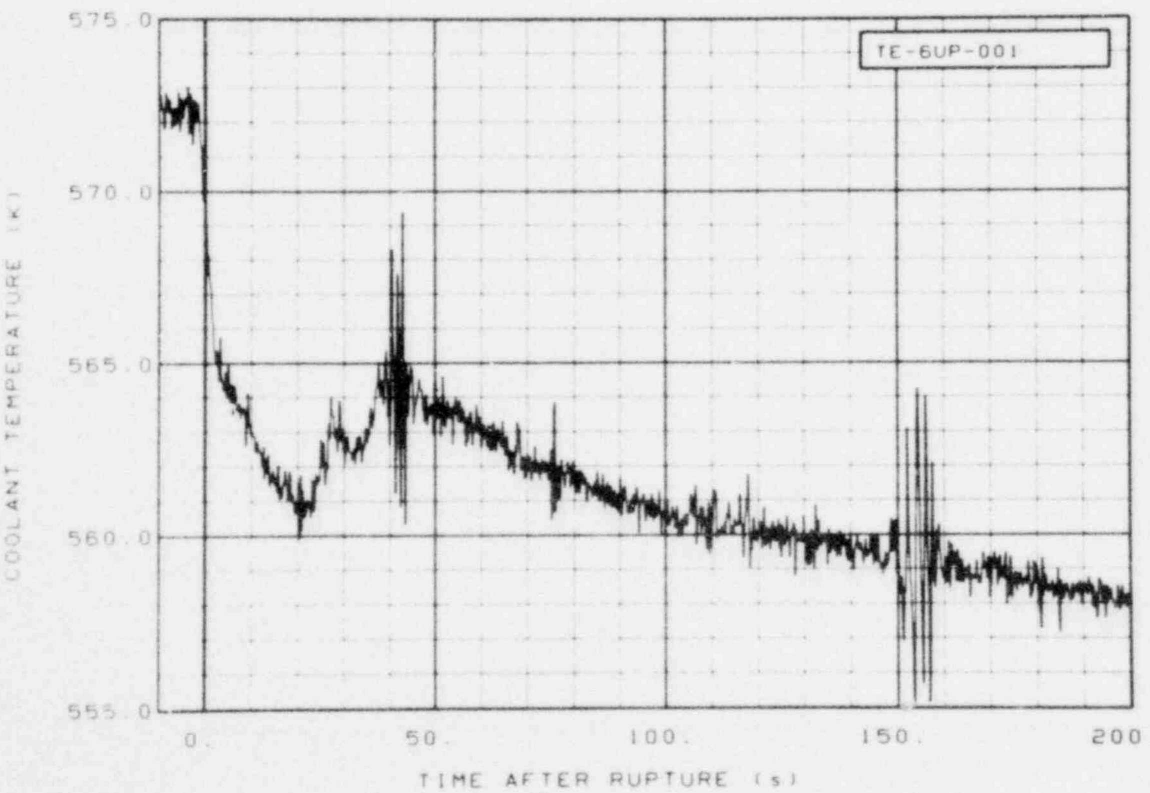


Figure 73. Coolant temperature in reactor vessel at upper end box of Fuel Assembly 6 (TE-6UP-001) (Qualified).

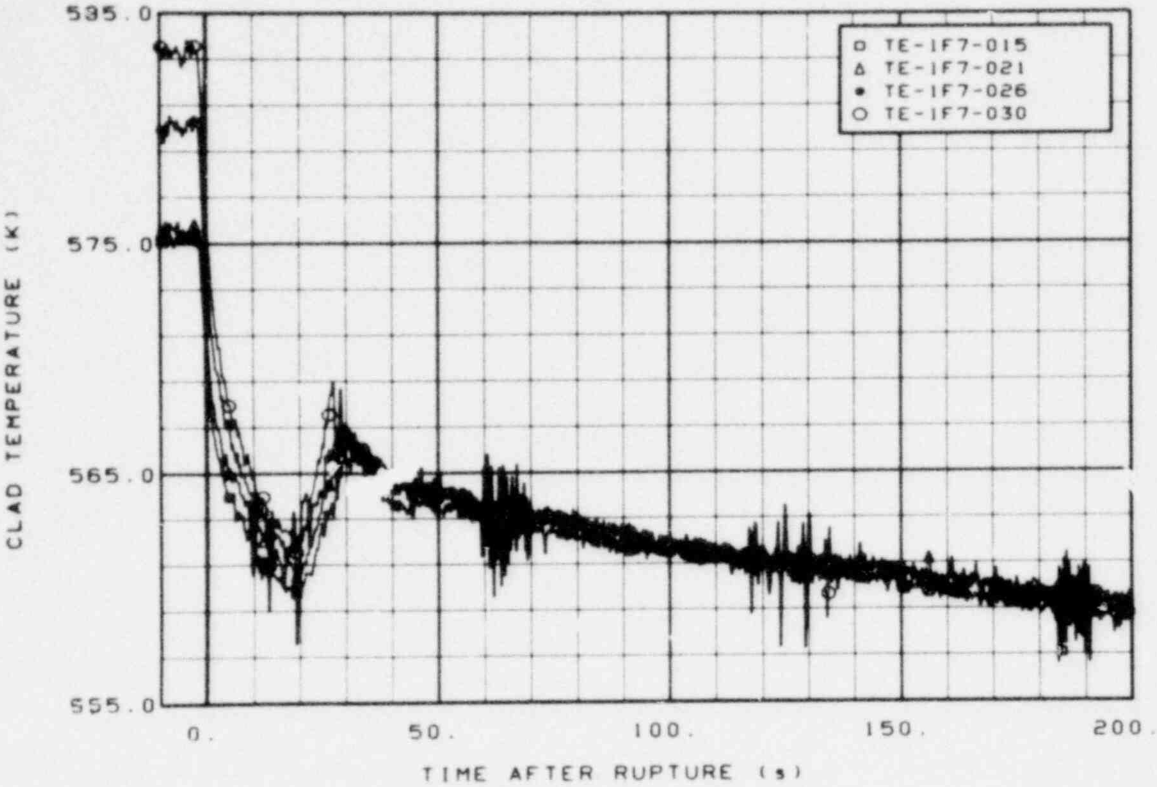


Figure 74. Temperature of cladding on Fuel Assembly 1, Rod F7 (TE-1F7-015, -021, -026, and -030) (Qualified).

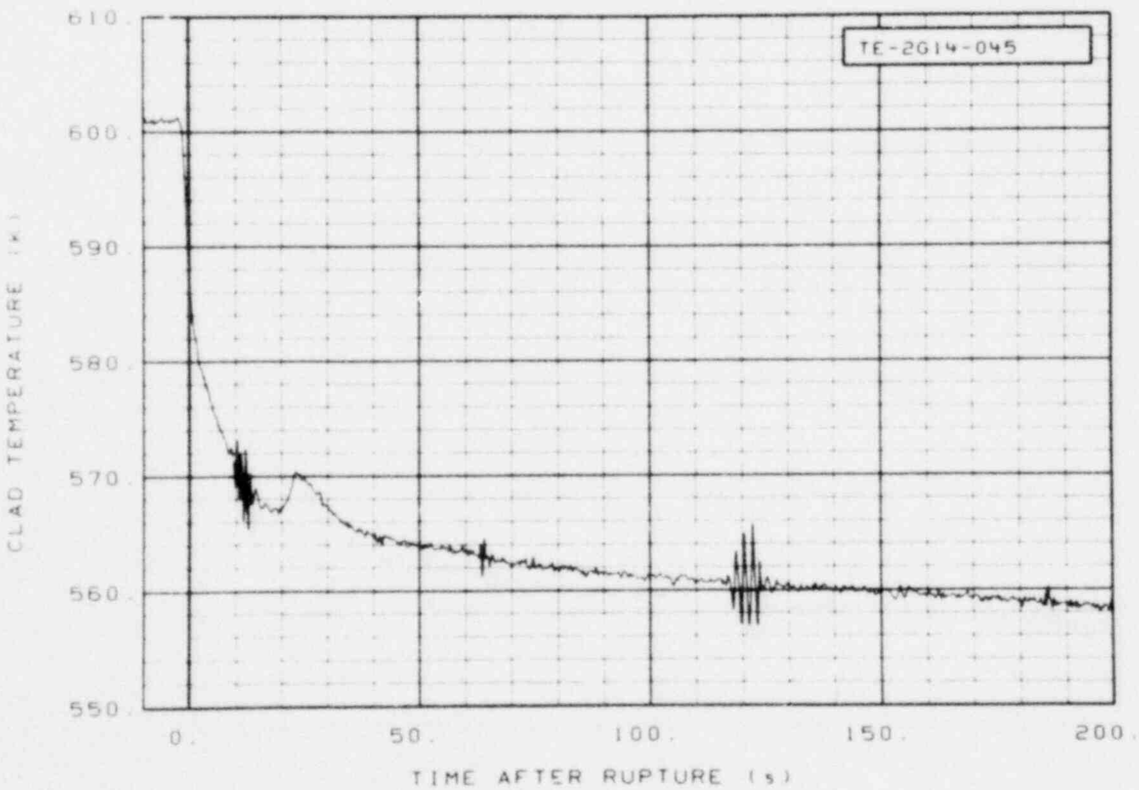


Figure 75. Temperature of cladding on Fuel Assembly 2, Rod G14 (TE-2G14-045) (Qualified).

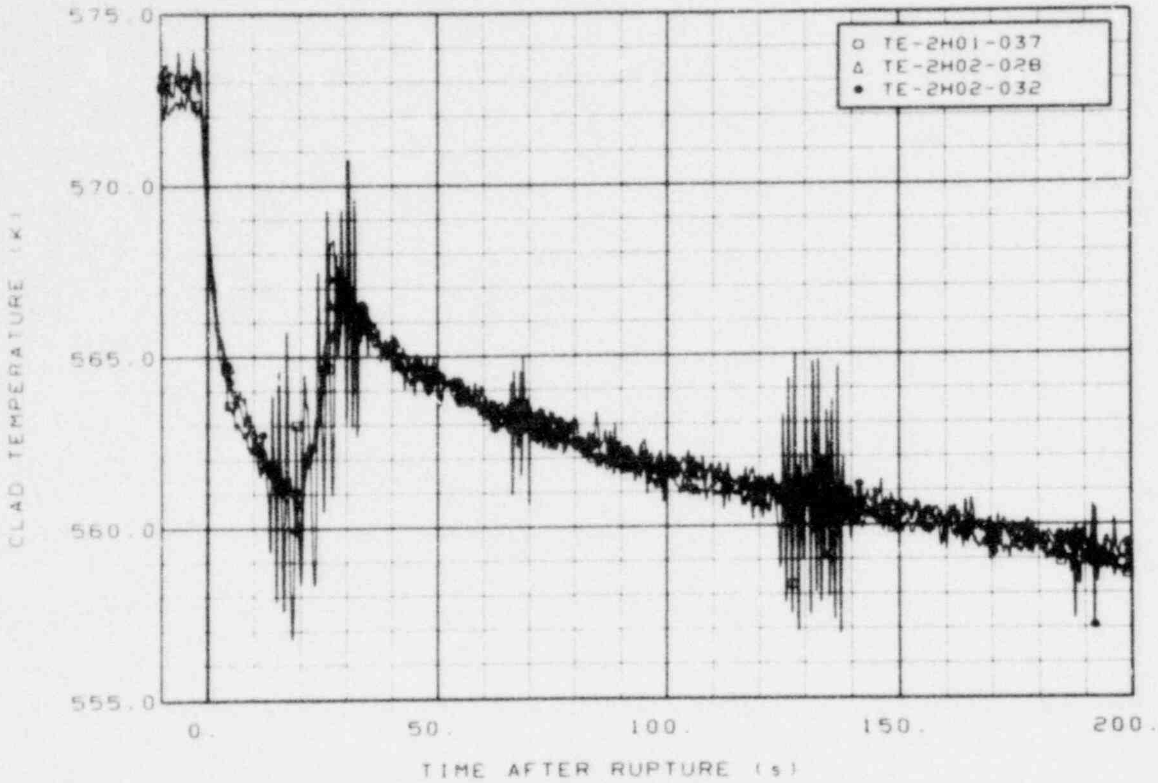


Figure 76. Temperature of cladding on Fuel Assembly 2, Rods H1 and H2 (TE-2H01-037, TE-2H02-028, and -032) (Qualified).

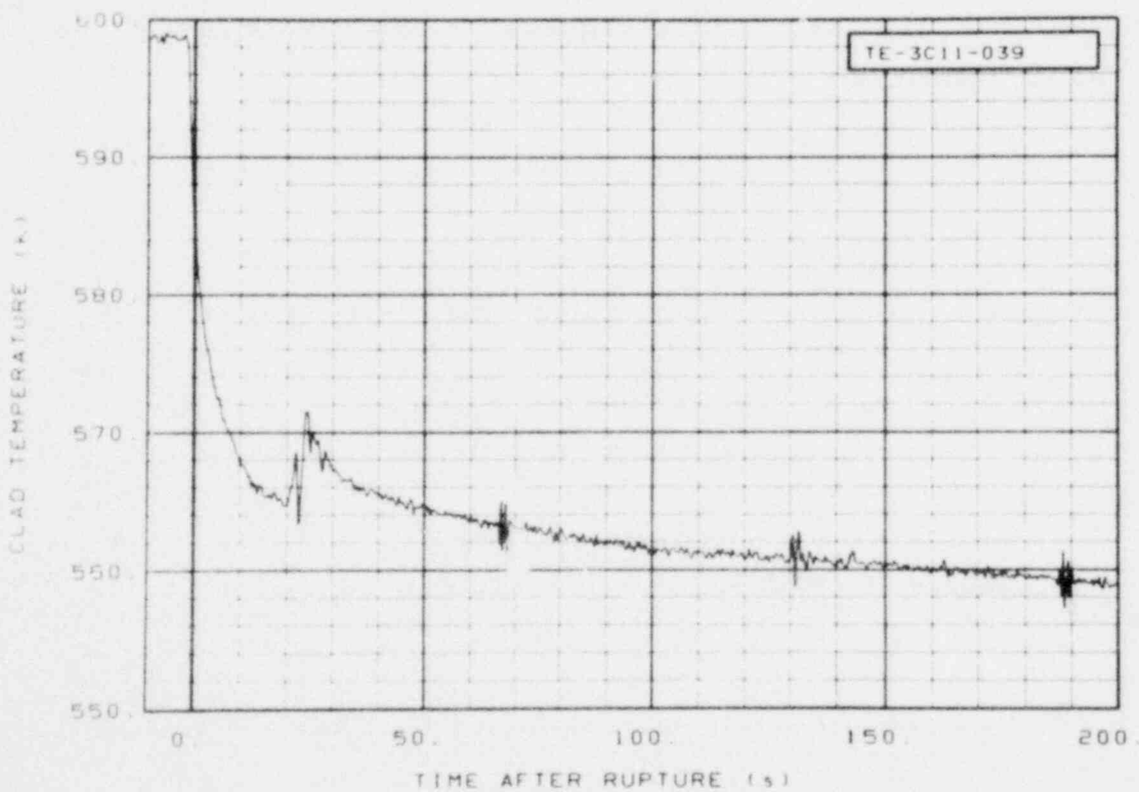


Figure 77. Temperature of cladding on Fuel Assembly 3, Rod C11 (TE-3C11-039) (Qualified).

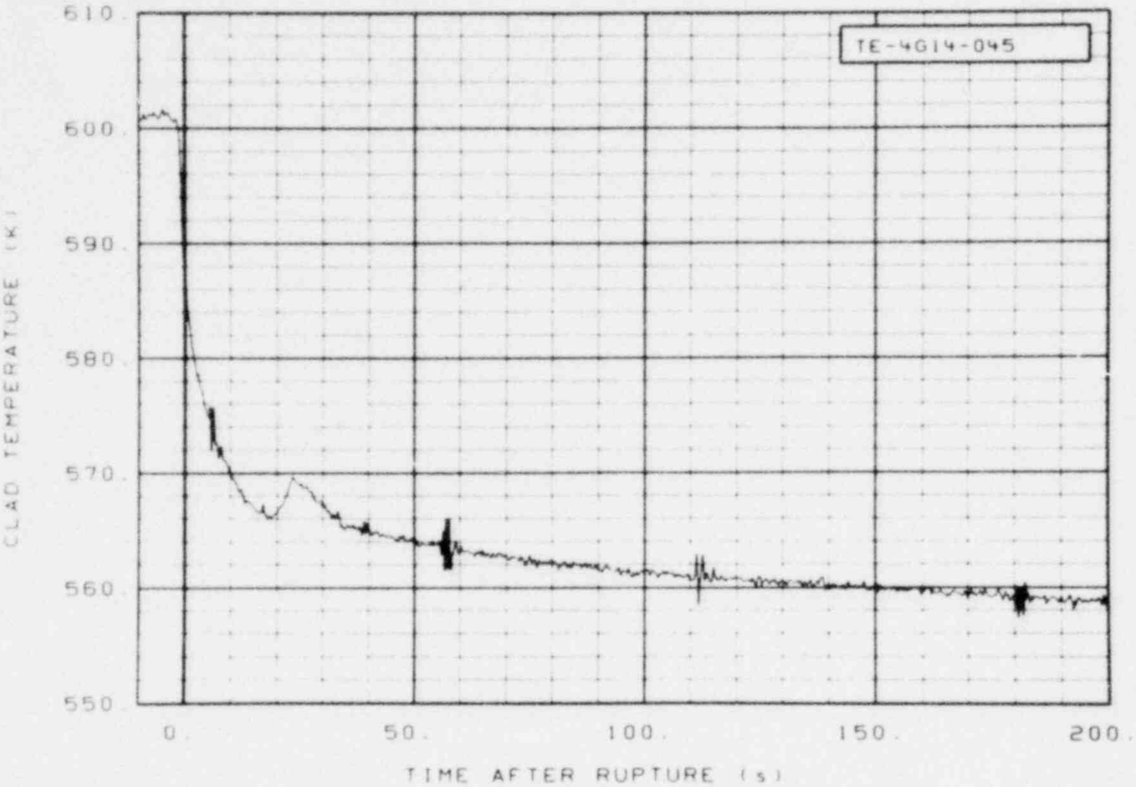


Figure 78. Temperature of cladding on Fuel Assembly 4, Rod G14 (TE-4G14-045) (Qualified).

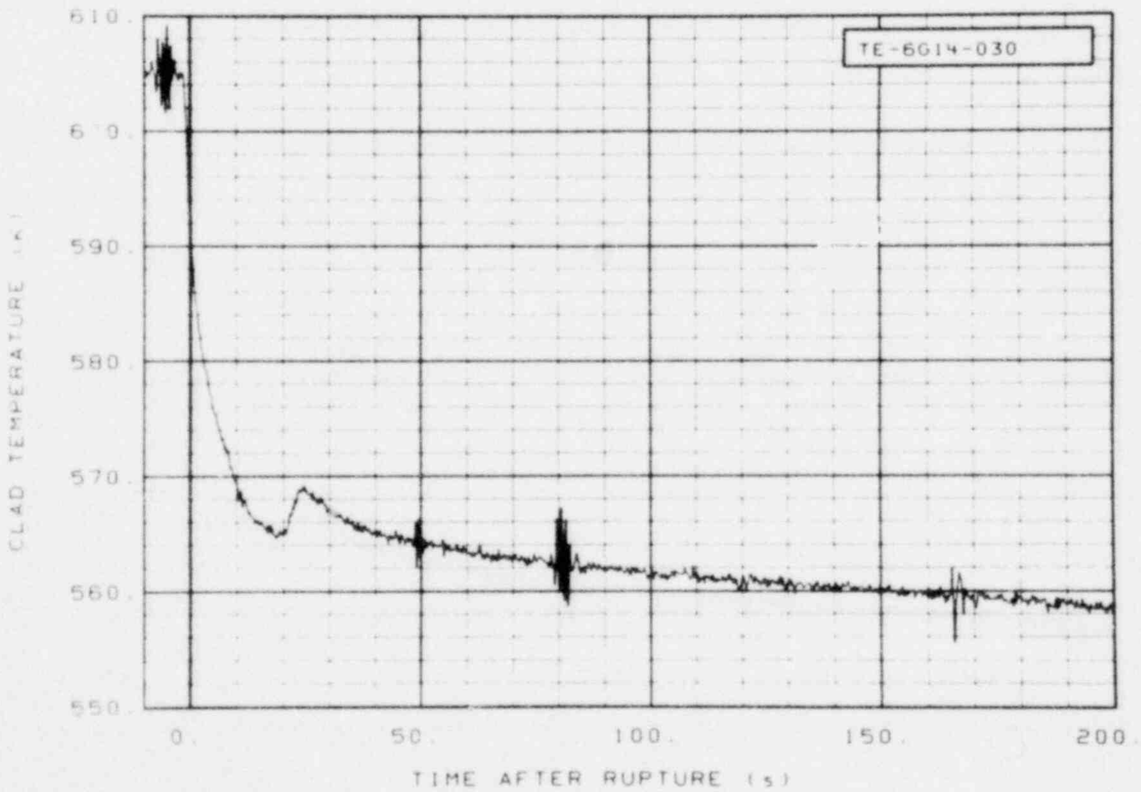


Figure 79. Temperature of cladding on Fuel Assembly 6, Rod G14 (TE-6G14-030) (Qualified).

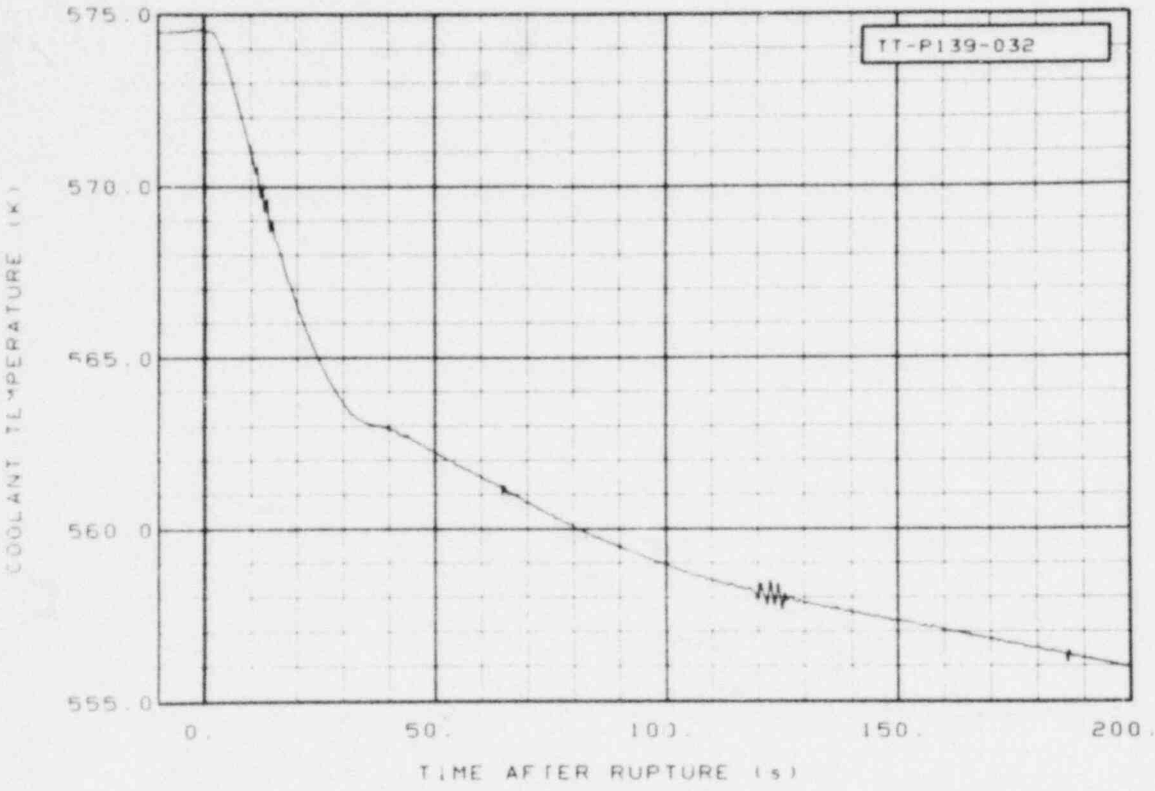


Figure 80. Coolant temperature in intact loop hot leg, Channel A (TT-P139-032) (Qualified, high range instrument, not valid below 535 K).

LONG-TERM PLOTS
(0 to 5000 seconds)

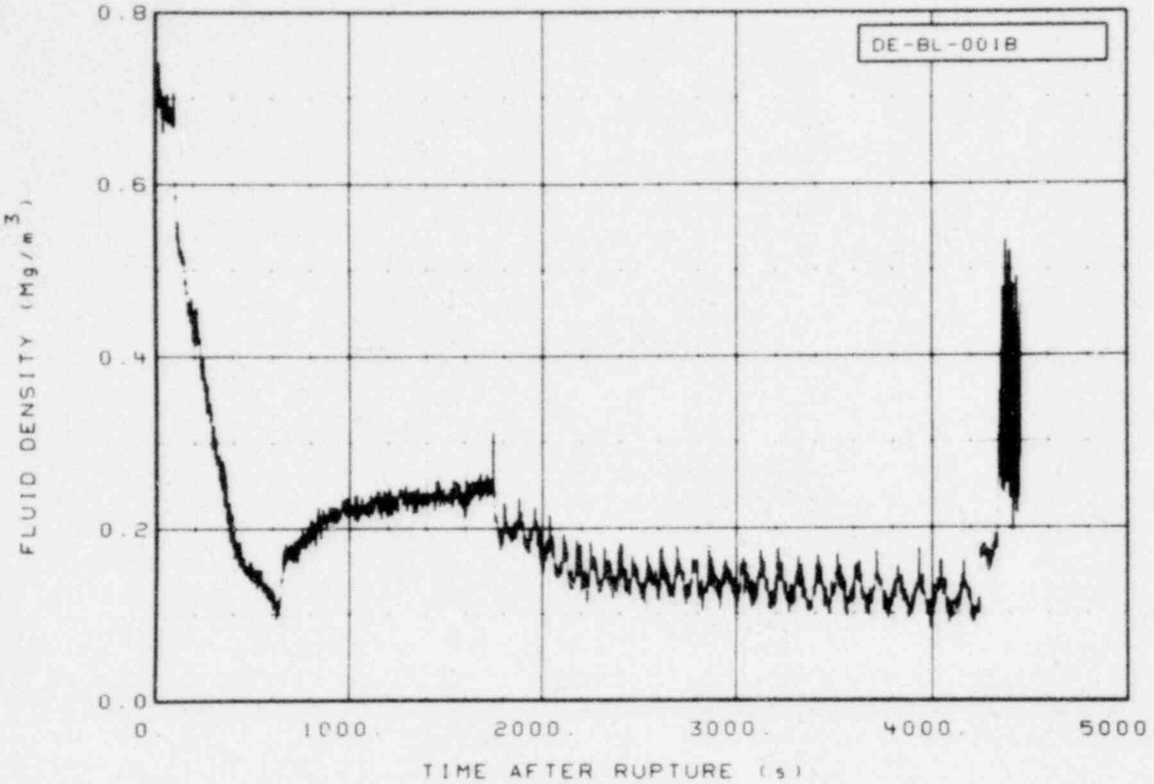


Figure 81. Fluid density in broken loop cold leg, chordal density (DE-BL-001B) (Qualified, second calibration point determined from intact loop liquid level during first 600 s).

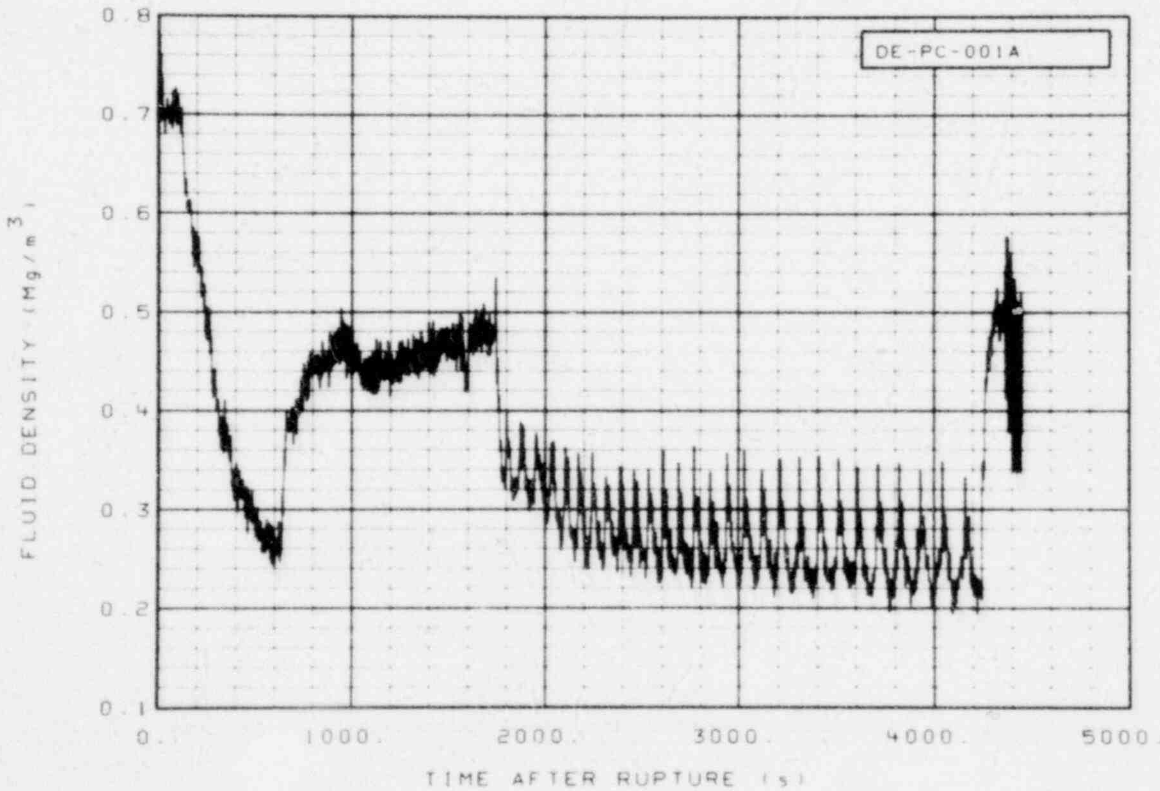


Figure 82. Fluid density in intact loop cold leg, chordal density (DE-PC-001A) (Qualified, second calibration point determined from intact loop liquid level during first 600 s).

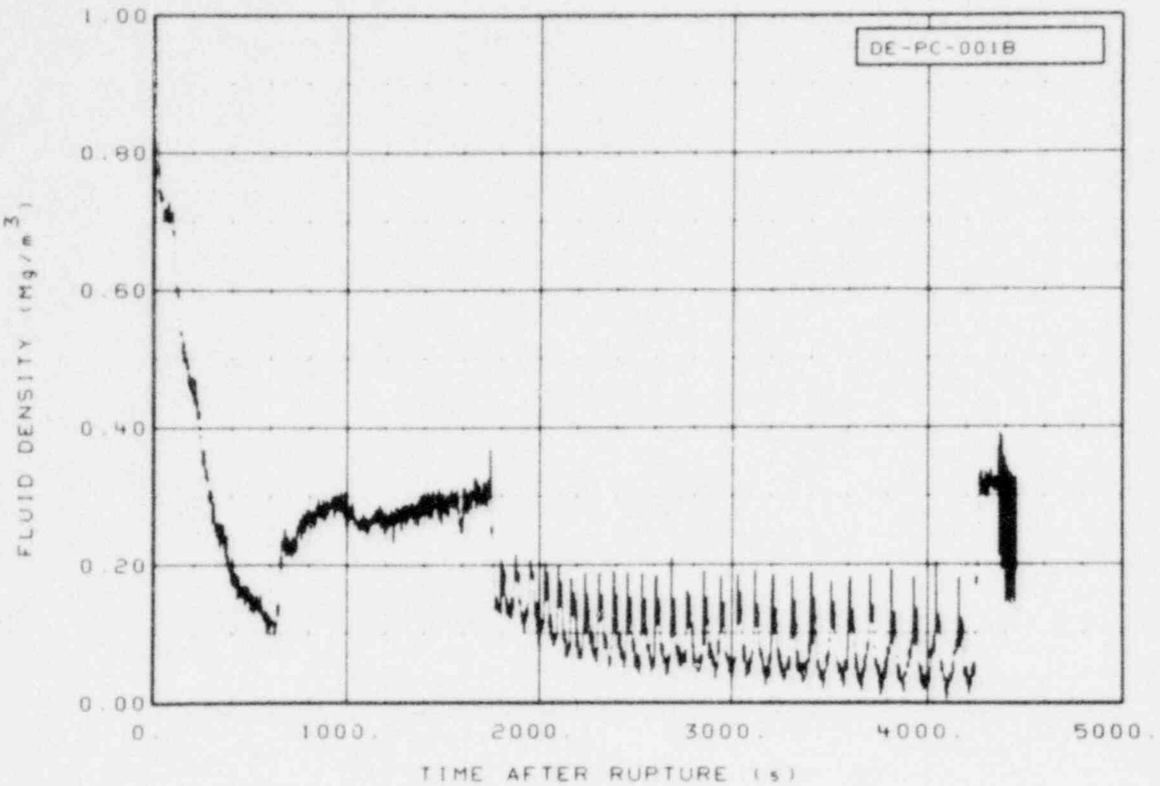


Figure 83. Fluid density in intact loop cold leg, chordal density (DE-PC-001B) (Qualified).

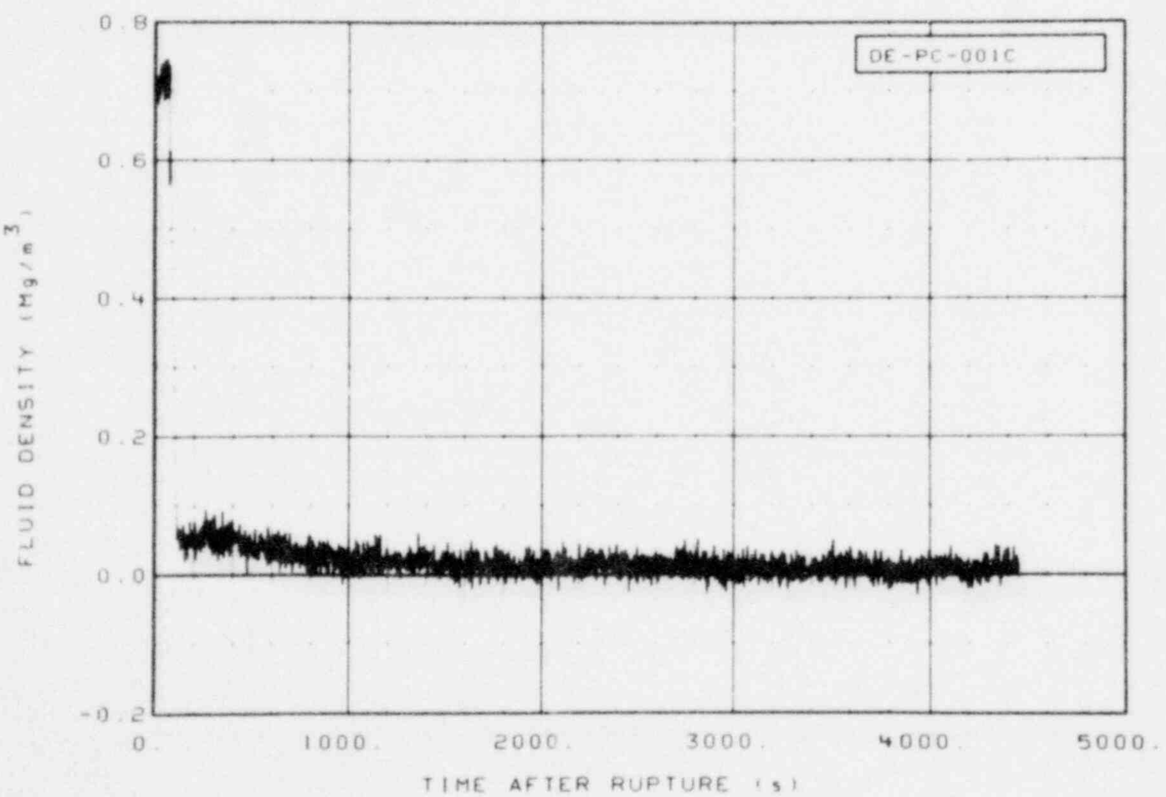


Figure 84. Fluid density in intact loop cold leg, chordal density (DE-PC-001C) (Qualified).

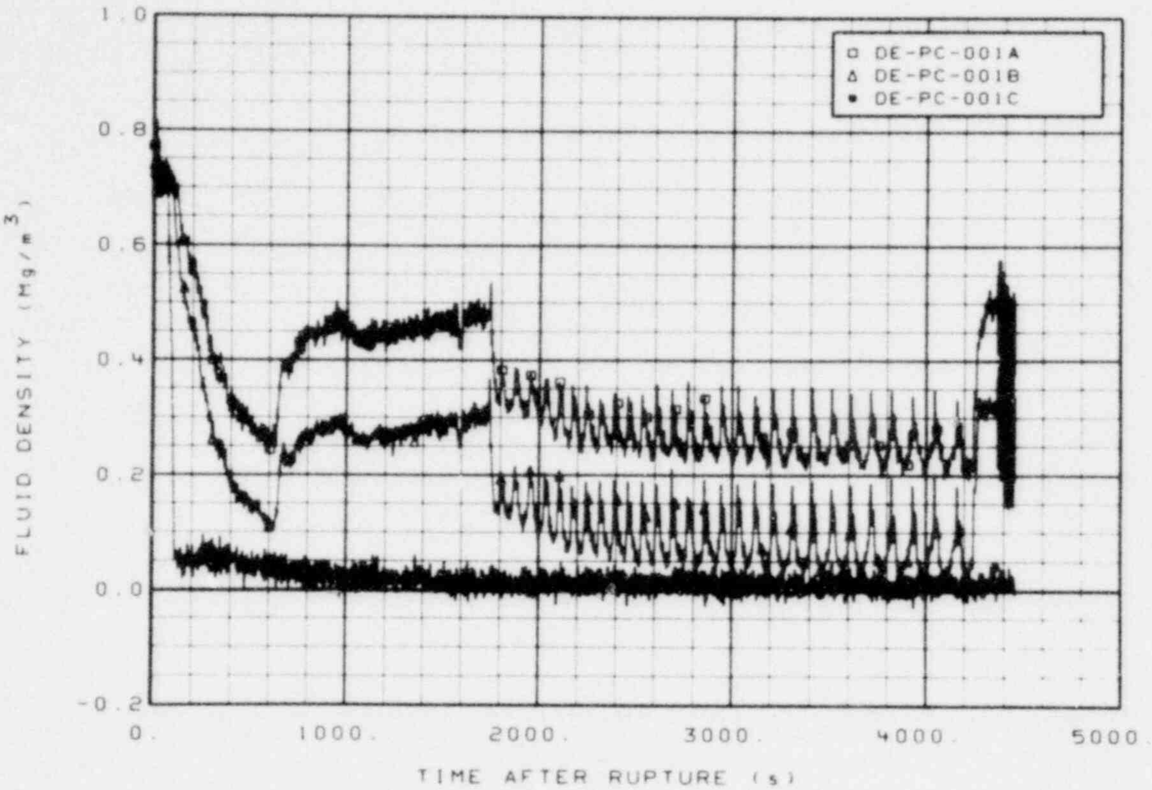


Figure 85. Fluid density in intact loop cold leg, chordal density (DE-PC-001A, -001B, and -001C) (Qualified, second calibration point for A determined from intact loop liquid level during first 600 s).

