308
5-31-77
HRC 2 pens
40 up to cottage

Q1 # 1065

TREE-NUREG-1065
for U.S. Nuclear Regulatory Commission

EXPERIMENT DATA REPORT FOR LOFT NONNUCLEAR TEST L1-3

GARY M. MILLAR

April 1977

MASTER

EG&G Idaho, Inc.

IDAHO NATIONAL ENGINEERING LABORATORY

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

IDAHO OPERATIONS OFFICE UNDER CONTRACT EY-76-C-07-1570

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161
Price: Printed Copy \$9.75; Microfiche \$3.00

"The NRC will make available data tapes and operational computer codes on research programs dealing with postulated loss-of-coolant accidents in light water reactors. Persons requesting this information must reimburse the NRC contractors for their expenses in preparing copies of the data tapes and the operational computer codes. Requests should be submitted to the Research Applications Branch, Office of Nuclear Regulatory Research, Nuclear Regulatory Commission, Washington, D.C. 20555."

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the Energy Research and Development Administration, nor the Nuclear Regulatory Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

EXPERIMENT DATA REPORT FOR LOFT

NONNUCLEAR TEST L1-3

Approved:

L. P. Leach, Acting Manager
LOFT Experimental Program Division

L. F. Burdge, Director
LOFT

NOTICE
This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

TREE-NUREG-1065

Distributed Under Category:
NRC-2
Water Reactor Safety Research
Systems Engineering

EXPERIMENT DATA REPORT FOR LOFT
NONNUCLEAR TEST L1-3

by

Gary M. Millar

EG&G Idaho, Inc.

April 1977

PREPARED FOR THE
U.S. NUCLEAR REGULATORY COMMISSION AND
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
IDAHO OPERATIONS OFFICE
UNDER CONTRACT NO. EY-76-C-07-1570

ACKNOWLEDGMENTS

Appreciation is expressed to J. R. Chappell, L. D. Goodrich, G. Hammer, H. C. Robinson, T. K. Samuels, and the personnel of the LOFT Data Systems Branch for their special help in preparing this document.

ABSTRACT

Test L1-3 was the third in a series of five nonnuclear isothermal blowdown tests conducted by the Loss of Fluid Test (LOFT) Program. For this test the LOFT Facility was configured to simulate a loss-of-coolant accident in a large pressurized water reactor resulting from a 200% double-ended shear break in a cold leg of the primary coolant system. A hydraulic core simulator assembly was installed in place of the nuclear core. The initial conditions in the primary coolant system intact loop were: temperature at 540°F, pressure at 2256 psig, and loop flow at 2.34×10^6 lbm/hr. During system depressurization, emergency core cooling water was specified to be injected into the lower plenum of the reactor vessel using an accumulator, a low-pressure injection system pump, and a high-pressure injection system pump to provide data on the effects of emergency core cooling on the system thermal-hydraulic response. Injection into the lower plenum was initiated from the high- and low-pressure injection systems. Injection from the accumulator, however, was not initiated because a valve was inadvertently left closed. The experiment, therefore, was not completely successful in that one of the objectives outlined in the experiment operating specification for this test was not accomplished. Test L1-3 was repeated as Test L1-3A to meet the experimental requirements. Despite these difficulties, Test L1-3 did provide very valuable data to verify experiment repeatability.

SUMMARY

The intent of this report is to present selected data from LOFT Test L1-3, which was performed as a part of the L1 (nonnuclear) series of LOFT Program tests. The data are presented in the form of graphs in engineering units for easy interpretation. In conjunction with the data obtained from direct measurement, chosen computed parameters are included to facilitate in the analysis of the system thermal-hydraulic behavior. Plots of representative instrument types and ranges and their associated error bands are also presented.

The L1 test series consists of five nonnuclear blowdown experiments which are initiated with isothermal conditions established in the reactor coolant loop. Test L1-3, the third test in the L1 series, was conducted on June 28, 1976.

The LOFT Integral Test Facility is a highly instrumented, pressurized water reactor test system designed to be representative of large pressurized water reactors (LPWR) for the simulation of loss-of-coolant accidents (LOCA). The test assembly consists of:

- (1) A reactor vessel with a hydraulic core simulator installed in place of a nuclear core.
- (2) An intact loop with active steam generator, pressurizer, and two primary coolant pumps connected in parallel.
- (3) A broken loop with a simulated pump, a 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-emergency core coolant (ECC) injection system consisting of a low-pressure injection system (LPIS) pump, a high-pressure injection system (HPIS) pump, and an accumulator.

For the performance of the L1-3 loss-of-coolant experiment (LOCE), the test assembly was configured to represent a 200% double-ended offset shear in a cold leg of a LPWR.

The areas of interest specific to Test L1-3 were to evaluate (a) the effect of intact loop resistance on system thermal-hydraulic response by comparison with corresponding results from Test L1-2 and (b) the effect on system thermal-hydraulic response by injection of ECC directly into the lower plenum of the reactor vessel. To establish the importance of intact loop resistance, this test was conducted with low resistance orifice plates installed in the steam generator which were based on core flow area scaling. To determine system response, ECC was specified to be directed to the lower plenum injection line using accumulator ACC-A, HPIS pump A, and LPIS pump A. The accumulator injection failed to initiate; HPIS flow and LPIS flow were initiated at 32.6 and 37.5 seconds after rupture, respectively. This failure of accumulator injection is not important to future LOFT nuclear operation since the plant protection system (PPS) would have initiated all modes of ECC. The PPS was intentionally deactivated for the performance of this experiment.

Test L1-3 was initiated from primary coolant system initial conditions of 2256 psig and 540°F with an intact loop flow rate of 2.34×10^6 lbm/hr. The complete set of initial test conditions is specified in Reference 1 and is summarized in Table III of this report. Measured experiment conditions for Test L1-3 were within their specified tolerance bands except that the intact loop flow rate was 2.34×10^6 lbm/hr instead of the 2.15×10^6 lbm/hr as specified. This discrepancy did not adversely affect the experiment.

Data were successfully collected and processed from 512 of the 549 data channels utilized during Test L1-3. Instrument malfunctions

pertinent to a particular data channel are specified in Table VI. Of the instruments which produced no useful data, none impacted the success of the experiment.

Test L1-3 was not completely successful in accomplishing the objectives as presented in Reference 1 and summarized in Section I of this report since accumulator injection did not initiate. This experiment, however, did provide extremely valuable information to verify data repeatability for the same experiment conducted from essentially the same initial conditions.

CONTENTS

ACKNOWLEDGMENTS	ii
ABSTRACT.	iii
SUMMARY	iv
I. INTRODUCTION.	1
II. SYSTEM CONFIGURATION.	6
III. MEASUREMENTS AND INSTRUMENTATION	12
IV. TEST PROCEDURES	30
V. INITIAL CONDITIONS.	35
VI. DATA CONSISTENCY CHECKS	41
VII. DATA PRESENTATION	51
1. TEST L1-3 MEASURED PARAMETERS SHORT-TERM PLOTS (1 Second or Less)	101
2. TEST L1-3 MEASURED PARAMETERS MEDIUM-TERM PLOTS (-10 to 70 Seconds).	117
3. TEST L1-3 MEASURED PARAMETERS LONG-TERM PLOTS (175- and 500-Second Plots).	187
4. TEST L1-3 COMPUTED PARAMETERS.	209
5. TEST L1-3 ERROR BAND PLOTS	241
VIII. REFERENCES.	264
IX. LIST OF ABBREVIATIONS AND ACRONYMS.	267

FIGURES

1. LOFT major components.	10
2. LOFT piping schematic (with instrumentation)	11
3. Gamma densitometer beam configuration.	14
4. Gamma densitometer flow regime logic	15

5.	LOFT thermo-fluids measurements instrumentation.	19
6.	LOFT reactor vessel instrumentation.	20
7.	LOFT pressurizer instrumentation	21
8.	LOFT steam generator instrumentation	22
9.	LOFT intact loop pump instrumentation.	23
10.	LOFT accumulator instrumentation	24
11.	LOFT ECC system instrumentation (left side).	25
12.	LOFT suppression tank instrumentation.	26
13.	Determination of time of rupture (T_o) and valve opening time	53

TEST L1-3 MEASURED PARAMETERS
SHORT-TERM PLOTS (1 SECOND OR LESS)

14.	Valve opening (%) for broken loop QOBV, cold leg valve (CV-P138-1), and hot leg valve (CV-P138-15)	102
15.	Valve opening (%) for broken loop cold leg QOBV. (CV-P138-1) and cold QOBV inlet pressure (PT-P138-111).	102
16.	Valve opening (%) for broken loop hot leg QOBV (CV-P138-15) and hot leg QOBV inlet pressure (PT-P138-112).	103
17.	Pressure in broken loop cold leg (PE-BL-1, -4, and -8) (filtered to 250 Hz)	103
18.	Pressure in broken loop hot leg (PE-BL-2, -3, and -6) (filtered to 250 Hz)	104
19.	Pressure in intact loop cold leg, hot leg, steam generator outlet, and pressurizer (PE-PC-1, -2, -3A, and -4) (filtered to 250 Hz).	104
20.	Pressure in reactor vessel core simulator instrument stalk and downcomer instrument stalk 1 (PE-CS-1FF and -2FF and PE-1ST-3FF) (filtered to 250 Hz)	105
21.	Pressure in blowdown suppression tank bottom, 180° from top vertical reference (PE-SV-1, -22, -24, and -44).	105

22.	Pressure in blowdown suppression tank bottom, 180° from top vertical reference (PE-SV-3, -26, -27, and -43)	106
23.	Pressure in blowdown suppression tank submerged, 112.5° from top vertical reference (PE-SV-2, -23, and -25)	106
24.	Pressure in blowdown suppression tank submerged, 112.5° from top vertical reference (PE-SV-4, -28, and -29)	107
25.	Pressure in blowdown suppression tank vapor space, 67.5° from top vertical reference (PE-SV-58 and -61)	107
26.	Pressure in blowdown suppression tank vapor space, 45° from top vertical reference (PE-SV-57 and -59)	108
27.	Pressure in blowdown suppression tank top, 0° from top vertical reference (PE-SV-17, -55, and -60)	108
28.	Pressure in blowdown suppression tank submerged, 230° from top vertical reference (PE-SV-15 and -16)	109
29.	Pressure in blowdown suppression tank header (PE-SV-14 and -18)	109
30.	Pressure in blowdown suppression tank B-end submerged along vertical centerline (PE-SV-11, -13, and -27).	110
31.	Pressure in blowdown suppression tank A-end submerged along vertical centerline (PE-SV-10, -12, and -24).	110
32.	Pressure in blowdown suppression tank in a transverse plane, 316.5 in. from B-end reference (PE-SV-1, -2, and -58)	111
33.	Pressure in blowdown suppression tank in a transverse plane, 316.5 in. from B-end reference (PE-SV-15, -55, and -57)	111
34.	Pressure in blowdown suppression tank in a transverse plane, 263 in. from B-end reference (PE-SV-22 and -23)	112
35.	Pressure in blowdown suppression tank in a transverse plane, 263 in. from B-end reference (PE-SV-17 and -59)	112

36.	Pressure in blowdown suppression tank in a transverse plane, 28.5 in. from B-end reference (PE-SV-3, -4, -16, -60, and -61).	113
37.	Pressure in blowdown suppression tank header snubber (end) (PE-SV-30)	113
38.	Pressure in blowdown suppression tank header snubber (end) (PE-SV-31)	114
39.	Pressure in blowdown suppression tank header snubber (bend) (PE-SV-45).	114
40.	Pressure in blowdown suppression tank header snubber (bend) (PE-SV-46).	115
41.	Pressure in blowdown vacuum relief system rupture disc standpipe (PE-SV-54).	115
42.	Pressure in bellows between broken loop and blowdown suppression tank header (PE-SV-70). . . .	116