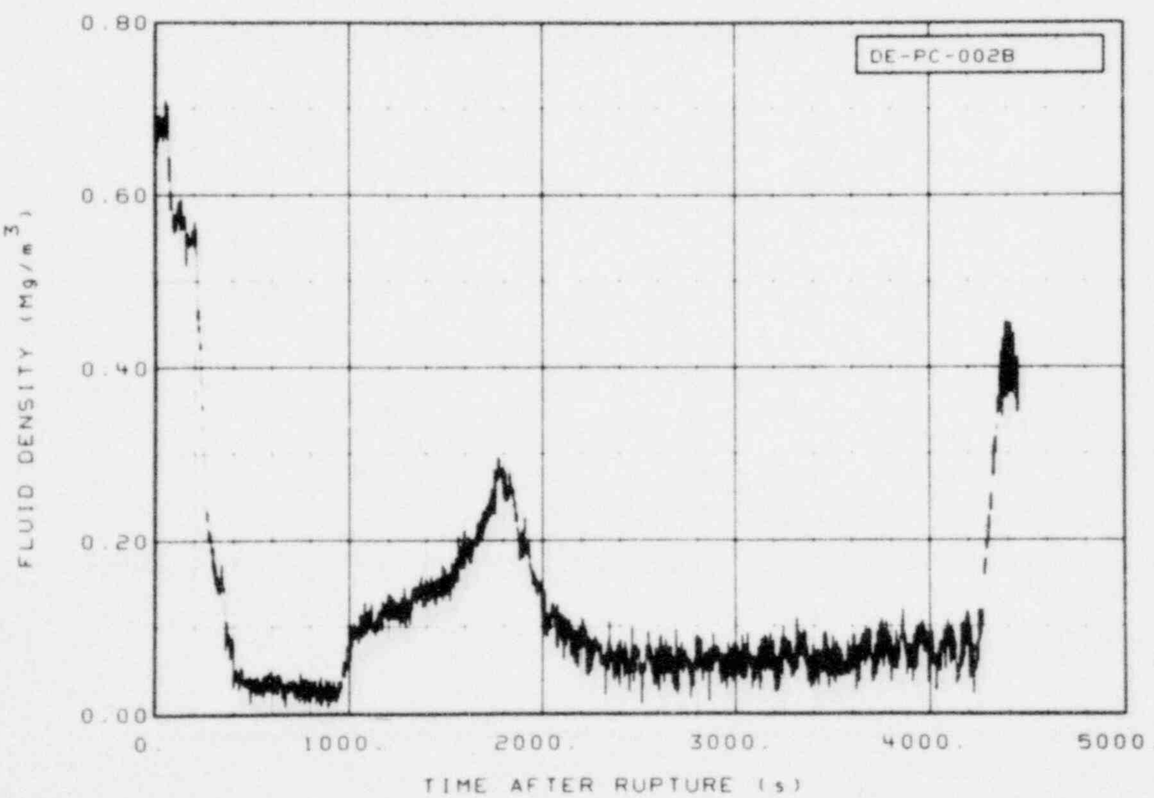


Figure 86. Fluid density in intact loop hot leg, chordal density (DE-PC-002B) (Qualified).

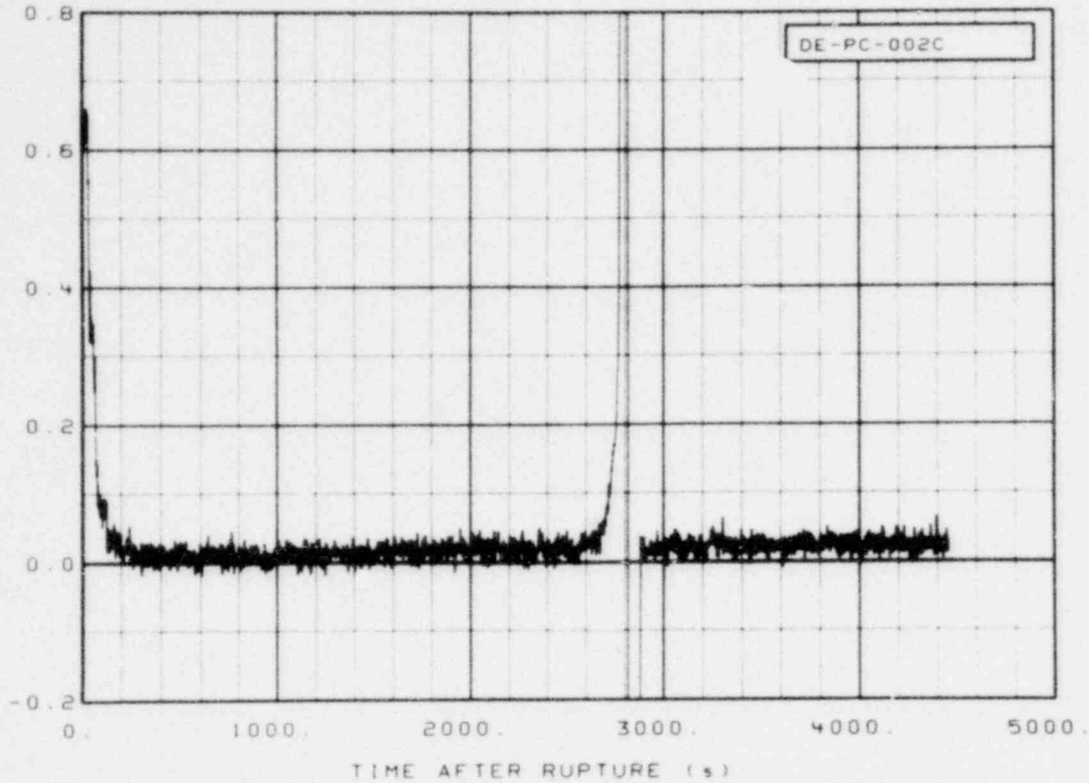


Figure 87. Fluid density in intact loop hot leg, chordal density (DE-PC-002C) (Qualified, anomalous output from 2600 to 3000 s

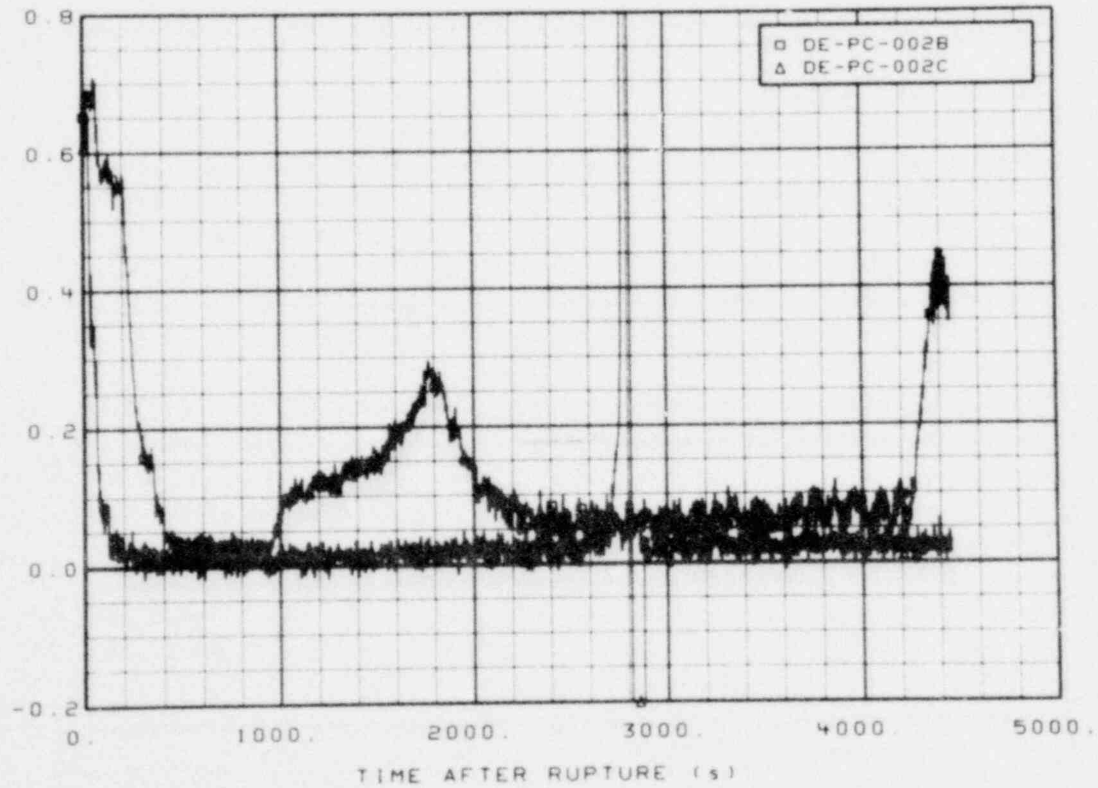


Figure 88. Fluid density in intact loop hot leg, chordal density (DE-PC-002B and -002C) (Qualified, anomalous output from C from 2600 to 3000 s).

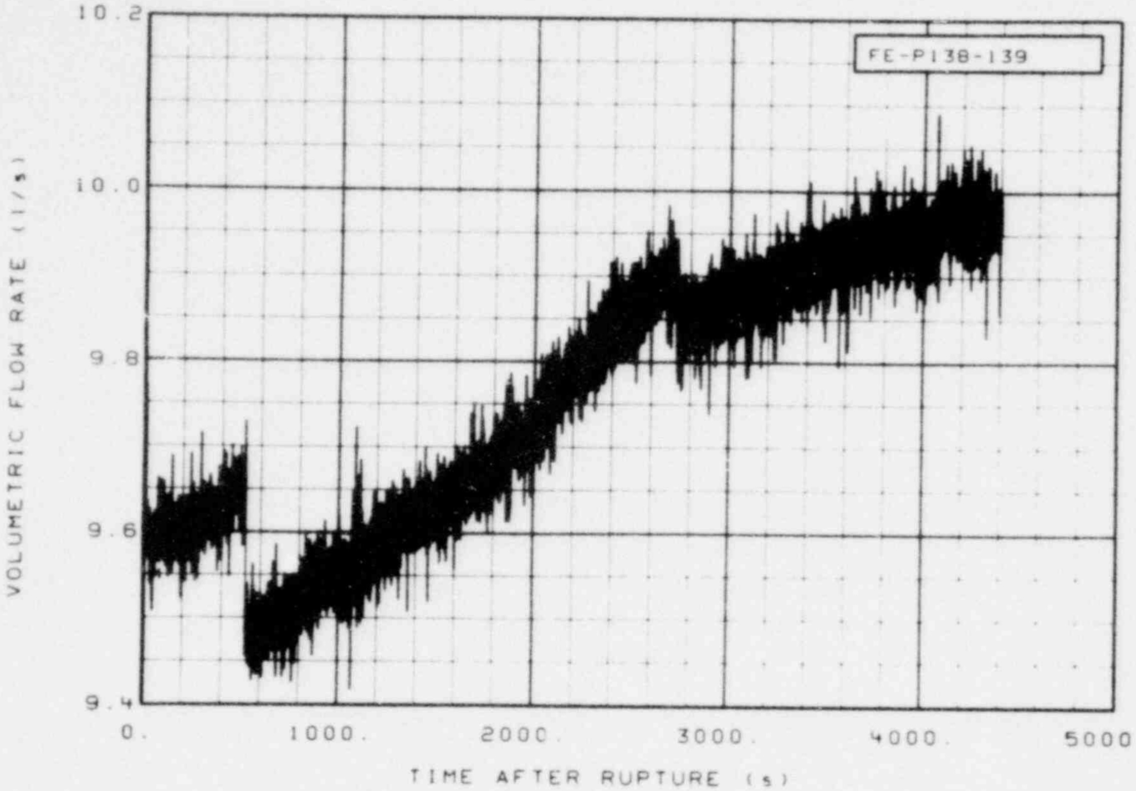


Figure 89. Flow rate in blowdown suppression tank spray system pump discharge line (FE-P138-139) (Qualified).

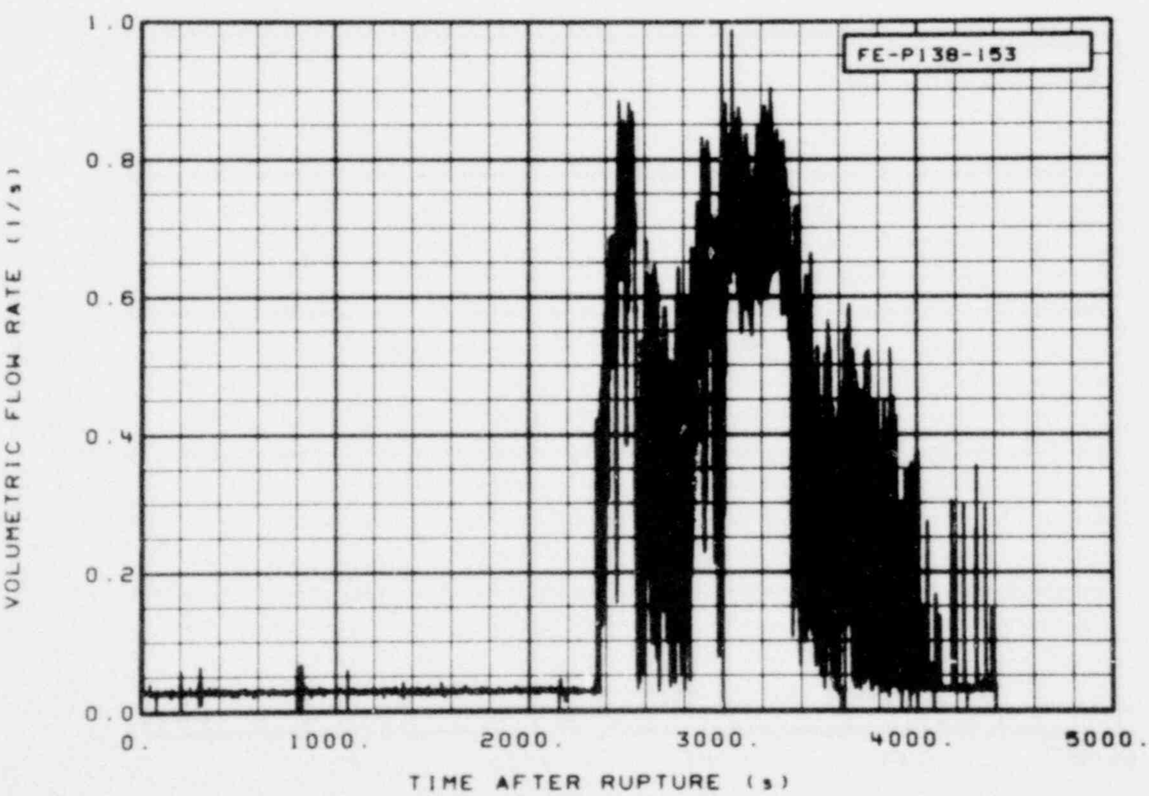


Figure 90. Flow rate in blowdown suppression tank spray system pump recirculation line (FE-P138-153) (Qualified).

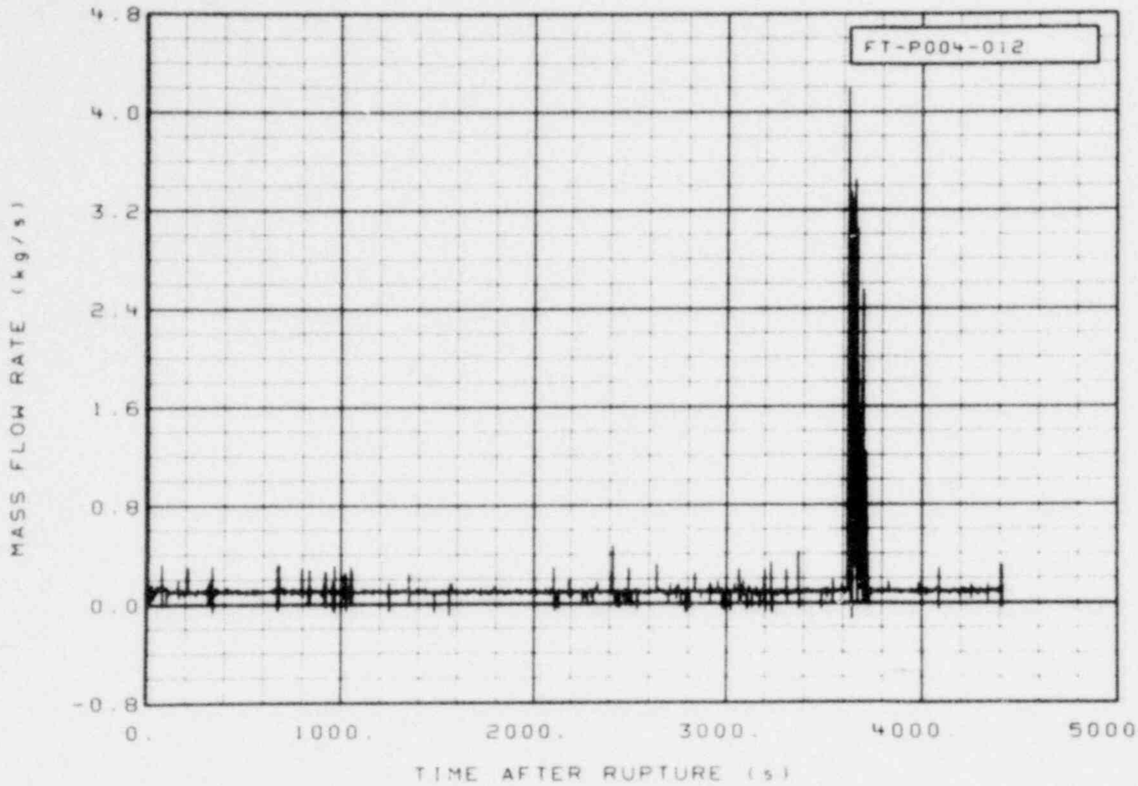


Figure 91. Steam flow rate at condenser inlet (FT-P004-012) (Qualified).

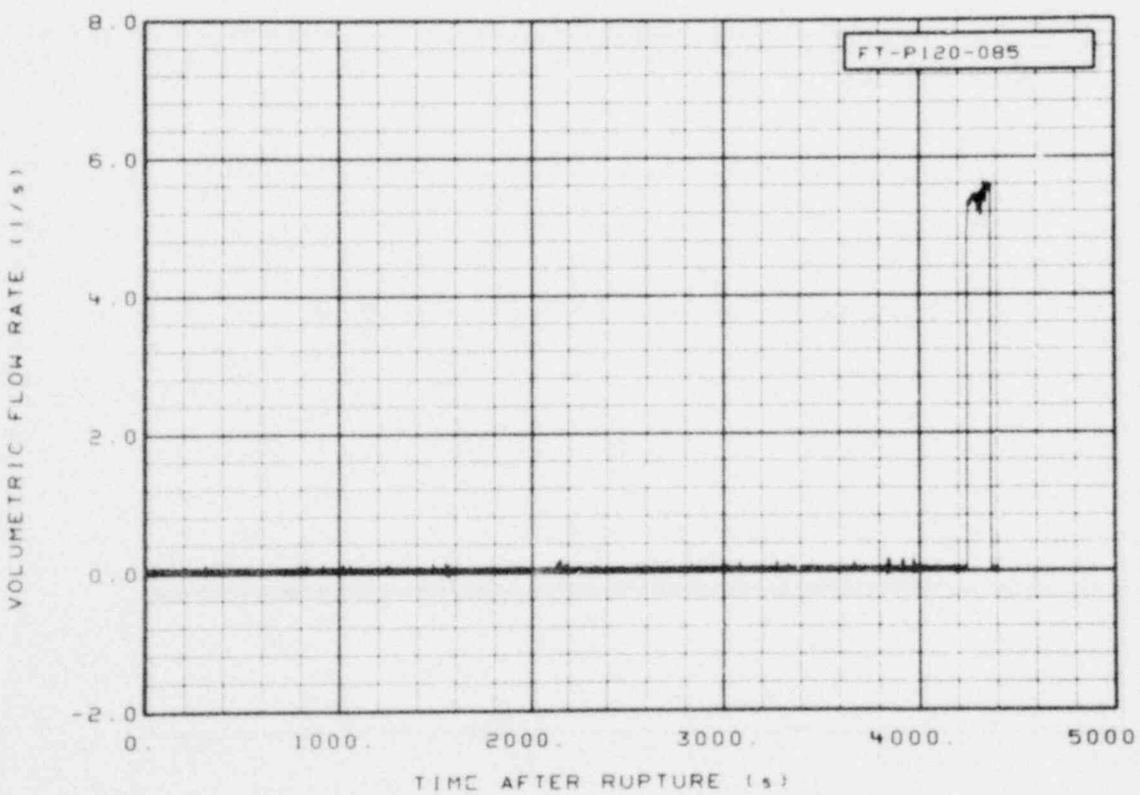


Figure 92. Flow rate in LPIS Pump A discharge (FT-P120-085) (Qualified).

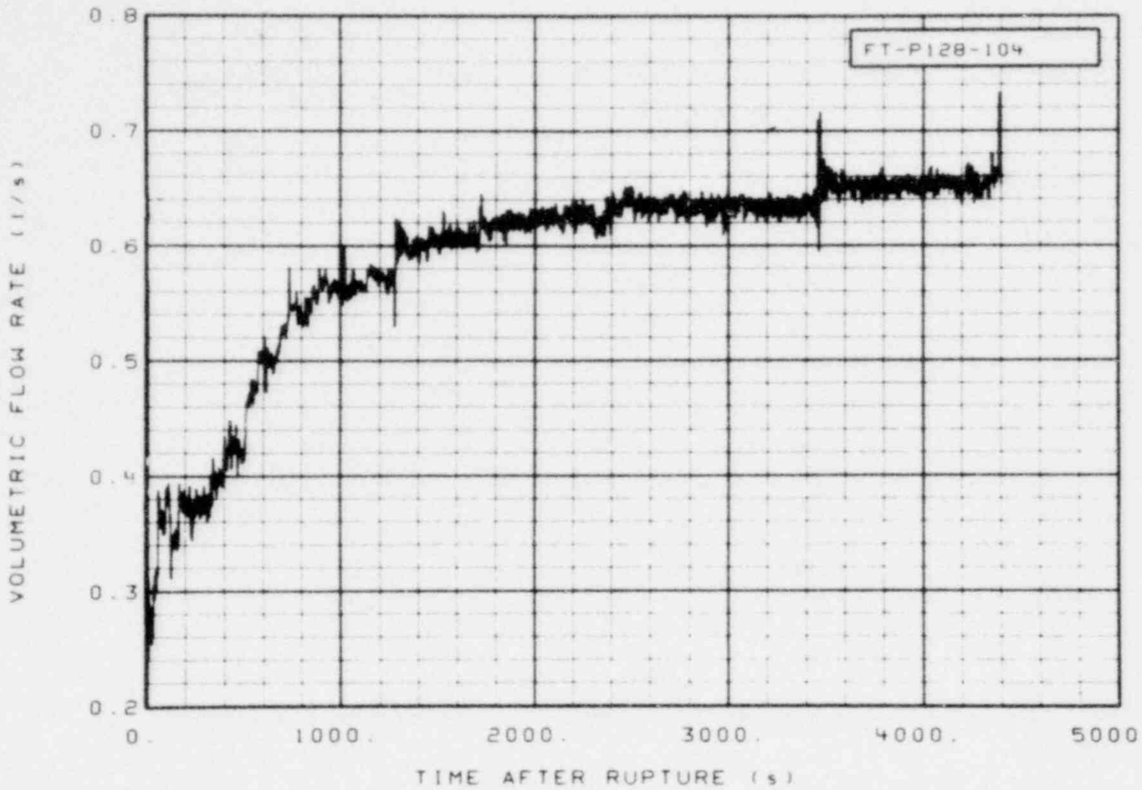


Figure 93. Flow rate in HPIS Pump A discharge (FT-P128-104) (Qualified, IC = 0.0 l/s).

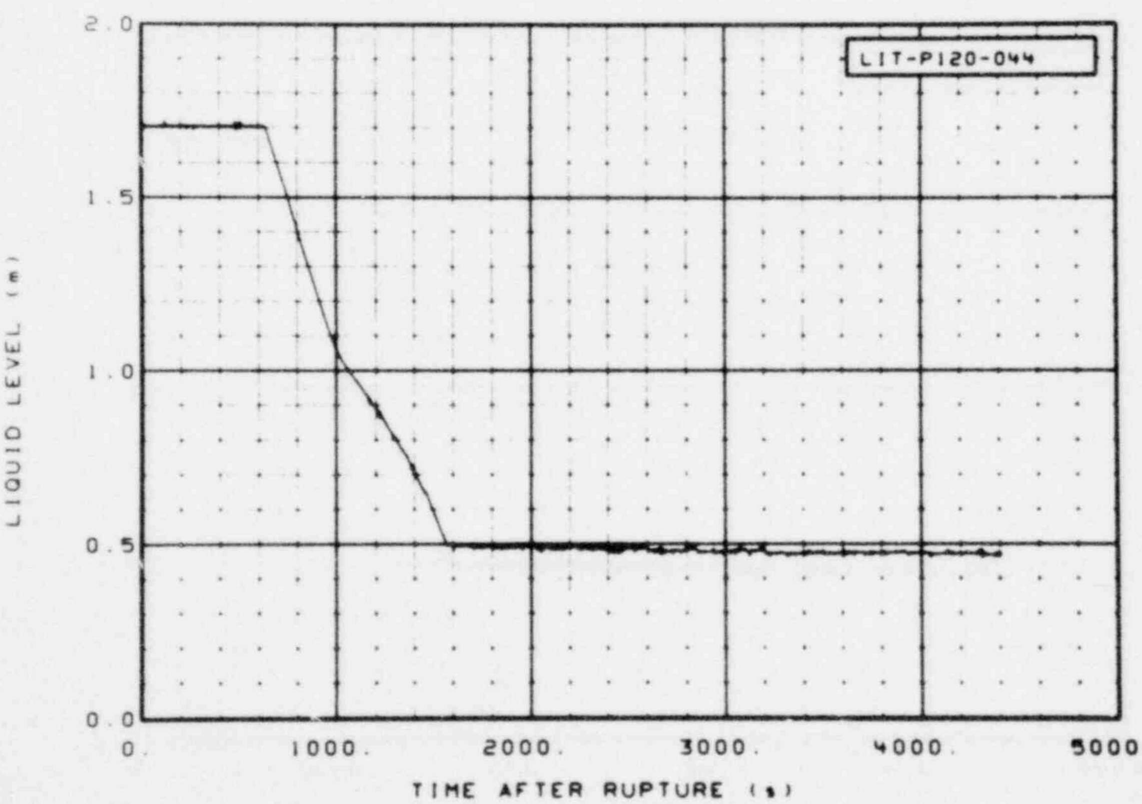


Figure 94. Liquid level in ECCS Accumulator A (LIT-P120-044) (Qualified).

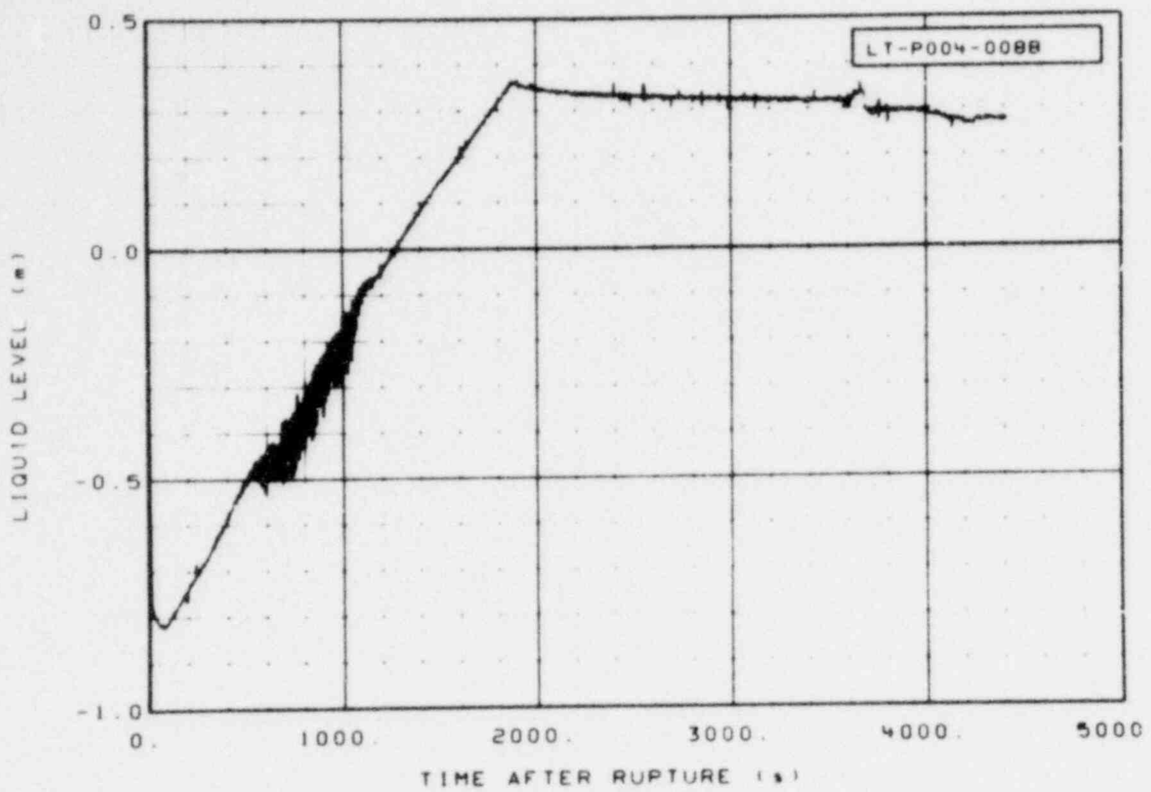


Figure 95. Liquid level in steam generator secondary side, wide range (LT-P004-008B) (Qualified, does not indicate correct level during transient, IC = 0.20 m).

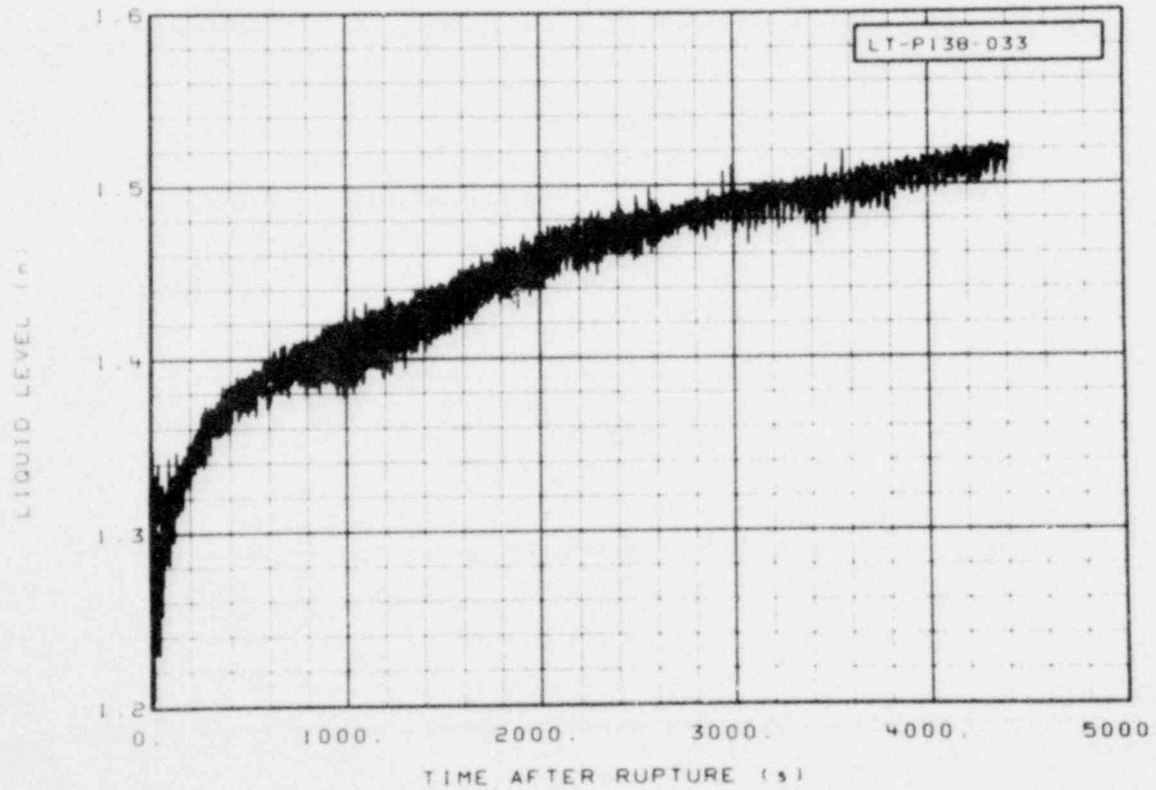


Figure 96. Liquid level in blowdown suppression tank, north end (LT-P138-033) (Qualified).

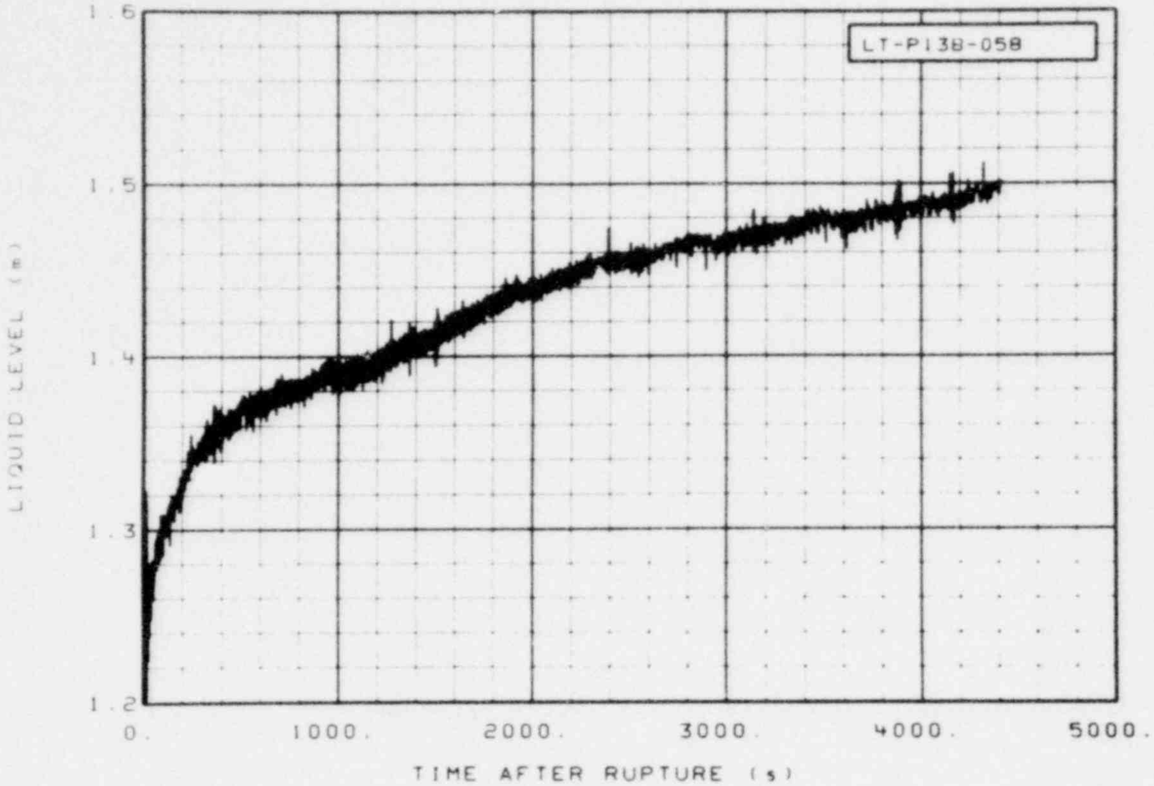


Figure 97. Liquid level in blowdown suppression tank, south end (LT-P138-058) (Qualified).

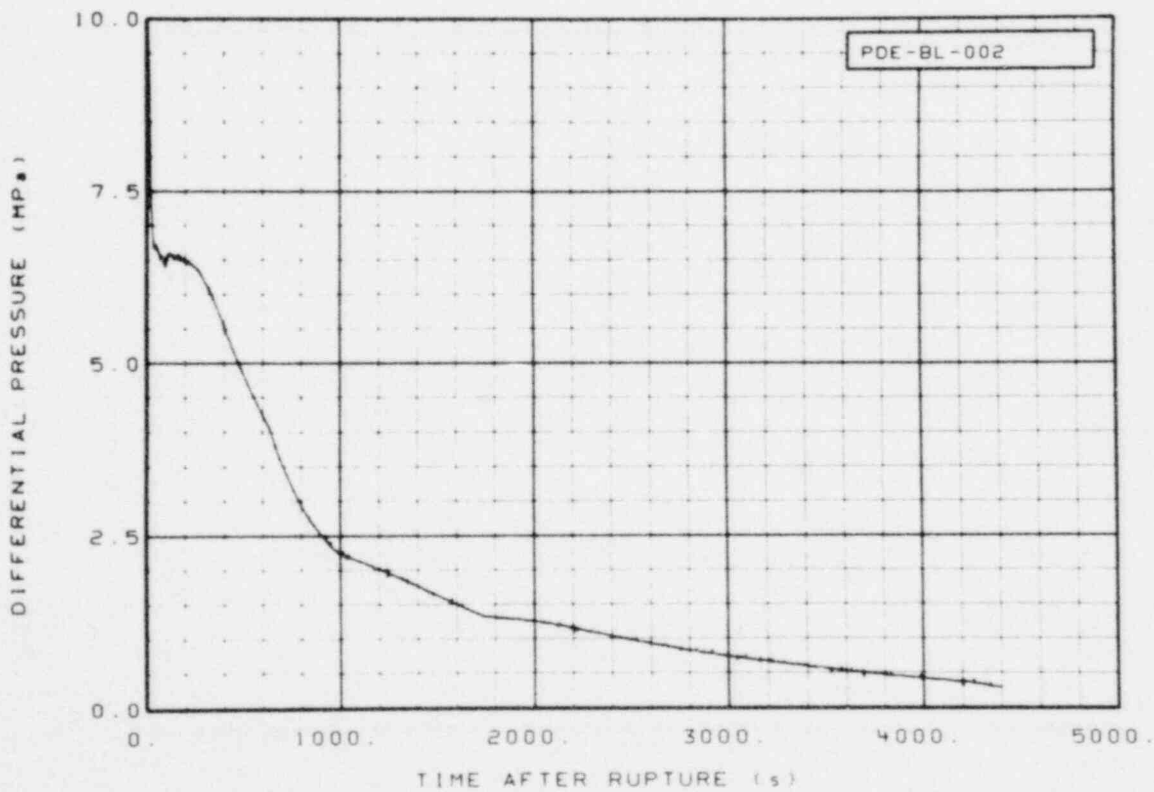


Figure 98. Differential pressure in broken loop cold leg across small break orifice (PDE-BL-002) (Qualified, for short term response see Figure 33).