TEST L1-3 MEASURED PARAMETERS
MEDIUM-TERM PLOTS (-10 TO 70 SECONDS)

43.	Density in broken loop cold leg, chordal density (DE-BL-1A, -1B, and -1C) (filtered to 4 Hz)	118
44.	Density in broken loop hot leg, chordal density (DE-BL-2A, -2B, and -2C) (filtered to 4 Hz)	118
45.	Density in broken loop, average fluid densities (DE-BL-1 and -2) (filtered to 4 Hz).	119
46.	Density in intact loop cold leg, chordal density (DE-PC-1B and -1C) (filtered to 4 Hz).	119
47.	Density in intact loop hot leg, chordal density (DE-PC-2A, -2B, and -2C) (filtered to 4 Hz). . . .	120
48.	Density in intact loop at steam generator outlet, chordal density (DE-PC-3A, -3B, and -3C) (filtered to 4 Hz)	120
49.	Density in intact loop, average fluid densities (DE-PC-2 and -3) (filtered to 4 Hz).	121
50.	Average fluid velocity in broken loop cold leg at DTT flange (FE-BL-1) (filtered to 4 Hz)	121

51.	Average fluid velocity in broken loop hot leg at DTT flange (FE-BL-2) (filtered to 4 Hz)	122
52.	Average fluid velocity in broken loop cold and hot legs at DTT flanges (FE-BL-1 and -2) (filtered to 4 Hz)	122
53.	Average fluid velocity in reactor vessel core simulator instrument stalk (FE-CS-1) (filtered to 4 Hz)	123
54.	Average fluid velocity in intact loop cold leg at DTT flange (FE-PC-1) (filtered to 4 Hz)	123
55.	Average fluid velocity in intact loop hot leg at DTT flange (FE-PC-2) (filtered to 4 Hz)	124
56.	Average fluid velocity in intact loop steam generator outlet at DTT flange (FE-PC-3) (filtered to 4 Hz)	124
57.	Average fluid velocity in intact loop cold leg, hot leg, and steam generator outlet at DTT flanges (FE-PC-1, -2, and -3) (filtered to 4 Hz).	125
58.	Average fluid velocity in reactor vessel downcomer stalk 1, 47.1 in. above reactor vessel bottom (FE-1ST-1) (filtered to 4 Hz)	125
59.	Average fluid velocity in reactor vessel downcomer stalk 2, 47.1 in. above reactor vessel bottom (FE-2ST-1) (filtered to 4 Hz)	126
60.	Average fluid velocity in reactor vessel downcomer stalks 1 and 2, 47.1 in. above reactor vessel bottom (FE-1ST-1 and FE-2ST-1) (filtered to 4 Hz)	126
61.	Flow rate in ECCS LPIS pump A discharge (FT-P120-85)	127
62.	Flow rate in ECCS HPIS pump A discharge (FT-P128-104).	127
63.	Flow rate in intact loop hot leg venturi (FT-P139-27-1 and -27-3)	128
64.	Liquid level in reactor vessel downcomer instrument stalk 1, bubble plot (LE-1ST-1 and -2).	129

65.	Liquid level in reactor vessel downcomer instrument stalk 2, bubble plot (LE-2ST-1 and -2)	130
66.	Liquid level in blowdown suppression tank (LT-P138-33 and -58)	131
67.	Liquid level in pressurizer, southeast side (LT-P139-6).	131
68.	Liquid level in pressurizer, southwest side (LT-P139-7).	132
69.	Liquid level in pressurizer, north side (LT-P139-8).	132
70.	Liquid level in steam generator secondary coolant system (LT-P4-88).	133
71.	Average momentum flux in broken loop cold leg at DTT flange (ME-BL-1) (filtered to 4 Hz).	133
72.	Average momentum flux in broken loop hot leg at DTT flange (ME-PC-2) (filtered to 4 Hz).	134
73.	Average momentum flux in broken loop cold and hot legs at DTT flanges (ME-BL-1 and -2) (filtered to 4 Hz)	134
74.	Average momentum flux in reactor vessel core simulator stalk (ME-CS-1) (filtered to 4 Hz) . . .	135
75.	Average momentum flux in intact loop cold leg at DTT flange (ME-PC-1) (filtered to 4 Hz)	135
76.	Average momentum flux in intact loop steam generator outlet at DTT flange (ME-PC-3) (filtered to 4 Hz)	136
77.	Average momentum flux in intact loop cold leg and steam generator outlet at DTT flanges (ME-PC-1 and -3) (filtered to 4 Hz).	136
78.	Average momentum flux in reactor vessel downcomer stalk 1, 44.5 in. above reactor vessel bottom (ME-1ST-1) (filtered to 4 Hz)	137
79.	Momentum flux in reactor vessel downcomer stalk 2, 44.5 in. above reactor vessel bottom (ME-2ST-1) (filtered to 4 Hz)	137
80.	Differential pressure in broken loop hot leg across 14-to-5-in. contraction (PdE-BL-1) (filtered to 4 Hz)	138

81.	Differential pressure in broken loop cold leg across 14-to-5-in. contraction (PdE-BL-2) (filtered to 4 Hz)	138
82.	Differential pressure in broken loop across break planes (PdE-BL-3 and -4)	139
83.	Differential pressure in broken loop hot leg across pump simulator (PdE-BL-5)	139
84.	Differential pressure in broken loop hot leg across steam generator simulator outlet flange (PdE-BL-6)	140
85.	Differential pressure in broken loop hot leg across the steam generator simulator (PdE-BL-7) . .	140
86.	Differential pressure in broken loop hot leg across steam generator simulator inlet flange (PdE-BL-8) (filtered to 4 Hz)	141
87.	Differential pressure in reactor vessel core simulator to downcomer instrument stalk 2, 24.5 in. from reactor vessel bottom (PdE-CS-1) (filtered to 4 Hz)	141
88.	Differential pressure in intact loop cold leg across primary coolant pumps 1 and 2 (PdE-PC-1) . .	142
89.	Differential pressure in intact loop across the steam generator (PdE-PC-2)	142
90.	Differential pressure in intact loop hot leg piping from reactor vessel outlet to the flow venturi (PdE-PC-3) (filtered to 4 Hz)	143
91.	Differential pressure in intact loop hot leg piping from flow venturi to steam generator inlet (PdE-PC-4) (filtered to 4 Hz)	143
92.	Differential pressure in intact loop cold leg primary coolant pump discharge to reactor vessel inlet nozzle (PdE-PC-5) (filtered to 4 Hz)	144
93.	Differential pressure in intact loop cold leg reactor vessel inlet to broken loop cold leg reactor vessel inlet (PdE-PC-7) (filtered to 4 Hz)	144
94.	Differential pressure in reactor vessel downcomer stalk 1 to the blowdown suppression tank (PdE-RV-1)	145

95.	Differential pressure in reactor vessel intact loop cold leg inlet to downcomer stalk 2 (PdE-RV-3) (filtered to 4 Hz).	145
96.	Differential pressure in reactor vessel upper plenum to the intact loop hot leg reactor vessel outlet nozzle (PdE-RV-4).	146
97.	Differential pressure in blowdown suppression tank across vacuum breaker line (PdE-SV-9)	146
98.	Differential pressure in reactor vessel down- comer stalk 2, between 209.4 and 24.5 in. above reactor vessel bottom (PdE-2ST-2) (filtered to 4 Hz).	147
99.	Differential pressure in intact loop across the reactor vessel inlet and outlet nozzles (PdT-P139-30).	147
100.	Pressure in broken loop cold and hot legs (PE-BL-1 and -2)	148
101.	Pressure in broken loop cold leg (PE-BL-1, -4, and -8).	148
102.	Pressure in broken loop hot leg (PE-BL-2, -3, and -6).	149
103.	Pressure in reactor vessel core simulator instrument stalk, wide range (PE-CS-1A).	149
104.	Pressure in reactor vessel core simulator instrument stalk, narrow range (PE-CS-1B).	150
105.	Pressure in intact loop cold leg, hot leg, and steam generator outlet (PE-PC-1, -2, and -3A).	150
106.	Pressure in intact loop steam generator outlet, narrow range (PE-PC-3B).	151
107.	Pressure in intact loop cold leg, hot leg, and pressurizer (PE-PC-1, -2, and -4).	151
108.	Pressure in reactor vessel downcomer instrument stalk 1 and core simulator (PE-CS-1A and PE-1ST-1A and -3A)	152
109.	Pressure in reactor vessel downcomer instrument stalk 1, 24.5 in. above reactor vessel bottom, narrow range (PE-1ST-1B)	152

110.	Pressure in reactor vessel downcomer instrument stalk 1, 209.4 in. above reactor vessel bottom, narrow range (PE-1ST-3B)	153
111.	Pressure in reactor vessel core simulator and downcomer instrument stalk 1 (PE-CS-1FF and PE-1ST-1FF and -3FF)	153
112.	Pressure in reactor vessel core simulator and downcomer instrument stalk 2 (PE-CS-1A and PE-2ST-1A)	154
113.	Pressure in reactor vessel downcomer instrument stalks 1 and 2 (PE-1ST-3FF and PE-2ST-3FF)	154
114.	Pressure in reactor vessel core simulator and downcomer instrument stalk 2 (PE-CS-2FF and PE-2ST-3FF).	155
115.	Pressure in blowdown suppression tank bottom under downcomer 4, 180° (PE-SV-1) (filtered to 60 Hz)	155
116.	Pressure in blowdown suppression tank across from downcomer 1, 157.5° (PE-SV-3)	156
117.	Pressure in blowdown suppression tank header above downcomer 4, 321° (PE-SV-14)	156
118.	Pressure in blowdown suppression tank 54.5 in. north of downcomer 2, 327° (PE-SV-17).	157
119.	Pressure in blowdown suppression tank header above downcomer 1 (PE-SV-18)	157
120.	Pressure in blowdown suppression tank bottom 54.5 in. north of downcomer 3, 180° (PE-SV-22)	158
121.	Pressure in blowdown suppression tank bottom 54.3 in. north of downcomer 2, 180° (PE-SV-26)	158
122.	Pressure in blowdown suppression tank bottom under downcomer 2, 180° (PE-SV-43)	159
123.	Pressure in blowdown suppression tank top 6 in. north of downcomer 4, 0° (PE-SV-55).	159
124.	Pressure in blowdown suppression tank top above downcomer 1, 0° (PE-SV-60)	160
125.	Pressure in blowdown suppression tank bottom (PE-SV-1, -22, -26, and -43)	160

126.	Pressure in blowdown suppression tank top (PE-SV-17, -55, and -60)	161
127.	Pressure in blowdown suppression tank header above downcomers 4 and 1 (PE-SV-14 and -18). . . .	161
128.	Pressure in ECCS lower plenum injection line (PT-P120-64).	162
129.	Pressure in ECCS lower plenum injection line and lower plenum (PT-P120-64 and PE-1ST-1A).	162
130.	Pressure in ECCS LPIS pump A discharge (PT-P120-83)	163
131.	Pressure in blowdown suppression tank header 35 in. south of downcomer 1 (PT-P138-23)	163
132.	Pressure in blowdown suppression tank top (PT-P138-55 and -56)	164
133.	Pressure in intact loop hot leg venturi (PT-P139-2 and -3)	164
134.	Pump speed for intact loop pumps 1 and 2 (RPE-PC-1 and -2).	165
135.	Temperature in broken loop cold leg, hot leg, and reflood assist bypass system (TE-BL-1, -2, and -3).	165
136.	Temperature in broken loop cold leg and hot leg warmup lines (TE-CL-1 and TE-HL-2)	166
137.	Temperature in reactor vessel core simulator instrument stalk (TE-CS-1)	166
138.	Temperature in intact loop cold leg, hot leg, and steam generator outlet (TE-PC-1, -2, and -3) .	167
139.	Temperature in blowdown suppression tank liquid at tank bottom (TE-P138-22).	167
140.	Temperature in blowdown suppression tank vapor at tank top (TE-P138-34)	168
141.	Temperature in broken loop cold leg QOBV inlet and isolation valve inlet (TE-P138-62 and -63)	168
142.	Temperature in broken loop hot leg QOBV inlet and isolation valve inlet (TE-P138-66 and -65) . .	169