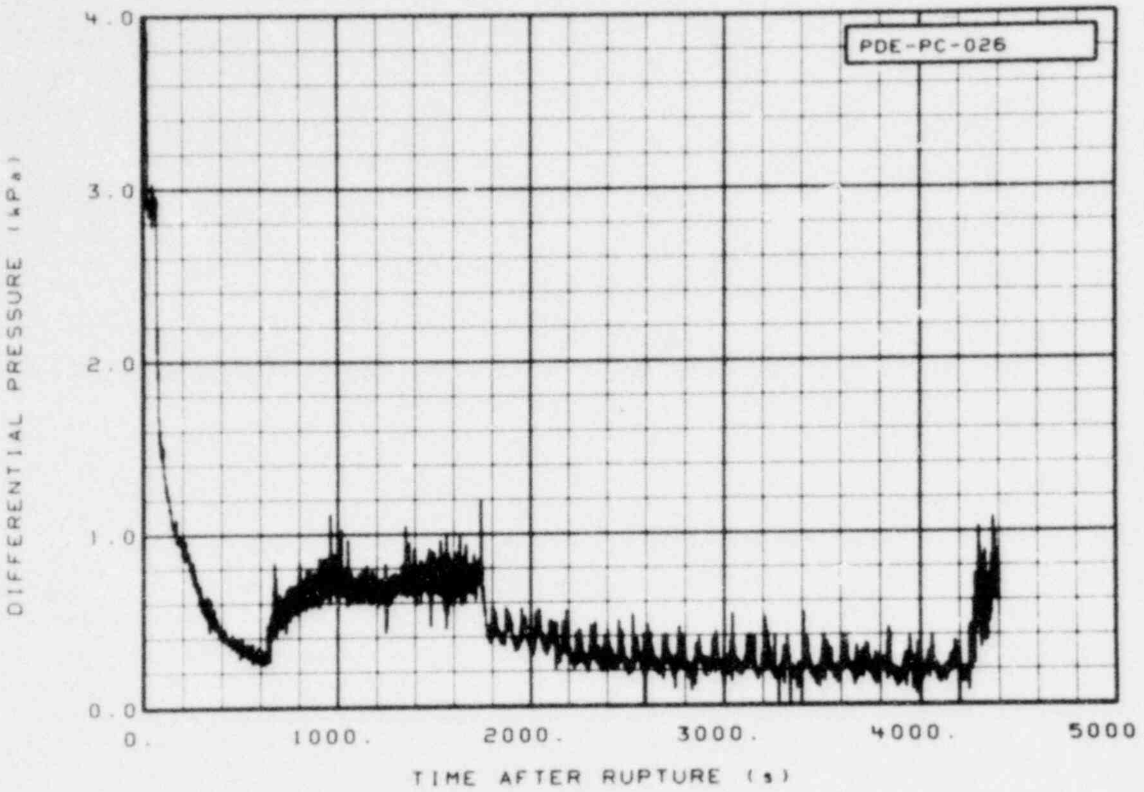


Figure 99. Differential pressure in intact loop cold leg across ECC Rake 2 bottom pitot tube facing pumps (PDE-PC-026) (Qualified, IC = 29.0 kPa).

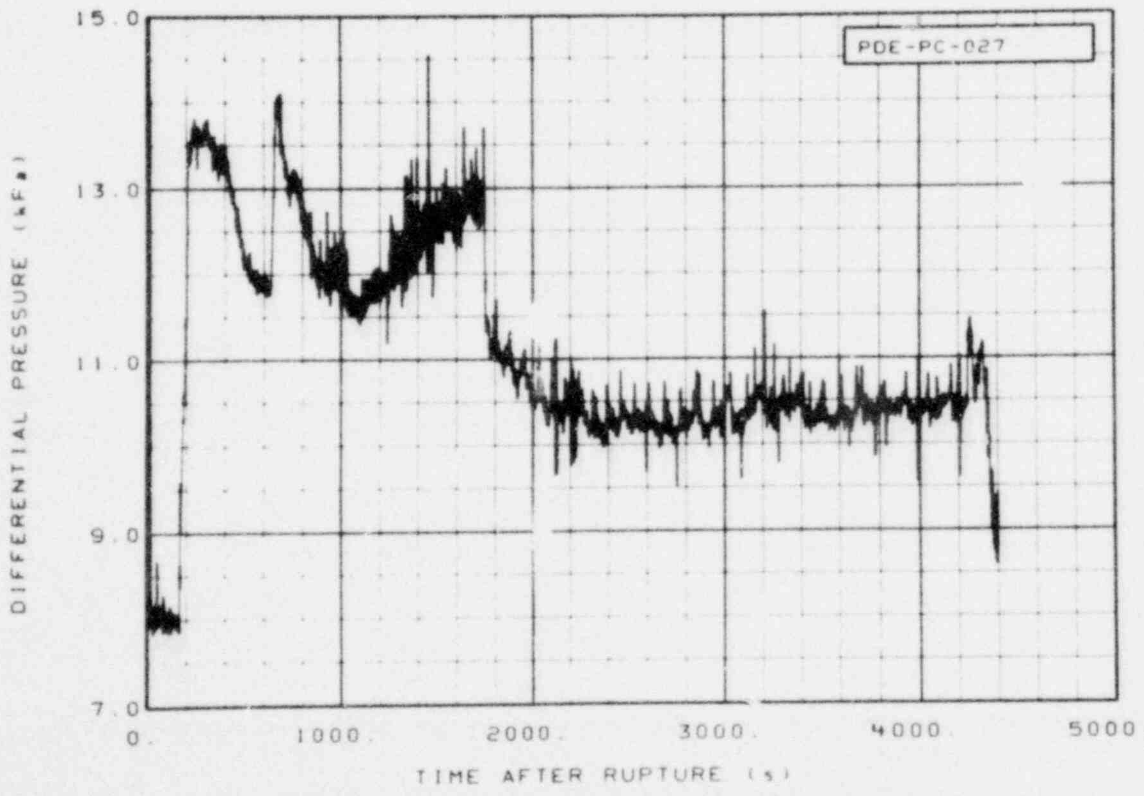


Figure 100. Differential pressure in intact loop from steam generator outlet to bottom of loop seal (PDE-PC-027) (Qualified, minimum forced to 7.23 kPa, IC = 50 kPa, voiding of the pipe increases the differential pressure).

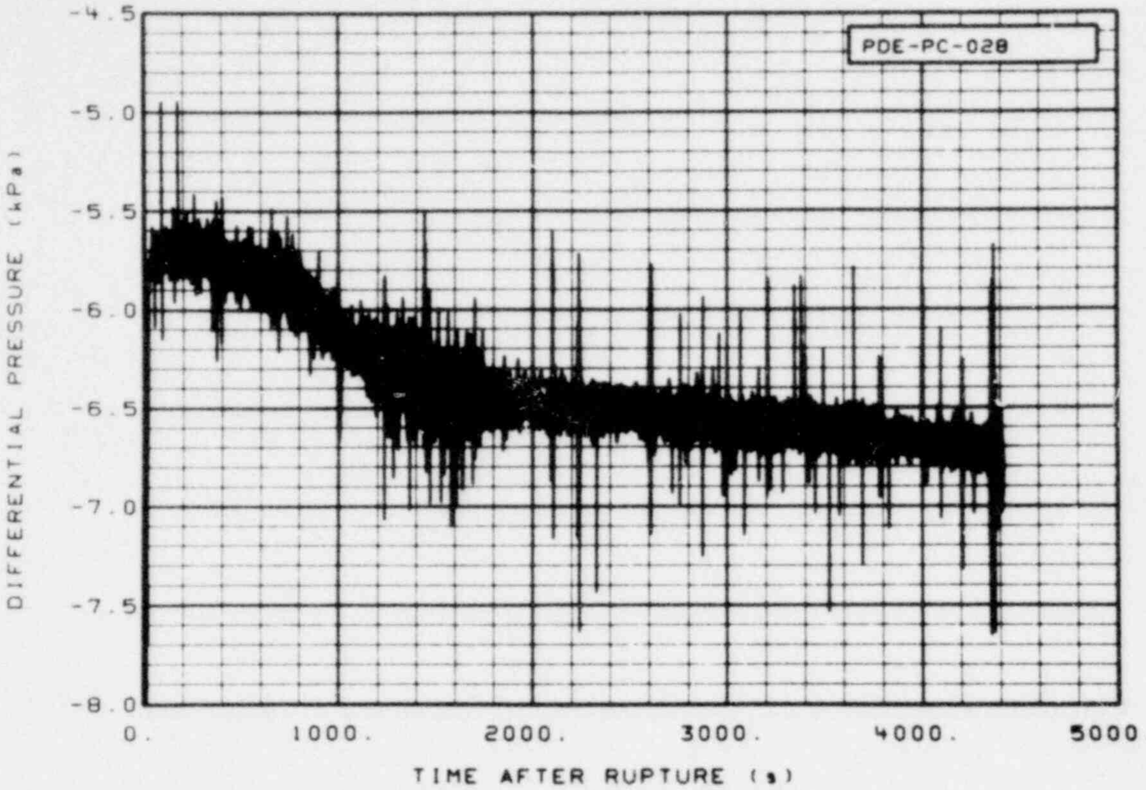


Figure 101. Differential pressure in intact loop from bottom of loop seal to primary coolant Pump 2 inlet (PDE-PC-028) (Qualified, forced to -5.6 kPa at zero flow (about 60 s), IC = -31 kPa, voiding of the pipe increases the differential pressure).

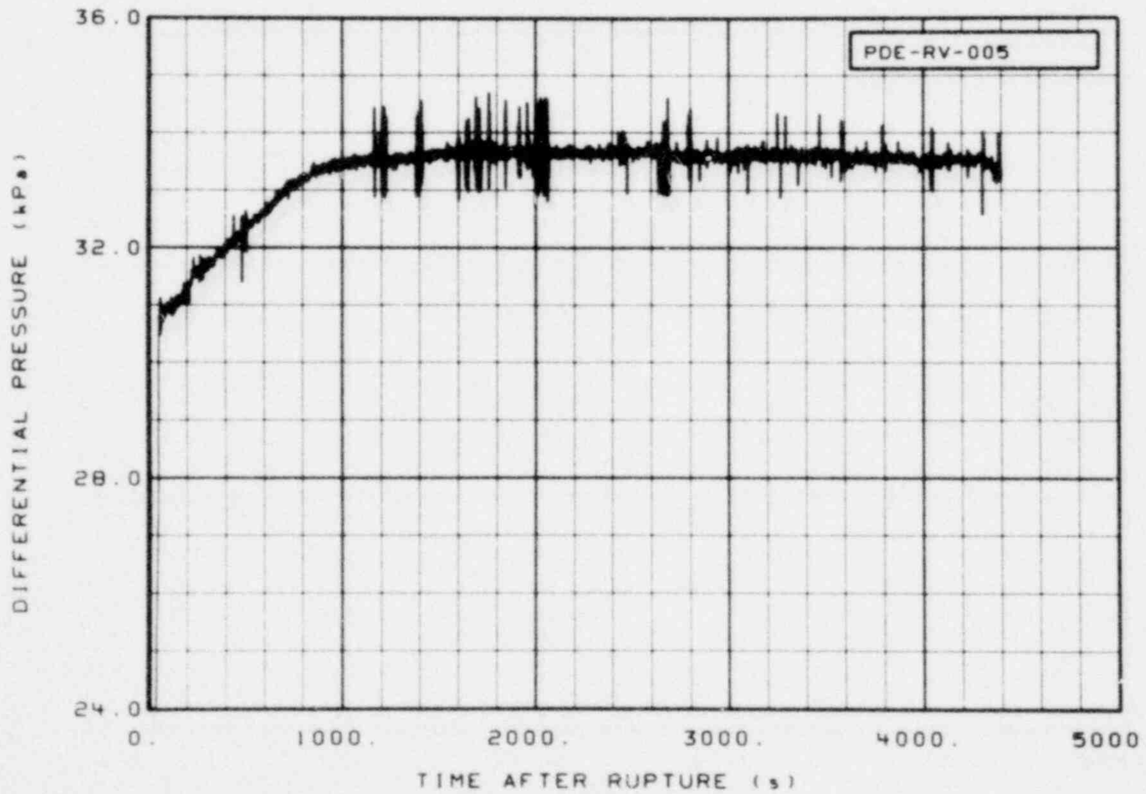


Figure 102. Differential pressure in reactor vessel from vessel top to intact loop hot leg outlet (PDE-RV-005) (Qualified, minimum forced to 14.5 kPa, use caution when converting to level, for short term response see Figure 45).

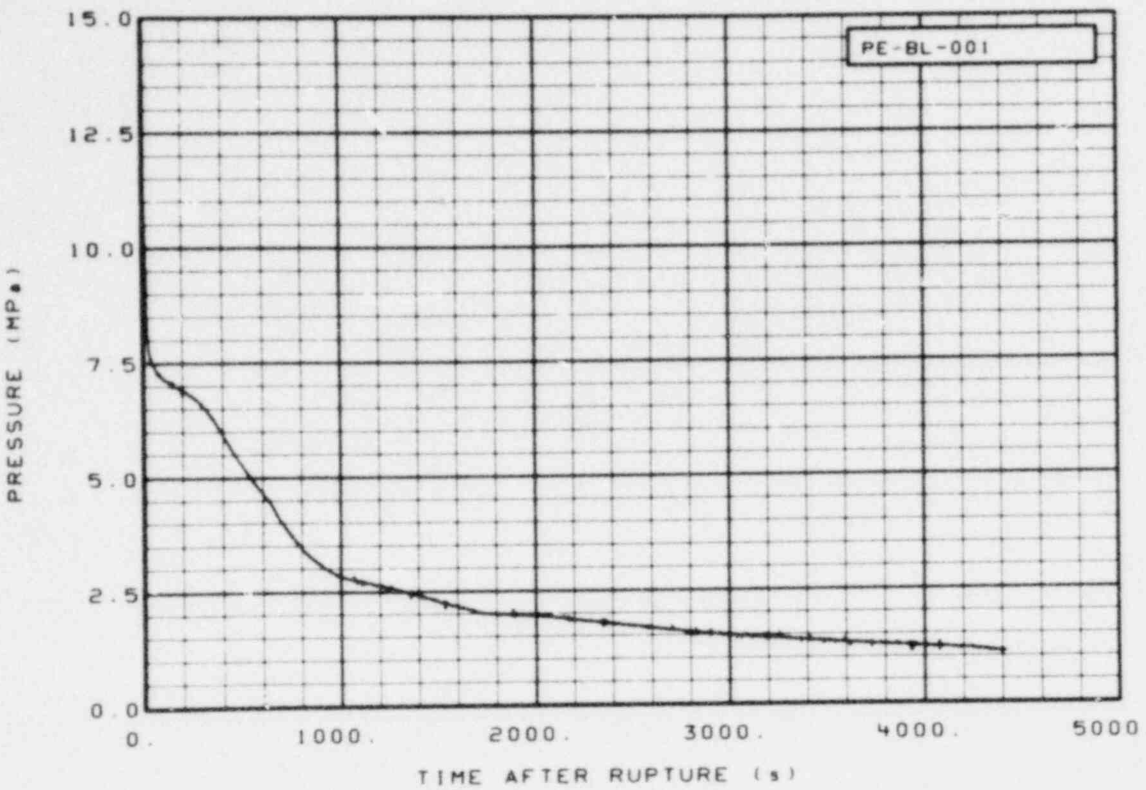


Figure 103. Pressure in broken loop cold leg (PE-BL-001) (Qualified, IC = 15.0 MPa).

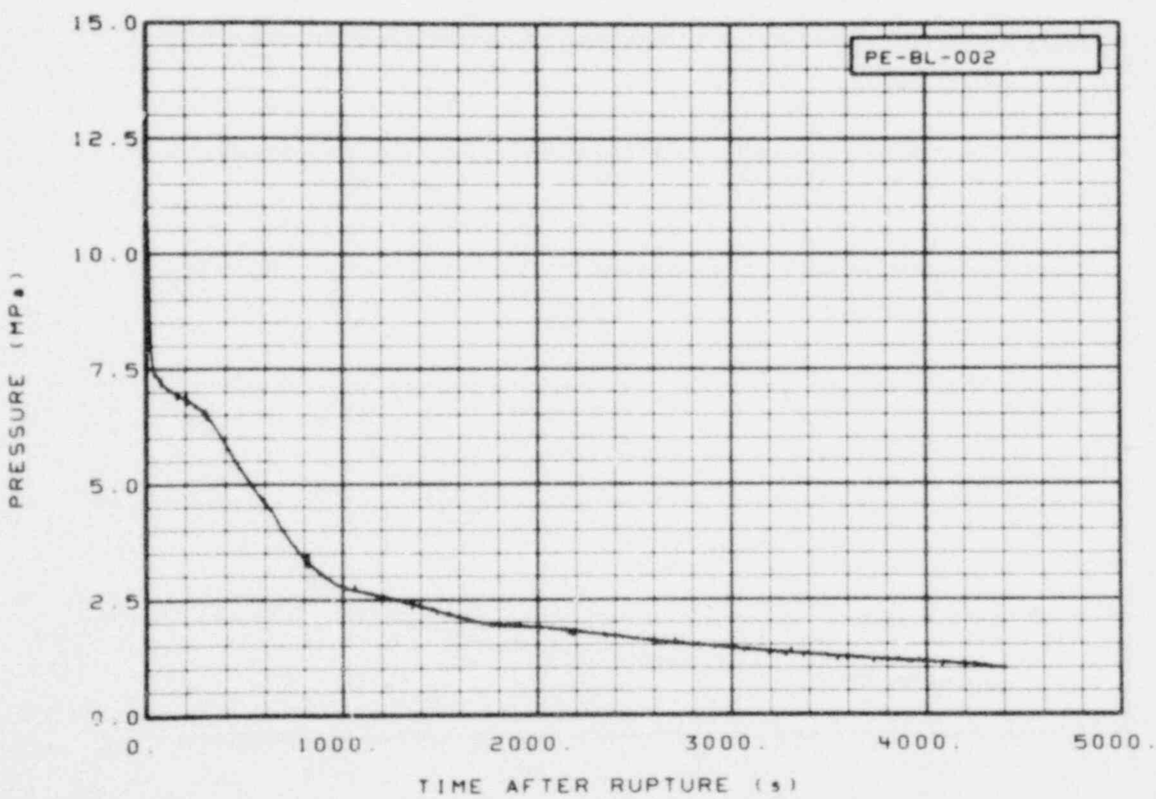


Figure 104. Pressure in broken loop hot leg (PE-BL-002) (Qualified, IC = 14.8 MPa).

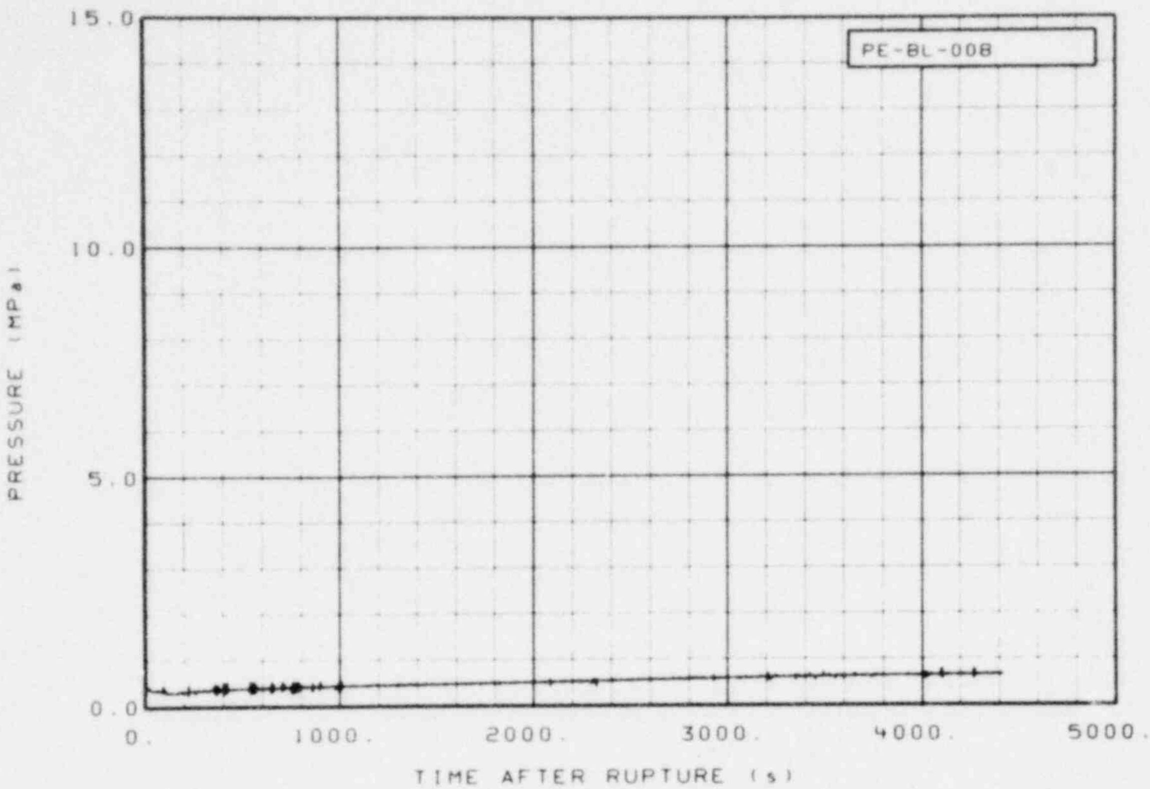


Figure 105. Pressure in broken loop cold leg 8-inch pipe (PE-BL-008) (Qualified, IC = 15.0 MPa).

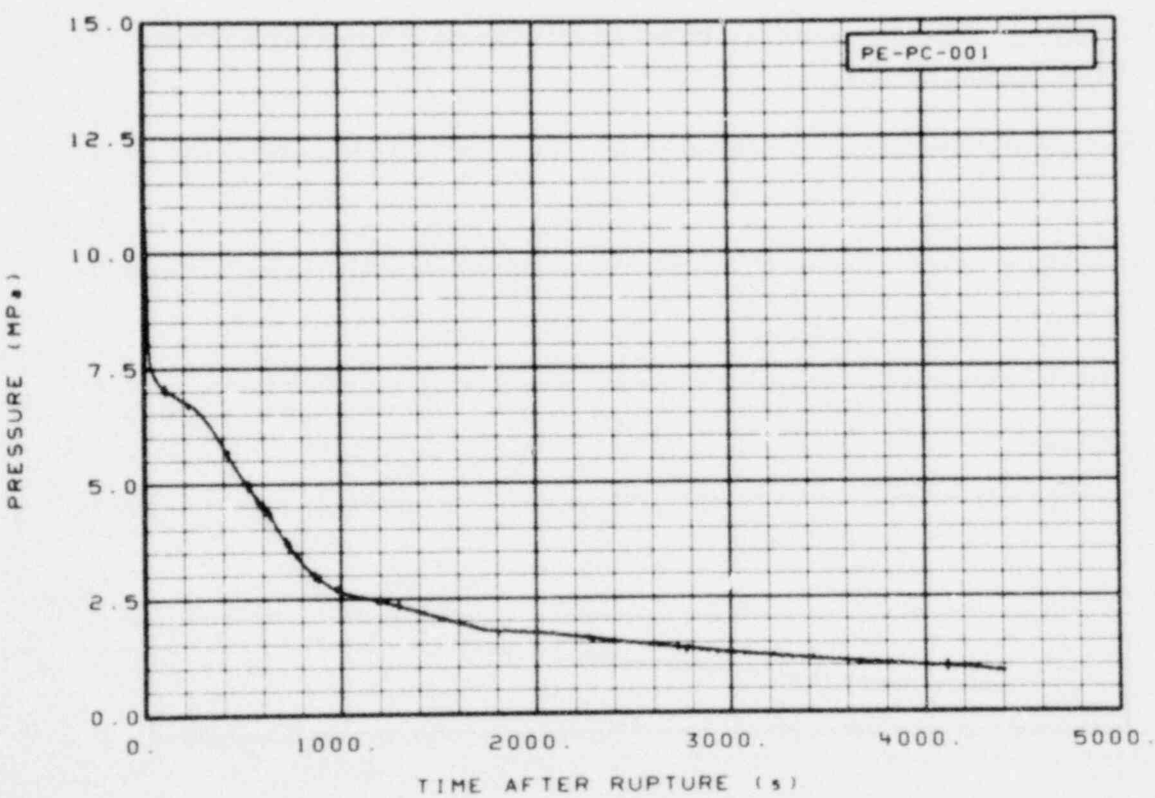


Figure 106. Pressure in intact loop cold leg (PE-PC-001) (Qualified, IC = 15.0 MPa).

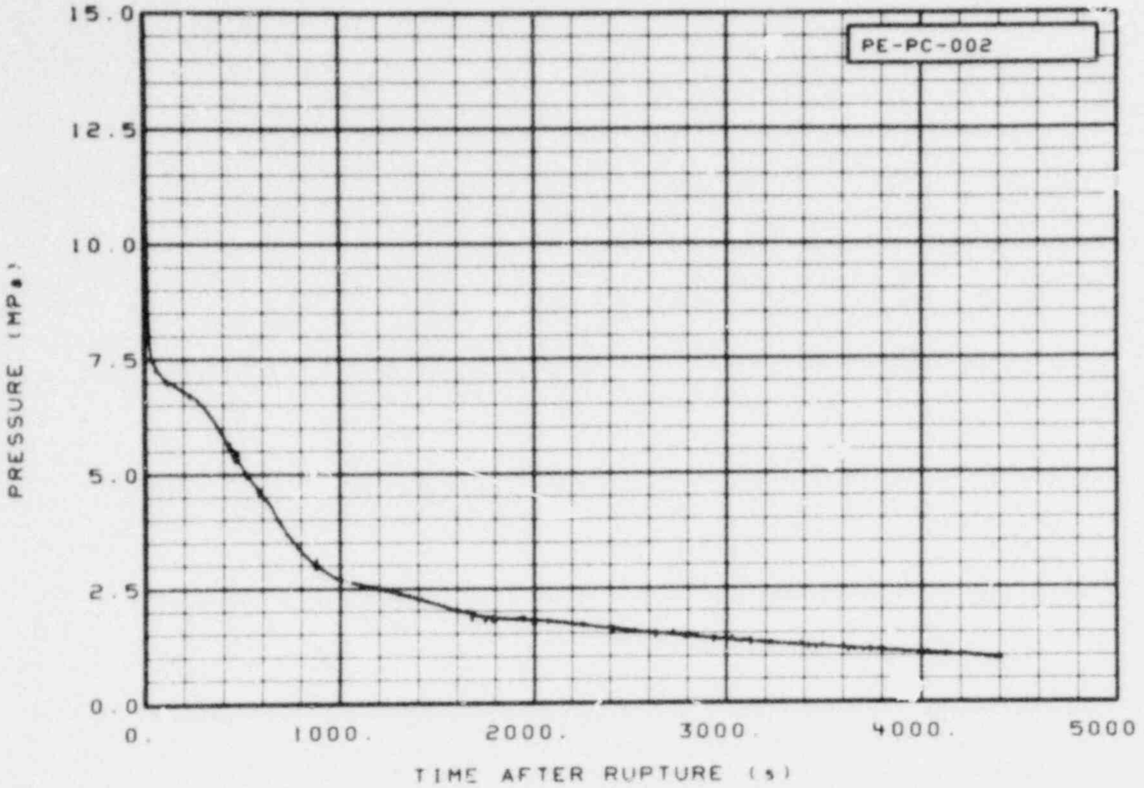


Figure 107. Pressure in intact loop hot leg (PE-PC-002) (Qualified, IC = 14.85 MPa).

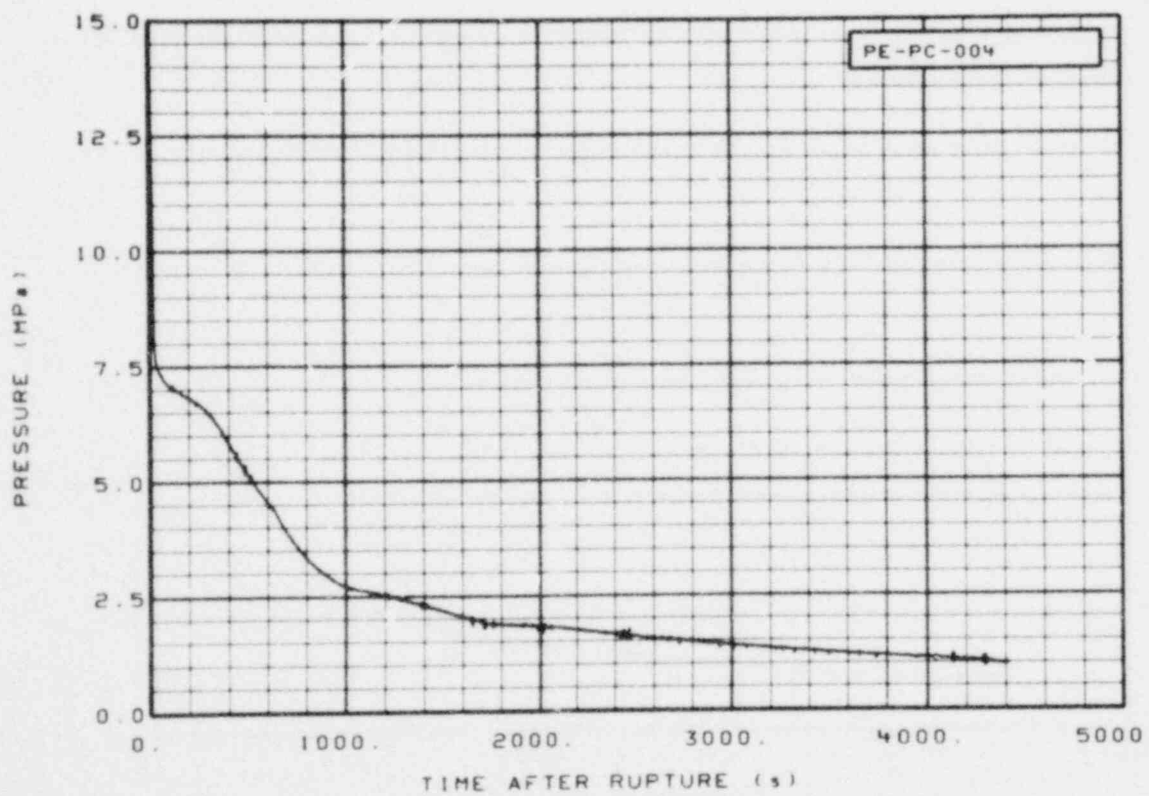


Figure 108. Pressure in pressurizer (PE-PC-004) (Qualified, IC = 14.8 MPa).

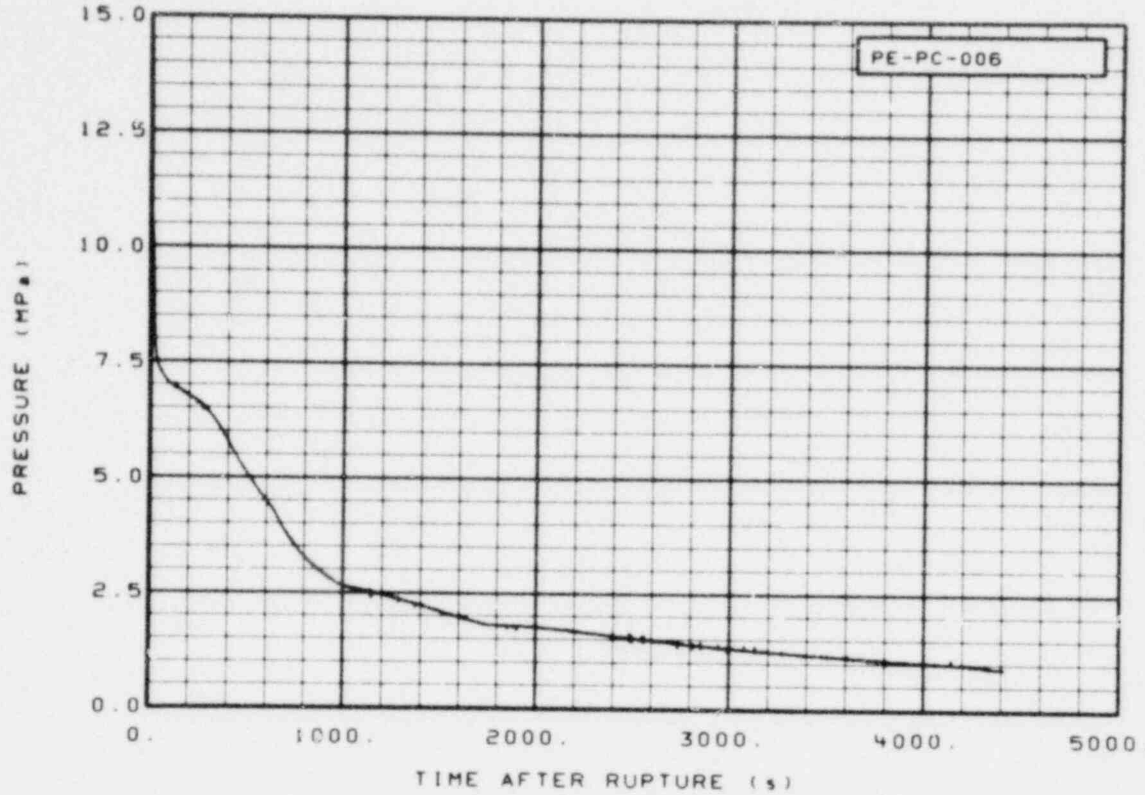


Figure 109. Reference pressure in intact loop (PE-PC-006) (Qualified, IC = 14.5 MPa).

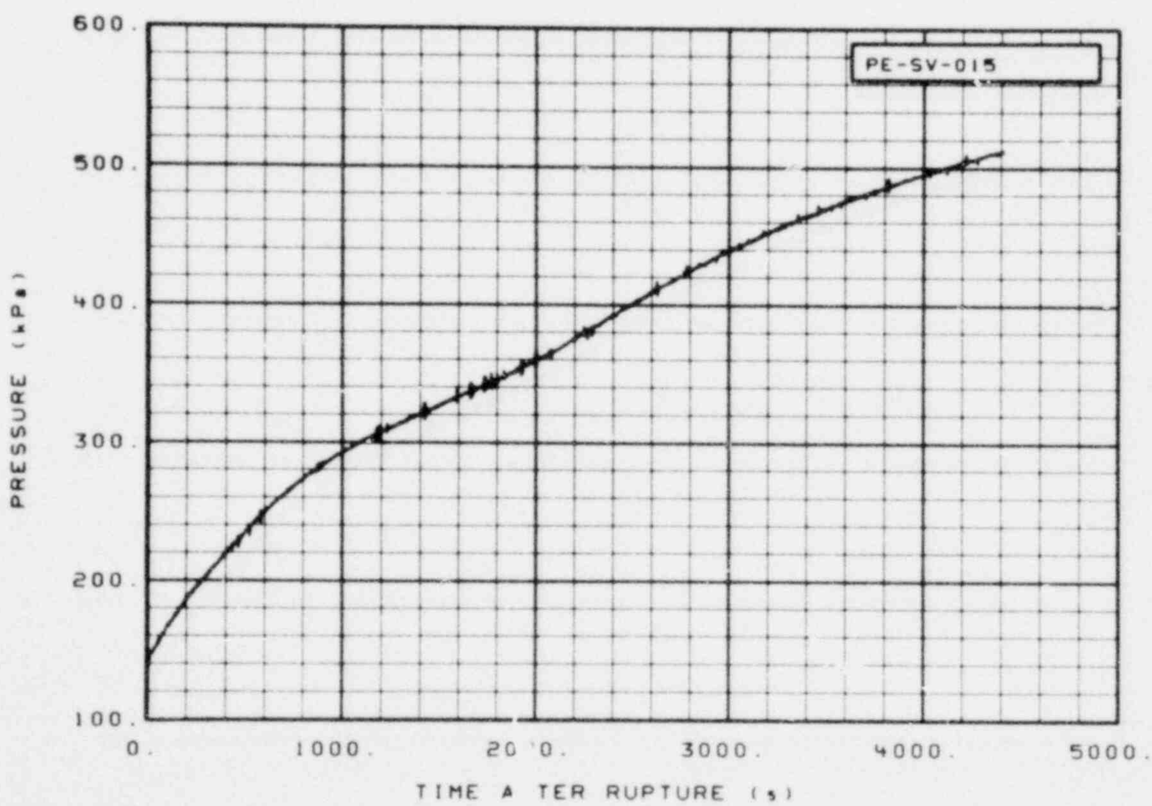


Figure 110. Pressure in blowdown suppression tank su merged near Downcomer 4 (PE-SV-015) (Qualified, IC = 107.3 kPa).

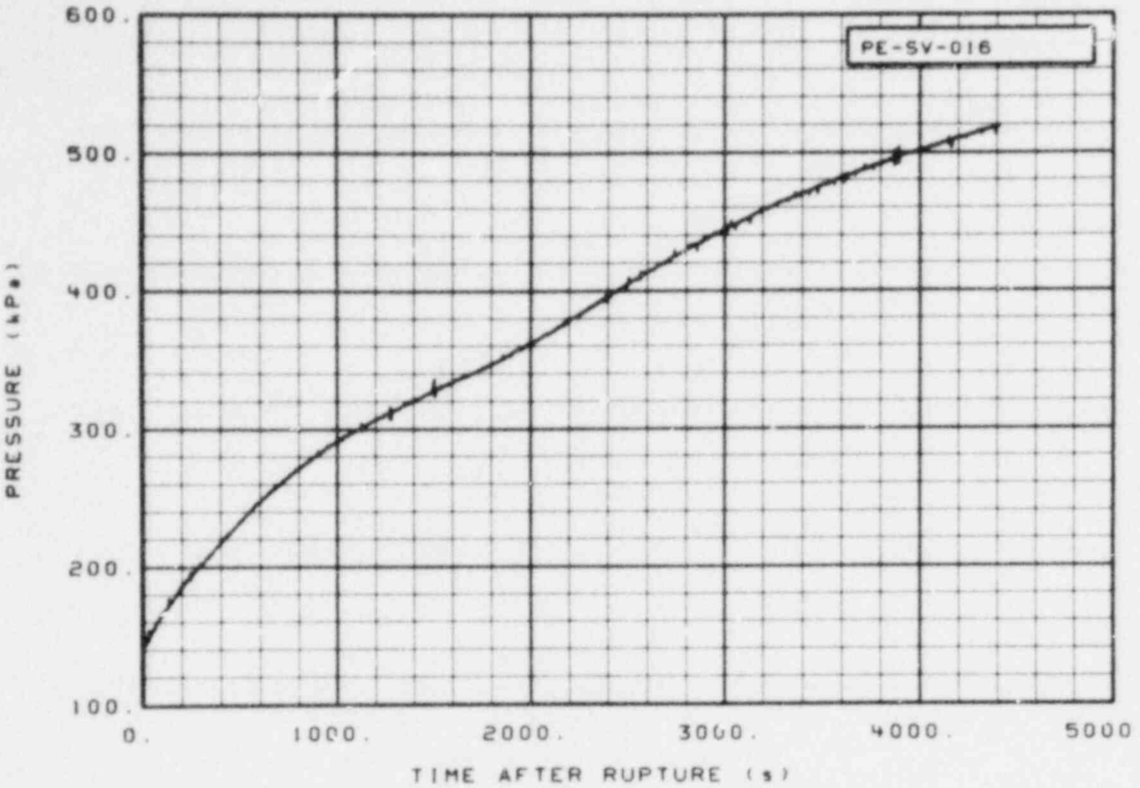


Figure 111. Pressure in blowdown suppression tank submerged near Downcomer 1 (PE-SV-016) (Qualified, IC = 107.7 kPa).

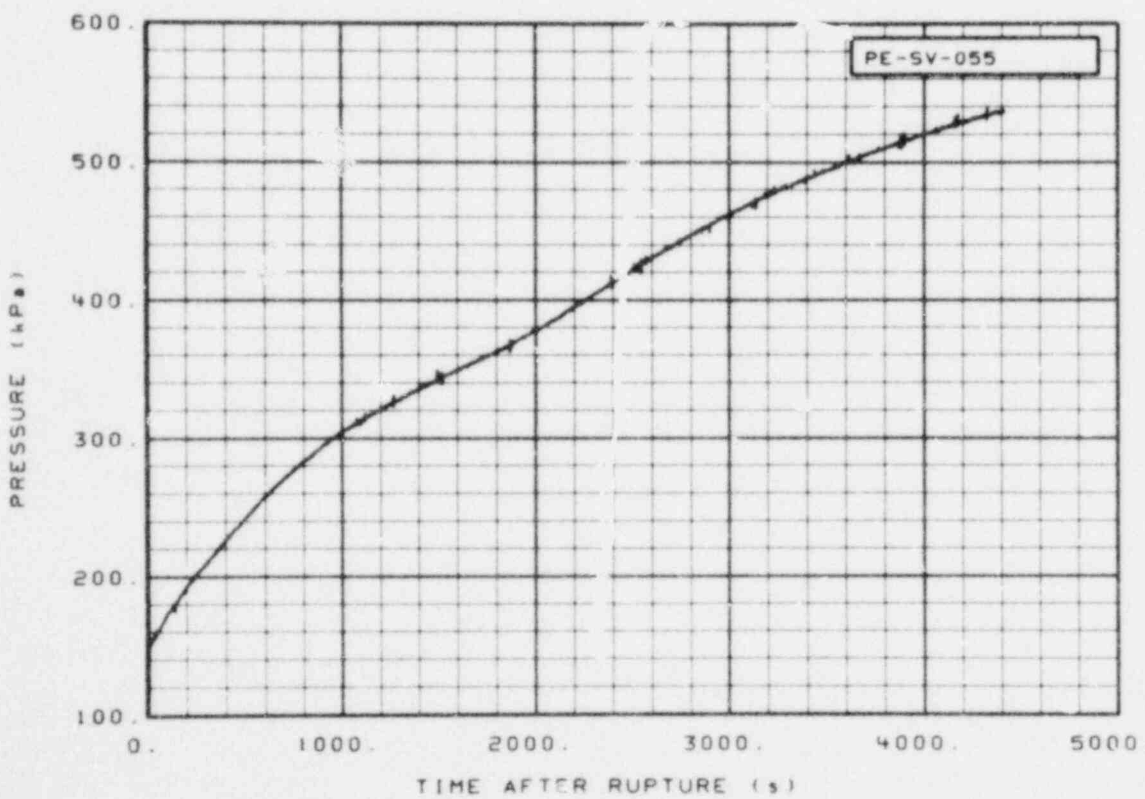


Figure 112. Pressure in blowdown suppression tank top north of Downcomer 4 (PE-SV-055) (Qualified, IC = 114.2 kPa).

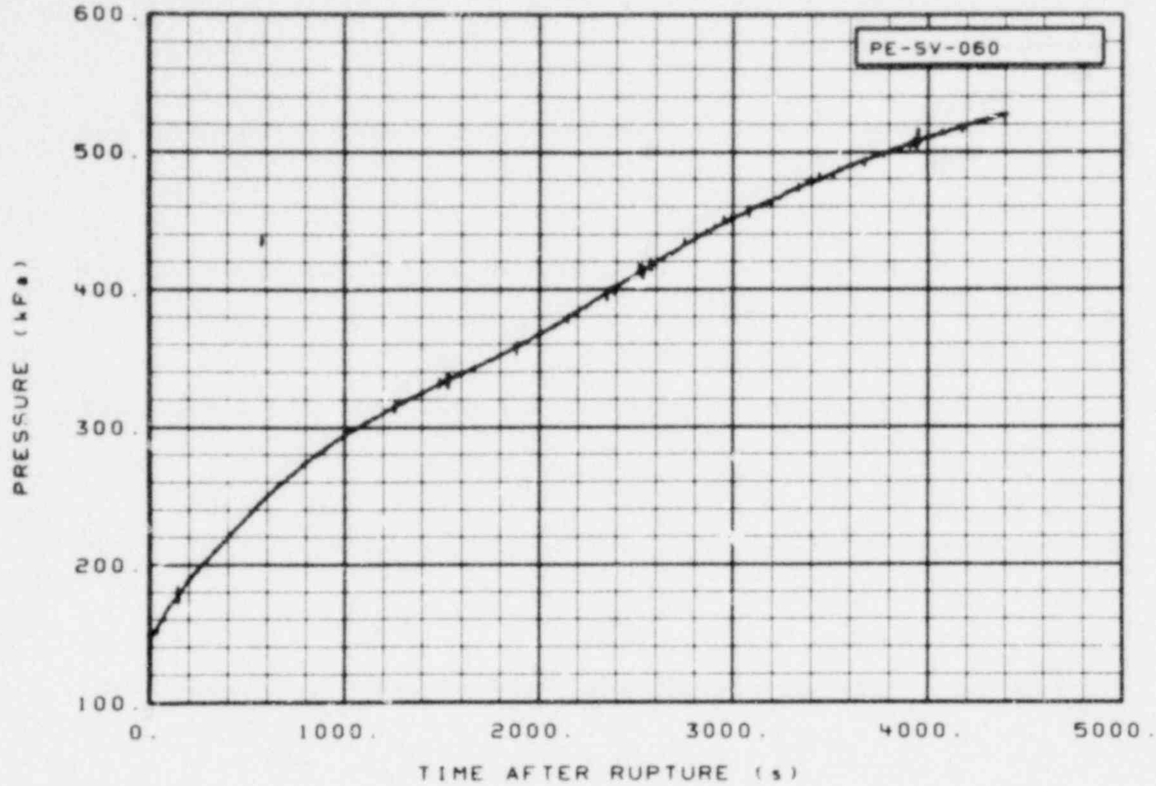


Figure 113. Pressure in blowdown suppression tank top above Downcomer 1 (PE-SV-060) (Qualified, IC = 111.0 kPa).

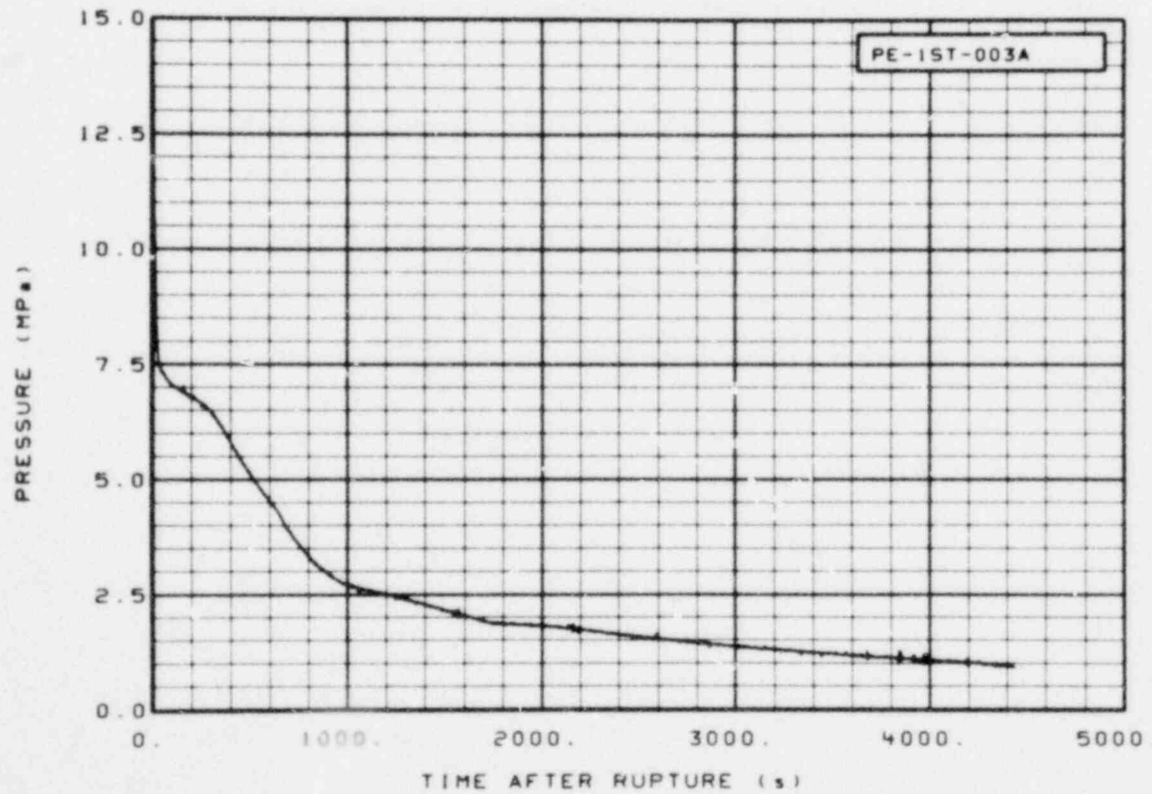


Figure 114. Pressure in reactor vessel Downcomer Stalk 1 (PE-1ST-003A) (Qualified, IC = 15.0 MPa).

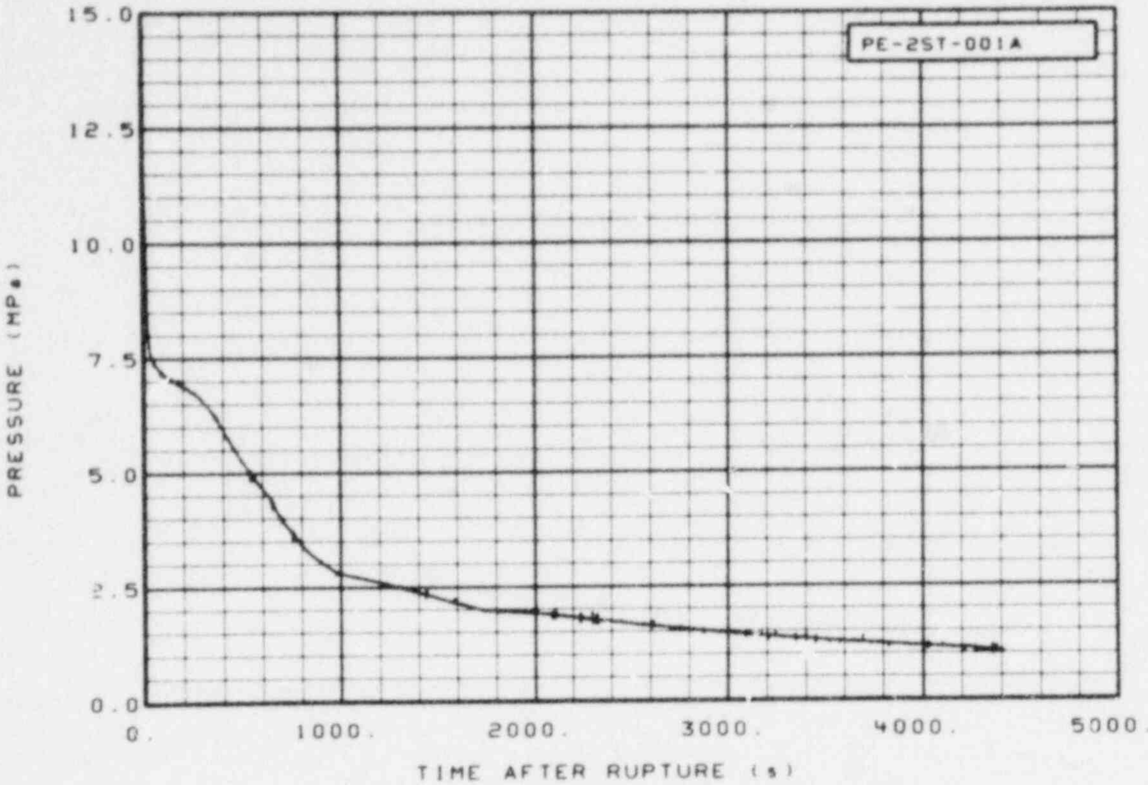


Figure 115. Pressure in reactor vessel Downcomer Stalk 2 (PE-2ST-001A) (Qualified, IC = 15.1 MPa).

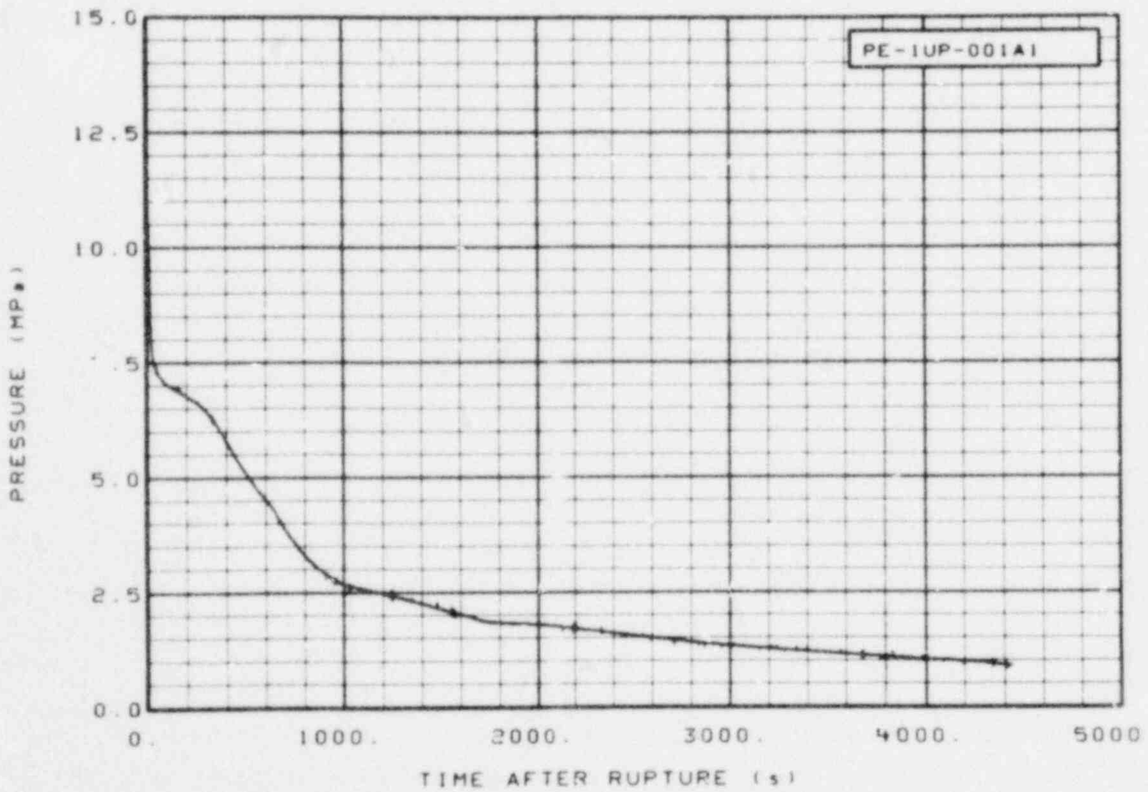


Figure 116. Pressure in reactor vessel above upper end box of Fuel Assembly 1 (PE-1UP-001A1) (Qualified, IC = 14.9 MPa).

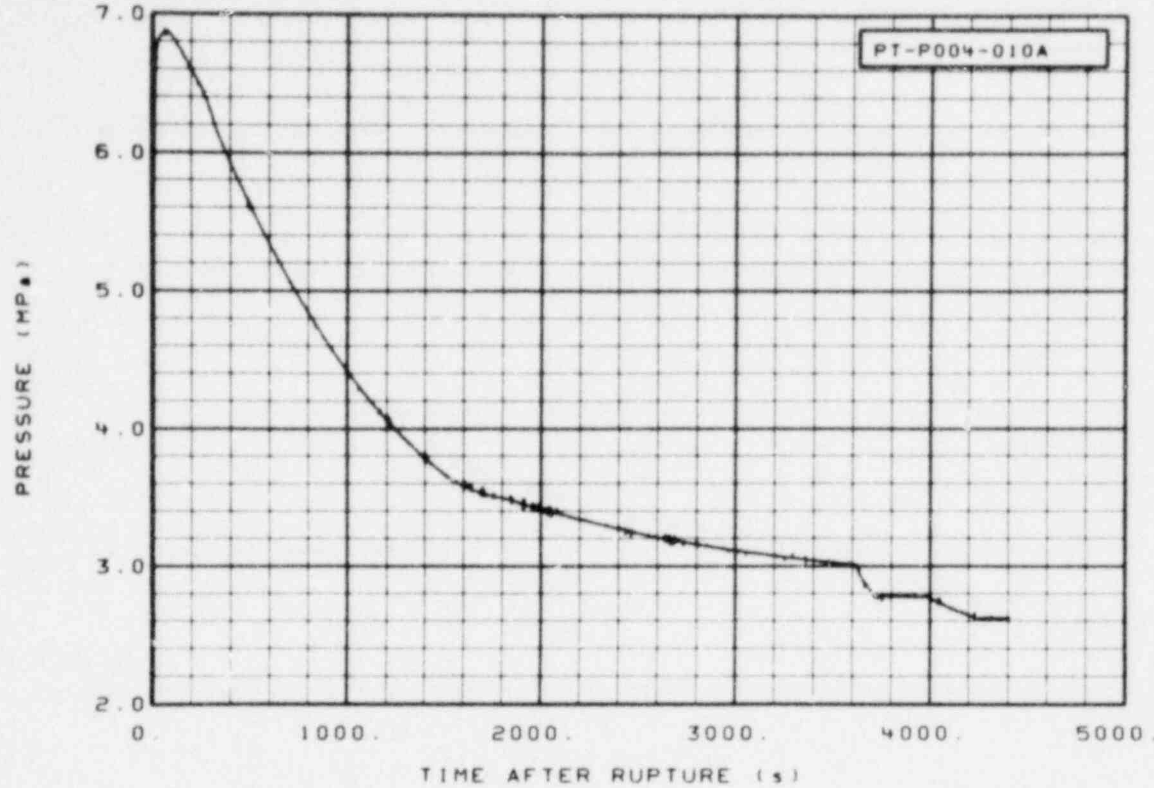


Figure 117. Pressure in steam generator secondary side 10-inch outlet (PT-P004-010A) (Qualified, IC = 5.43 MPa).

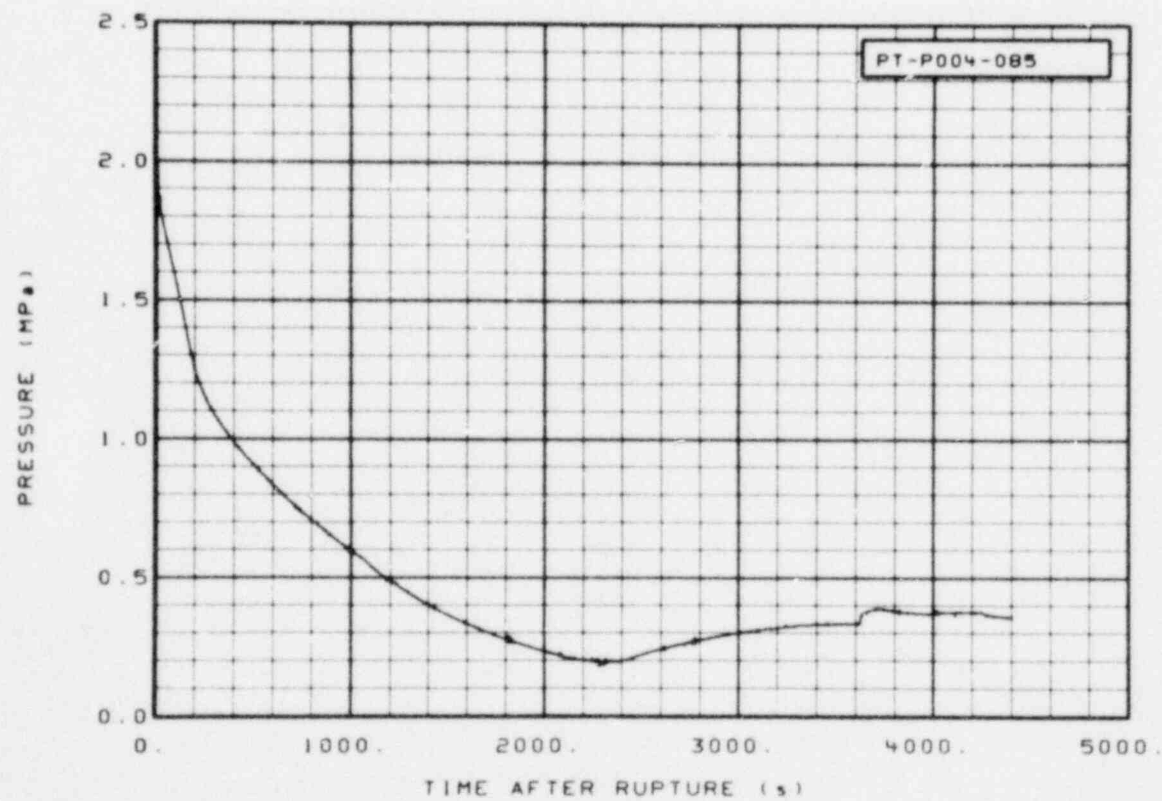


Figure 118. Pressure in secondary coolant system condenser 12-inch inlet (PT-P004-085) (Qualified, IC = 2.1 MPa).

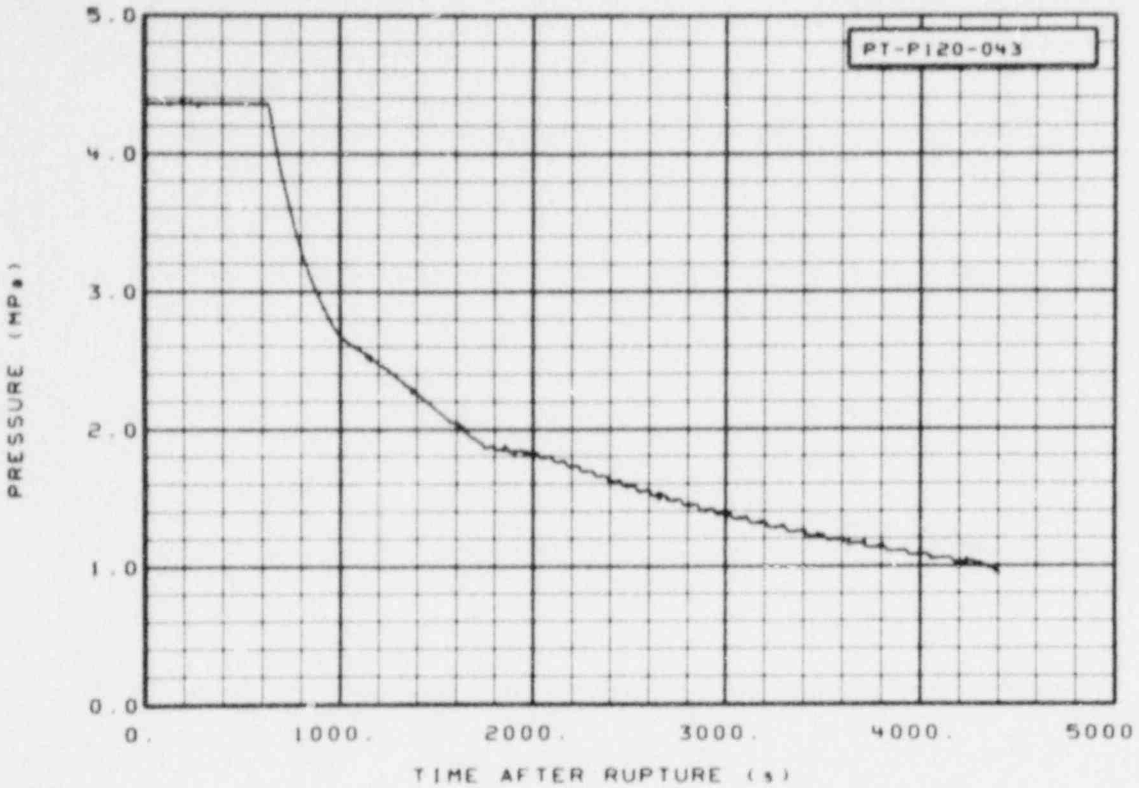


Figure 119. Pressure in ECCS Accumulator A (PT-P120-043) (Qualified).

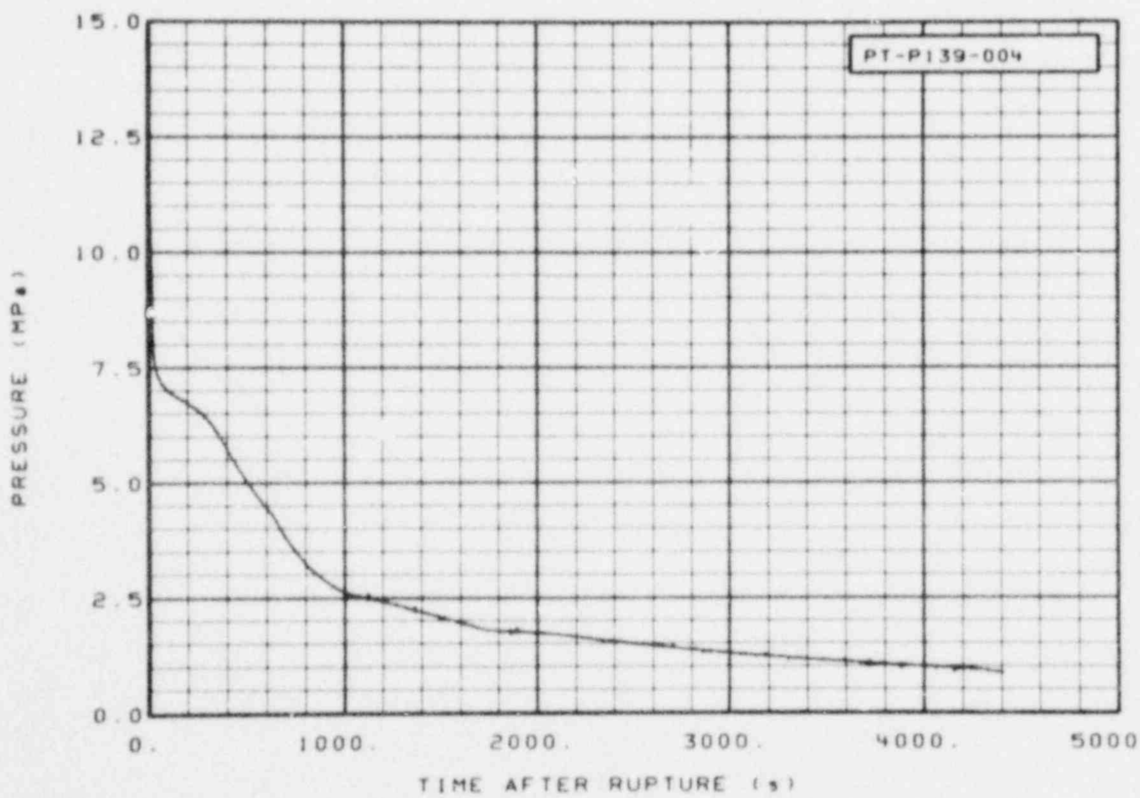


Figure 120. Pressure in intact loop hot leg (PT-P139-004) (Qualified, IC = 14.85 MPa).

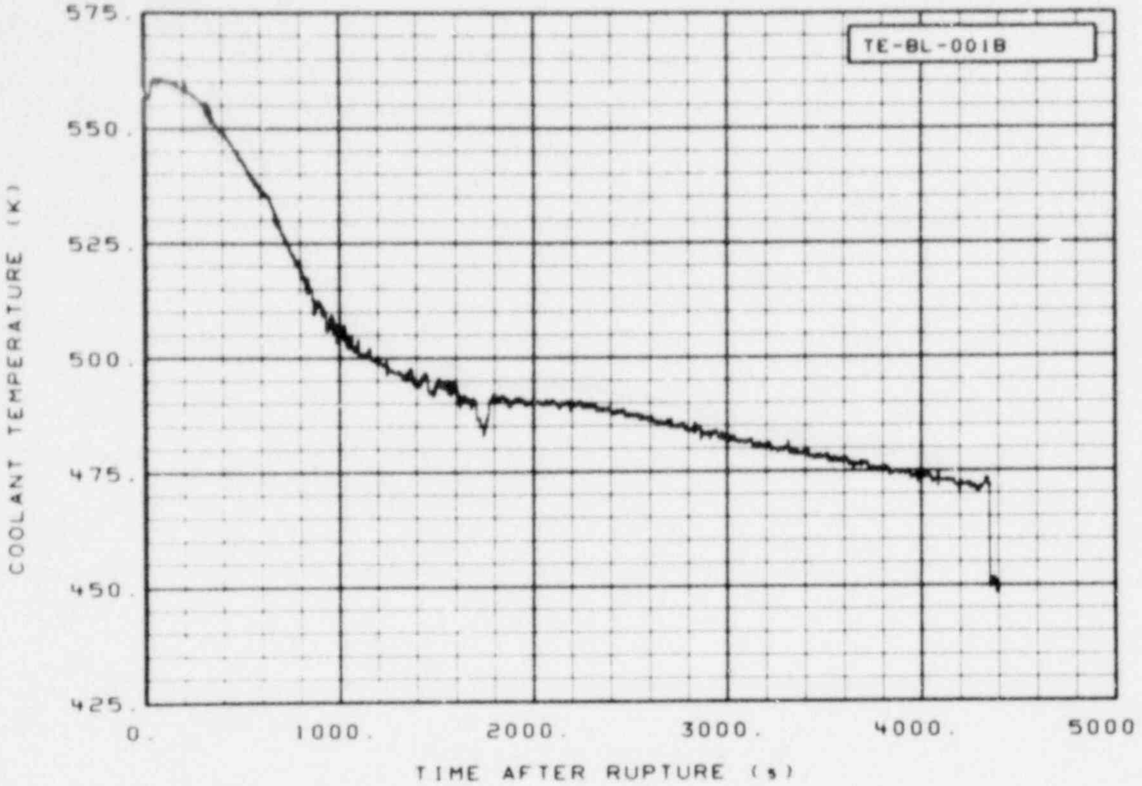


Figure 121. Coolant temperature in broken loop cold leg (TE-BL-001B) (Qualified).

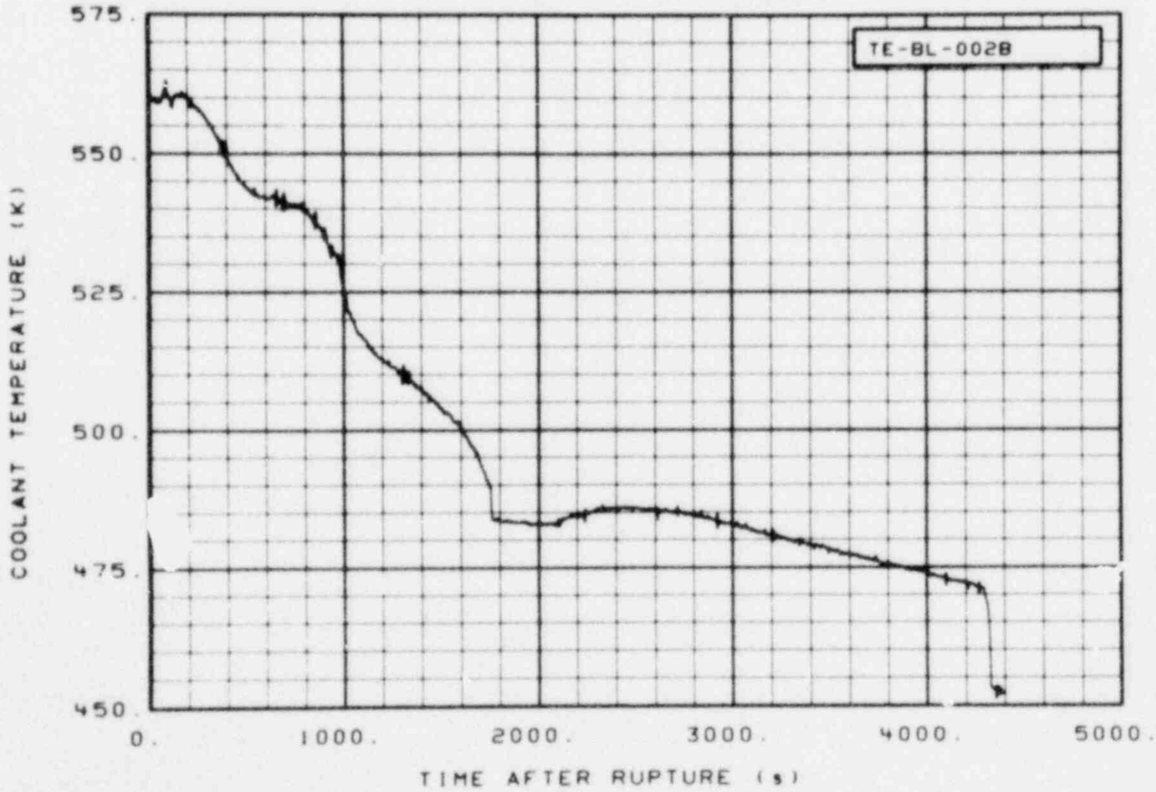


Figure 122. Coolant temperature in broken loop hot leg (TE-BL-002B) (Qualified).

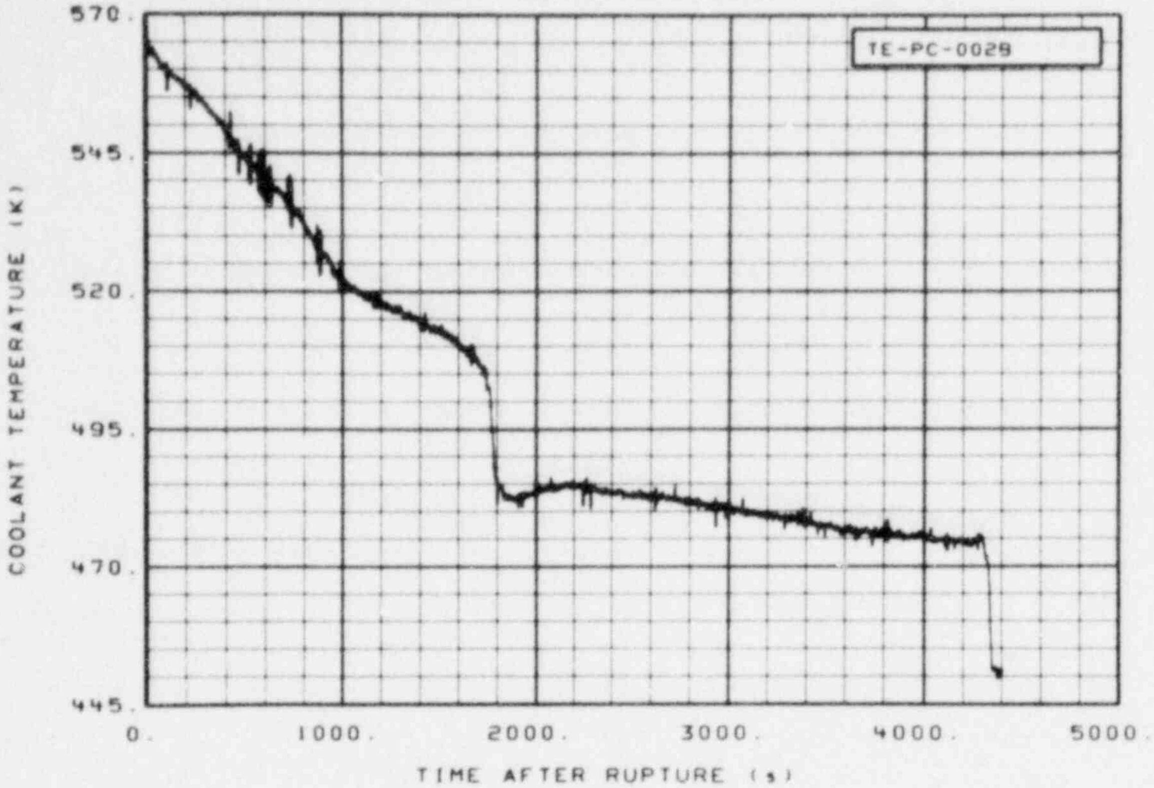


Figure 123. Coolant temperature in intact loop hot leg (TE-PC-002B) (Qualified, IC = 575.5 K).

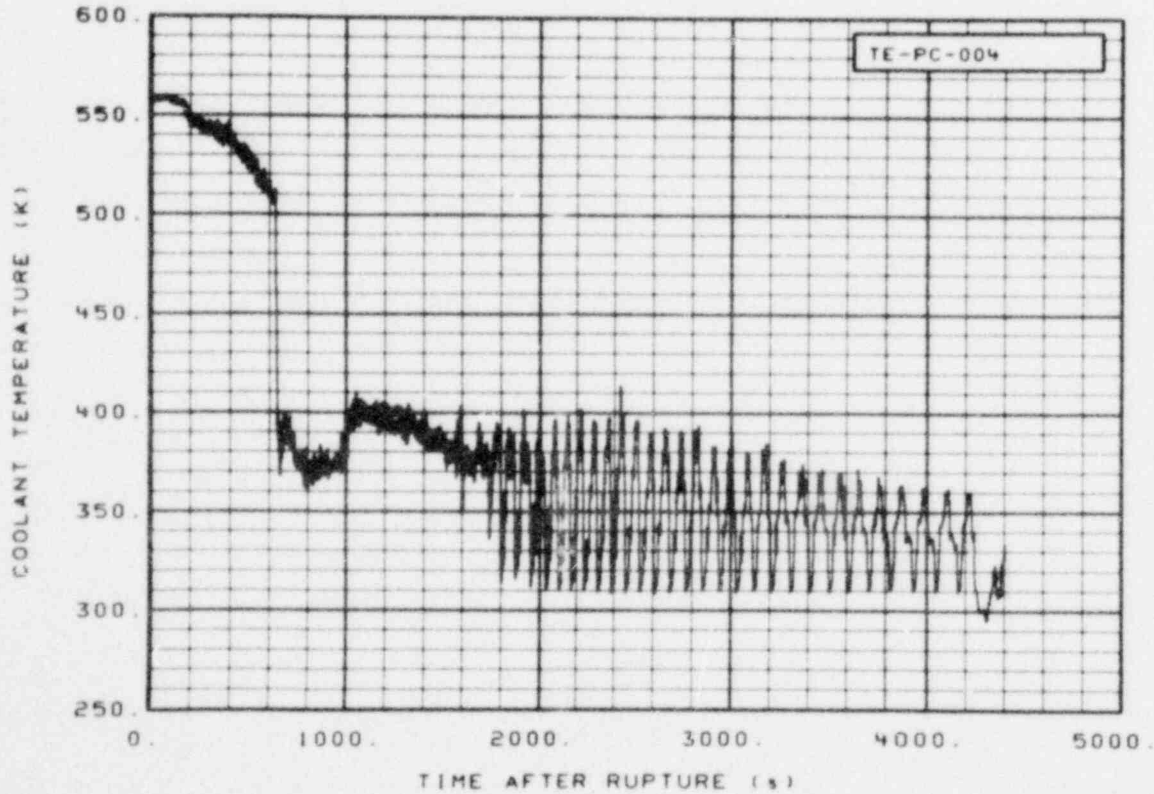


Figure 124. Coolant temperature in intact loop cold leg at bottom of ECC Rake 1 (TE-PC-004) (Qualified).