143.	Temperature in intact loop pressurizer vapor and liquid (TE-P139-19 and -20).	169
144.	Temperature in intact loop cold leg upstream of DTT flange (TE-P139-29)	170
145.	Temperature in intact loop hot leg in elbow near venturi (TE-P139-32 and -33).	170
146.	Temperature in steam generator intact loop cold leg, hot leg, and secondary side (TE-SG-1, -2, and -3).	171
147.	Temperature in blowdown suppression tank B-end thermocouple stalk (TE-SV-1, -2, and -3)	171
148.	Temperature in blowdown suppression tank B-end thermocouple stalk (TE-SV-4, -5, and -6)	172
149.	Temperature in blowdown suppression tank A-end thermocouple stalk (TE-SV-7, -8, and -9)	172
150.	Temperature in blowdown suppression tank A-end thermocouple stalk (TE-SV-10, -11, and -12).	173
151.	Temperature in blowdown suppression tank 107.2 in. from tank bottom (TE-SV-1 and -7).	173
152.	Temperature in blowdown suppression tank 93.0 in. from tank bottom (TE-SV-2 and -8).	174
153.	Temperature in blowdown suppression tank 74.7 in. from tank bottom (TE-SV-3 and -9).	174
154.	Temperature in blowdown suppression tank 57.2 in. from tank bottom (TE-SV-4 and -10)	175
155.	Temperature in blowdown suppression tank 39.0 in. from tank bottom (TE-SV-5 and -11).	175
156.	Temperature in blowdown suppression tank 14.7 in. from tank bottom (TE-SV-6 and -12).	176
157.	Temperature in reactor vessel downcomer instrument stalk 1 (TE-1ST-1, -2, -3, and -4).	176
158.	Temperature in reactor vessel downcomer instrument stalk 1 (TE-1ST-6, -8, -9, and -10)	177
159.	Temperature in reactor vessel downcomer instrument stalk 1 (TE-1ST-11, -12, -13, and -14).	177

160.	Temperature in reactor vessel downcomer instrument stalk 2 (TE-2ST-2, -4, -7, and -9).	178
161.	Temperature in reactor vessel downcomer instrument stalk 2 (TE-2ST-10, -12, and -14)	178
162.	Temperature in reactor vessel downcomer instrument stalk 1, 189.3 in. from reactor vessel bottom (TE-1ST-1).	179
163.	Temperature in reactor vessel downcomer instrument stalks 1 and 2, 165.3 in. above reactor vessel bottom (TE-1ST-2 and TE-2ST-2).	179
164.	Temperature in reactor vessel downcomer instrument stalk 1, 141.3 in. above reactor vessel bottom (TE-1ST-3).	180
165.	Temperature in reactor vessel downcomer instrument stalks 1 and 2, 117.3 in. above reactor vessel bottom (TE-1ST-4 and TE-2ST-4).	180
166.	Temperature in reactor vessel downcomer instrument stalk 1, 69.3 in. above reactor vessel bottom (TE-1ST-6).	181
167.	Temperature in reactor vessel downcomer instrument stalk 2, 33.3 in. above reactor vessel bottom (TE-2ST-7).	181
168.	Temperature in reactor vessel downcomer instrument stalk 1, 29.3 in. above reactor vessel bottom (TE-1ST-8).	182
169.	Temperature in reactor vessel downcomer instrument stalks 1 and 2, 25.3 in. above reactor vessel bottom (TE-1ST-9 and TE-2ST-9).	182
170.	Temperature in reactor vessel downcomer instrument stalks 1 and 2, 21.3 in. above reactor vessel bottom (TE-1ST-10 and TE-2ST-10).	183
171.	Temperature in reactor vessel downcomer instrument stalk 1, 17.3 in. above reactor vessel bottom (TE-1ST-11).	183
172.	Temperature in reactor vessel downcomer instrument stalks 1 and 2, 13.3 in. above reactor vessel bottom (TE-1ST-12 and TE-2ST-12).	184
173.	Temperature in reactor vessel downcomer instrument stalk 1, 9.3 in. above reactor vessel bottom (TE-1ST-13).	184

174. Temperature in reactor vessel downcomer instrument stalks 1 and 2, 45.9 in. above reactor vessel bottom in DTTs (TE-1ST-14 and TE-2ST-14). . . 185

175. Temperature in ECCS lower plenum injection line (TT-P120-65) 185

TEST L1-3 MEASURED PARAMETERS
LONG-TERM PLOTS (175- AND 500-SECOND PLOTS)

176. Density in broken loop cold leg, chordal density (DE-BL-1A, -1B, and -1C) 188

177. Density in broken loop hot leg, chordal density (DE-BL-2A, -2B, and -2C) 188

178. Fluid velocity in broken loop cold leg at DTT flanges (FE-BL-1). 189

179. Fluid velocity in reactor vessel downcomer instrument stalk 2, 47.1 in. above reactor vessel bottom (FE-2ST-1) 190

180. Flow rate in blowdown suppression tank spray system 60-gpm header (FE-P138-138) 191

181. Flow rate in blowdown suppression tank spray system pump discharge (FE-P138-139). 191

182. Flow rate in blowdown suppression tank spray system 220-gpm header (FE-P138-140). 192

183. Flow rate in blowdown suppression tank spray system pump recirculation line (FE-P138-153) . . . 192

184. Flow rate in ECCS LPTS pump A discharge (FT-P120-85) 193

185. Liquid level in blowdown suppression tank (LT-P138-33 and -58) 193

186. Momentum flux in the broken loop cold leg at DTT flange (ME-BL-1) 194

187. Momentum flux in reactor vessel downcomer instrument stalk 2, 44.5 in. above reactor vessel bottom (ME-2ST-1) 194

188. Pressure in reactor vessel core simulator instrument stalk, narrow range, and intact loop steam generator outlet (PE-CS-1B and PE-PC-3B). 195

189.	Pressure in blowdown suppression tank across from downcomer 1, 157.5°, and bottom 54.5 in. north of downcomer 3, 180° (PE-SV-3 and -22) . . .	195
190.	Pressure in blowdown suppression tank top north of downcomer 4 and above downcomer 1 (PE-SV-55 and -60)	196
191.	Pressure in ECCS lower plenum injection line (PT-P120-64).	196
192.	Pressure in ECCS LPIS pump A discharge (PT-P120-83)	197
193.	Pressure in blowdown suppression tank top 48 in. north of downcomer 1 and 49 in. north of downcomer 2 (PT-P138-55 and -66).	197
194.	Pressure in blowdown suppression tank spray system pump discharge and cooldown heat exchanger outlet (PT-P138-136 and -151).	198
195.	Temperature in broken loop cold leg and hot leg (TE-BL-1 and -2)	198
196.	Temperature in reactor vessel core simulator instrument stalk (TE-SC-1)	199
197.	Temperature in intact loop cold leg, hot leg, and steam generator outlet (TE-PC-1, -2, and -3) .	199
198.	Temperature in blowdown suppression tank spray system pump discharge (TE-P138-142).	200
199.	Temperature in blowdown suppression tank spray system 60-gpm header and 220-gpm spray header (TE-P138-141 and -143)	200
200.	Temperature in blowdown suppression tank B-end thermocouple stalk (TE-SV-1, -2, and -3)	201
201.	Temperature in blowdown suppression tank B-end thermocouple stalk (TE-SV-4, -5, and -6)	201
202.	Temperature in blowdown suppression tank A-end thermocouple stalk (TE-SV-7, -8, and -9)	202
203.	Temperature in blowdown suppression tank A-end thermocouple stalk (TE-SV-10, -11, and -12). . . .	202
204.	Liquid level in blowdown suppression tank north end (LT-P138-33)	203

205.	Liquid level in blowdown suppression tank south end (LT-P138-58)	203
206.	Pressure in blowdown suppression tank across from downcomer 1, 157.5° (PE-SV-3)	204
207.	Pressure in blowdown suppression tank bottom 54.5 in. north of downcomer 3, 180° (PE-SV-26)	204
208.	Pressure in blowdown suppression tank bottom under downcomer 2 and under downcomer 3, 180° (PE-SV-43 and -44)	205
209.	Pressure in blowdown suppression tank top 48 in. north of downcomer 1 and 49 in. north of downcomer 2 (PT-P138-55 and -56).	205
210.	Temperature in blowdown suppression tank B-end thermocouple stalk (TE-SV-1, -2, and -3)	206
211.	Temperature in blowdown suppression tank B-end thermocouple stalk (TE-SV-4 and -6).	206
212.	Temperature in blowdown suppression tank A-end thermocouple stalk (TE-SV-10).	207

TEST L1-3 COMPUTED PARAMETERS

213.	Flow regime and average density in broken loop cold leg.	210
214.	Flow regime and average density in broken loop hot leg	211
215.	Flow regime and average density in intact loop hot leg	212
216.	Enthalpy in broken loop cold leg	213
217.	Enthalpy in broken loop hot leg.	213
218.	Enthalpy in intact loop cold leg	214
219.	Enthalpy in intact loop hot leg.	214
220.	Enthalpy in intact loop at steam generator outlet	215
221.	Mass flow rate per system volume in broken loop cold leg calculated from FE-BL-1 and ME-BL-1.	215

222.	Mass flow rate per system volume in broken loop cold leg calculated from DE-BL-1 and ME-BL-1	216
223.	Mass flow rate per system volume in broken loop cold leg calculated from DE-BL-1 and FE-BL-1.	216
224.	Mass flow rate per system volume in broken loop cold leg calculated from DE-BL-1 and PdE-BL-2	217
225.	Mass flow rate per system volume in broken loop hot leg calculated from DE-BL-2 and ME-BL-2.	217
226.	Mass flow rate per system volume in broken loop hot leg calculated from DE-BL-2 and FE-BL-2.	218
227.	Mass flow rate per system volume in broken loop hot leg calculated from DE-BL-2 and PdE-BL-1 . . .	218
228.	Mass flow rate per system volume in intact loop cold leg calculated from FE-PC-1 and ME-PC-1 . . .	219
229.	Mass flow rate per system volume in intact loop cold leg calculated from FE-PC-1, PE-PC-1, and DE-PC-1B	219
230.	Mass flow rate per system volume in intact loop cold leg calculated from DE-PC-1B and ME-PC-1.	220
231.	Mass flow rate per system volume in intact loop cold leg calculated from DE-PC-1B and FE-PC-1.	220
232.	Mass flow rate per system volume in intact loop hot leg calculated from FE-PC-2 and PE-PC-2.	221
233.	Mass flow rate per system volume in intact loop hot leg calculated from DE-PC-2 and FE-PC-2.	221
234.	Mass flow rate per system volume in intact loop steam generator outlet calculated from FE-PC-3, PE-PC-3A, and DE-PC-3	222
235.	Mass flow rate per system volume in intact loop steam generator outlet calculated from DE-PC-3 and ME-PC-3.	222