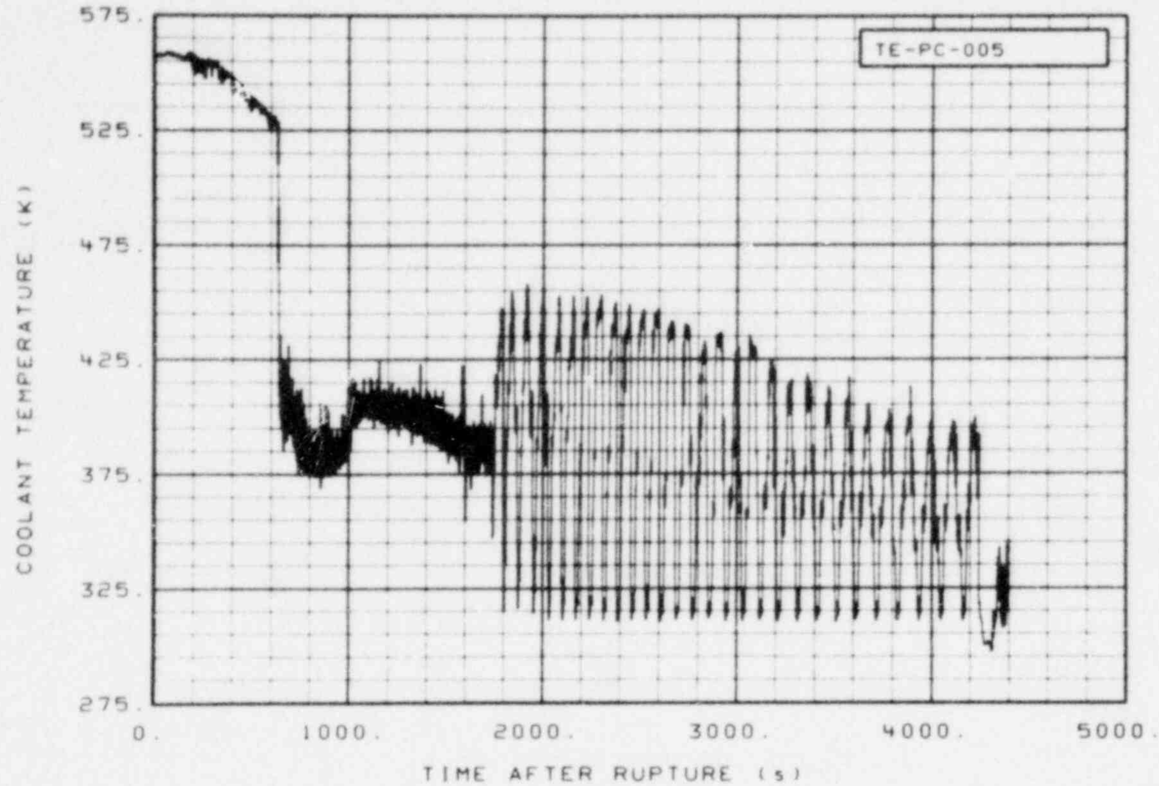


Figure 125. Coolant temperature in intact loop cold leg next to bottom of ECC Rake 1 (TE-PC-005) (Qualified).

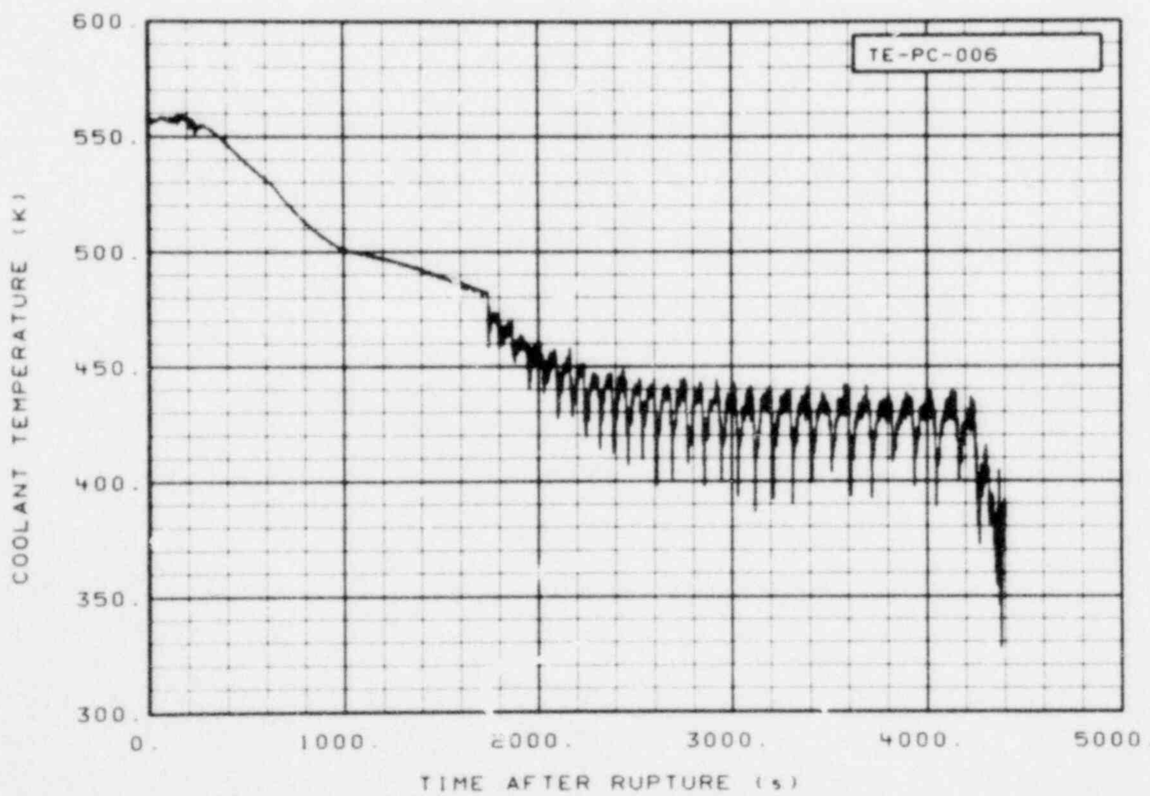


Figure 126. Coolant temperature in intact loop cold leg next to top of ECC Rake 1 (TE-PC-006) (Qualified).

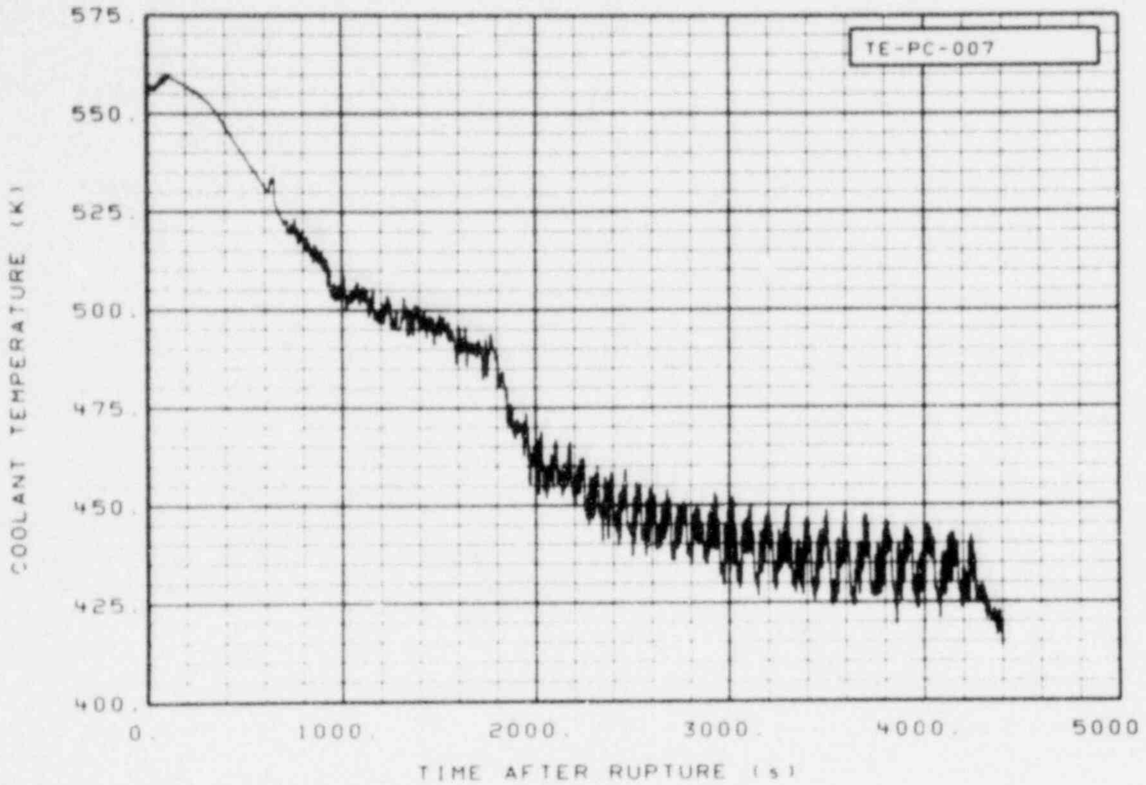


Figure 127. Coolant temperature in intact loop cold leg at top of ECC Rake 1 (TE-PC-007) (Qualified).

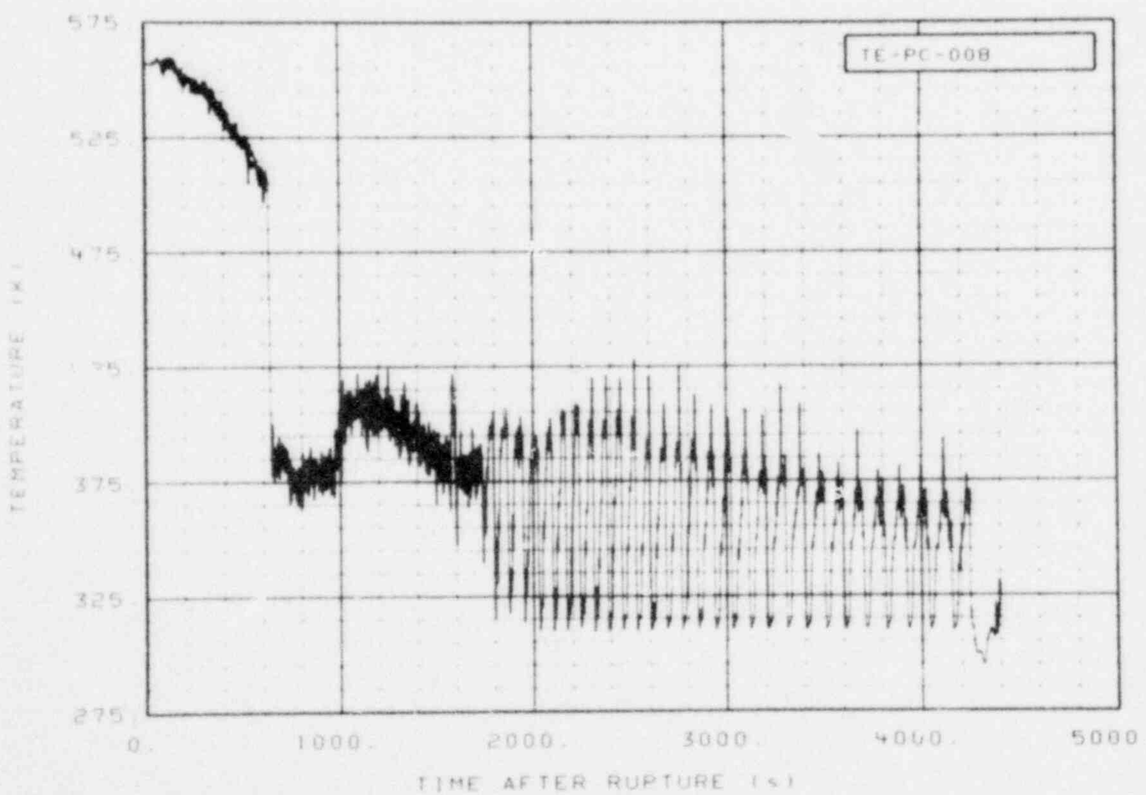


Figure 128. Coolant temperature in intact loop cold leg at bottom of ECC Rake 2 (TE-PC-008) (Qualified).

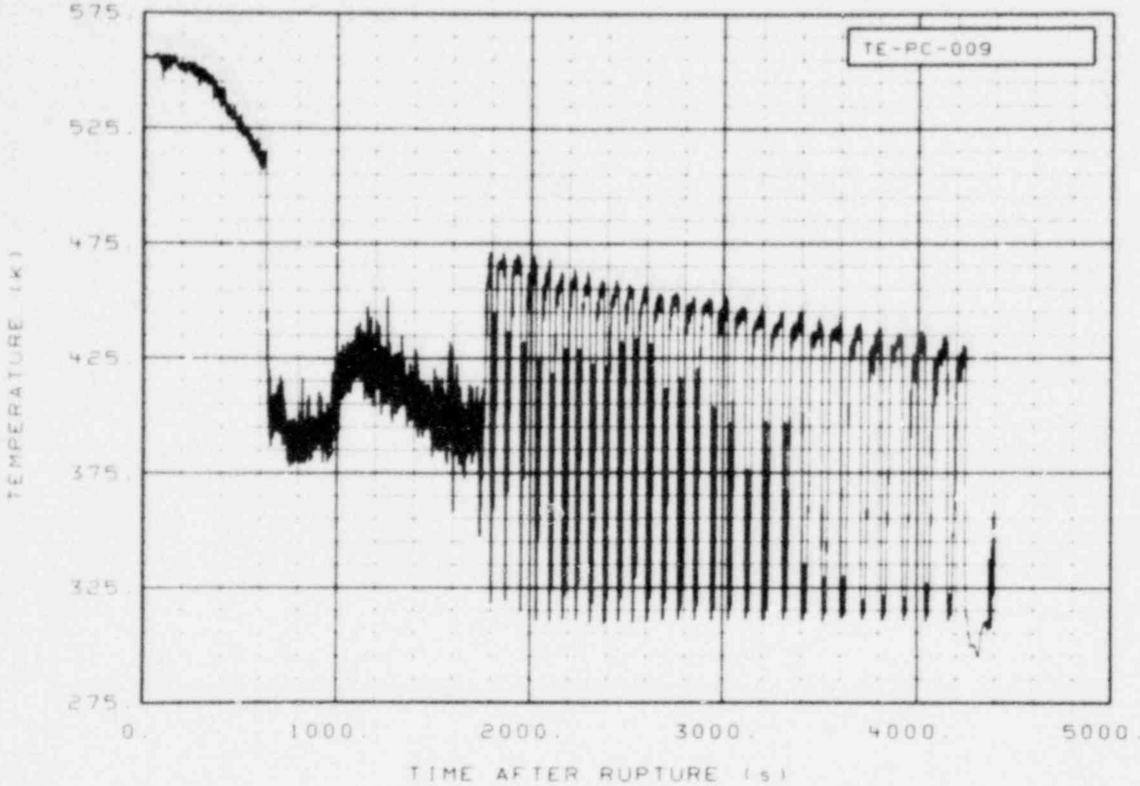


Figure 129. Coolant temperature in intact loop cold leg next to bottom of ECC Rake 2 (TE-PC-009) (Qualified).

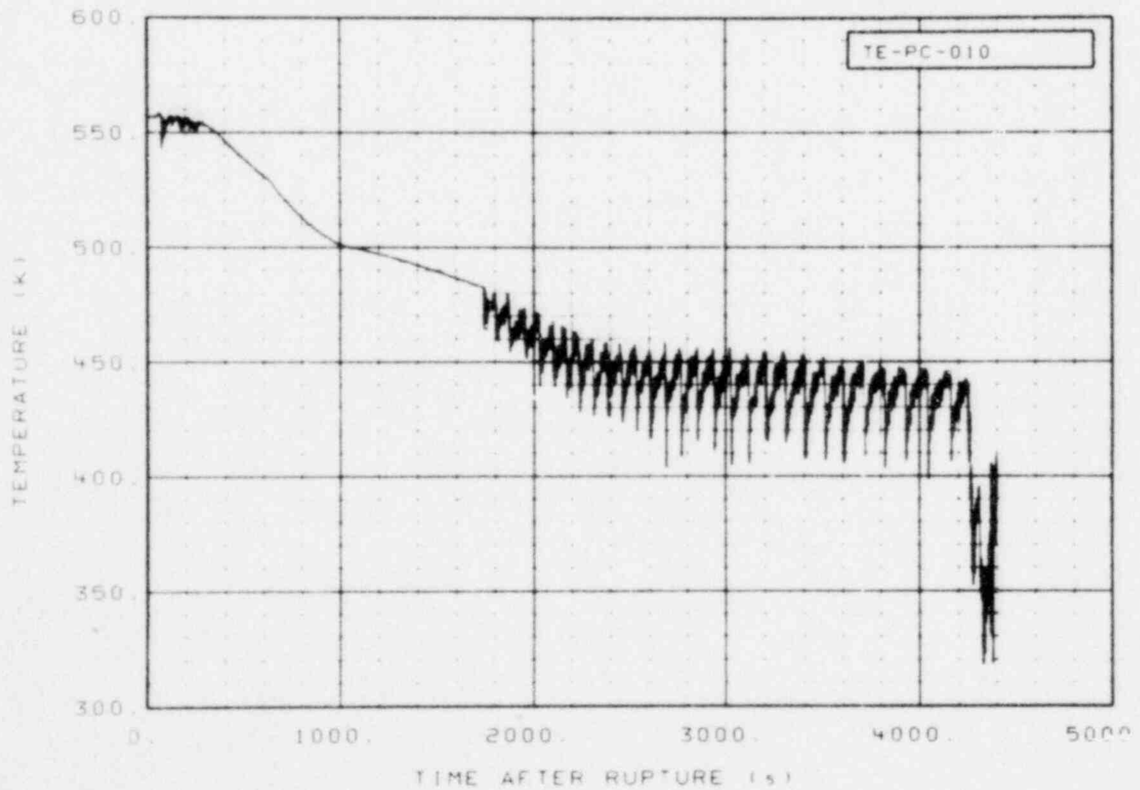


Figure 130. Coolant temperature in intact loop cold leg next to top of ECC Rake 2 (TE-PC-010) (Qualified).

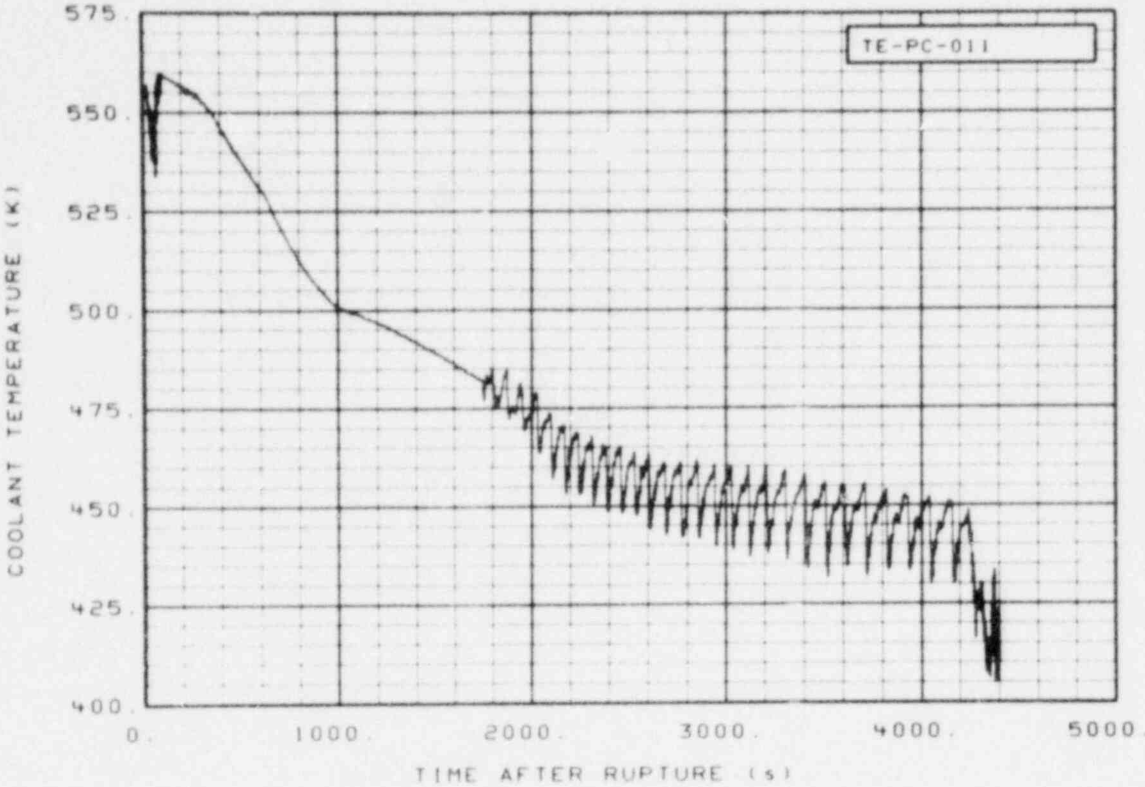


Figure 131. Coolant temperature in intact loop cold leg at top of ECC Rake 2 (TE-PC-011) (Qualified).

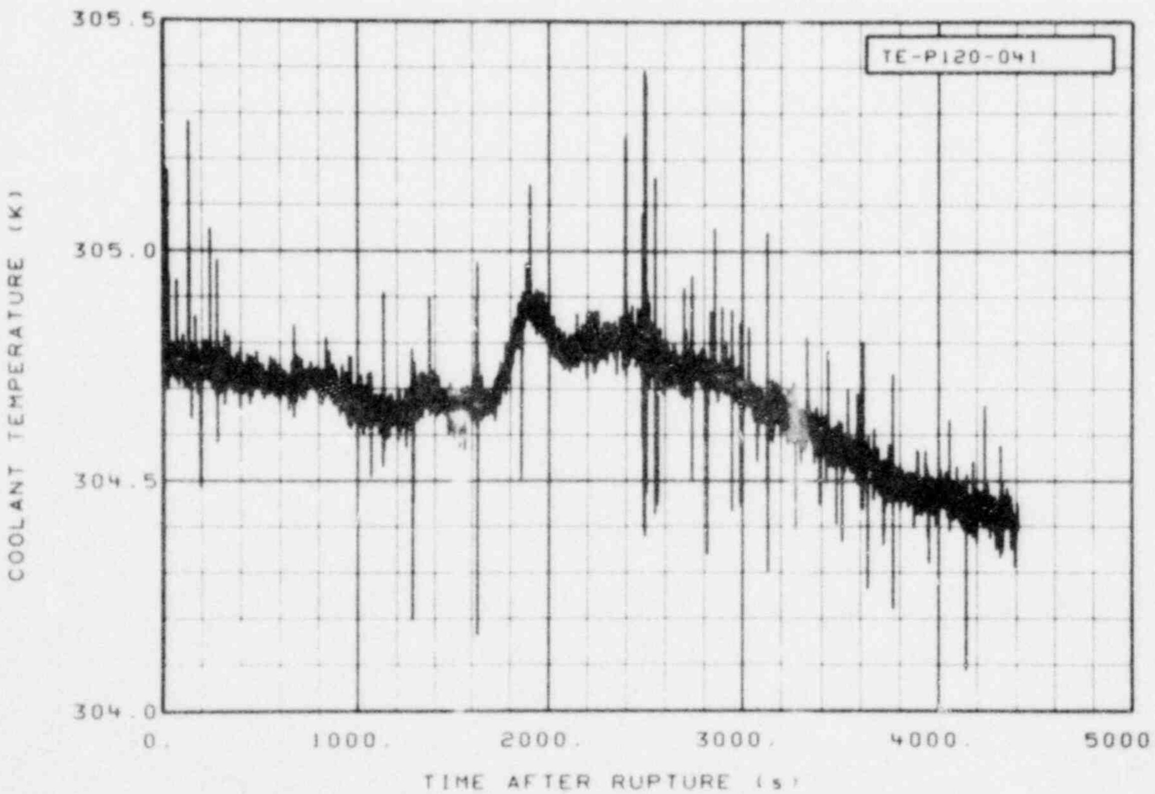


Figure 132. Liquid temperature in ECCS Accumulator A (TE-P120-041) (Qualified).

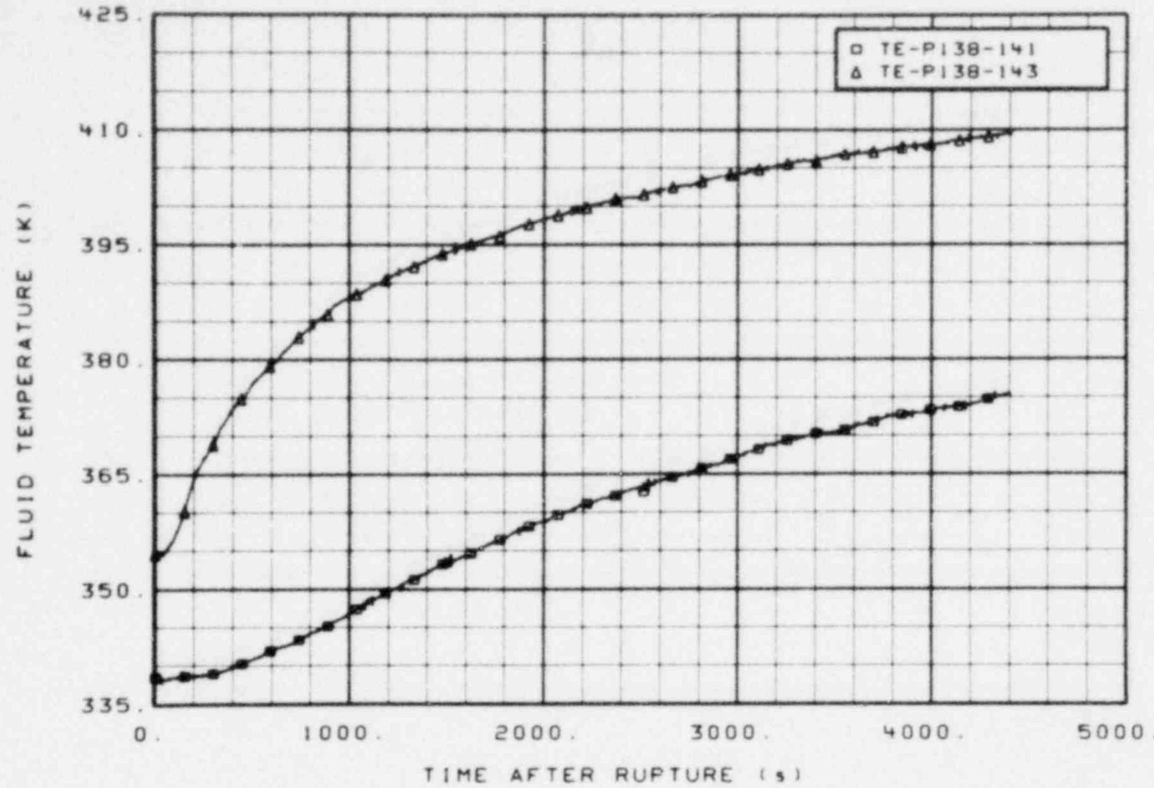


Figure 133. Fluid temperature in blowdown suppression tank spray system 3.8 and 13.9 l/s spray headers (TE-P138-141 and -143) (Qualified).

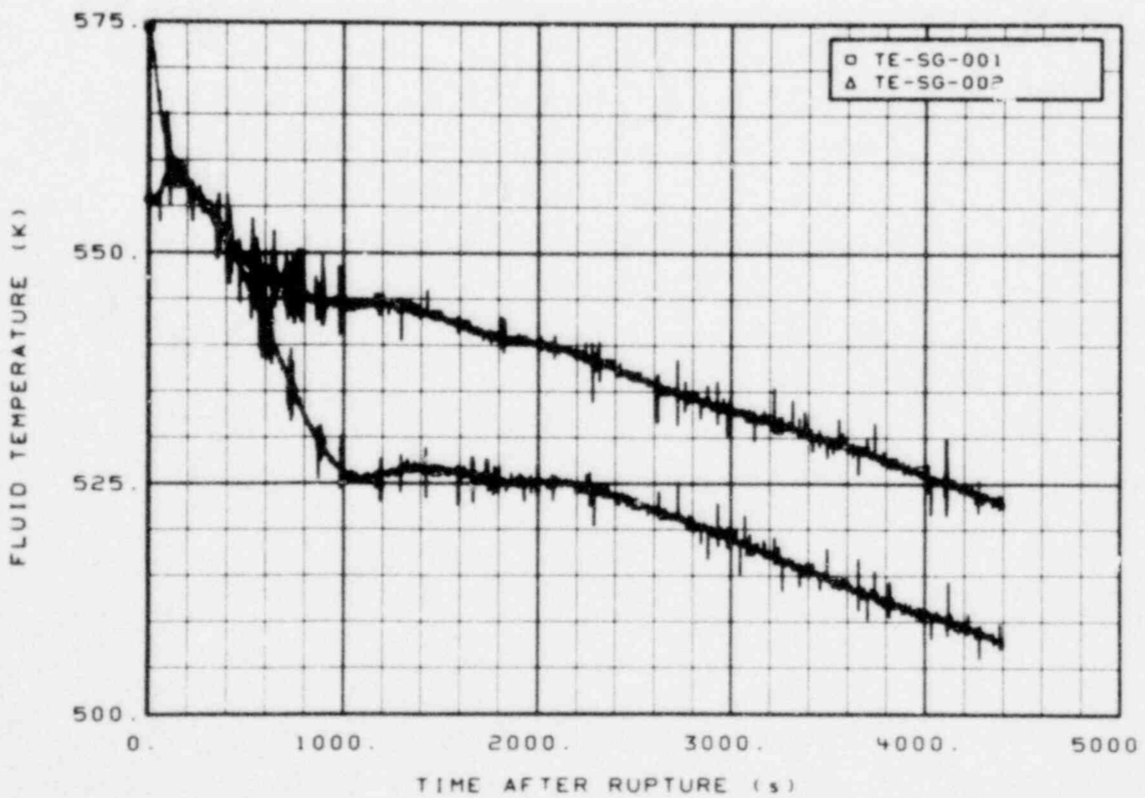


Figure 134. Fluid temperature in intact loop steam generator inlet and outlet plenums (TE-SG-001 and -002) (Qualified, possibly experiencing hot wall effects after about 375 and 800 s, respectively).

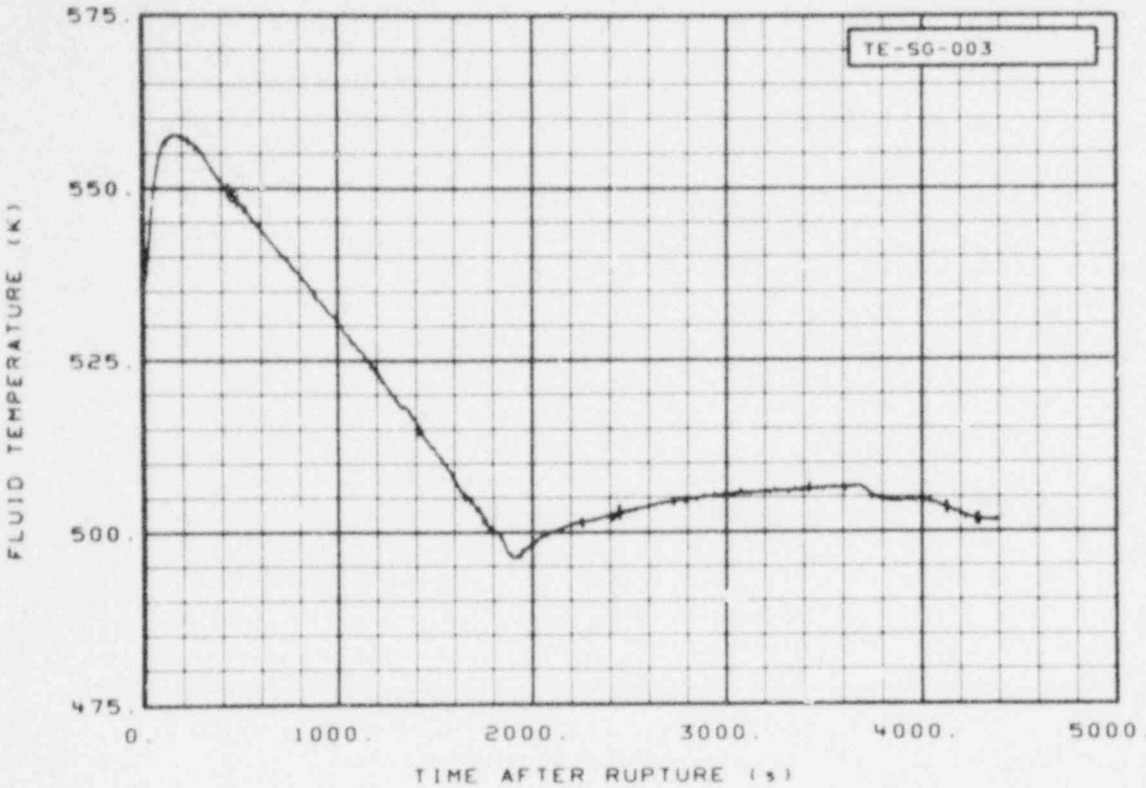


Figure 135. Fluid temperature in steam generator secondary side downcomer (TE-SG-003) (Qualified, IC = 536.0 K).

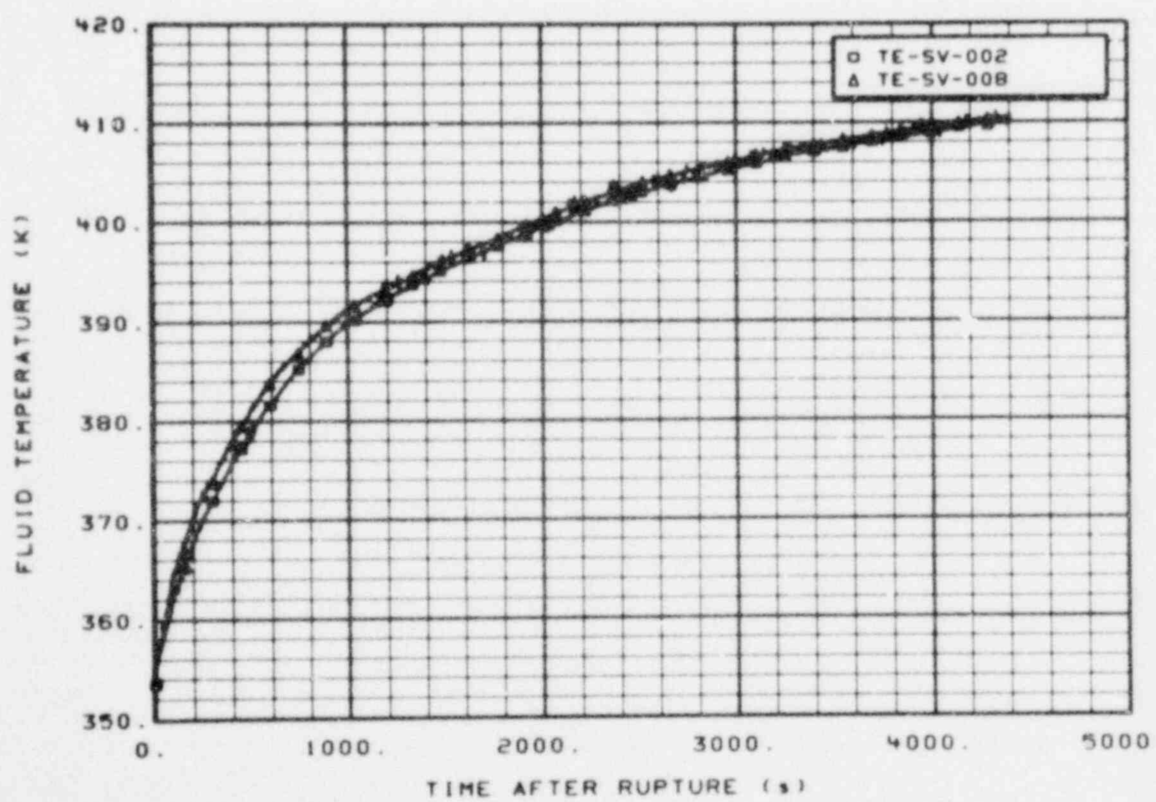


Figure 136. Fluid temperature in blowdown suppression tank 2.362 m above tank bottom (TE-SV-002 and -008) (Qualified).

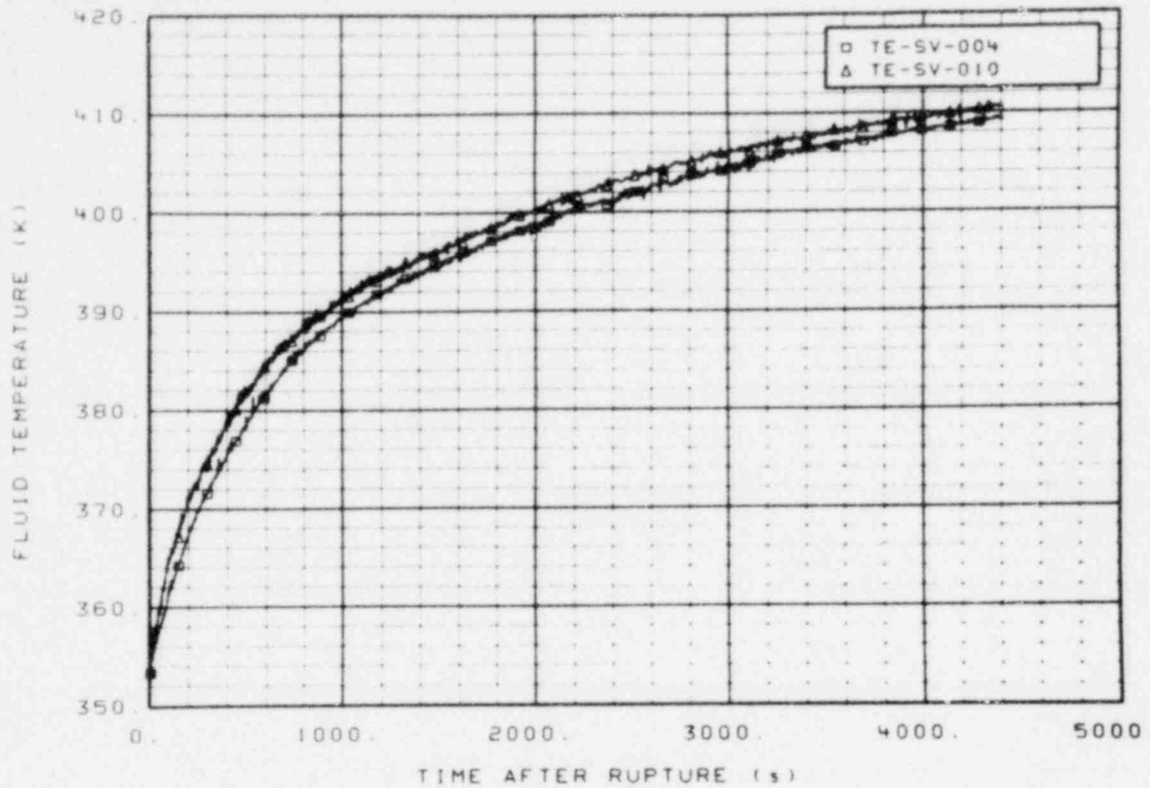


Figure 137. Fluid temperature in blowdown suppression tank 1.453 m above tank bottom (TE-SV-004 and -010) (Qualified).

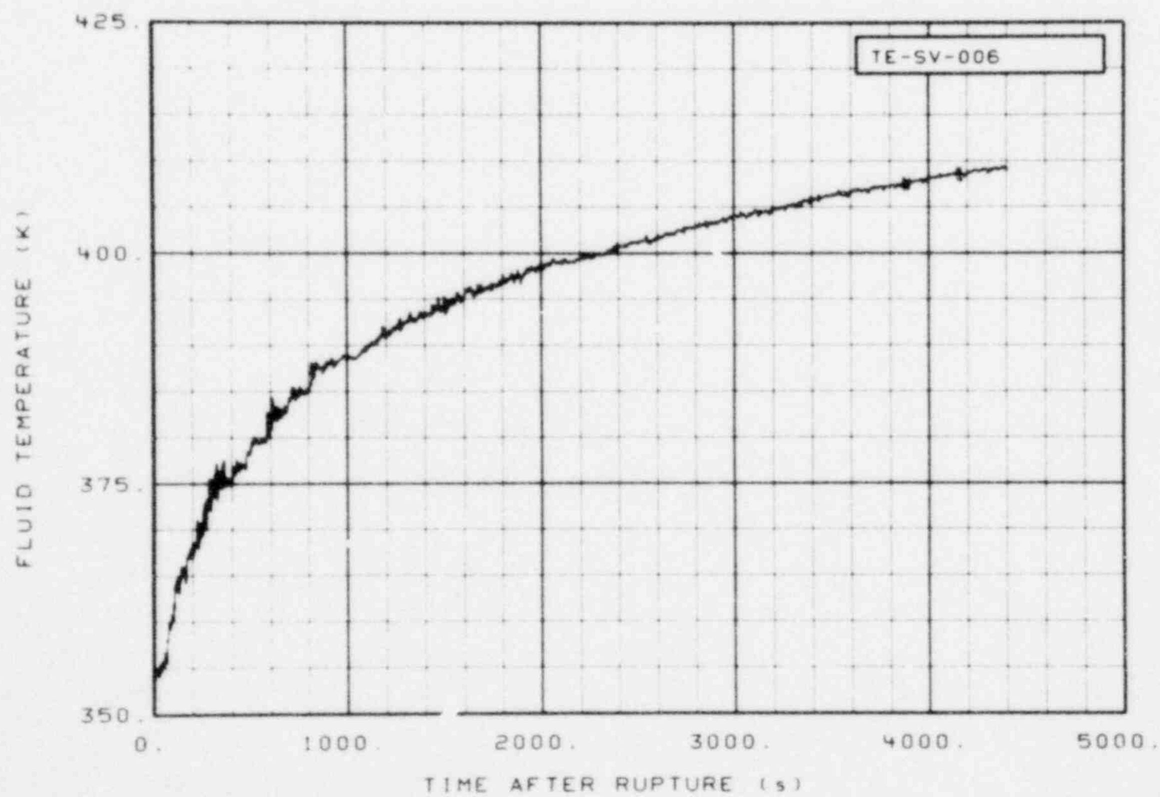


Figure 138. Fluid temperature in blowdown suppression tank 0.373 m above tank bottom (TE-SV-006) (Qualified).

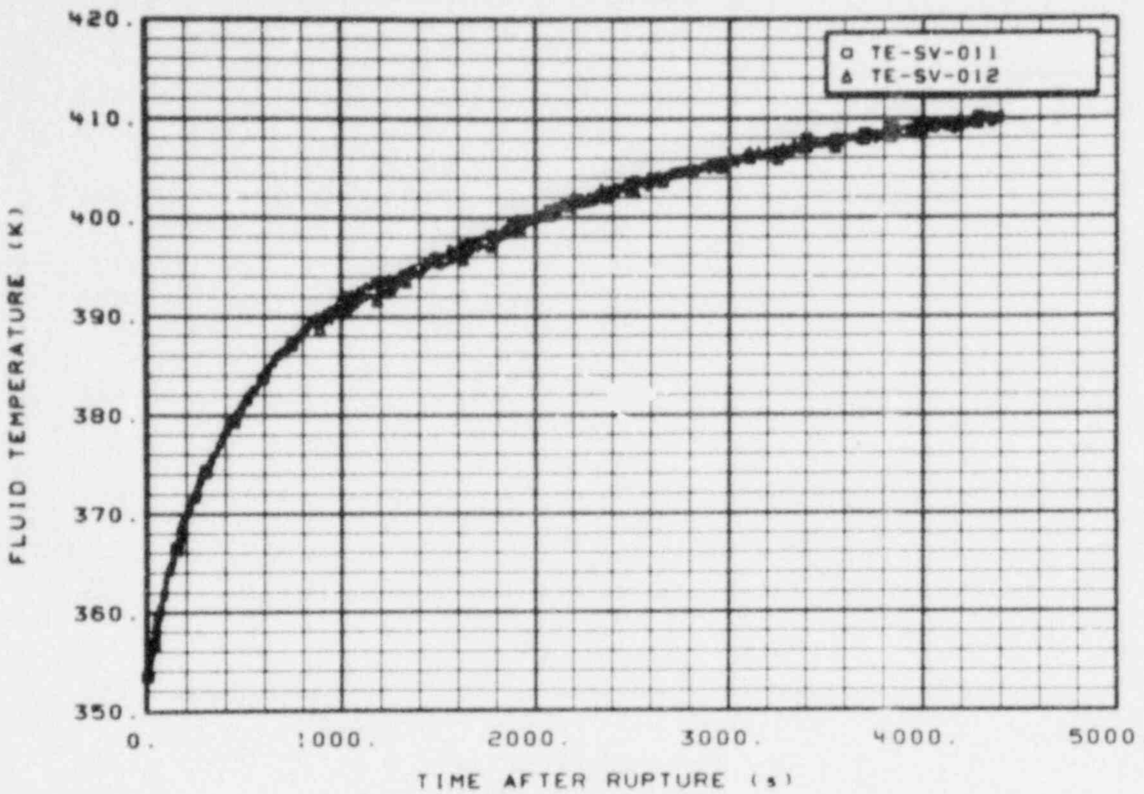


Figure 139. Fluid temperature in blowdown suppression tank 0.991 and 0.373 m above tank bottom (TE-SV-011 and -012) (Qualified).

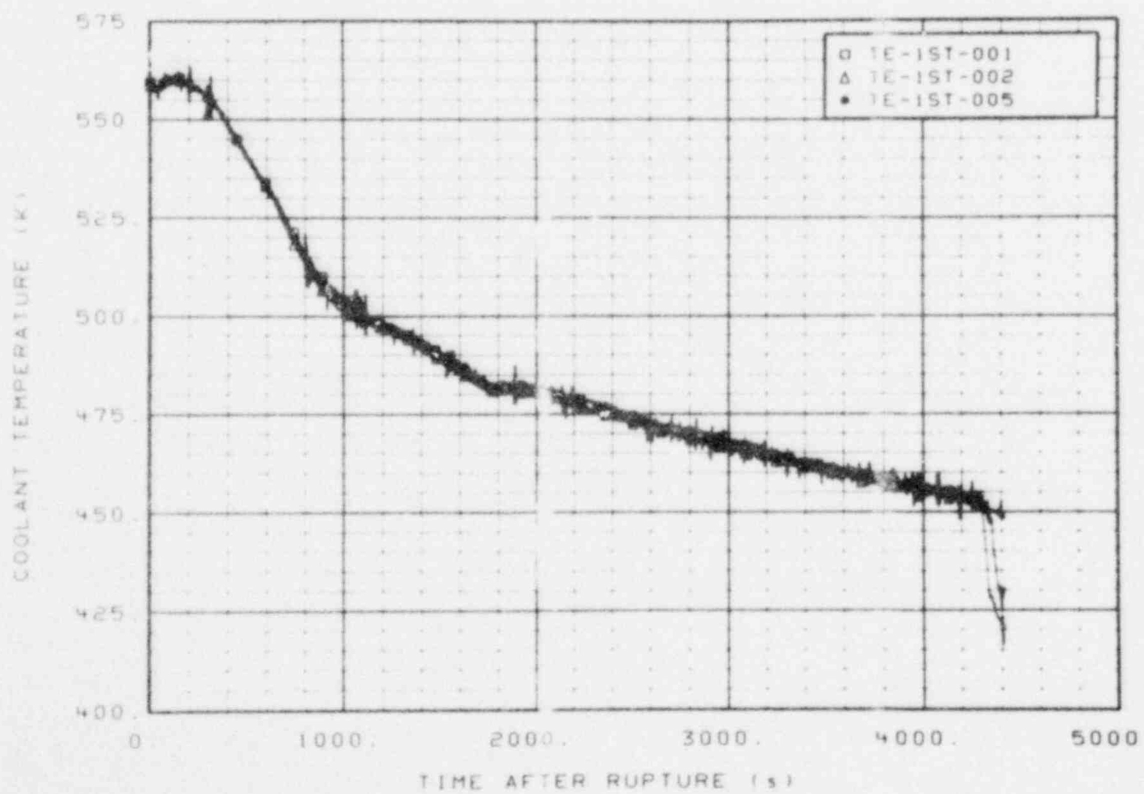


Figure 140. Coolant temperature in reactor vessel Downcomer Instrument Stalk 1 (TE-1ST-001, -002, and -005) (Qualified).

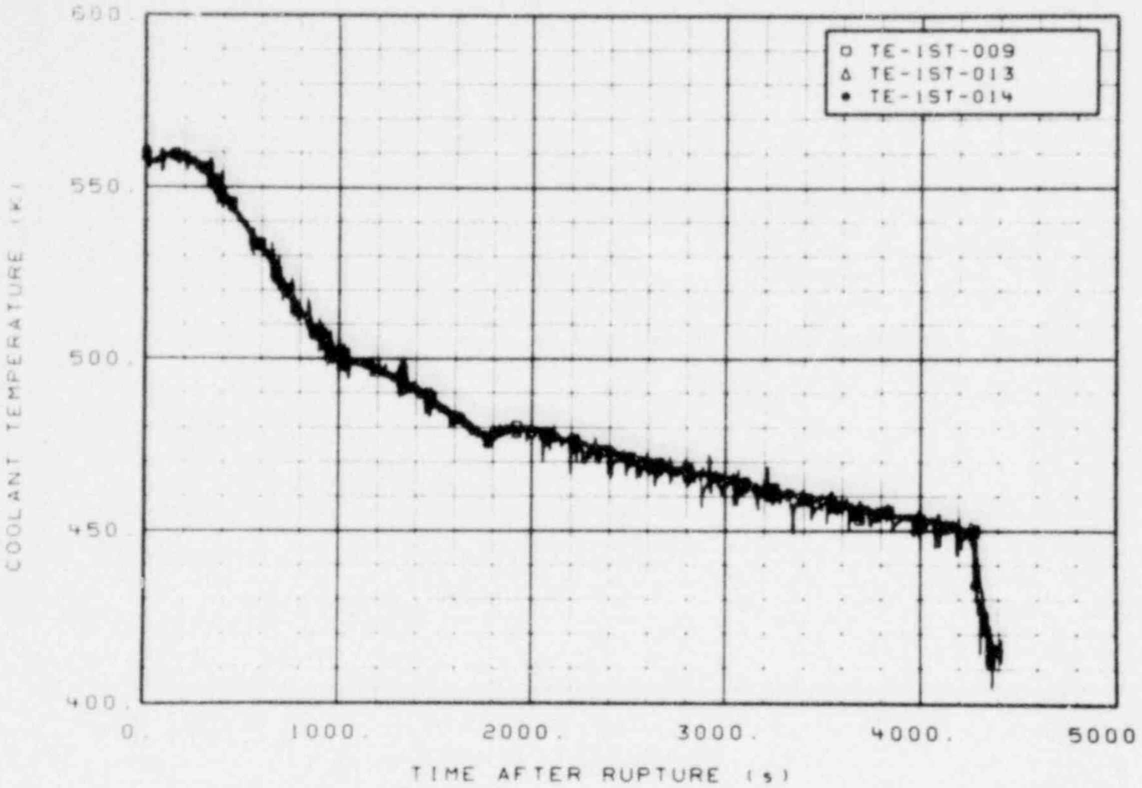


Figure 141. Coolant temperature in reactor vessel Downcomer Instrument Stalk 1 (TE-1ST-009, -013, and -014) (Qualified).

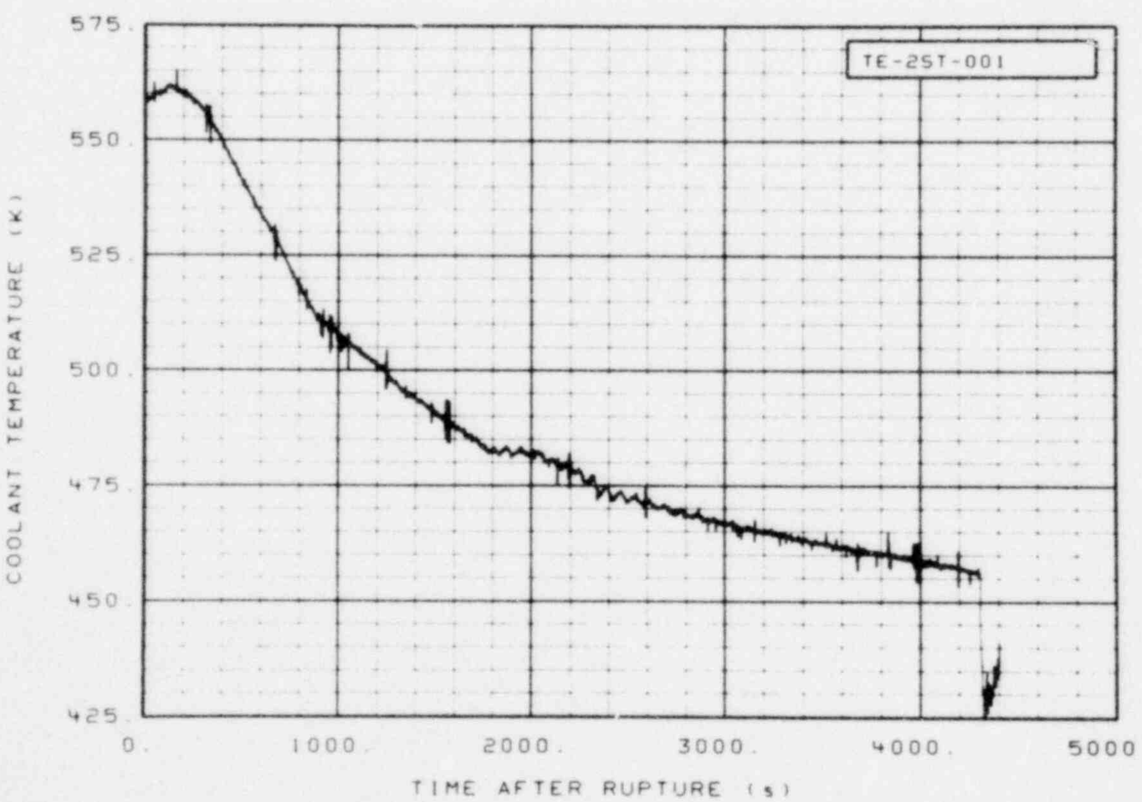


Figure 142. Coolant temperature in reactor vessel Downcomer Instrument Stalk 2 (TE-2ST-001) (Qualified).

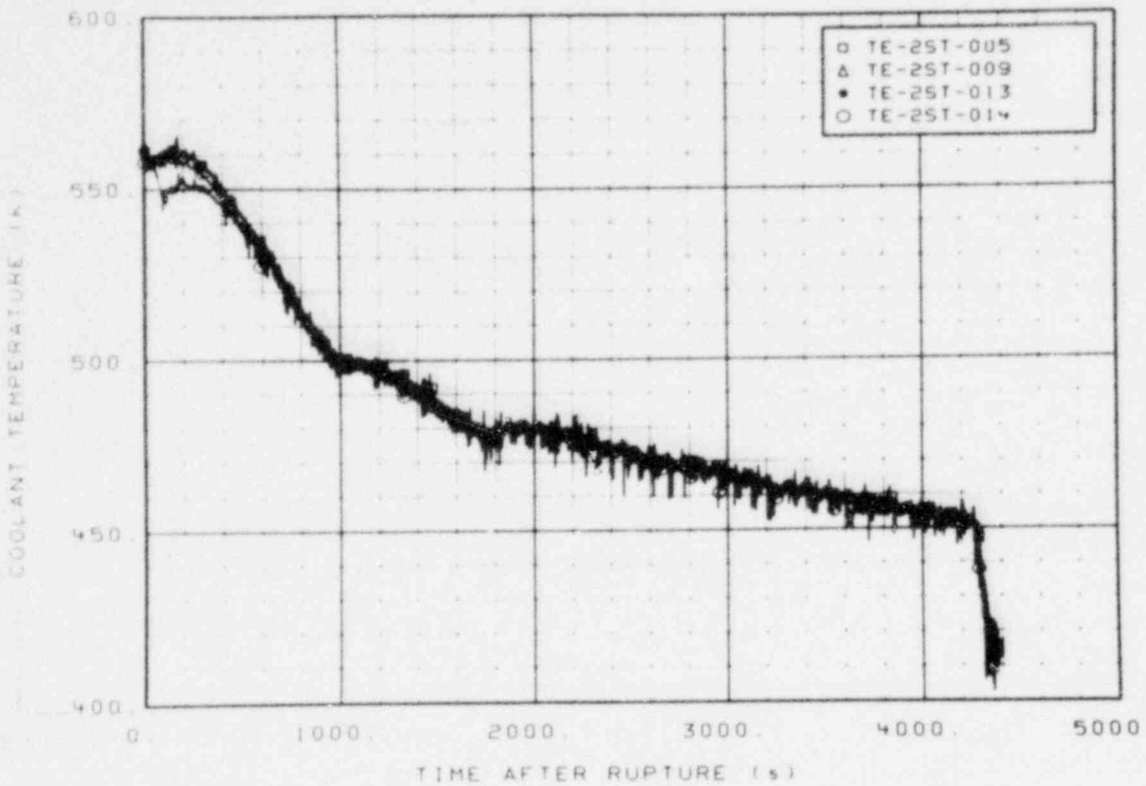


Figure 143. Coolant temperature in reactor vessel Downcomer Instrument Stalk 2 (TE-2ST-005, -009, -013, and -014) (Qualified).

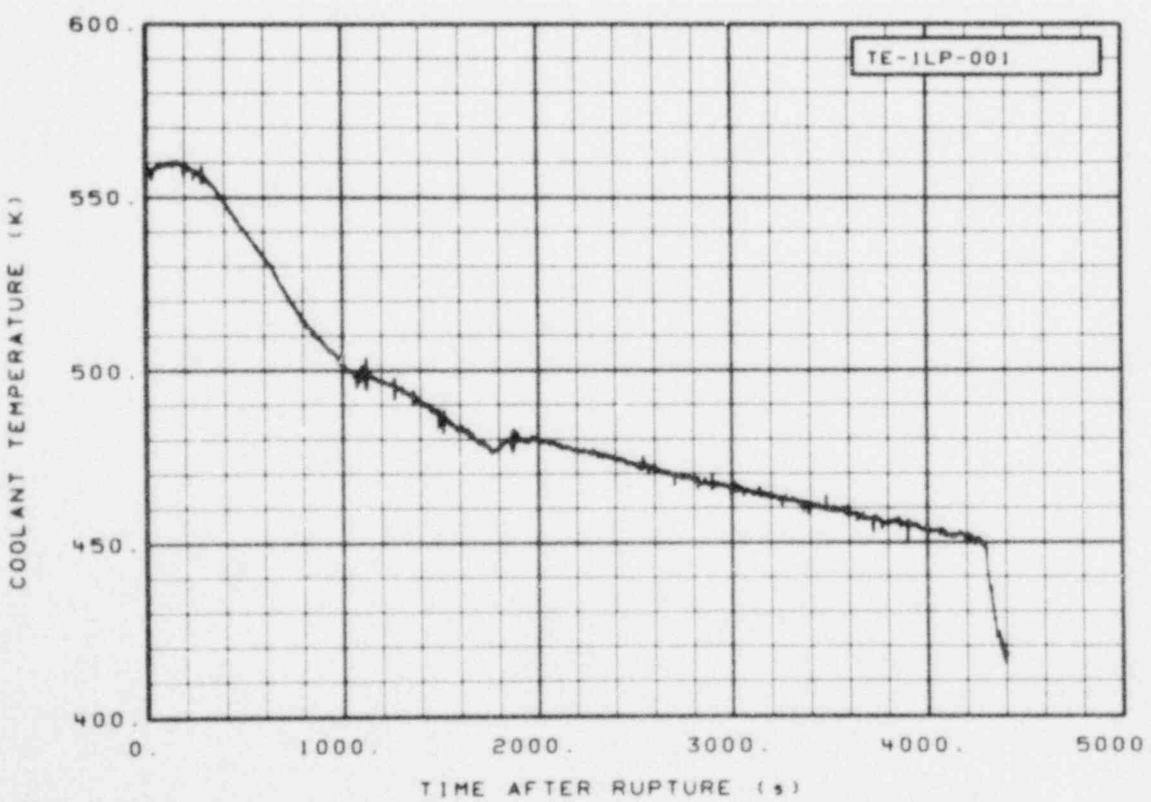


Figure 144. Coolant temperature in reactor vessel at lower end box of Fuel Assembly 1 (TE-1LP-001) (Qualified).

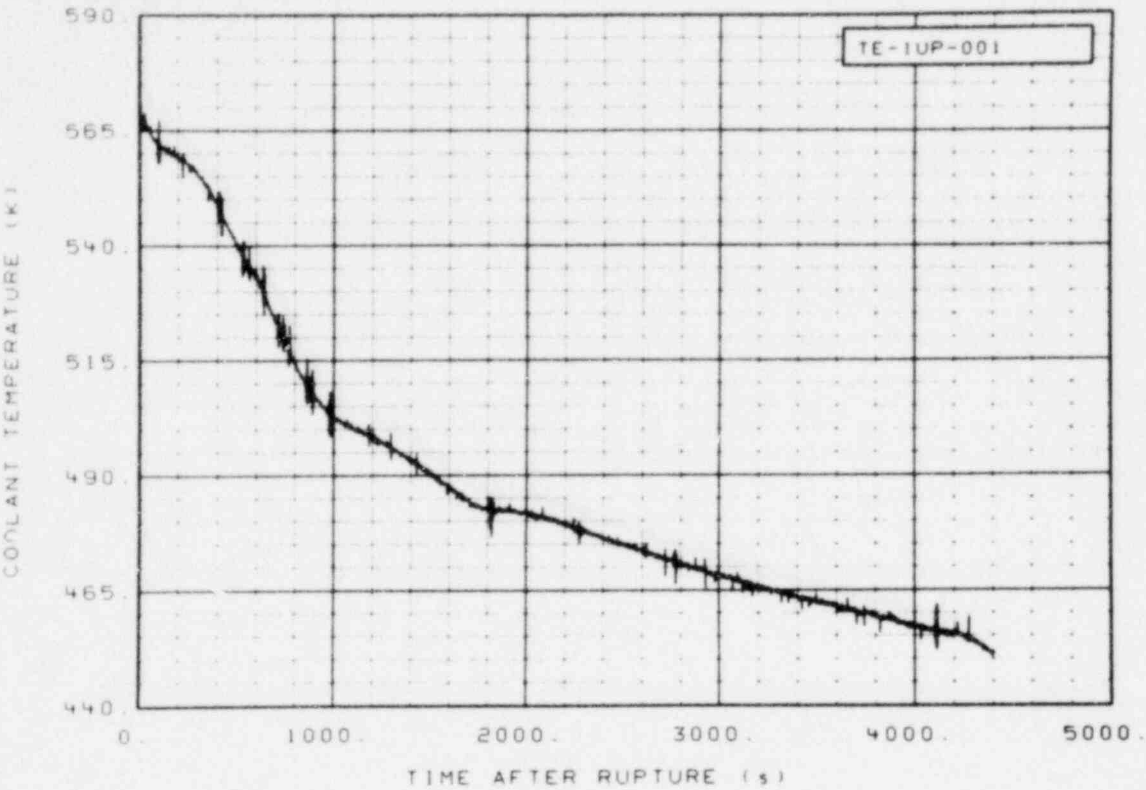


Figure 145. Coolant temperature in reactor vessel at upper end box of Fuel Assembly 1 (TE-1UP-001) (Qualified, IC = 584.6 K).

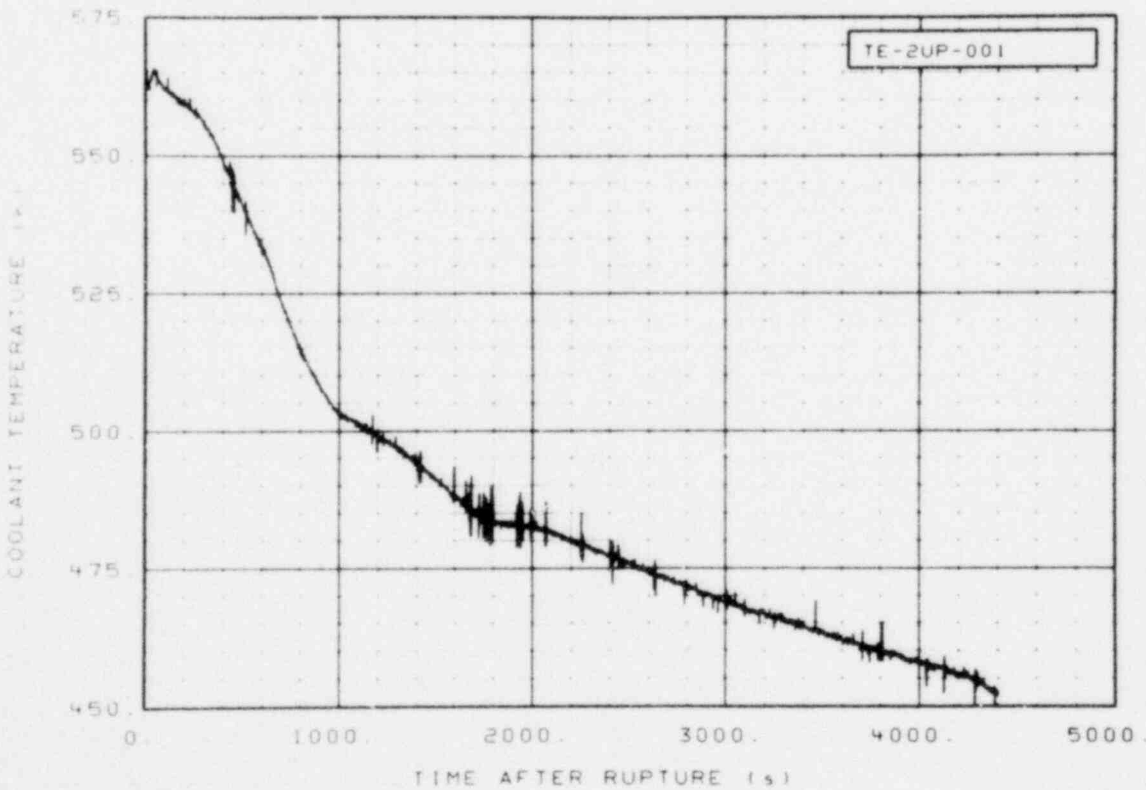


Figure 146. Coolant temperature in reactor vessel at upper end box of Fuel Assembly 2 (TE-2UP-001) (Qualified, IC = 573.4 K).

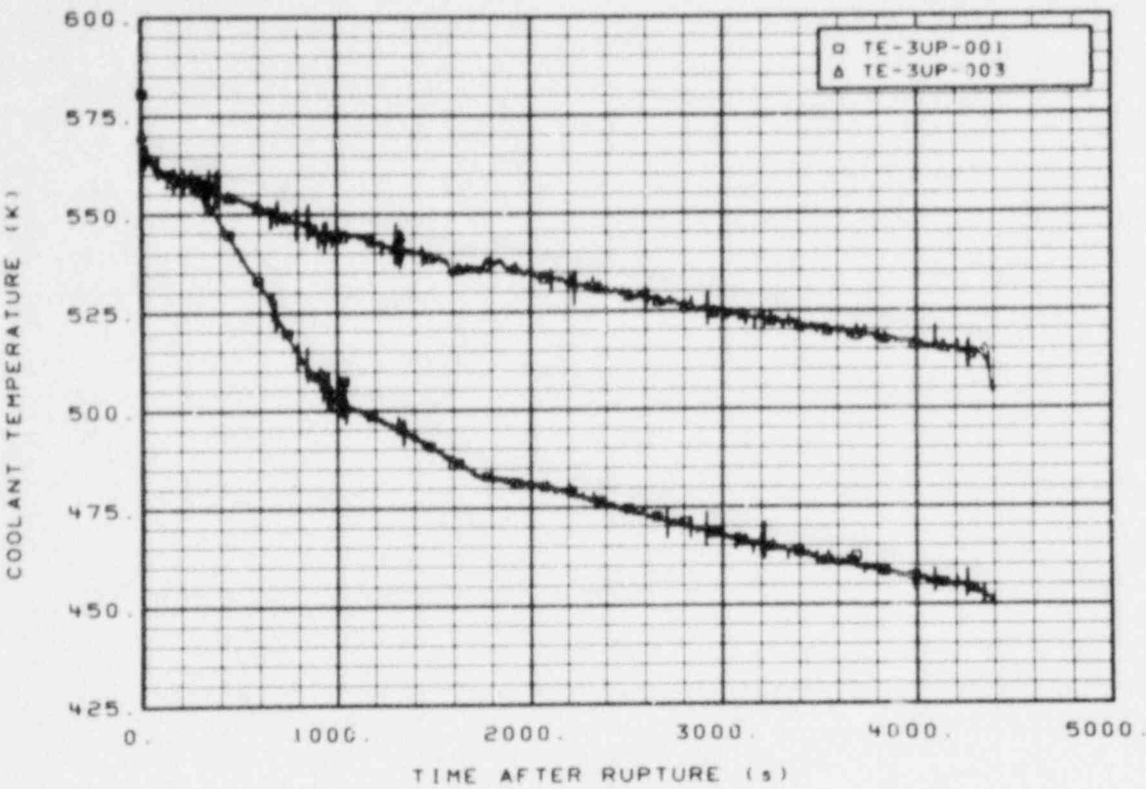


Figure 147. Coolant temperature in reactor vessel above Fuel Assembly 3 at upper end box and above outlet nozzle (TE-3UP-001 and -003) (Qualified).

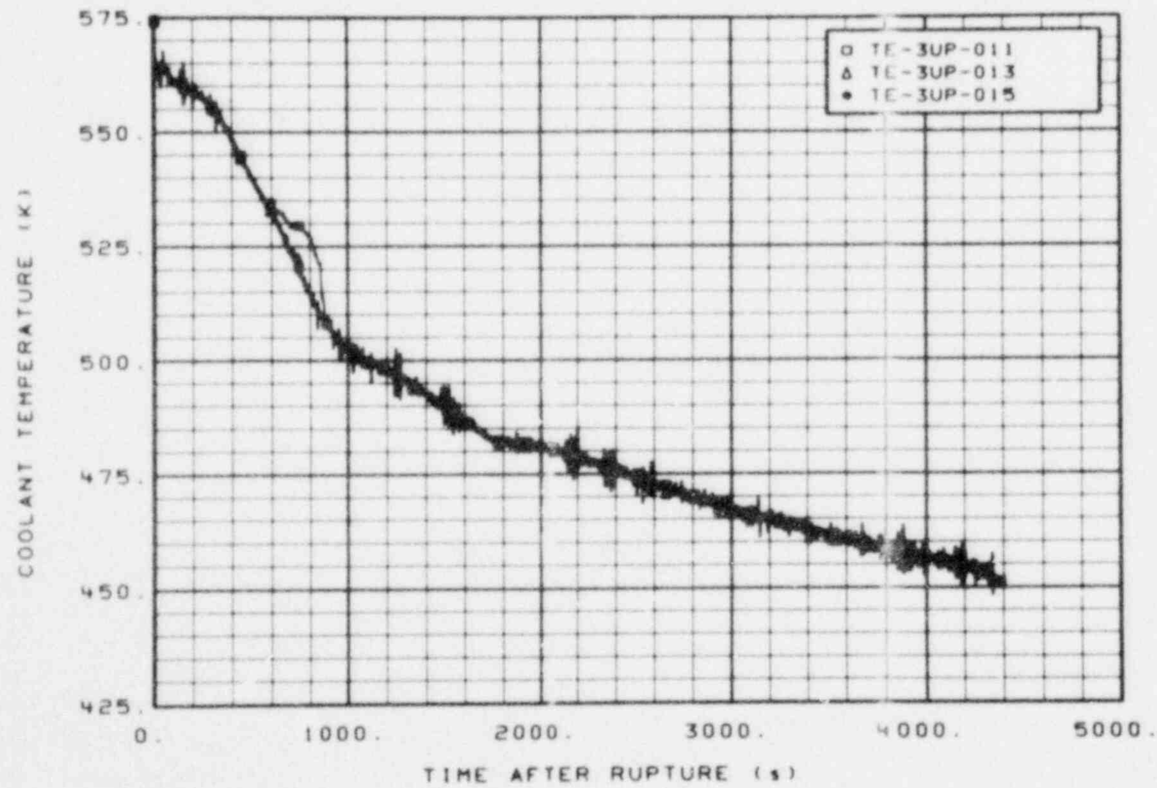


Figure 148. Coolant temperature in reactor vessel at liquid level sting above Fuel Assembly 3 (TE-3UP-011, -013, and -015) (Qualified).

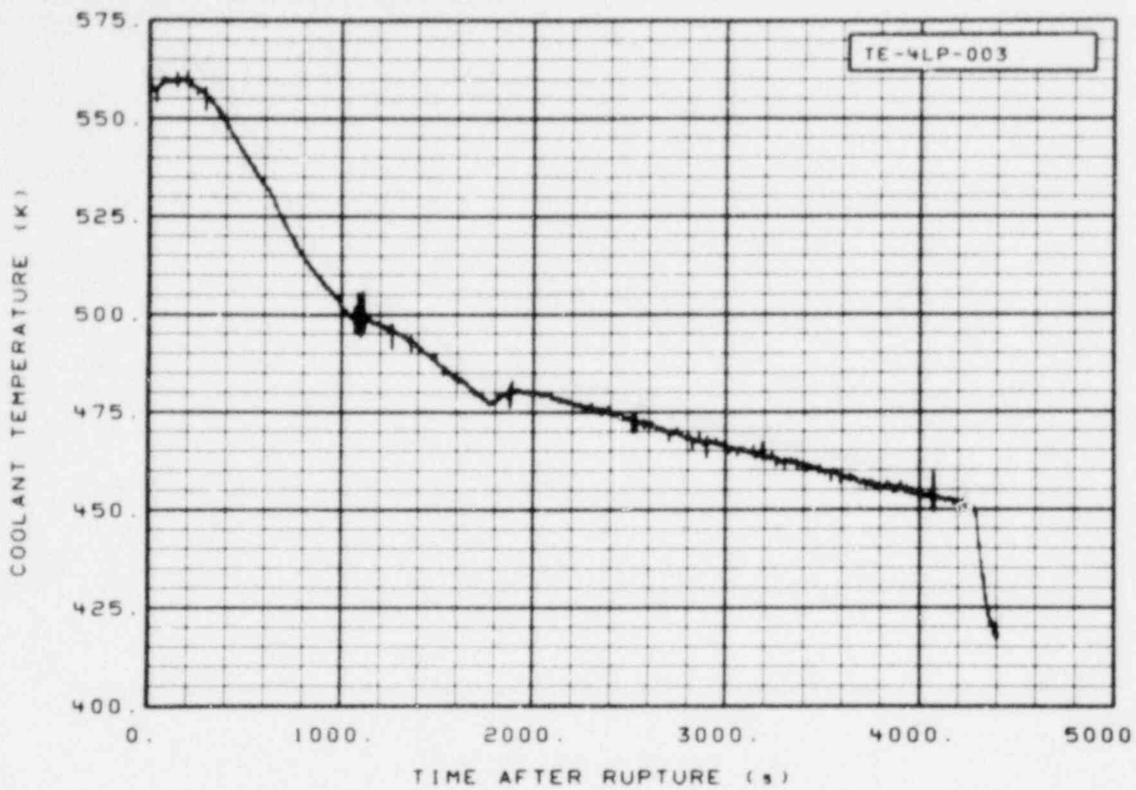


Figure 149. Coolant temperature in reactor vessel at lower end box of Fuel Assembly 4 (TE-4LP-003) (Qualified).

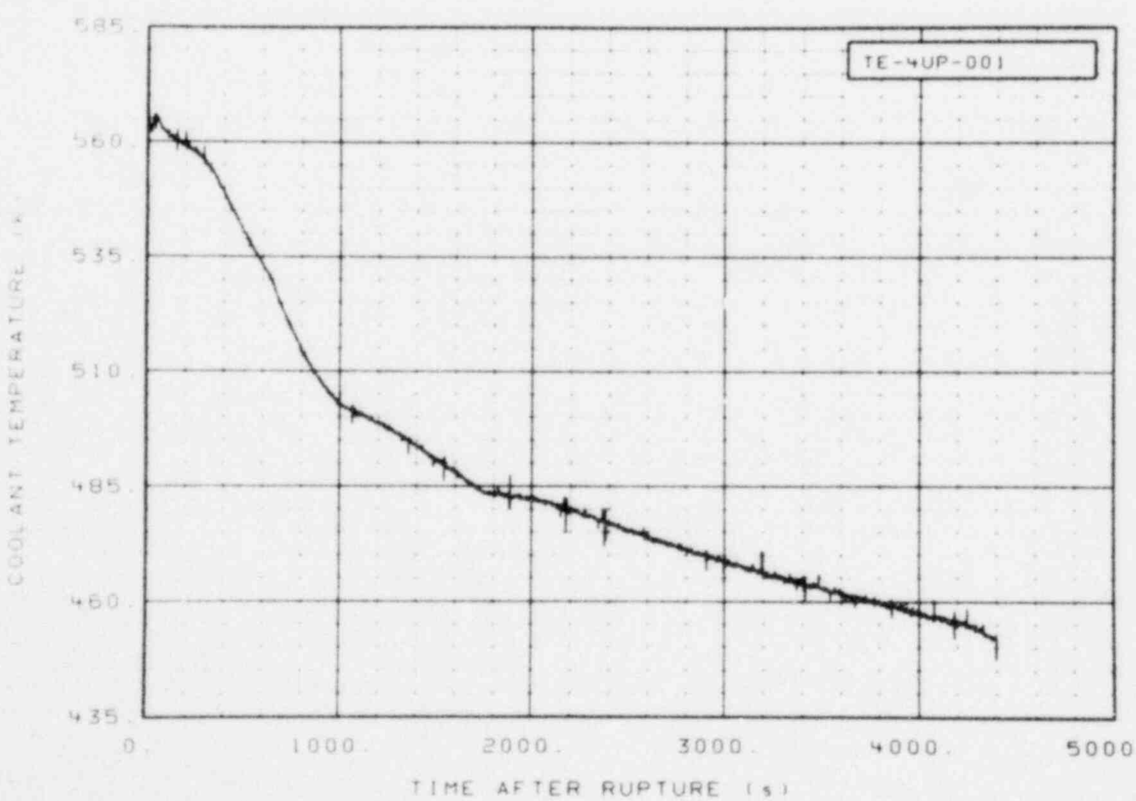


Figure 150. Coolant temperature in reactor vessel at upper end box of Fuel Assembly 4 (TE-4UP-001) (Qualified, IC = 573.9 K).