236.	Mass flow rate per system volume in intact loop steam generator outlet calculated from DE-PC-3 and FE-PC-3.	223
237.	Mass flow rate per system volume in intact loop pressurizer calculated from LT-PI39-8 and PE-PC-4.	223
238.	Pump speed, electrical, in intact loop primary coolant pumps 1 and 2.	224
239.	Pump speed, electrical and mechanical, in intact loop primary coolant pump 1.	224
240.	Pump speed, electrical and mechanical, in intact loop primary coolant pump 2.	225
241.	Pump motor slip in intact loop primary coolant pumps 1 and 2.	225
242.	Pump motor individual electrical horsepower in intact loop primary coolant pumps 1 and 2.	226
243.	Pump motor total electrical horsepower in intact loop primary coolant pumps 1 and 2.	226
244.	Pump total water horsepower in intact loop primary coolant pumps 1 and 2.	227
245.	Pump combined efficiency in intact loop primary coolant pumps 1 and 2.	227
246.	Pressure, closure, in intact loop (filtered to 4 Hz).	228
247.	Static quality in broken loop cold leg	228
248.	Static quality in broken loop hot leg.	229
249.	Static quality in intact loop cold leg	229
250.	Static quality in intact loop hot leg.	230
251.	Static quality in intact loop at steam generator outlet	230
252.	Flow quality in broken loop cold leg	231
253.	Flow quality in broken loop hot leg.	231
254.	Flow quality in intact loop cold leg	232

255.	Flow quality in intact loop hot leg.	232
256.	Flow quality in intact loop at steam generator outlet	233
257.	Saturation temperature in broken loop cold leg overlaid with TE-BL-1.	233
258.	Saturation temperature in broken loop hot leg overlaid with TE-BL-2.	234
259.	Saturation temperature in intact loop cold leg overlaid with TE-PC-1.	234
260.	Saturation temperature in intact loop hot leg overlaid with TE-PC-2.	235
261.	Saturation temperature in intact loop steam generator outlet overlaid with TE-PC-3	235
262.	Saturation temperature in reactor vessel core simulator instrument stalk overlaid with TE-CS-1 .	236
263.	Saturation temperature in reactor vessel downcomer instrument stalk 1 overlaid with TE-1ST-9	236
264.	Saturation temperature in reactor vessel downcomer instrument stalk 2 overlaid with TE-2ST-9	237
265.	Void fraction in broken loop cold leg.	237
266.	Void fraction in broken loop hot leg	238
267.	Void fraction in intact loop cold leg.	238
268.	Void fraction in intact loop hot leg	239
269.	Void fraction in intact loop at steam generator outlet	239

TEST L1-3 ERROR BAND PLOTS

270.	Valve opening (%) in broken loop hot leg Q0BV with error bands (CV-P138-15).	242
271.	Chordal density in broken loop cold leg with error bands (DE-BL-1A) (filtered to 4 Hz).	242
272.	Average velocity in broken loop cold leg at DTT flange with error bands (FE-BL-1) (filtered to 4 Hz)	243

273.	Average velocity in reactor vessel downcomer instrument stalk 1 with error bands (FE-1ST-1) (filtered to 4 Hz)	243
274.	Flow rate in blowdown suppression tank spray system pump discharge with error bands (FE-P138-139).	244
275.	Flow rate in ECCS LPIS pump A discharge with error bands (FT-P120-85)	244
276.	Flow rate in ECCS HPIS pump A discharge with error bands (FT-P128-104).	245
277.	Flow rate in intact loop hot leg venturi with error bands (FT-P139-27-3)	245
278.	Liquid level in blowdown suppression tank south end with error bands (LT-P138-58).	246
279.	Liquid level in pressurizer north side with error bands (LT-P139-8).	246
280.	Momentum flux in broken loop cold leg at DTT flange with error bands (ME-BL-1) (filtered to 4 Hz).	247
281.	Momentum flux in reactor vessel downcomer instrument stalk 1 with error bands (ME-1ST-1) (filtered to 4 Hz)	247
282.	Differential pressure in broken loop hot leg at 14-to-5-in. reduction with error bands (PdE-BL-1) (filtered to 4 Hz)	248
283.	Differential pressure in broken loop cold leg at 14-to-5-in. reduction with error bands (PdE-BL-2) (filtered to 4 Hz)	248
284.	Differential pressure in broken loop cold leg across break plane with error bands (PdE-BL-3) . .	249
285.	Differential pressure in broken loop hot leg across steam generator simulator outlet flange with error bands (PdE-BL-6) (filtered to 4 Hz) . .	249
286.	Differential pressure in intact loop cold leg across primary coolant pumps 1 and 2 with error bands (PdE-PC-1)	250
287.	Differential pressure in intact loop across steam generator with error bands (PdE-PC-2). . . .	250

288.	Differential pressure in intact loop hot leg reactor vessel outlet to flow venturi with error bands (PdE-PC-3)	251
289.	Differential pressure from reactor vessel downcomer stalk 1 to blowdown suppression tank with error bands (PdE-RV-1)	251
290.	Differential pressure in intact loop across the reactor vessel inlet and outlet nozzles with error bands (PdT-P139-30)	252
291.	Pressure in broken loop hot leg with error bands (PE-BL-2).	252
292.	Pressure in reactor vessel core simulator instrument stalk, wide range, with error bands (PE-CS-1A)	253
293.	Pressure in reactor vessel core simulator instrument stalk, narrow range, with error bands (PE-CS-1B)	253
294.	Pressure in reactor vessel core simulator instrument stalk, short-term plot, with error bands (PE-CS-2FF).	254
295.	Pressure in reactor vessel core simulator instrument stalk, 70-second plot, with error bands (PE-CS-2FF).	254
296.	Pressure in blowdown suppression tank header above downcomer 4, short-term plot, with error bands (PE-SV-14)	255
297.	Pressure in blowdown suppression tank header above downcomer 4, 70-second plot, with error bands (PE-SV-14)	255
298.	Pressure in ECCS lower plenum injection point with error bands (PT-P120-64).	256
299.	Pressure in ECCS LPIS pump A discharge with error bands (PT-P120-83)	256
300.	Pressure in blowdown suppression tank top with error bands (PT-P138-55).	257
301.	Pressure in broken loop cold leg QOBV inlet, short-term plot, with error bands (PT-P138-111).	257
302.	Pressure in blowdown suppression tank spray system pump discharge with error bands (PT-P138-136).	258

303.	Pump speed in intact loop operating pump 2 with error bands (RPE-PC-2)	258
304.	Temperature in broken loop hot leg with error bands (TE-BL-2)	259
305.	Temperature in blowdown suppression tank liquid at tank bottom with error bands (TE-P138-22)	259
306.	Temperature in blowdown suppression tank vapor at tank top with error bands (TE-P138-34)	260
307.	Temperature in broken loop cold leg at QOBV inlet with error bands (TE-P138-62)	260
308.	Temperature in broken loop cold leg isolation valve inlet with error bands (TE-P138-63)	261
309.	Temperature in blowdown suppression tank spray system 60-gpm header with error bands (TE-P138-141)	261
310.	Temperature in intact loop pressurizer liquid with error bands (TE-P139-20)	262
311.	Temperature in intact loop cold leg at steam generator inlet plenum with error bands (TE-SG-1)	262
312.	Temperature in blowdown suppression tank B-end thermocouple stalk with error bands (TE-SV-6)	263

TABLES

I.	Nomenclature for LOFT Instrumentation.	18
II.	Chronology of Events for Test L1-3	34
III.	LOCE L1-3 Initial Conditions	36
IV.	Primary Coolant Temperature Distribution at Rupture	38
V.	Water Chemistry Results for Test L1-3.	40
VI.	Measured Parameters for LOFT Test L1-3	54
VII.	Computed Parameters for LOFT Test L1-3	85

EXPERIMENT DATA REPORT FOR LOFT NONNUCLEAR TEST L1-3

I. INTRODUCTION

The intent of this report is to present the L1-3 test data in an uninterpreted but readily usable form for use by the nuclear community in advance of detailed analysis and interpretation. The data, presented herein in the form of graphs in engineering units, have been analyzed and qualified to the extent necessary to ensure that they are reasonable and consistent. Initial assessment of the data from this test and comparison with the experiment prediction^[2] for Test L1-3 were performed in the quick look report^[3] for nonnuclear experiment L1-3. Test L1-3A has subsequently been performed as a repeat of Test L1-3, since Test L1-3 did not meet all of the test objectives and specifications presented in Reference 1.

The Loss of Fluid Test (LOFT) Program is part of the Water Reactor Safety Research Program sponsored by the Nuclear Regulatory Commission and is administered by the Energy Research and Development Administration. The tests are conducted at the Idaho National Engineering Laboratory (INEL), Test Area North (TAN). The objectives of the program are:

- (1) To provide data required to evaluate the adequacy and improve the analytical methods currently used to predict the loss-of-coolant accident (LOCA) response of large pressurized water reactors (LPWRs). The performance of engineered safety features (ESF) with particular emphasis on emergency core cooling system (ECCS) and the quantitative margins of safety inherent in the performance of ESF is of primary interest.
- (2) To identify and investigate any unexpected-event(s) or threshold(s) in the response of either the plant or the ESF, and

develop analytical techniques that adequately describe and account for such unexpected behavior.

In order to meet these objectives, the LOFT Integral Test Facility^[a] has been designed to simulate the major components of a LPWR, and several series of the experiments have been planned to produce data on the combined thermal, hydraulic, nuclear, and structural processes expected to occur during a LOCA.

The first LOFT test series (designated L1) is the nonnuclear test series which consists of five isothermal blowdown tests. This test series has been designed to make available large scale isothermal blowdown and reflood system data as a first phase of the LOFT Program. Varied parameters include break size, break location, break opening time, primary coolant system flow resistance, emergency core coolant (ECC) injection location, and primary coolant system pressure. Blowdown suppression tank performance, as influenced by initial tank level, water temperature, pressure, and spray system control, will be evaluated. Specifically, the purposes of this test series are:

- (1) To determine that the equipment/systems function properly
- (2) To demonstrate that the entire test facility can withstand the structural loads of blowdown
- (3) To determine that the blowdown test procedures are adequate

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

- (4) To provide experience to operators prior to nuclear tests
- (5) To obtain isothermal loss-of-coolant experiment (LOCE) data for comparison with similar data from other experimental programs, and to experimentally verify thermal-hydraulic system behavior prior to nuclear blowdown.

A detailed description of the LOFT Facility and the L1 test series can be found in Reference 4.

Tests in the L1 test series conducted prior to Test L1-3 consist of:

- (1) Test L1-1^[5], which was conducted from initial conditions of 540°F and 1322 psig and was a 100% hot leg break simulation. ECC injection was directed to the cold leg.
- (2) Test L1-2^[6], which was conducted from initial conditions of 540°F and 2255 psig and was a 200% cold leg break simulation without ECC injection. ECC was injected into the intact loop cold leg 13.3 minutes after Test L1-2 initiation for a "hot wall delay" experiment.

Test L1-3 was conducted from initial conditions of 540°F and 2256 psig and was a 200% cold leg break simulation. ECC injection was directed to the lower plenum of the reactor vessel using low-pressure injection system (LPIS) pump A and high-pressure injection system (HPIS) pump A. The accumulators, however, failed to inject ECC into the lower plenum during this test. Test L1-3, therefore was repeated as Test L1-3A^[7] to obtain accumulator ACC-A injection.

The specific purposes of Test L1-3 were to:

- (1) Compare break flow data with predictions
- (2) Measure pump resistance and coastdown characteristics
- (3) Determine system performance with ECC injection into the lower plenum
- (4) Determine two-phase flow resistance of various system components
- (5) Evaluate the scaling effects of the various primary system components
- (6) Evaluate the effect of intact loop resistance on system thermal-hydraulic performance by comparison with corresponding results from Test L1-2.

Test L1-3 met all of these objectives except number 3. Since L1-3 was nearly identical to L1-3A up to the time of accumulator injection (22 seconds after blowdown initiation), Test L1-3 provides a good measure of experiment repeatability. Also, since Test L1-3 did include HPIS and LPIS injection, some indication of degraded ECC performance is provided by the L1-3 data.

Section II of this report briefly describes the LOFT system and the facility configuration specific to this test. Section III discusses the LOFT instrumentation system including the basic types of detectors utilized, the methods of obtaining certain measurements, and the LOFT data reduction process. Section IV summarizes the test procedures used to conduct Test L1-3 and presents a chronology of events that occurred during the test. Section V presents the initial conditions of the test, both specified and as measured. Section VI discusses numerous methods employed to verify the consistency and accuracy of the data presented. Finally, Section VII presents the data graphs and provides tables of

comments and supporting information necessary for the interpretation of the data.

II. SYSTEM CONFIGURATION

The LOFT Facility has been designed to simulate the major components and system responses of a LPWR during a LOCA. The test assembly is comprised of five major subsystems which have been instrumented such that desirable system parameters can be measured and recorded during a 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. System instrumentation is discussed in Section III.

The LOFT reactor vessel simulates the reactor vessel of a LPWR. It has an annular downcomer, a lower plenum, lower core support plates, a core simulator, and an upper plenum. The downcomer connects with the cold leg of both the intact loop and the broken loop and contains two experimental instrument stalks; the upper plenum connects the hot leg of both the intact loop and the broken loop. The core simulator contains an experimental instrument stalk and a hydraulic orifice plate assembly to simulate the flow resistance of a nuclear core which will be installed for nonnuclear LOCE L1-5.

The intact loop simulates the unbroken loops of a LPWR. This loop contains a steam generator, two circulating coolant pumps connected in parallel, a pressurizer, a venturi flowmeter, and connecting piping. Each circulating coolant pump is powered by a primary system motor generator (PSMG) set consisting of an ac motor coupled to an ac generator through an adjustable fluid clutch. A flywheel is connected directly to each generator shaft. For this experiment, the primary side steam generator inlet and outlet plenums contained square edged orifice plates sized for low resistance based on core flow area scaling. Thus, these orifices provided a similar pressure drop at scaled flow rates around the LOFT intact loop (excluding the reactor vessel) as exists in a LPWR operating loop. The secondary side of the steam generator was filled to a predetermined level and isolated from the remainder of the secondary coolant system. The intact loop circulating coolant pumps

were used to bring the system to the initial test temperature of 540°F. For Test L1-3, the electrical power to the PSMG sets was terminated within 1 second after blowdown initiation. This action left the PSMG sets electrically connected to their respective intact loop pumps such that pump coastdown characteristics were under the influence of the 7,500-lbm/ft² inertia flywheels on the generators. This electrically coupled system represented the inertia and the subsequent coastdown of the circulating coolant pumps in a LPWR. When the intact loop pumps reached a speed of approximately 750 rpm, the electrical power to the pump motors was interrupted by opening the generator field breakers.

The broken loop simulates the broken loop of a LPWR. It consists basically of a hot leg and cold leg that are connected to the reactor vessel and the blowdown suppression tank header. Each leg consists of a break plane orifice which determines the break size to be simulated, a quick-opening blowdown valve (QOBV) which simulates a pipe break, a recirculation line, an isolation valve, and connecting piping. The recirculation lines established a small flow from the broken loop to the intact loop to maintain these loop temperatures approximately equal prior to the blowdown. These recirculation paths are secured just prior to blowdown initiation.

Test L1-3 simulated a 200% double-ended shear break in a cold leg of a LPWR operating loop. In this configuration, the broken loop hot leg contained, in addition to the above mentioned components, a steam generator simulator and a pump simulator. These simulators have hydraulic orifice plate assemblies installed which have similar (passive) resistances to flow as a real steam generator and a locked rotor pump. The break flow area (break plane orifice area) in this configuration is 0.09 ft²; this is 100% of the possible break flow area in each line.

The blowdown suppression system simulates the containment back pressure of a LPWR. This system is comprised of the blowdown suppression tank header, the blowdown suppression tank (BDST), the nitrogen pressurization system, and the blowdown suppression tank spray

system (BDSTSS). The blowdown header is connected to the suppression tank by four suppression tank downcomers that extend inside the tank and discharge below the water level established as a Test L1-3 initial condition. The nitrogen pressurization system is supplied by the LOFT inert gas system and utilizes a remote controlled pressure regulator to establish and maintain the specified BDST initial pressure. The spray system consists of a centrifugal pump which discharges through a heatup heat exchanger and either three spray headers or a pump recirculation line that contains a cooldown heat exchanger. The spray pump suction can be aligned to either the BDST or the borated water storage tank (BWST). The three spray headers have a 20-gpm, a 60-gpm, and a 220-gpm flow rate capacity and are located in the BDST along the upper centerline.

To model the containment back pressure of a LPWR, predetermined initial conditions are established in the BDST. Thus, prior to blowdown initiation, the spray pump suction is aligned to the BDST and BDST water is recirculated through the three spray headers. Steam is admitted to the heatup heat exchanger until the BDST water is heated to its specified temperature. Following BDST heatup, flow is secured through the three spray headers and the BDSTSS piping is cooled down using the cooldown heat exchanger in the pump recirculation line. Prior to BDST spray initiation, the spray pump suction is specified to be shifted to the BWST so that a cooler water source is available for BDST pressure suppression. For Test L1-3, suppression tank spray was manually initiated and adjusted to 320 gpm after accumulator nitrogen entered the tank to establish the pressure suppression effectiveness of the BDSTSS. Therefore, the blowdown effluent was contained within the BDST while obtaining the same peak pressure as if the break was in a LPWR which was discharging into its containment vessel.

The LOFT ECCS simulates the ECCS of a LPWR. The accumulator, the HPIS, and the LPIS were specified to be used during this experiment. Each system was configured to inject scaled flow rates of ECC directly into the lower plenum of the reactor vessel. To provide these scaled flow rates, accumulator ACC-A, HPIS pump A, and LPIS pump A were

selected. Accumulator ACC-A was preset to inject ECC at a system pressure of 600 psig. Due to a procedural error, however, accumulator ACC-A and backup accumulator ACC-B failed to initiate injection. HPIS pump A was preset to inject at 17.2 gpm and to initiate by LOCE control at 22 seconds after the initiation of blowdown; LPIS pump A was adjusted to initiate by LOCE control at 35.5 seconds after the initiation of blowdown. While the above ECCS injection times and pressure represent those preset test conditions specified in the EOS, the actual recorded parameters are presented in the test summary and Section IV.

The LOFT major components are shown pictorially in Figure 1, and a LOFT piping schematic, with instrumentation, is shown in Figure 2. Reference 1 gives details of the experiment configuration and operation; Reference 4 gives a detailed description of the LOFT system.

Fig. 1 LOFT major components.

Fig. 2 LOFT piping schematic (with instrumentation).

III. MEASUREMENTS AND INSTRUMENTATION

The LOFT instrumentation system was designed to measure and record the important events that occur during a LOCE. For Test L1-3, 549 channels of data were recorded. Data from the thermal-hydraulic measurements (i.e., temperatures, pressures, flow rates, liquid levels, densities, pump speeds, and QOBV positions as functions of time) are of primary importance and are included in this report. Mechanical measurement data such as acceleration and strain were recorded for monitoring structural loads on the LOFT system but are not of primary interest as the results are specific to the LOFT mechanical arrangement and therefore are not included.

Thermocouples and resistance temperature devices were used to sense the fluid temperatures at all major locations in the system.

Pressure measurements were generally obtained with strain-gage-type transducers with pressure transmission lines connecting the transducers to the measurement points. A few piezoelectric-type transducers were used where high frequency response was desired rather than absolute accuracy. Free-field pressure transducers, in which the sensing elements were inside a bellows arrangement, were also used to eliminate connecting transmission lines and thereby produce higher frequency response without the distortion caused by the lines.

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

Flow velocities were generally obtained by use of turbine flowmeters, which consisted of rotating vanes with magnetic blades and stationary magnetic pickup coils. Other methods of determining flow velocity included calculation by:

- (1) Dividing mass flow from venturi meters by the density and flow area
- (2) Dividing momentum flux from the drag discs by the density and taking the square root of the quotient.

Density was measured by means of gamma densitometers (shown in Figure 3), which use the attenuation of gamma rays from a cesium-137 source to sense the mass of fluid within a pipe. The densitometers used in LOFT each have three beams (designated A, B, and C) which traverse the lower, middle, and upper parts of the pipe, respectively, for the horizontal pipe densitometers. For the steam generator discharge densitometer, where the pipe is vertical, the densitometer 'B' beam is in the plane of the adjacent pipe bends. By using the logic table given in Figure 4 and special calibrations, the average density and the flow regime can be obtained. The special calibrations mentioned were obtained from testing with lucite and wood representations of various fluid density distributions in an actual piece of LOFT piping. These calibrations were then used to produce weighting factors to be used on each beam in combining the individual beam outputs to obtain the average density. Experimentation showed the use of simple weighting factors to be as accurate for average density as several more complex methods of determining the fluid distribution in the pipe. The resultant weighting factors were changed as a function of the flow regime. The weighting factors used in this report were as shown in the following equations:

$$\bar{\rho} = 0.437\rho_A + 0.417\rho_B + 0.146\rho_C$$

for stratified flow, and

$$\bar{\rho} = 0.345\rho_A + 0.401\rho_B + 0.254\rho_C$$

for other flow regimes.

Another method used in LOFT for obtaining fluid density is by means of drag discs, which sense momentum flux, and turbine meters, which

ANC-A-7051

Relation of source and detector to pipe in DE-BL-1 and DE-PC-1 (view looking toward reactor vessel).

ANC-A-7052

Relation of source and detector to pipe in DE-BL-2 and DE-PC-2 (view looking toward reactor vessel).

ANC-A-7050

Relation of source and detector to pipe in DE-PC-3 (view looking down).

Fig. 3 Gamma densitometer beam configuration.

Fig. 4 Gamma densitometer flow regime logic.

measure velocity. The density is obtained from these measurements by dividing the momentum flux by the square of velocity:

$$\rho = \frac{\rho v^2}{v^2} \quad \begin{array}{l} \text{(from drag disc)} \\ \text{(from turbine meters).} \end{array}$$

This simplified approach neglects the effects of phase slip, velocity, and the density distributions near the measurement locations.

Liquid levels were obtained by means of (a) differential pressure transducers in the pressurizer, accumulators, and 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.

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 such that pump speed and direction of rotation can be determined. Pump speed was also calculated from the PSMG set frequency. No allowance for slip between the electrical field and the rotor was used in this latter calculation.

Acceleration, displacement, mechanical strain, and valve off-on indicators were sensed by accelerometers, linear variable differential transformers, bonded strain gages, and microswitches, respectively. Since these are not considered of prime importance in understanding this experiment, they are not included here. This information will be reported in an addendum to this report if sufficient requests for the information are received.

Many variables can be computed by combining measured parameters. Some of these variables are shown in Section VII.

The data acquisition and visual display system (DAVDS) was used to record the measurement data from the various instrumentation systems on a combination of narrow-band digital recorders, medium-band multiplexed frequency modulator (FM) analog tape recorders, wide-band analog tape recorders, strip charts, and oscillograph recorders. Redundant records were made where different uses dictated more than one recording mode or extra safety measures were desired for critical measurements.

A digital computer was used to collect the data at the LOFT Facility and to perform equipment calibrations and post-test data reduction and plotting. Immediately following the test, the computer was used to reduce critical channels of digital data so that a decision could be made quickly as to the success of the experiment. The digital data was transferred to magnetic tape and the tape recorded analog data was converted into digital form on magnetic tape compatible with the IBM-360/75 computer data processing programs.