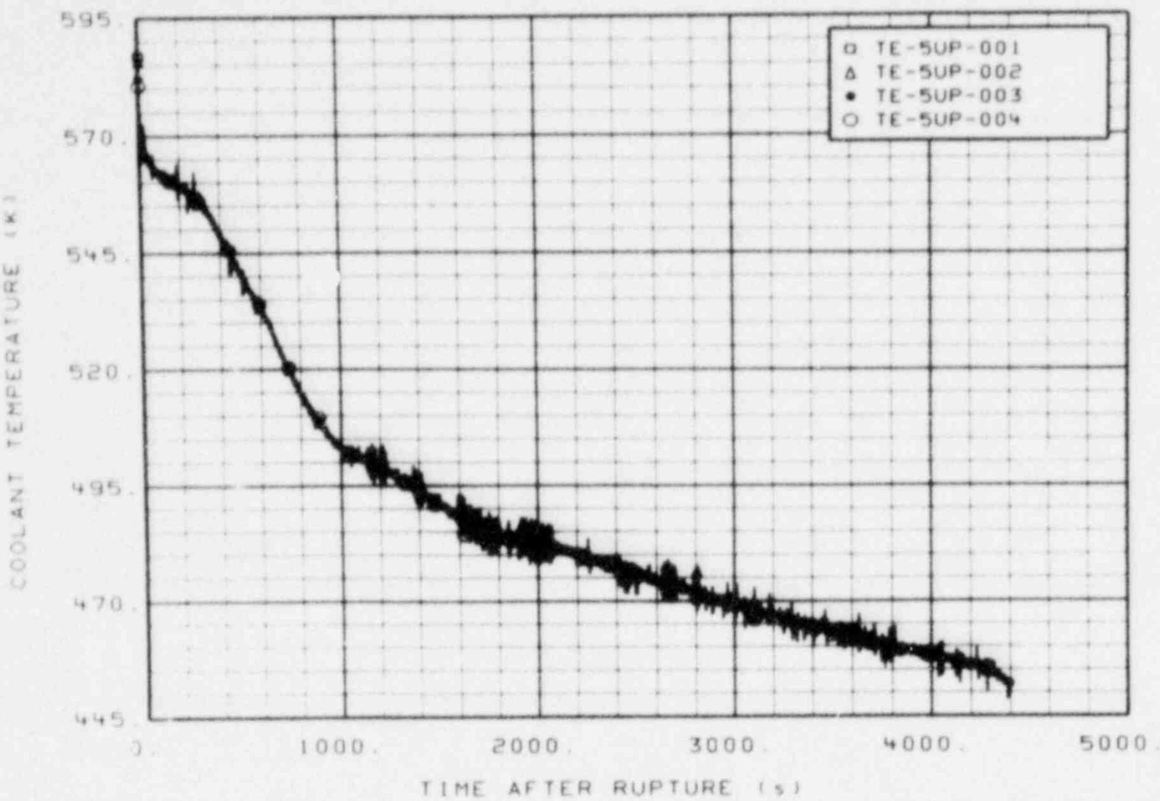


Figure 151. Coolant temperature in reactor vessel at upper end box of Fuel Assembly 5 (TE-5UP-001, -002, -003, and -004) (Qualified).

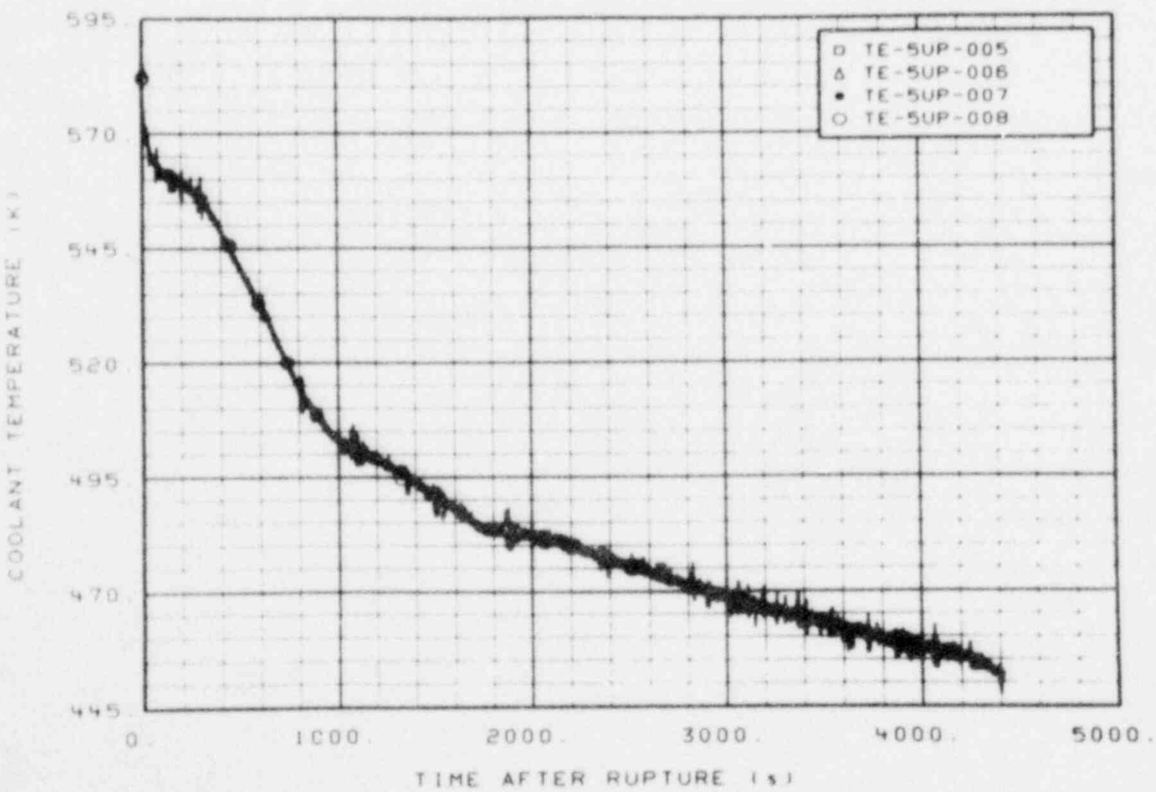


Figure 152. Coolant temperature in reactor vessel at upper end box of Fuel Assembly 5 (TE-5UP-005, -006, -007, and -008) (Qualified).

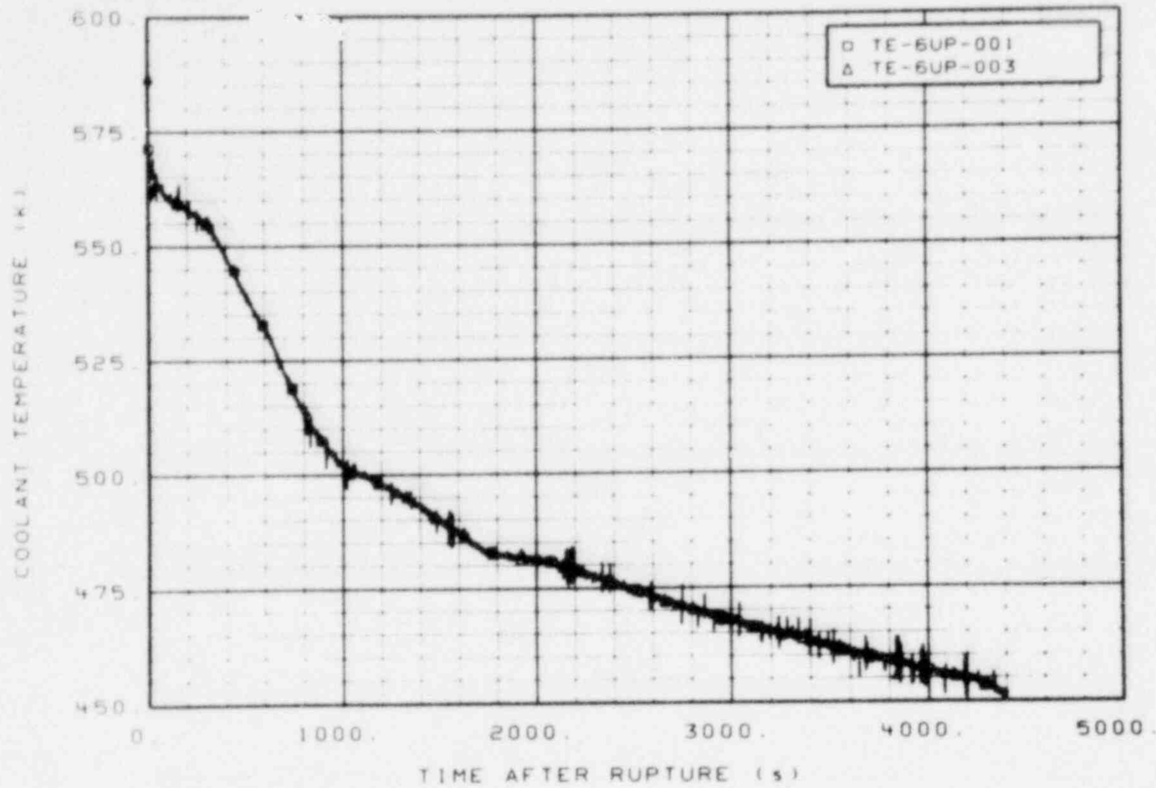


Figure 153. Coolant temperature in reactor vessel at upper end box of Fuel Assembly 6 (TE-6UP-001 and -003) (Qualified).

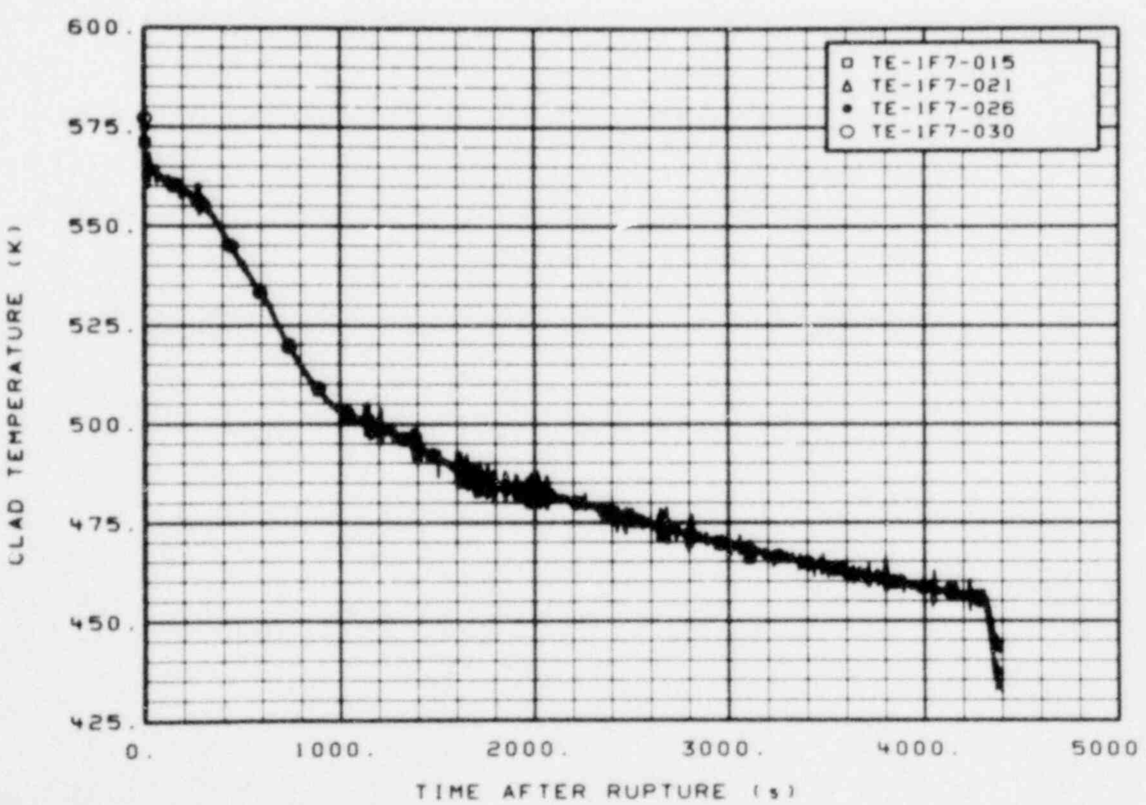


Figure 154. Temperature of cladding on Fuel Assembly 1, Rod F7 (TE-1F7-015, -021, -026, and -030) (Qualified).

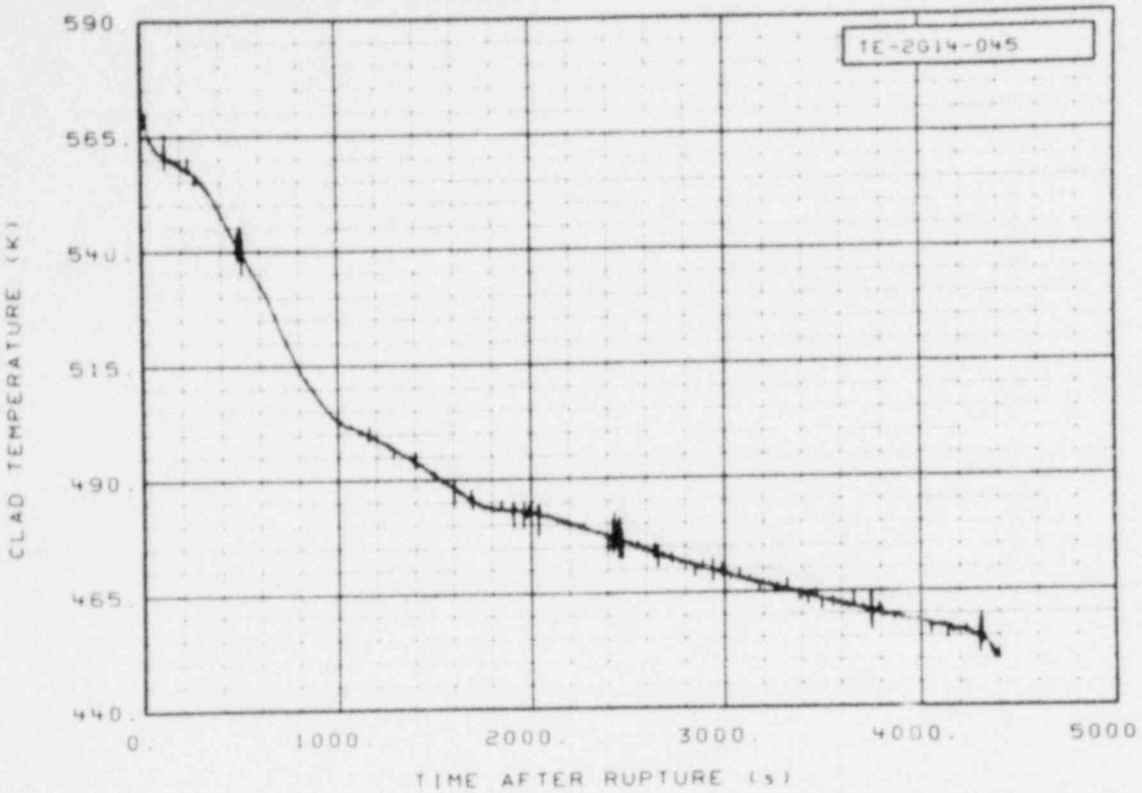


Figure 155. Temperature of cladding on Fuel Assembly 2, Rod G14 (TE-2G14-045) (Qualified, IC = 601 K).

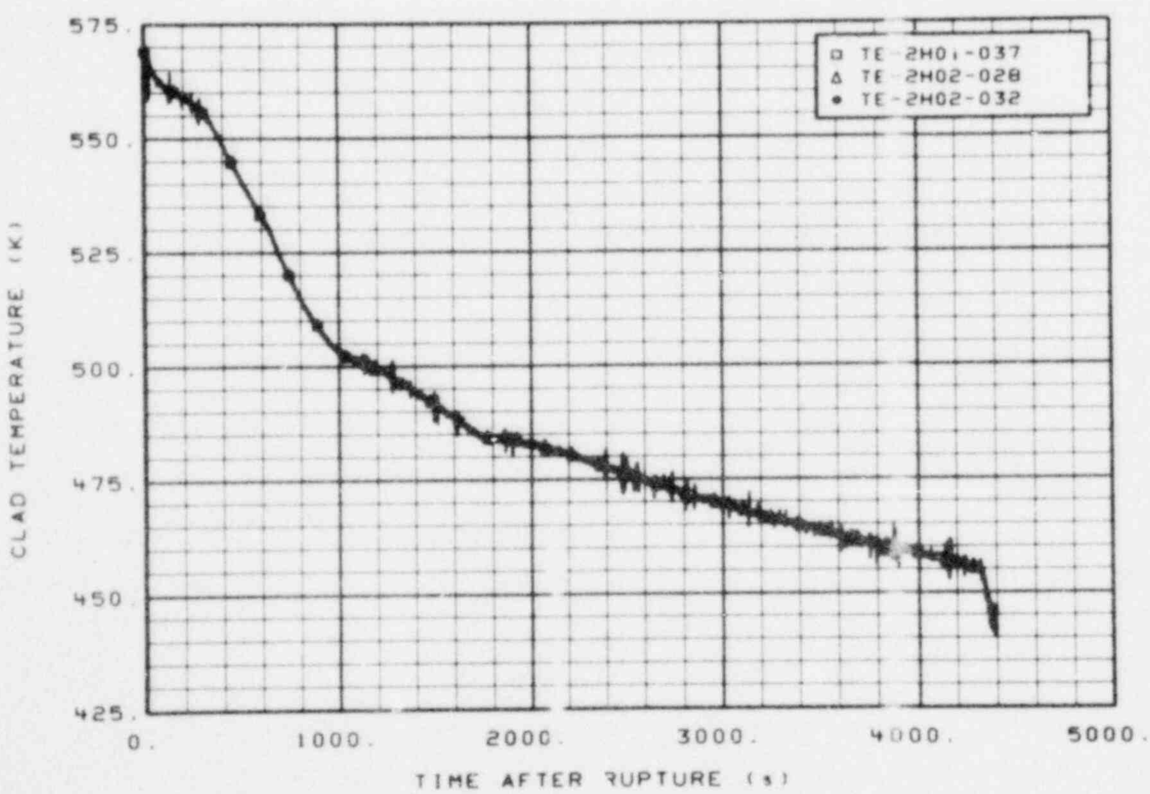


Figure 156. Temperature of cladding on Fuel Assembly 2, Rods H1 and H2 (TE-2H01-037, TE-2H02-028 and -032) (Qualified).

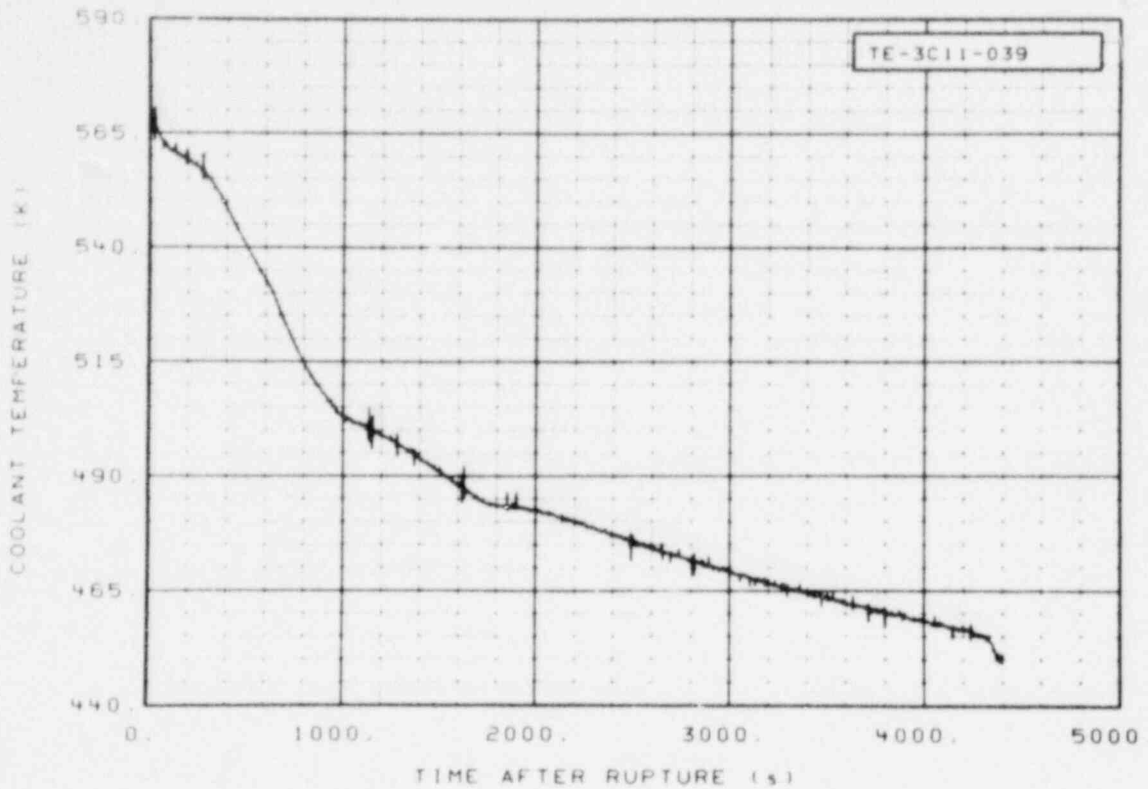


Figure 157. Temperature of cladding on Fuel Assembly 3, Rod C11 (TE-3C11-039) (Qualified, IC = 598.8 K).

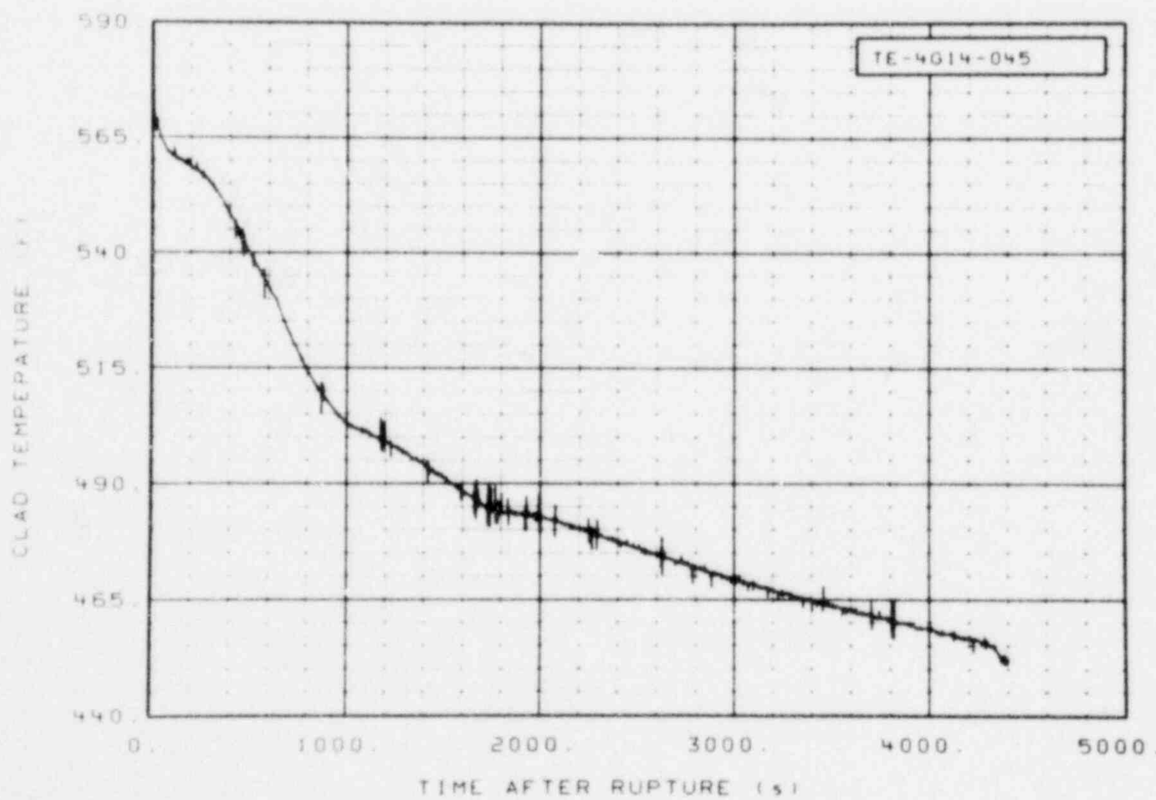


Figure 158. Temperature of cladding on Fuel Assembly 4, Rod G14 (TE-4G14-045) (Qualified, IC = 601.0 K).

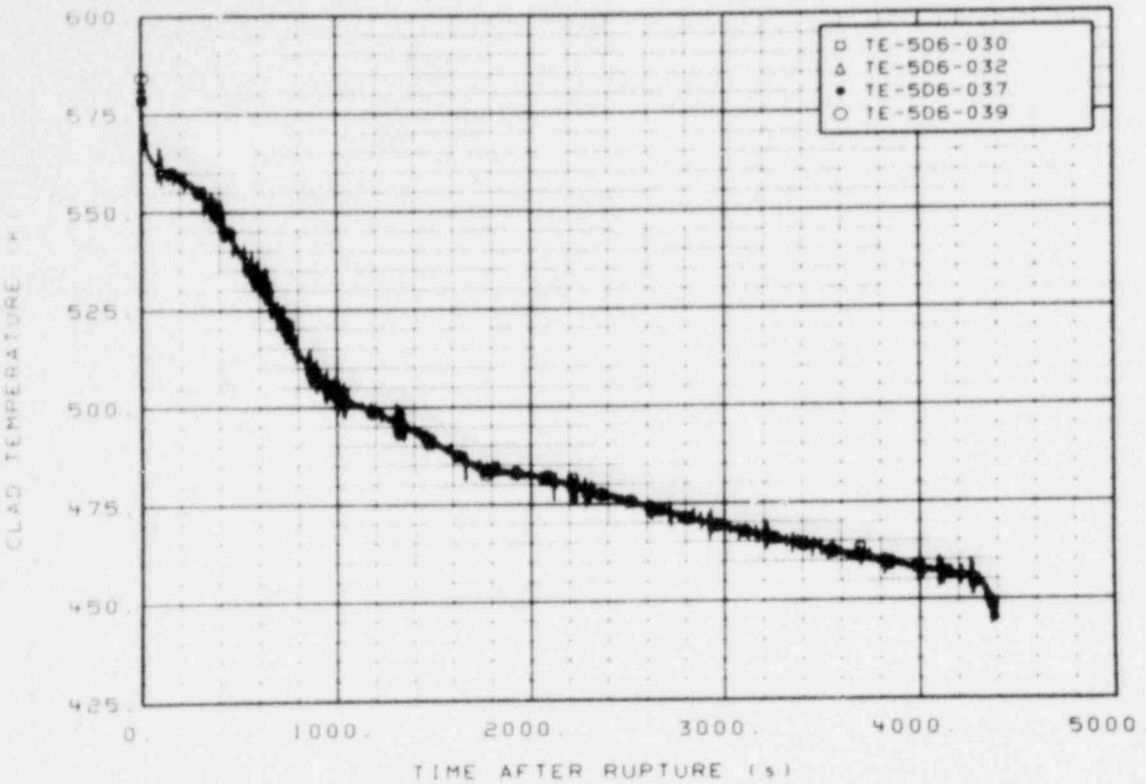


Figure 159. Temperature of cladding on Fuel Assembly 5, Rod D6 (TE-5D6-030, -032, -037, and -039) (Qualified).

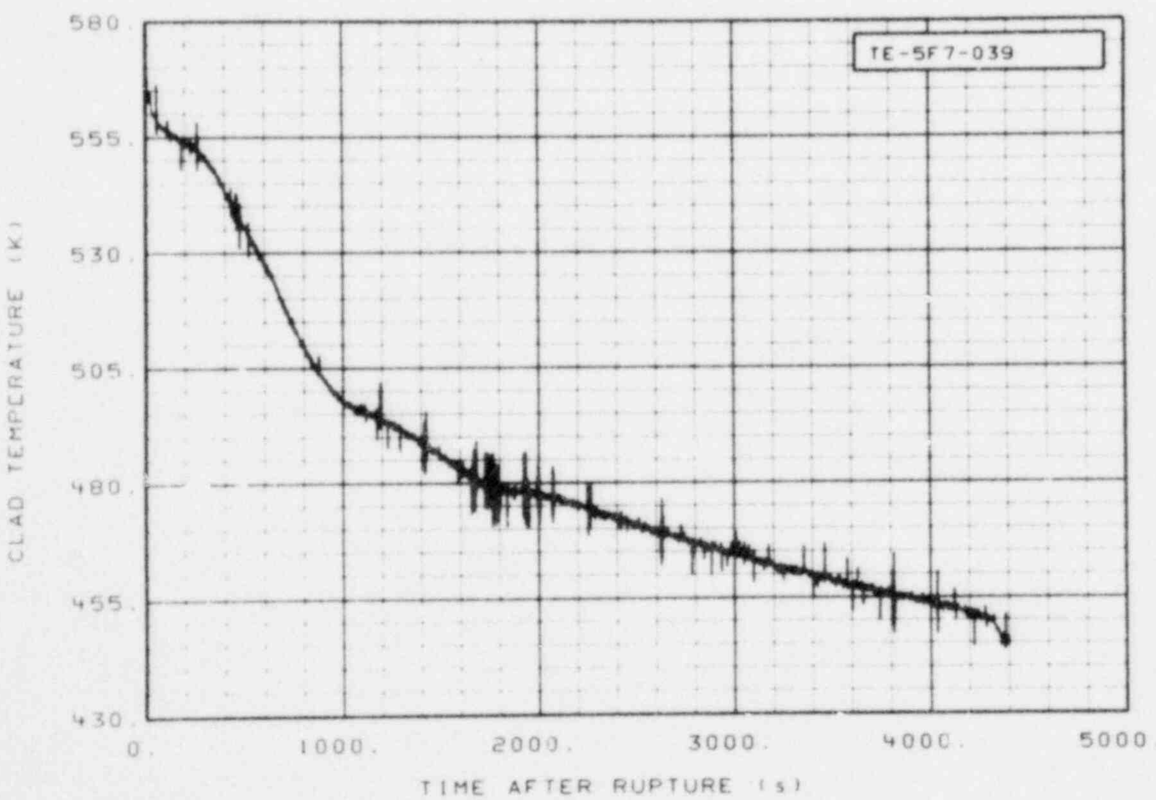


Figure 160. Temperature of cladding on Fuel Assembly 5, Rod F7 (TE-5F7-039) (Qualified, IC = 582.2 K).

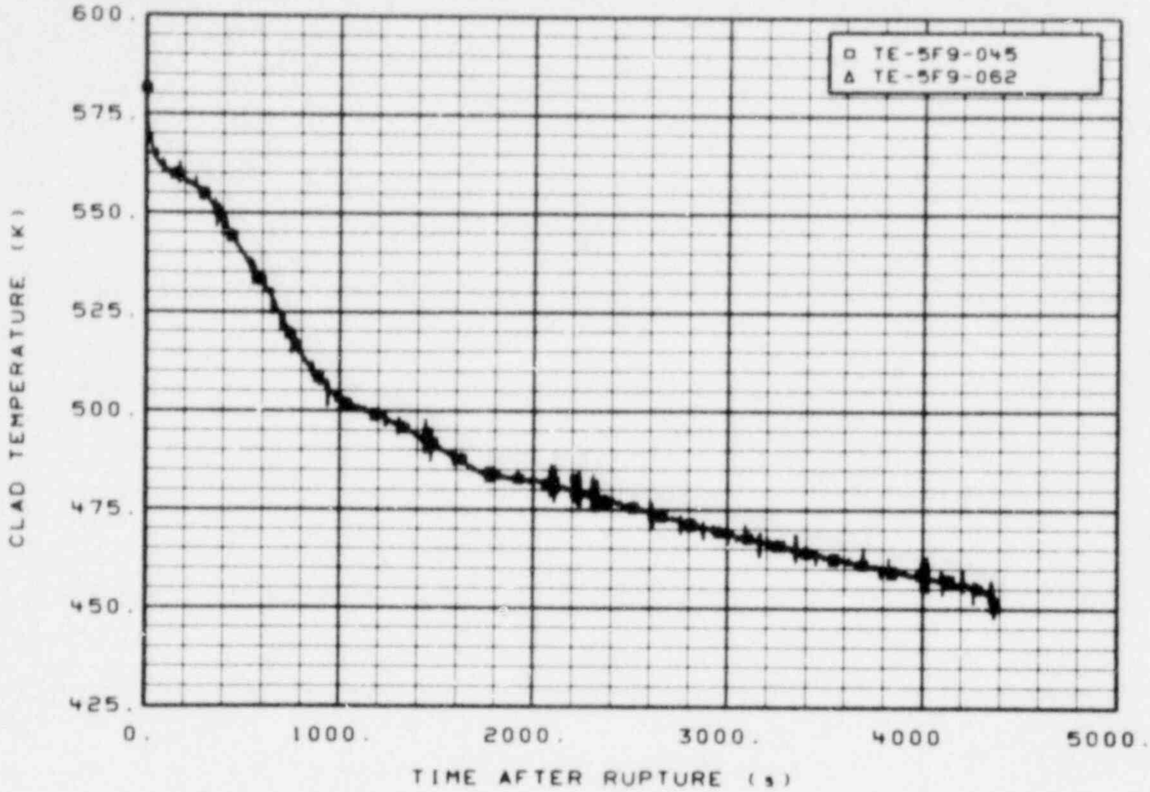


Figure 161. Temperature of cladding on Fuel Assembly 5, Rod F9 (TE-5F9-045 and -062) (Qualified).

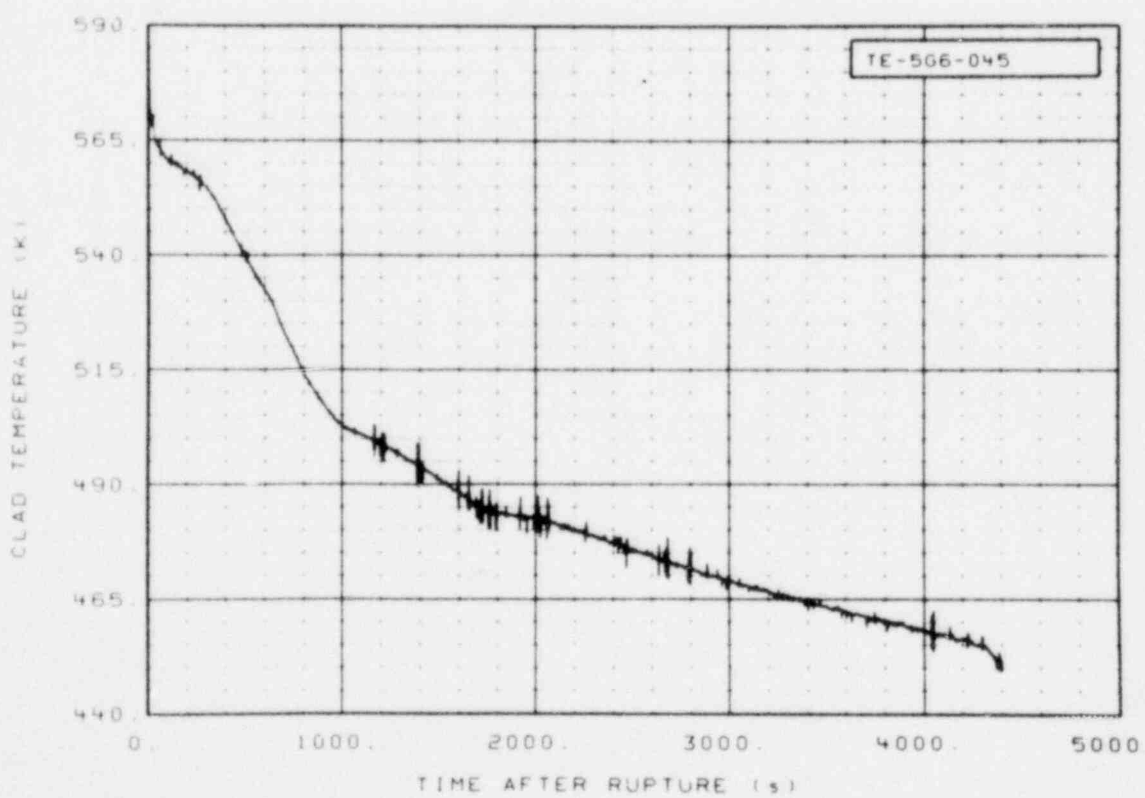


Figure 162. Temperature of cladding on Fuel Assembly 5, Rod G6 (TE-5G6-045) (Qualified, IC = 591.7 K).