The IBM-360/75 computer was used to further reduce the data. Calibration factors were first applied to produce engineering units data plots so that engineering specialists could examine each channel for discrepancies or unexpected events. After the data graphs were examined and qualified, they were then used to generate graphs and compute variables. Specifics of these topics are given in Section VII and a complete description of the data acquisition system and data reduction is given in References 8 and 9.

Figure 2 shows a piping schematic with instrument locations indicated. Table I gives the nomenclature for LOFT instrumentation designations. Figure 5 shows an isometric view of the major system components with instrument locations indicated, and Figures 6 through 12 give more specific locations for instruments located on individual components. Reference 4 should be consulted for details of instrument design and locations. (Locations, ranges, and frequency responses for

TABLE I

NOMENCLATURE FOR LOFT INSTRUMENTATION

Designations for the different types of transducers.

1. CV	- Control Valve
2. DE	- Densitometer
3. FE	- Flow
4. FT	- Flow
5. LE	- Level
6. LIT	- Level
7. LT	- Level
8. ME	- Momentum Flux
9. PdE	- Differential Pressure
10. PE	- Pressure
11. PT	- Pressure
12. RPE	- Pump Speed
13. TE	- Temperature
14. TT	- Temperature

Designations for the different systems, except for the nuclear core which has not been installed.

1. BL	- Broken Loop
2. CS	- Core Simulator
3. PC	- Intact Loop
4. RV	- Reactor Vessel
5. SG	- Steam Generator
6. ST	- Downcomer Instrument Stalk
7. SV	- Blowdown Suppression Tank

Fig. 5 LOFT thermo-fluids measurements instrumentation.

Fig. 7 LOFT pressurizer instrumentation.

Fig. 8. LOFT steam generator instrumentation.

Fig. 9 LOFT intact loop pump instrumentation.

Fig. 10 LOFT accumulator instrumentation.

Fig. 11 LOFT ECC system instrumentation (left side).

Note:
All Dimensions
in Inches

Fig. 12 LOFT suppression tank instrumentation.

instruments used in obtaining data presented in this report may also be obtained from Table VI which is presented in Section VII.)

Instruments were calibrated before installation either by the instrument vendor or at the INEL. Calibration data were then correlated with other parameters to determine the functional relationships between systematic errors and variables other than those the instrument was designed to measure. These error functions were then represented by mathematical equations (usually in the form of polynomials of degree five or less) and incorporated in the data reduction program.

The turbine meters and the drag discs in the intact loop were calibrated to convert the point measurement values to the mean values across the entire flow area. These calibrations were performed using the data from the single-phase variable frequency pump tests conducted prior to blowdown initiation. Least squares curve fits were calculated for the square root of the intact loop differential pressures plotted against the pump speed to confirm the adequacy of the differential pressure offset corrections. Similarly, the intact loop venturi meter data were plotted against the square root of the corrected differential pressure measurements to confirm or adjust the venturi meter offset corrections. The corrected venturi meter data were then used to calculate average velocities and momentum fluxes in the intact loop and the reactor vessel. These calculated quantities were subsequently compared to the measured turbine meter velocities and drag disc momentum fluxes to verify or to provide changes to the respective instrument calibration equations.

Additional calibrations were performed on specified turbine meters and drag discs to convert the point measurements to average measurements. These instruments included broken loop turbine meters and drag discs in the intact loop and reactor vessel which were overranged during the pump frequency tests. In the intact loop and reactor vessel, the flow rates calculated using the turbine meters and their associated areas were normalized with the intact loop venturi during steady-state (initial) conditions to determine the calibration factors for the

turbine flowmeters. The flow rate for the turbine meter in the core simulator was calculated with a core flow area equal to that of the nuclear core to be installed for Test L1-5. Calibration factors were then determined by normalizing this flow rate with the venturi flow rate. These calibration factors for the turbine meters were then squared and applied to the respective drag discs. Similar calibration factors were developed for the broken loop drag discs using the results of accumulator blowdown tests (where the accumulator flow was directed through the broken loop). Average measurements were then obtained by multiplying the calibration factors with the respective point measurements. The additional calibration factors obtained in this manner and used in the presented data for Test L1-3 are summarized below:

FE-BL-1	-----	1.00	MF-R1 -1	-----	1.00
FE-BL-2	-----	1.00	ME-BL-2	-----	1.00
			ME-CS-1	-----	0.0727
			ME-PC-3	-----	0.550

The presented data for average velocity and average momentum flux are based on the following flow areas at the instrument locations:

<u>Instrument</u>	<u>Flow Area</u>
FE-BL-1 and -2 ME-BL-1 and -2	0.6485 ft ²
FE-PC-1, -2, and -3 ME-PC-1, -2, and -3	0.6485 ft ²
FE-CS-1 ME-CS-1	1.78 ft ²
FE-1ST-1 and FE-2ST-1 ME-1ST-1 and ME-2ST-1	1.52 ft ²

Upper and lower error bands based on 95% (2σ) confidence levels were added as overlays to the plots of certain representative instruments. These plots can be found in Section 5 of the presented data. The error band plots presented for the LOFT process instruments are valid only for steady-state measurements. These instruments are listed in Reference 4 and are characterized by the P... designation in the channel measurement identifications.

Information on the calibration factors, accuracy, and response of specific instruments is given in the LOFT Experimental Measurements Uncertainty Analysis^[10]. Instrument calibrations and system testing conducted subsequent to completing the uncertainty analysis have been used to update the information presented and to process the data contained herein. Reference 10 is currently being revised to reflect the improved information and the observed performance obtained to date.

IV. TEST PROCEDURES

In preparation for Test L1-3, the primary coolant system was filled and vented and the system water chemistry was established to the specifications listed in Table V. The secondary coolant system, ECCS, blowdown suppression system, and supporting plant systems were configured as specified in the experiment operating specification (EOS)^[1].

Prior to the heatup of the plant, 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 200, 500, 1000, 1500, 2000, and 2250 psig at cold plant temperature and zero flow conditions. The DAVDS recorded 20 seconds of data at each pressure plateau to provide information to determine the degree of sensitivity of the pressure sensing instruments. The system was concurrently inspected for leakage at the various test pressures.

The plant was brought to the initial temperature of 540°F in a stepwise manner using the work energy addition of the primary coolant pumps. During the warmup, the purification and sampling systems were valved into the primary system to maintain water chemistry requirements and to provide a water sample at system conditions for subsequent analysis. Isothermal conditions were obtained in the nonflowing broken loop by means of the recirculation lines back to the intact loop. Before plant temperature exceeded 200°F, the secondary side of the steam generator was drained to the 0% power program reference level (116 inches from the top of the tube sheet), water chemistry was established, and the steam generator secondary side was valved out. Concurrently with the primary plant heatup, the BDST temperature was

increased as the tank was pressurized with nitrogen to its specified initial conditions.

The plant was stabilized at three points during heatup: 250°F - 500 psig, 460°F - 2250 psig, and 540°F - 2250 psig. At each stabilization point a burst (20 to 30 seconds) of data was recorded under flow and no-flow conditions for calibration checks and to determine the degree of instrument temperature sensitivity. At the 460°F stabilization point, a single-phase pump coastdown test was conducted with an initial flow of 3.6×10^6 lbm/hr. At the 540°F stabilization point, frequency tests were performed by varying primary coolant pump frequency from 20 to 60 Hz in 10-Hz increments. Following the frequency tests, single-phase pump coastdown tests were conducted with initial flows of 2.15×10^6 lbm/hr and 3.6×10^6 lbm/hr. Data were recorded for about 60 seconds for each of the three pump coastdowns, and the data were used for calibration checks. Following each pump coastdown, data were recorded for zero-flow conditions. When the plant temperature was stabilized at 540°F, a pressure test was performed at zero-flow conditions by varying the primary coolant system pressure from 2250 to 1450 psig and back to 2250 psig in 200-psig increments. At each pressure plateau, approximately 20 seconds of DAVDS data were recorded to determine the degree of hot instrument pressure sensitivity. When plant conditions were again stabilized at 540°F and 2250 psig, the plant was allowed to soak for more than 6 hrs to assure isothermal conditions for the blowdown. During this 6-hr soak an electrical calibration of the DAVDS was performed. Additionally, ECCS accumulator ACC-A was filled and pressurized to its specified values and a dry run of all the critical steps required prior to blowdown initiation was conducted.

Prior to blowdown initiation, the system parameters were checked to insure that they were within specified bands and last-minute instrument and valve lineup checks were performed. During this period, the initial-condition water samples were taken from the primary coolant system, the secondary coolant system, and the BDST. The pressurizer, steam generator, and BDST water levels were established. A computer program calibration and a data integrity check of the DAVDS was

performed. The purification system, which was the primary mode of plant temperature control, was valved out. The conditions in the intact loop were established to provide 2.15×10^6 lbm/hr flow with temperature and pressure at 540°F and 2250 psig, respectively, at the time of blowdown initiation. Primary coolant pump injection flow was initiated and the broken loop recirculation lines to the intact loop were closed.

Immediately prior to blowdown (within 60 seconds) the DAVDS was activated and data recording was started, the QOBV isolation valves were opened, and the pressurizer heaters were secured. Pressure fluctuations noted in the recorded data just prior to blowdown initiation are due to intermittent operation of the HPIS injection to maintain the pretest conditions. Test L1-3 blowdown was initiated. QOBV-1 commenced opening 2.5 msec before QOBV-2 and opened to a 12-inch Schedule 160 pipe area in 23 msec; QOBV-2 opened to the same flow area in 17 msec. Thus Test L1-3 successfully simulated a simultaneous 200% offset cold leg shear.

Electrical power to the PSMG sets was terminated within 1 second after blowdown initiation which allowed the pumps to coast down under the influence of the flywheels and the fluid dynamic forces on the pump impellers. The PSMG set field breakers were tripped at 24 seconds (before the primary coolant pumps coasted down below 12.5 Hz).

ECC injection was directed to the lower plenum of the reactor vessel during blowdown. Injection from accumulator ACC-A failed to initiate due to an improper valve lineup. HPIS pump A was initiated by LOCE control 32.6 seconds after the initiation of blowdown and injected at a flow rate of 18.4 gpm. The specified initiation of the HPIS was 22 ± 2 seconds and at a flow rate of 17.2 ± 2 gpm. This discrepancy had no detrimental effect on the test. LPIS pump A was initiated by LOCE control 37.5 seconds after the initiation of blowdown.

The BDST spray was manually initiated at 94.5 seconds after blowdown and was adjusted to a total flow rate of 320 gpm. Initially, spray flow suction was taken from the BDST. Approximately 213 seconds

after blowdown initiation, BDSTSS pump suction was shifted from the BDST to the BWST. This departure from procedure had no adverse impact on the conduct of the test. BDSTSS flow was continued for approximately 5.7 min and then secured.

The DAVDS digital recording system obtained approximately 6 minutes of data after simulated rupture and was secured. The DAVDS analog system continued recording blowdown suppression tank parameters for 10 minutes after blowdown initiation and was then secured. An electrical calibration of the DAVDS was performed following the test completion.

A sequence of events for Test L1-3 is provided in Table II.

TABLE II
CHRONOLOGY OF EVENTS FOR TEST L1-3

Event	Time After Blowdown Initiation (sec)
L1-3 Initiation	0
End of subcooled blowdown	~0.10
PCS ^[a] pump trip	~1.0
Pressurizer empty	~12
Accumulator ACC-A injection initiation	Failed to initiate
HPIS injection initiation	32.6 ^[b]
LPIS injection initiation	37.5 ^[c]
End of saturated blowdown	~50
PCS-BDST reached equilibrium pressure	~50
First evidence of ECC in lower plenum	56.3
Reactor vessel lower plenum liquid full	70.6
BDST spray initiated (pump suction from BDST)	94.5
BDST spray pump suction shifted to BWST	~213
BDST spray completed	~436

[a] Primary coolant system.

[b] Specified in EOS to be 22 ± 2 seconds.

[c] Specified in EOS to be 35.5 ± 2 seconds.

V. INITIAL CONDITIONS

The initial conditions and tolerance bands for Test L1-3 are presented in Table III along with the values measured immediately prior to the blowdown initiation. These pretest requirements and the justification for their selection are specified in EOS Volume 2^[1].

Only one initial condition was out of tolerance for this test: The measured intact loop flow rate was 2.34×10^6 lbm/hr instead of the maximum 2.2×10^6 lbm/hr as specified in EOS Volume 2. This discrepancy did not have any adverse effect on the experiment.

Table IV gives the fluid temperature distribution of the primary coolant system immediately prior to blowdown initiation. As can be seen, the system temperature distribution was nearly constant, except for the pressurizer liquid and vapor space. This essentially isothermal condition was due to the greater than 6-hour soak at the initial condition temperature and pressure before the commencement of blowdown.

Table V 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 analysis for these systems are presented for pre-LOCE and post-LOCE conditions. These analyses were required to utilize the data from the reactor vessel downcomer liquid level probes.

TABLE III

LOCE L1-3 INITIAL CONDITIONS

Parameter	EOS Specified Value	Measured Value
Primary coolant system:		
Flow rate (lbm/hr)	$2.15 \pm 0.05 \times 10^6$	2.34×10^6
Pressure (psig) ^[a]	2250 ± 25	2256
Temperature (°F)	540 ± 2	540
ECC accumulator:		
Gas volume (ft ³)	39 ± 2.4	Failed to
Water volume injected (ft ³)	90.8 ± 2.4	initiate
Pressure (psig) ^[a]	600 ± 25	flow
Temperature (°F)	90 ± 5	
Pressurizer:		
Steam volume (ft ³)	Not specified	14.2
Water volume (ft ³)	22.4 ± 3.5	19.8
Water temperature (°F)	Specified by	656 (vapor)
	saturation pressure	645 (liquid)
Pressure (psig) ^[a]	2250 ± 15	2250
Steam generator secondary:		
Water volume (ft ³)	Not specified	121.5
Water level (in.)	116 ± 1	116
Water temperature (°F)	Specified by	539
	saturation conditions	
Pressure (psig) ^[a]	Specified by	945
	saturation conditions	
Suppression tank:		
Liquid level (in.)	50.0 ± 1	50.8
Gas volume (ft ³)	Not specified	1957
Liquid volume (ft ³)	1036 ± 28	1053
Downcomer submergence (in.)	16 ± 1 ^[b]	17 ^[b]

TABLE III (contd.)

Parameter	EOS Specified Value	Measured Value
Water temperature (°F)	188.5 $\pm$ 6.5	188
Pressure (gas space) (psig) ^[a]	11.9 $\pm$ 2	10
Differential water level between downcomer interior volume and suppression tank (in.)	Not specified	5.6

[a] Local barometric pressure = 12.5 psia.

[b] Based on average submergence of four downcomers.

TABLE IV

PRIMARY COOLANT TEMPERATURE DISTRIBUTION AT RUPTURE

Location	Detector	Temperature (°F)
Intact loop hot leg (near vessel)	TE-PC-2	543
Intact loop steam generator inlet	TE-SG-1	538
Intact loop steam generator outlet	TE-SG-2	542
Intact loop cold leg (near steam generator outlet)	TE-PC-3	542
Intact loop cold leg (near vessel)	TE-PC-1	541
Reactor vessel downcomer:		
Instrument stalk 1	TE-1ST-2	540
Instrument stalk 2	TE-2ST-2	541
Reactor vessel lower plenum:		
Instrument stalk 1	TE-1ST-9	540
Instrument stalk 2	TE-2ST-9	539
Reactor vessel core simulator	TE-CS-1	544
Broken loop hot leg (near vessel)	TE-BL-2	537
Broken loop hot leg (steam generator simulator inlet) ^[a]	PE-BL-3	543 (+3.9)

TABLE IV (contd.)

Location	Detector	Temperature (°F)
Broken loop cold leg (near vessel)	TE-BL-1	541
Broken loop cold leg at break plane ^[a]	PE-BL-3	528 (+4.7)
Intact loop pressurizer:		
Liquid space	TE-P139-20	645
Vapor space	TE-P139-19	656

[a] From saturation pressure at the end of subcooled blowdown.

TABLE V

WATER CHEMISTRY RESULTS FOR TEST L1-3

Parameter	Primary Coolant Intact Loop			Blowdown Suppression Tank			Secondary Coolant System	
	Specified	Pre-LOCE ^[a]	Post-LOCE ^[b]	Specified	Pre-LOCE	Post-LOCE	Specified	Pre-LOCE
PH	9.5-10.5	10.11	9.81	4.0-0.5	9.76	9.62	9.0-10.2	9.41
Conductivity ($\frac{\mu\text{mho}}{\text{cm}}$) (025 C)	1-40	24.6	15.8	24-40	13.5	16.5	---	56
Total solids (ppm)	---	25	7.5	---	28	75.5	---	39.9
Total gas (cc/kg)	100 max	32.04	---	---	20.77	19.5	---	9
Dissolved oxygen (ppm)	0.10 max	<0.005	4.55	---	---	---	0.10 max	0
Lithium (ppm)	0.2-2.2	0.7	0.6	---	---	---	---	---
Hydrazine (ppm) (at <250°F)	1.0 min	<0.01	<1.0	---	---	---	1.0 min	<0.1
Chloride (ppm)	0.15 max	<0.1	<0.1	0.15 max	<0.1	<0.1	0.5 max	<0.1
Dissolved solids (ppm)	---	25	7.5	---	28	75	500 max	39
Undissolved solids (ppm)	1.0 max	<0.5	<1.0	1.0 max	<0.5	0.5	50 max	0.9
Hardness (ppm)	---	---	---	---	---	---	---	<0.1
Phosphate (ppm)	---	---	---	---	---	---	15-75	35.2
Gas O ₂ content (%) (by volume)	---	---	---	---	9	---	---	---

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

[b] Sample taken from the pressurizer.

VI. DATA CONSISTENCY CHECKS

As a subsequent step in the data reduction process described in Section III, all data presented in this report were subjected to a thorough review to verify that they were consistent and reasonable. Where possible, instrument channel outputs and computed parameters were compared to test predictions, previous tests, corresponding parameter channels, and calculated quantities. In many instances, these consistency checks were performed as data plot overlays and, therefore, the respective figure numbers are specified below as the individual topics are discussed. For other measurements, the comparisons and resulting calculations were performed within the company and are not included in this report. Those measurement comparisons that were determined to be within the accuracy of the particular instrument, as specified in Reference 10, were labeled as qualified engineering units data (QEUD). Specifically, several techniques have been developed and employed to perform data consistency checks on the presented data; these techniques are discussed below.

Measured system temperatures were qualified where possible by reviewing the isothermal temperature distributions just prior to blowdown initiation and during the blowdown transient. When temperatures measuring a similar condition were within the specified accuracy of the detectors, the detector output was considered reasonable and was qualified. All primary coolant system (PCS) temperature channels were reviewed in this manner, and selected initial temperature measurements are summarized in Table IV. Selected PCS temperature channels were overlaid in Figures 135 through 146 and Figures 157 through 175 for comparison of the temperature distribution. The pressurizer liquid and vapor space temperatures were checked for consistency by comparing these values with the saturation temperature for the corresponding pressurizer pressure at various points in time. This check was valid prior to and during the system blowdown until the pressurizer emptied at 12 seconds. Similarly, steam generator secondary coolant system (SCS) temperature was examined throughout the test by comparing the measured temperature with the saturation temperature for

the respective SCS pressure. BDST temperature elements TE-SV-1-6 and TE-SV-7-12 were evaluated by comparing the pretest measurements of the thermocouples in the same horizontal stratum. Overlays of these parameters are presented in Figures 151 through 156. Figures 147 through 150 compare TE-SV-1-4 and TE-SV-7-10 in the vertical plane of the gas space in the BDST. While the data from these temperature instruments are compared for consistency, it should be noted that TE-SV-1-4 and TE-SV-7-10 may not represent the actual vapor space temperature since these instruments were designed to measure liquid temperature. TE-SV-5-6 and TE-SV-11-12 could not be compared for pretest temperature distribution in the vertical plane due to temperature stratification in the BDST liquid. BDST temperature comparison after the initiation of blowdown was not meaningful for data consistency checks due to uneven mixing and condensation producing temperature stratification in the tank.

Pressure data were reviewed in a similar manner. During the approach to Test L1-3 initial conditions with the primary coolant pumps secured, the PCS was raised to various specified temperatures and pressures as described in Section V. At each data point, PCS pressure measurement detectors were compared to a 0.1% accuracy, 0 to 5000 psig pressure test gauge to verify that the slope had not statistically changed and to establish the offset of the instrument. Immediately prior to blowdown, PCS pressures were again compared to the test gauge standard to ensure that all detectors were measuring within their specified accuracy bands. During the blowdown transient, pressure data from corresponding measurement locations were compared by overlaying the data plots. These plots are presented in Figures 100 through 114. Pressurizer pressure was qualified by comparison with PCS pressure channels and by saturation temperature as discussed above; SCS pressure was qualified by comparison of saturation temperature to the measured temperature as presented in the paragraph on temperature techniques. The BDST pressure instruments were evaluated by comparing process and experimental pressure measurements prior to and during the blowdown transient. Representative instrument plots are presented for this comparison in Figures 21 through 42 and Figures 115 through 127. It

should be noted that the BDST experimental pressure data have all been adjusted to a 0-psig initial pressure for comparison of the tank pressure rise during blowdown. Initial BDST pressure can be obtained from the data plots of PT-P138-55 and PT-P138-56 in Figure 132.

Comparison of measured temperature with the saturation temperature of the pressure measurement at the same location provided another method to verify PCS data consistency. This technique, however, was valid only during the saturated blowdown transient up till the time the measurement location voided of fluid. After voiding occurred, the measured temperature increased above the corresponding saturation temperature due to radiant heating of the detector element by the structural system components and detector element stem conduction. Temperature detectors in the reactor vessel which became wetted by the ECCS lower plenum injection displayed a measured temperature which decreased below the corresponding saturation temperature as the detector became immersed in the cooler fluid. Comparisons of saturated temperature and measured temperature are presented in Figures 257 through 264.

Data consistency checks for the differential pressure measurements were provided by several basic methods. Prior to blowdown initiation, zero-flow data were recorded to determine instrument offsets. PCS operating conditions were then established as specified in EOS Volume 2, and selected PCS pressure drops were compared with predicted values. At various PCS operating 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 instruments by plotting the square root of the differential pressure against pump speed using data from the pump frequency tests conducted prior to blowdown. The results of least squares curve fits performed on these plots were then used to confirm instrument zero offsets. Both prior to and during the blowdown transient, differential pressure measurements were compared with the differential pressure computed by subtracting appropriate absolute pressure measurements. Finally, pressure closure was

calculated for three flow loops: (a) the PCS intact loop, (b) the broken loop hot leg to the BDST, and (c) the broken loop cold leg to the BDST. The pressure closure for these three loops is defined in Table VII and presented for loop (a) in Figure 246. Investigation of these data plots revealed that the algebraic sum of the differential pressures in the two broken loops was not zero on the blowdown transient and remained positive. It is believed that this deviation is caused by a velocity head and two-phase flow effects at the measurement locations and system components in the flow loop for which a differential pressure measurement did not exist. Further investigation of these results is needed to support the supposition and account for observed discrepancies.