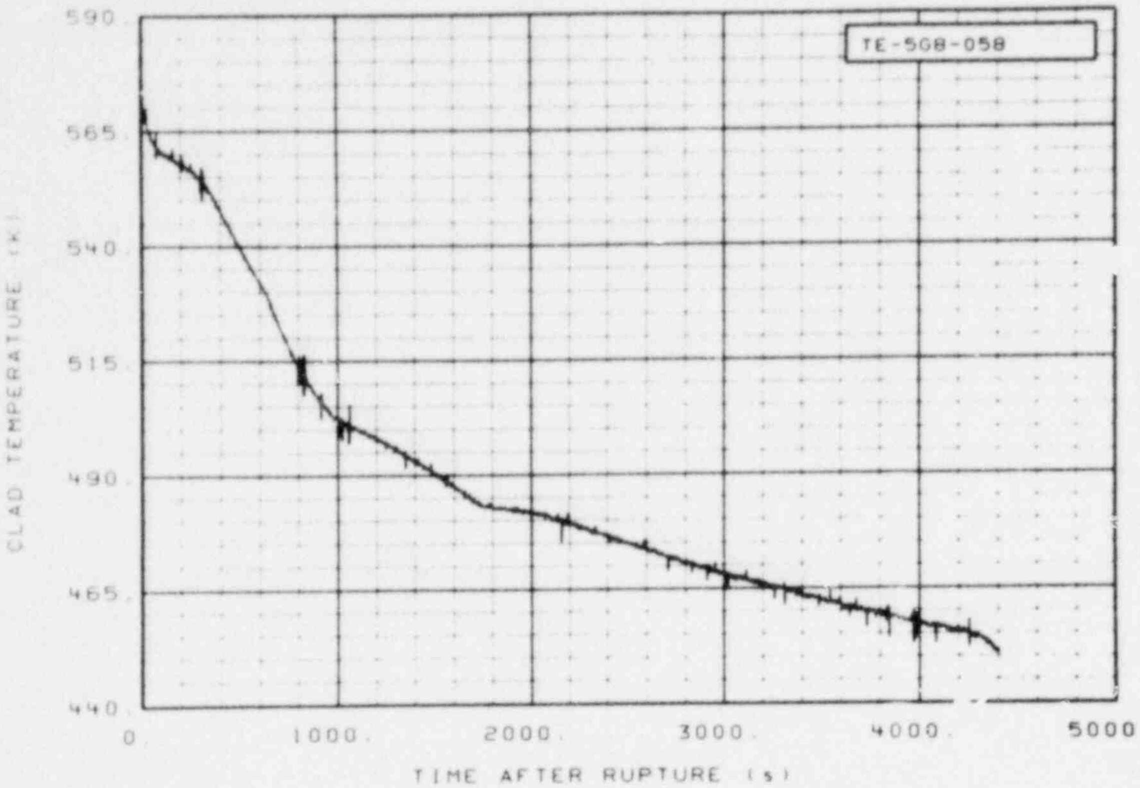


Figure 163. Temperature of cladding on Fuel Assembly 5, Rod G8 (TE-5G8-058) (Qualified, IC = 589.0 K).

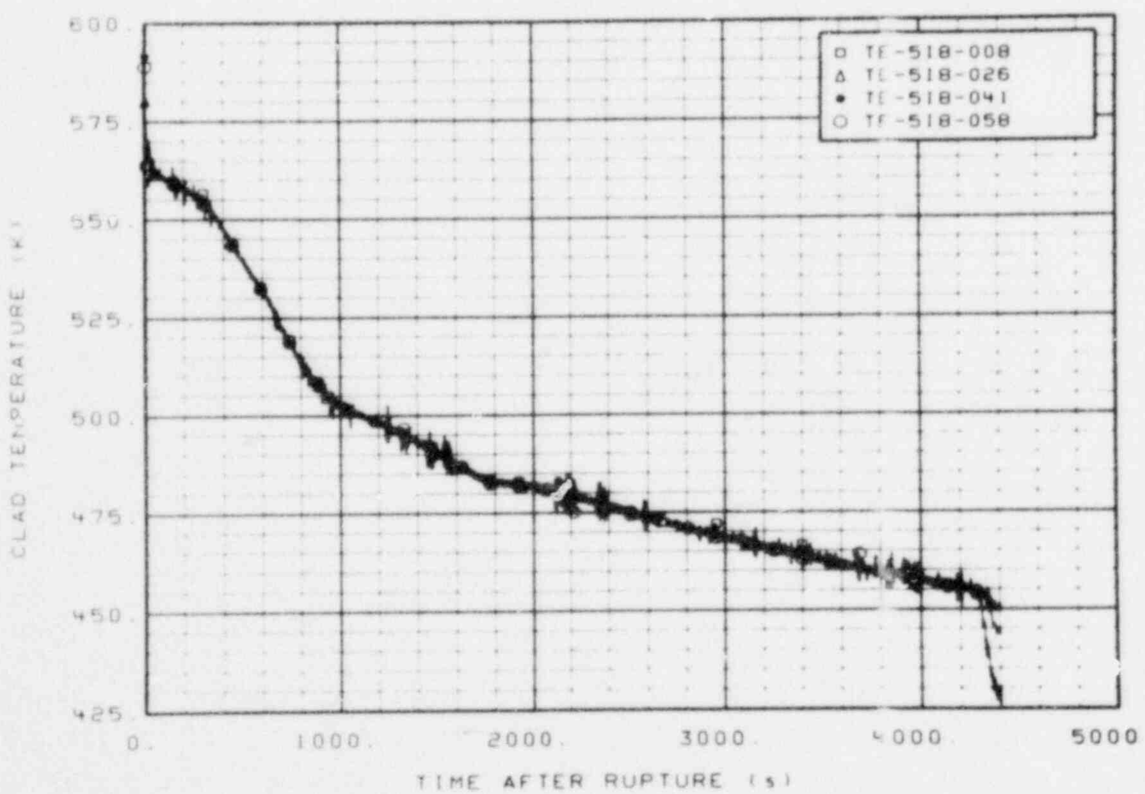


Figure 164. Temperature of cladding on Fuel Assembly 5, Rod I8 (TE-5I8-008, -026, -041, and -058) (Qualified).

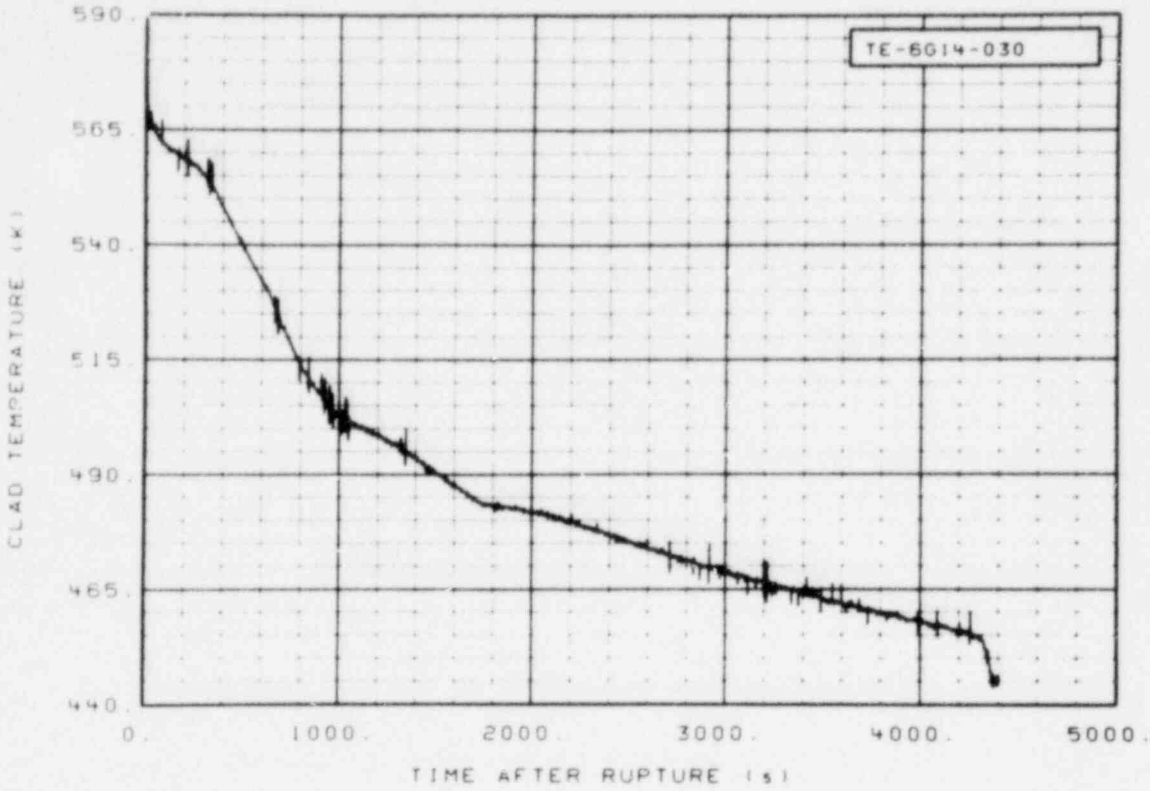


Figure 165. Temperature of cladding on Fuel Assembly 6, Rod G14 (TE-6G14-030) (Qualified, IC = 605 K).

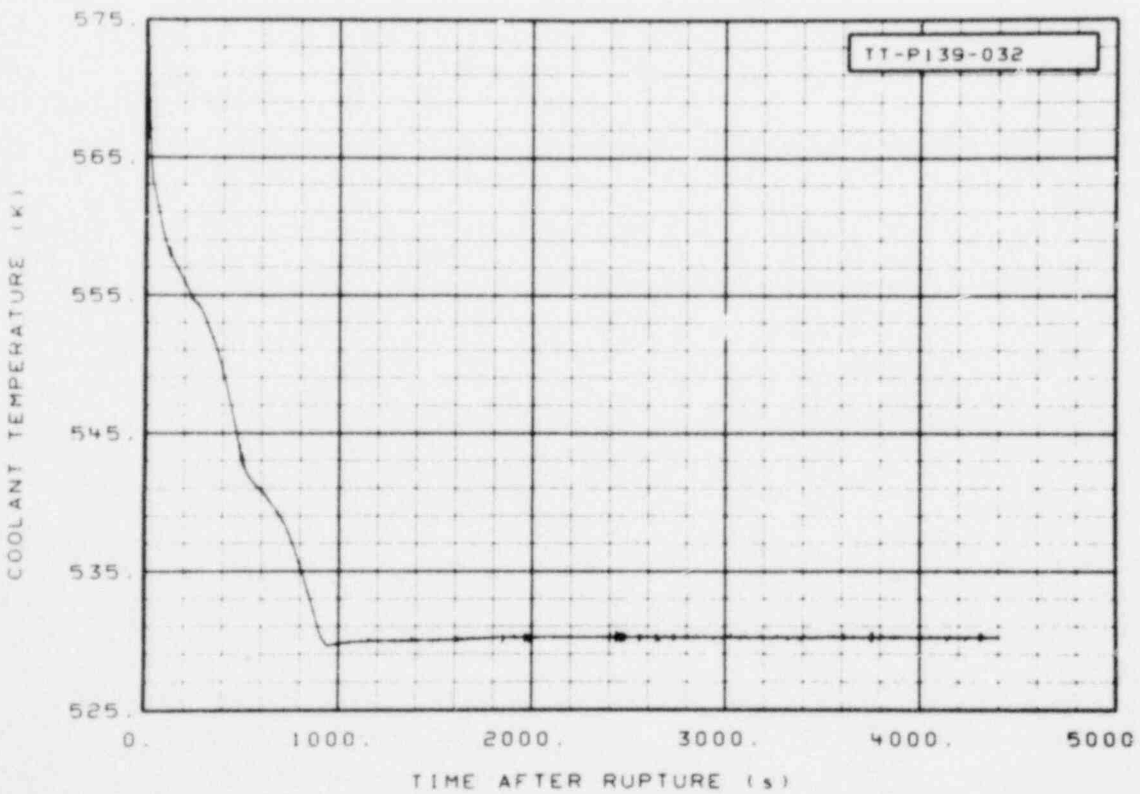


Figure 166. Coolant temperature in intact loop hot leg Channel A (TT-P139-032) (Qualified, high range instrument, not valid below 535 K, IC = 574.6 K).

POOR ORIGINAL

COMPUTED VARIABLES

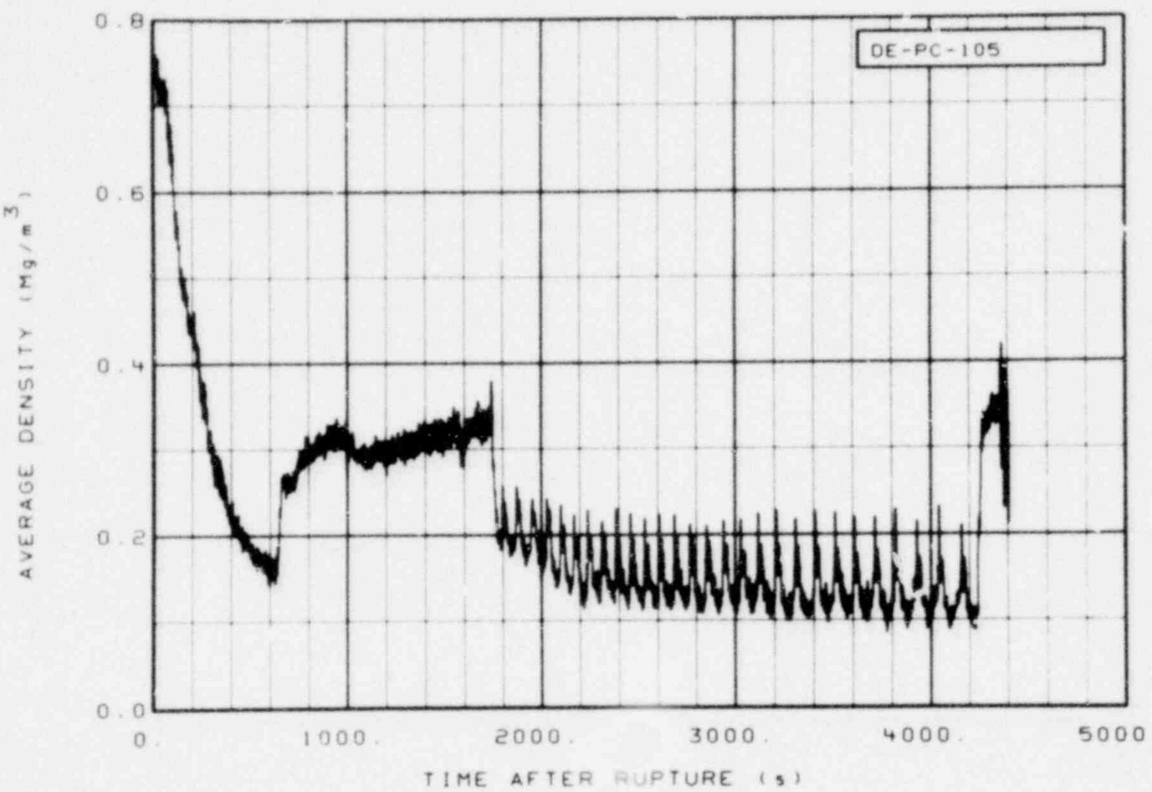


Figure 167. Average fluid density in intact loop cold leg (DE-PC-105) (Qualified, second calibration point of one input determined from intact loop liquid level during first 600 s).

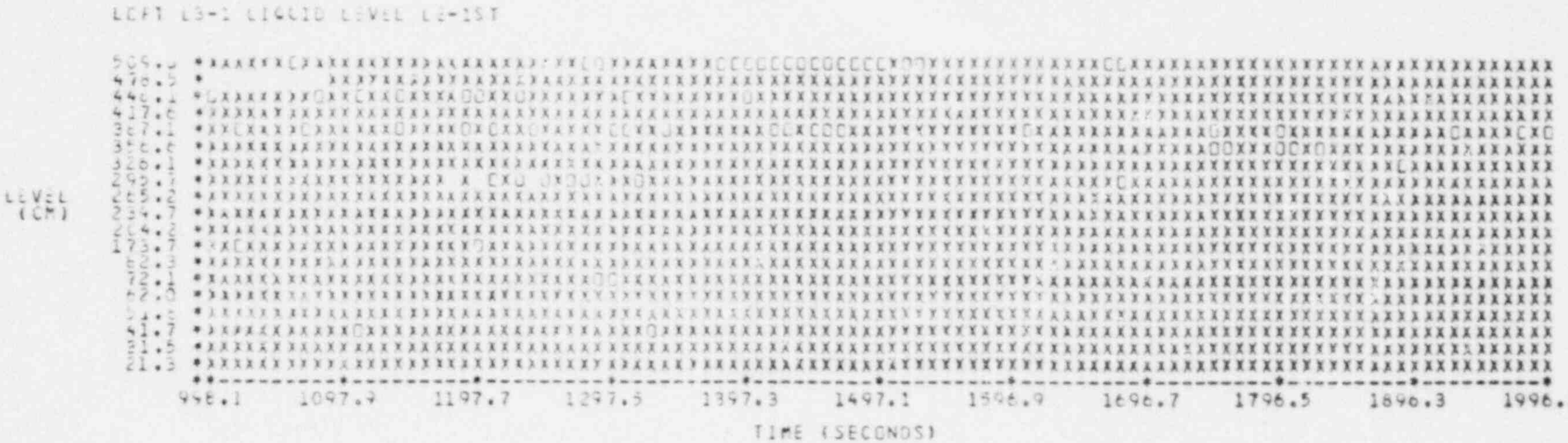
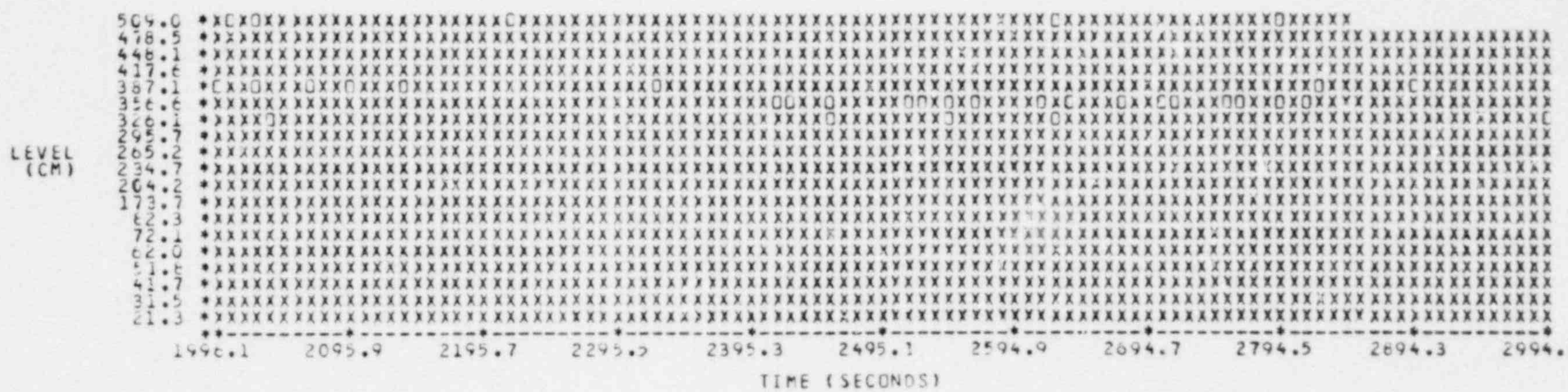


Figure 168. Liquid level in reactor vessel Downcomer Instrument Stalk 1, bubble plot (LE-1ST-1) (Qualified).

LOFT L3-1 LIQUID LEVEL LE-1ST



LOFT L3-1 LIQUID LEVEL LE-1ST

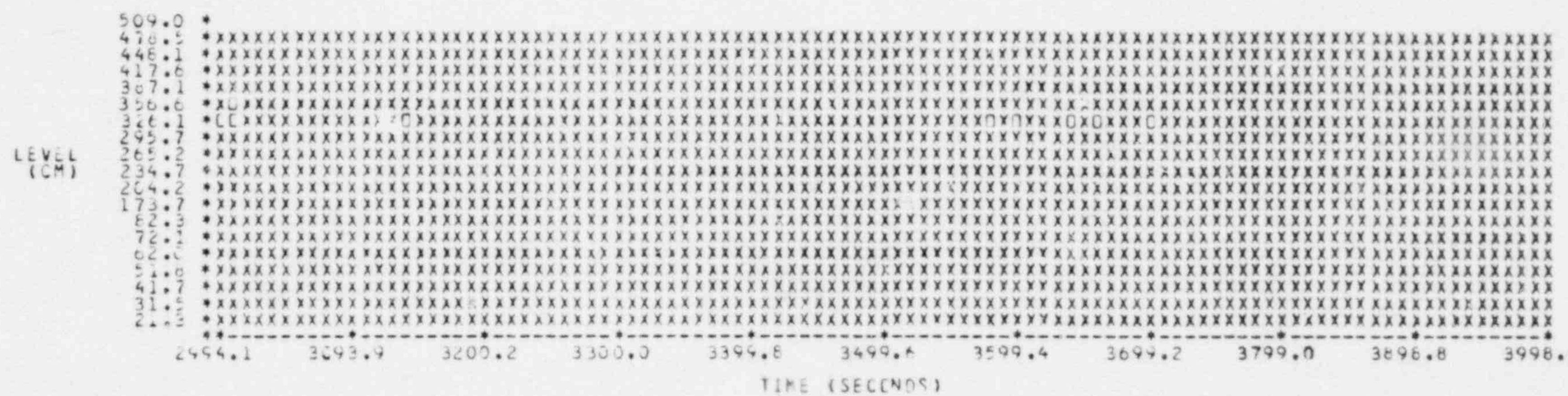


Figure 168. (continued)

Figure 168. (continued)

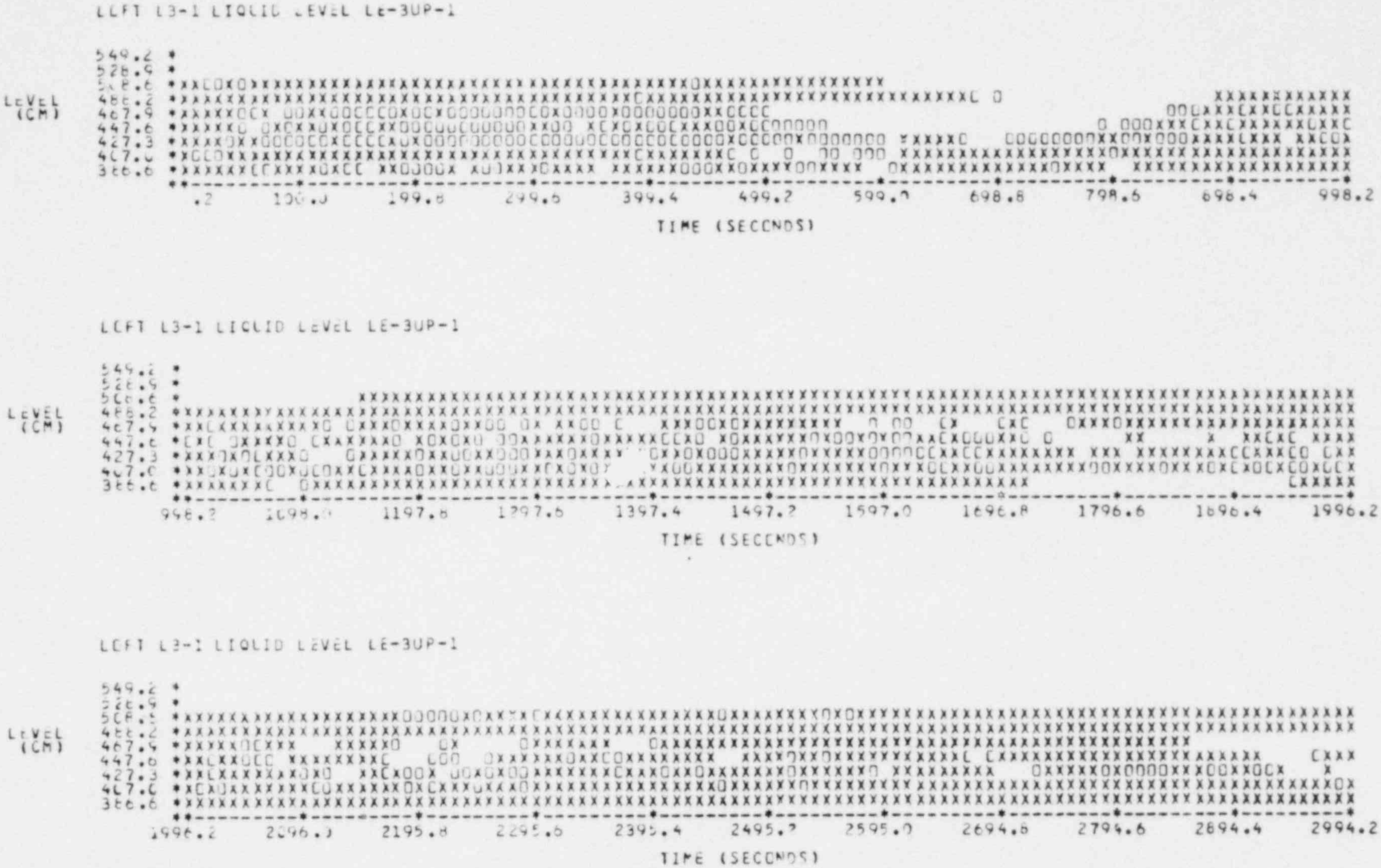
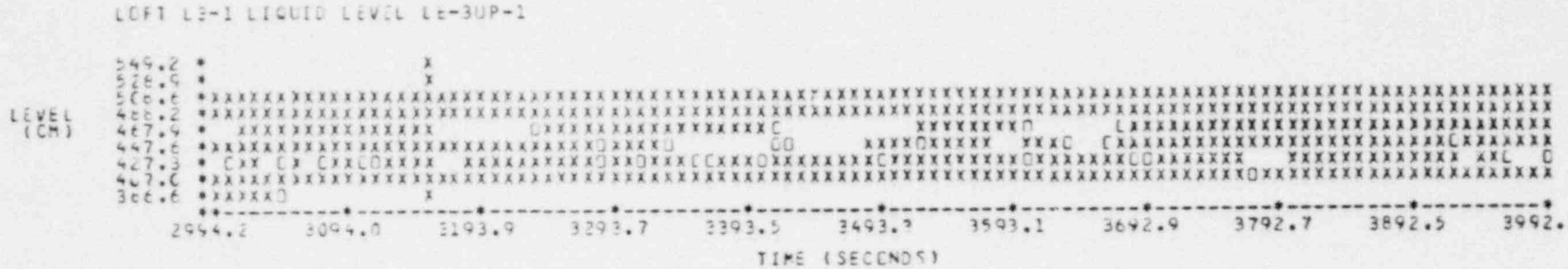


Figure 169. Liquid level in reactor vessel upper plenum above Fuel Assembly 3, bubble plot (LE-3UP-1) (Qualified).



END

Figure 169. (continued)

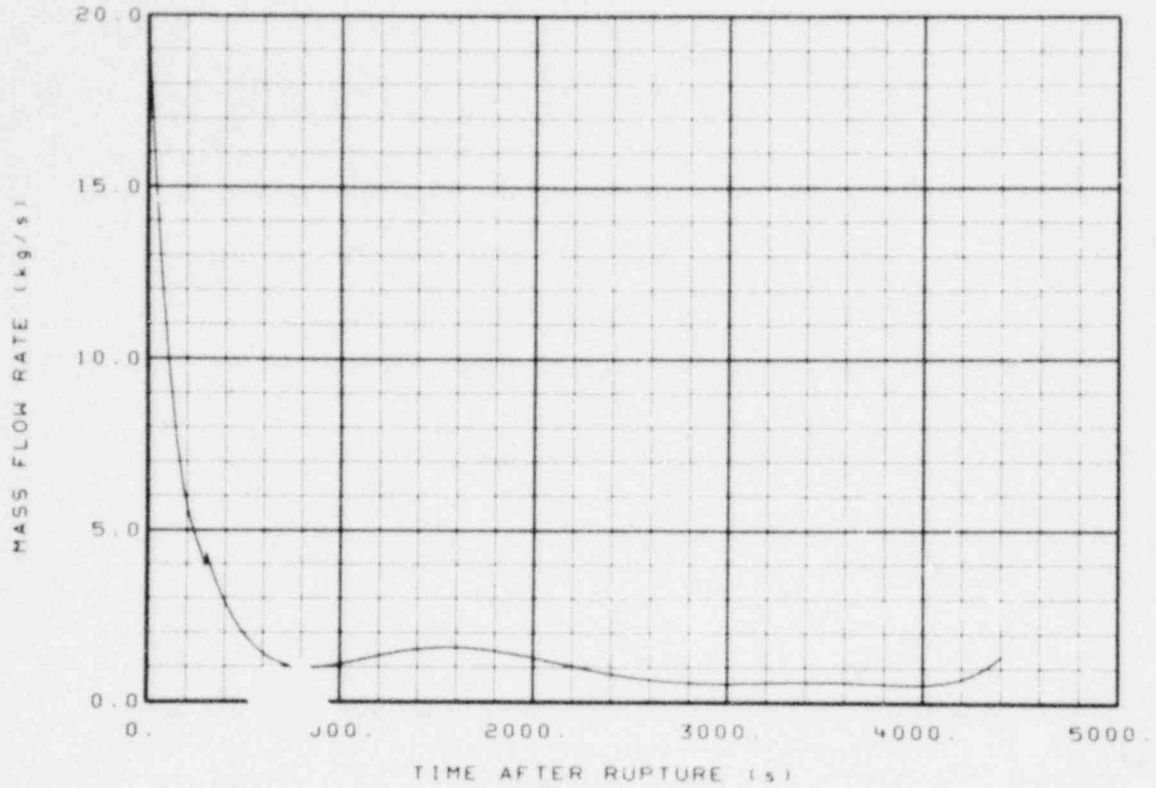


Figure 170. Mass flow rate in broken loop cold leg (Qualified).

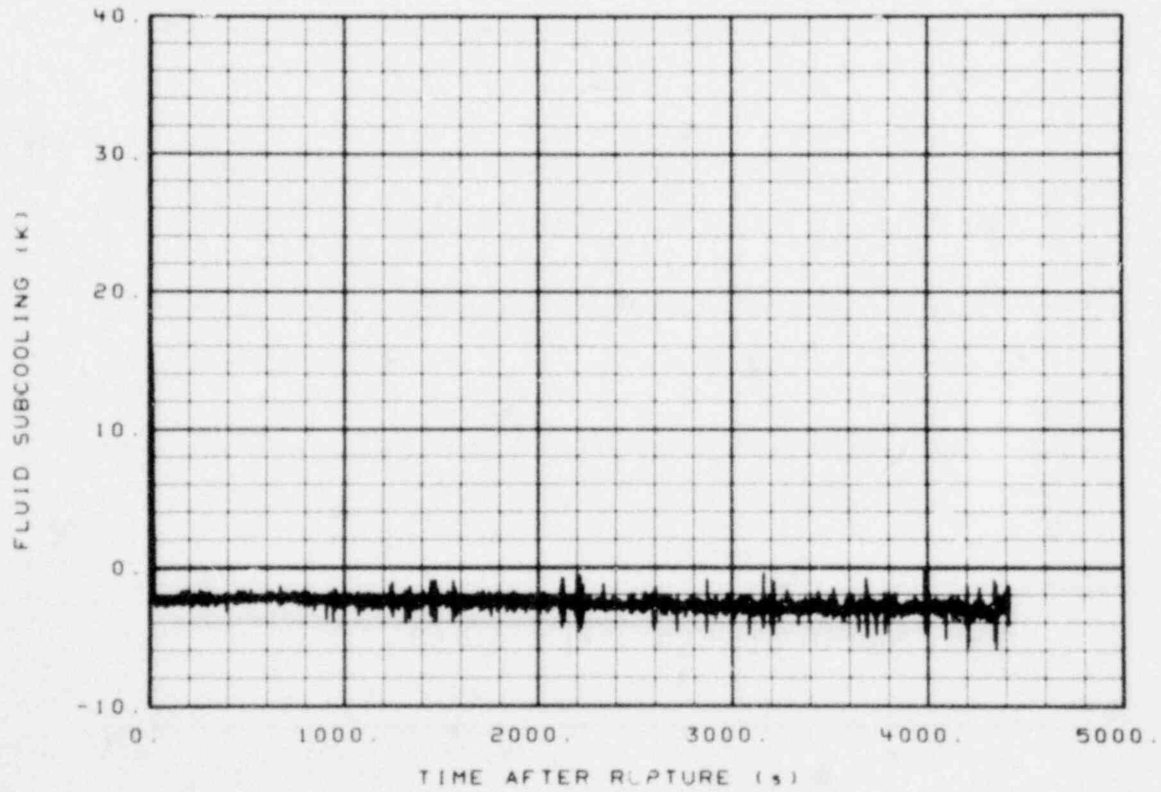


Figure 171. Fluid subcooling in reactor vessel upper plenum (Qualified).

REFERENCES

1. D. L. Reeder, *LOFT System and Test Description (5.5-ft Nuclear Core 1 LOCEs)*, NUREG/CR-0247, TREE-1208 (July 1978).

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

3. F. S. Miyasaki, *Digital Data Acquisition Program*, ANCR-1250 (August 1975).

4. N. L. Norman, *LOFT Data Reduction*, ANCR-1251 (August 1975).

5. G. D. Lassahn, *LOFT Experimental Measurements Uncertainties Analyses, Vol. XVI, LOFT Three-Beam Gamma Densitometer System*, TREE-NUREG-1089 (February 1979).

6. G. L. Biladeau, *LOFT Experimental Measurements Uncertainties Analyses, Vol. VI, LOFT Linear Variable Differential Transformer Displacement Transducer Uncertainty Analysis*, TREE-NUREG-1089 (February 1978).

7. S. Silverman, *LOFT Experimental Measurements Uncertainties Analyses, Vol. XIV, LOFT Drag Disc-Turbine Transducer Uncertainty Analysis*, TREE-NUREG-1089 (November 1978).

8. G. D. Lassahn, *LOFT Experimental Measurements Uncertainties Analyses, Vol. VII, LOFT Self-Powered Neutron Detector Uncertainty Analysis*, TREE-NUREG-1089 (August 1978).

9. L. D. Goodrich, Jr., *LOFT Experimental Measurements Uncertainties Analyses, Vol. XV, LOFT Primary Coolant Pump Speed Measurement Uncertainty Analysis*, TREE-NUREG-1089 (April 1978).

10. G. D. Lassahn, *LOFT Three-Beam Densitometer Data Interpretation*, TREE-NUREG-1111 (October 1977).

APPENDIX A

DATA CONSISTENCY CHECKS

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DATA CONSISTENCY CHECKS

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.

CHECKS OF PRE-LOCE DATA

A series of tests was conducted at various temperatures, pressures, and flow rates prior to the loss-of-coolant experiment (LOCE). These tests included static pressure, steady state flow, zero flow, pump coast down, isothermal, and accumulator blowdown tests. The following checks were performed on the transducers using the data from these tests.

Absolute Pressure Data

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

The blowdown suppression tank pressure transducers were checked against atmospheric pressure prior to the LOCE.

The steam generator pressure transducer was checked against the thermocouples in the steam generator by comparing the pressure obtained from the steam tables, using the steam generator temperature, with the pressure transducer reading.

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

Checks of Flow Data

Measurements of fluid flow included pump speed, differential pressure, venturi, turbines, drag discs, and the transit time flowmeter (TTF). The transducers were analyzed primarily to check the zero offset. Turbines and drag discs were also analyzed to check slope coefficient (gain) changes.

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 LOCE until the primary system motor generator field breakers were opened at 17.6 ± 0.5 s. Prior to the LOCE, the pump speed was further checked by reviewing the agreement with previous LOFT tests. Pump run voltages and currents were evaluated prior to the LOCE 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.

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 primary coolant system were then established, and selected primary coolant system 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 transducers 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 transducer zero offsets. Both prior to and during the LOCE, differential pressure measurements were compared with the differential pressure computed by subtracting appropriate absolute pressure measurements. Finally, pressure closure was calculated for the two flow loops: (a) the primary coolant system intact loop, and (b) the broken loop cold leg to the blowdown suppression tank.

Venturi Data

Consistency checks were performed by comparing the venturi mass flow rate with previous LOFT tests (with the same loop resistance) and to each other. 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.

In addition, the computed fluid velocity and the momentum flux were compared to the output of the turbines and drag discs in the intact loop and reactor vessel.

Drag-Disc Turbine (DTT) Data

For the drag discs in the intact loop, a check was performed at each pump frequency step. These were steady state flow tests performed at 20, 30, 40, 50, and 60 Hz. The data from each drag disc were compared with the momentum flux calculated from the intact loop venturi mass flow rate as described above. Reactor vessel and downcomer drag discs 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 LOCE. This analysis was performed on all the turbine flowmeters and drag discs in the intact loop and the reactor vessel with the exception of those instruments that failed.

Transit Time Flowmeter (TTF) Data

Checks of the TTF were performed during the pre-LOCE accumulator blowdown by comparing the computed velocity using different combinations of the TTF thermocouples.

In addition, a check of the TTF was performed by comparing the TTF data to the suppression tank liquid levels. The TTF data and the fluid density were used to calculate the total fluid mass that flowed out the break. This mass was then compared with the suppression tank fluid mass increase which was calculated using the liquid levels.

Gamma Densitometer Data

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

Level Measurement Data

Four system level measurements were evaluated: (a) Accumulator ACC-A liquid level, (b) blowdown suppression tank liquid level, (c) pressurizer liquid level, and (d) reactor vessel coolant level. The accumulator level was qualified by comparing the pre-LOCE liquid levels as measured with the level detector to the level measured by an external sightglass. Blowdown suppression tank liquid level measurements were qualified by comparing the two available measurements. The initial condition for the blowdown suppression tank level was established by taking an average of the two measurements. Similarly, pressurizer level was reviewed by redundant level measurements. The reactor vessel liquid level probes were verified by performing a pretest conductivity calibration with the vessel full under cold and hot plant conditions.

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.

CHECKS DURING AND AFTER THE LOCE

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.

Absolute Pressure Data

During the LOCE the saturated steam temperature was determined from the saturated steam table using pressure transducer data. The computed temperature was compared with the temperature measured by the thermocouple. However, this was valid only during saturation and until such time that the measurement location was voided of liquid. When complete voiding occurred, the measured temperature increased above the corresponding saturation temperature because of conduction and radiant heating of the detector element by the surrounding warmer environment (pipe walls, etc.).

Checks of Flow Data

Immediately prior to the LOCE, flow data were again compared for consistency. In addition, LOCE data were compared with previous similar tests. A summary of the consistency checks for the pump and flow transducers follows.

Pump Speed Data

Primary coolant pump speed, current, voltage, frequency, and power were measured during the LOCE. Pump speed measurements were checked by comparing the measured pump speed with that calculated from the pump frequency. This comparative analysis was valid prior to and during the LOCE, until the pump speed motor generator field breakers were opened. Pump voltage and current were compared with those of previous tests. Pump power was compared with the power calculated using voltage, current, and power factor.

Differential Pressure Data

Immediately prior to the LOCE, 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.

Venturi Data

The initial conditions data from the venturi were checked for data consistency by comparing them with pre-LOCE flow test data. The flow venturi was used only for steady state initial conditions information.

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. These values were then compared with the measured values from the DTT.

LOCE data were checked by comparing data from previous tests. 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.

Gamma Densitometer Data

Checks of the calibration constants were obtained from the all-liquid readings a few seconds prior to the LOCE and all steam conditions late in the LOCE. The fluid densities for the all-liquid and all-steam conditions were determined from the steam tables using temperature and pressure measurements. The densitometer beams which did not see all-steam conditions (DE-BL-001B and DE-PC-001A) were calibrated assuming that the liquid levels in the two cold legs were the same prior to 600 s. Knowing the density from DE-PC-001B, the liquid level in the pipe was determined, and the required second calibration points found.

Liquid Level Data

The accumulator level was verified by comparing the pre-LOCE and post-LOCE liquid levels, as measured with the level detector, with the level measured by an external sightglass. Further post-test data consistency evaluations were performed by comparing the injected accumulator volume, as determined by the external sightglass, with the accumulator volume flow rate integrated with respect to time. The blowdown suppression tank liquid level was evaluated by comparing two independent level measurements (LT-P138-33 and -58). Similarly, pressurizer level was reviewed by redundant level measurements. During the LOCE, the vessel level measurements were compared with vessel thermocouple data; when the fluid level dropped below a given thermocouple, the measured temperature increased.

Temperature Data

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

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