Three system level measurements were important for test LI 3: (a) BDST liquid level, (b) pressurizer coolant level, and (c) reactor vessel coolant level. BDST liquid level was evaluated by comparing two independent level measurements which are plotted as an overlay in Figure 66. Similarly, pressurizer level was reviewed by redundant level measurements which are presented for comparison in Figures 67 through 69. It should be noted that level instrument LT-P139-7 showed an unexpected level increase at 40 seconds; further investigation will be necessary to resolve this occurrence. The reactor vessel liquid level probes were verified to be indicating satisfactorily by performing a pretest conductivity calibration with the vessel liquid full and under cold and hot plant conditions.

Primary coolant pump speed measurements were checked for consistency by comparison with pump speed as calculated from the PSMG frequencies. This check was valid prior to and during the blowdown transient until the PSMG field breakers were opened at 24 seconds. These comparisons were overlaid in Figures 239 and 240. Prior to test initiation, the pump speed was further checked, along with the intact loop flow rate and pump differential pressure, by reviewing the agreement with the manufacturer's pump performance curves. Pump run voltages and currents were evaluated prior to the initiation of blowdown by calculating the pump electrical horsepower input, the pump water

horsepower, and finally the combined pump efficiency. These calculated efficiencies were then compared to previously recorded efficiencies determined during pump requalification tests.

To evaluate the PCS average fluid densities, calculations were performed by two independent methods using the gamma densitometer and drag disc turbine flowmeter outputs as described in Section III. To ensure that the gamma densitometer measurements were accurate for these calculations, the individual beam densities were compared to the known density of the PCS just prior to blowdown initiation. Additionally each densitometer gamma source was stowed in its lead cask to obtain an essentially infinite density data point for each densitometer calibration curve. These known density values were then used to adjust the instrument electronics to give the correct readings from the gamma densitometers. As a final pretest check on the densitometer calibrations, a high and low calibration tungsten shim of known density was inserted in each individual densitometer beam. DAVDS data were then taken and reviewed for these measurement channels in each shim position.

Several techniques were employed to verify the validity of the measured data from the turbine meters, the drag discs, and the intact loop mass flow rate venturi meters. In particular, the broken loop turbine meters and drag discs were calibrated as discussed in Section III. The intact loop venturi meter data were examined by performing least squares curve fits for the computed venturi meter velocities plotted against the square root of the differential pressure transducers in the intact loop. The results of these data consistency checks for this test indicated discrepancies in the intact loop mass flow rates measured by the venturi meters. New venturi meter calibration equation offsets were therefore derived by using the above curve fitting technique with the variable-frequency single-phase test data obtained prior to blowdown initiation. These corrected venturi meter mass flow rates were then used to calculate average velocities and momentum fluxes in the intact loop and the reactor vessel. These values were subsequently used to correlate the outputs of the turbine meters and the drag discs. Finally, the measured average turbine meter

velocities and drag disc momentum fluxes were confirmed or adjusted to produce consistent data in the pump frequency tests. As an independent check, the turbine meter and drag disc data were used to calculate fluid density as specified in Section III. These values were then compared to the known single-phase density prior to blowdown. This analysis was performed on all the turbine meters and drag discs in the intact loop and the reactor vessel with the exception of ME-PC-3 and ME-CS-1 and those instruments that failed as listed in Table VI. ME-PC-3 and ME-CS-1 were overranged during the pump frequency tests, and data consistency was verified by performing the pretest calibrations discussed in Section III.

The computed parameter, mass flow rate per system volume, was calculated by five different methods at various locations in the intact loop, broken loop, and the reactor vessel. A list of the measurement parameters, measurement locations, and the calculation methods used are summarized in Table VII. Comparison of the calculated results obtained by each method at a particular measurement location was utilized to provide the data consistency checks for this computed parameter. It should also be noted that these comparisons provided a redundant check of the individual instruments used for each computation. Mass flow rate per system volume could not be calculated for any method or at the respective locations using ME-PC-2 or the average density computed from DE-PC-1 due to the failure of ME-PC-2 and DE-PC-1A. For purposes of comparison, however, mass flow rates per system volume were calculated using the chordal density from DE-PC-1B instead of the average density for that location. Although they are not overlaid, selected results calculated by the various methods are presented for each location in Figures 221 through 236 for comparison.

The mass flow rates per system volume were also calculated for the pressurizer as defined in Table VII. Consistency was verified by (a) calculating each parameter using two similar but independent sets of input data and comparing results and (b) by integrating the mass flow rate with time and comparing the total mass ejected with the known mass

in the pressurizer prior to blowdown initiation. The results are presented in Figure 237.

System fluid velocities were evaluated during the blowdown transient by utilizing two independent methods. Velocities were measured directly by the turbine meters and were subsequently calculated using the gamma densitometers and drag disc as discussed in Section III. Data consistency checks were performed by comparing the turbine flowmeter velocities for representative system locations with the respective calculated velocities. To provide reliable data for these velocity checks, the gamma densitometers, the drag discs, and the turbine flowmeters were calibrated prior to test initiation as discussed in Section III and in this section. Fluid velocities could not be computed at the locations using MC-PC-2, and the average density was computed from DE-PC-1B due to the failure of ME-PC-2 and DE-PC-1A.

As a redundant approach to verify the validity of Test L1-3 data, selected instrument parameters were overlaid with plots from (a) the experiment prediction for Test L1-3^[2], (b) the Semiscale counterpart test (S-01-3)^[11], (c) the LOFT nonnuclear Test L1-2^[6], and (d) the LOFT nonnuclear Test L1-3A^[7]. Parameters of interest in these comparisons included broken and intact loop average densities, pressures, temperatures, fluid velocities, and computed mass flow rates per system volume. The differential pressure measurements across selected PCS components were also examined. The results of these comparisons are not included in this report.

Several additional methods are being developed to reconcile inconsistencies in the presented data. The mass flow rates through the break planes can be calculated by each of five different methods and then integrated with respect to time. Comparisons are then made between the resulting total mass ejected from each integral and the total mass of water initially in the PCS, including the mass of water injected by the ECCS. The five methods presently utilized to compute mass flow rates are:

- (1) $M = (\text{"densitometer"} \times \text{"drag disc"})^{1/2} \times A$
- (2) $M = (\text{"densitometer"}) \times (\text{"turbine meter"}) \times A$
- (3) $M = (\text{"drag disc"} / \text{"turbine meter"}) \times A$
- (4) $M = \text{Constant} \times (d\text{"BDST level"}/dt)$
- (5) $M = \text{Constant} \times (\Delta P^{14} \text{ to } 5 \text{ "reduction"} \times \text{"densitometer"})^{1/2}$.

To date, an analysis has been performed using broken loop data from Tests L1-1, L1-2, L1-3, and L1-3A to investigate the integrated mass flow rate using Methods 1 through 5 above. The general shape of the graphs of the mass flow integral as a function of time were similar for each experiment, although the magnitudes were different. The magnitudes of the integrals, however, were generally ordered the same. That is, Method 3 was highest, Method 1 was second, Method 4 was third, Method 5 was fourth, and Method 2 was lowest. Method 4, using the BDST level change with time, was the most erratic, probably due to pressure variations on the level detectors caused by waves and blowdown turbulence within the BDST. Further calculations using the mass of the water in the suppression tank, however, provided the best check on the integrated mass flow from the system.

A correction technique was formulated based on the assumption that the densitometer density was correct and that observed deviations in the mass balances were due to variations in the measured momentum flux and the measured velocity. The ratio of the integral from mass flow computed by Method 1 and the BDST mass change was used to determine a correction factor K_1 . Similarly, a constant K_2 was calculated for the turbine meter from Method 2. As a check, Method 3 was used to compute a mass flow integral with the drag disc data corrected by a factor equal to $1/K_1^2$. Then the correction factor for the turbine meter was calculated by comparison with the BDST mass change. The resulting factor compared well with the previously calculated K_2 . A similar correction constant was calculated for Method 5, again using the mass change in the BDST as a reference.

The results of this analysis for all four tests were then used to produce a set of correction factors for the mass flow rate data

calculated by Methods 1, 2, 3, and 5. When these correction factors are applied to the individual test data, however, unresolved discrepancies are present in the results. It is believed that these discrepancies are caused by the effect of two-phase flow at the measurement locations. Therefore, more detailed analysis needs to be performed to make the system mass balance a valid data consistency check.

The correction factors resulting from the above analysis are listed below along with method designation and the figure containing the applicable mass flow rate graph. These graphs should be multiplied by the respective correction factor to produce a more consistent mass balance.

Method		Correction Factor	Applicable Figure No.
(1)	1	0.778	222 and 225
(2)	2	1.417	223 and 226
(3)	3	0.443	221
(4)	5	0.917	224 and 227

It should be noted that these results have been applied only to the broken loop measurements. An analogous technique will be applied to the intact loop but as yet has not been performed.

VII. DATA PRESENTATION

The data presented in this report include selected pertinent thermal-hydraulic data from LOFT Test L1-3. The data have been divided into four categories: qualified engineering units data (QEUD), uninterpreted data, good data-not qualified, and channel failed. The "QEUD" designation was applied to measurements that have been compared to other measurements and have been found to be within the accuracy of the instrument. These data checks are discussed in detail in Section VI. The "uninterpreted data" designation was applied to measurements in which the instruments did not fail but the data are not in a readily usable form. The "good data-not qualified" designation was applied to measurements that appeared to be reasonable but no comparable measurement for cross-checking was recorded.

The data were processed to the extent of converting the data to engineering units, combining measurements to produce computed parameters, and overlaying graphs of corresponding parameters at several locations to facilitate comparison. Point values of momentum flux from the drag discs and velocity from the turbine flowmeters have been converted to average values by using the intact loop venturi meter as discussed in Section III. Data from the drag discs, the turbine flowmeters, and the gamma densitometers were filtered with a 4-Hz filter prior to presentation. Numerous other instrument channel outputs were also filtered prior to presentation. These channels are indicated in Table VI and on the individual plots along with the filter used.

Measurement uncertainties for each instrument were reported in Reference 10 and are subsequently being revised as dictated by in situ testing and calibrations. These uncertainties have been used to produce error band plots [plots of data with upper and lower bounds of the 95% (2σ) confidence levels overlaid]. For the drag discs and gamma densitometers, uncertainty analyses have been performed for the point measurements only. Further analyses will be required before average value uncertainties can be reported.

For LOFT Test L1-3, the instrumentation system performed well. Of 549 instrument channels recorded during this experiment, only 37 instruments failed. Many of the instruments (such as accelerometers and strain gages) were used to measure system loads or contributed little or nothing toward understanding what occurred in this test. Thus, data from only 199 of the instrument detectors recorded are included in this report.

Table VI lists the sensors that were intended to be reported for Test L1-3. It gives the detector location, range, and frequency response along with the figure number where the data can be found. This table also contains a "Comments" column which gives information reflecting on the usability of the data.

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

The data are presented in graphical form, and are arranged two plots per page. The data plots are further divided into five major sections with the individual plots in each section being presented in alphanumeric order to facilitate comparison and location of desired parameters. These data sections include:

1. Test L1-3 Measured Parameters -- Short-Term Plots (Figures 14 through 42). This section contains the detector outputs, including overlays, which were specifically designed for the short-term transient and, therefore, do not exceed 1-second duration.
2. Test L1-3 Measured Parameters -- 70-Second Plots (Figures 43 through 175).

3. Test L1-3 Measured Parameters -- Long-Term Plots (Figures 176 through 212). This section contains selected detector outputs, including overlays of 175-sec and 500-sec duration.
4. Test L1-3 Computed Parameters (Figures 213 through 269).
5. Test L1-3 Error Band Plots (Figures 270 through 312). This section contains error band plots for several representative instrument types, ranges, and frequency responses. These error bands are based on 95% (2σ) confidence levels.

Time zero for each plot is the average of the times at which each of the QOBVs opened to 17% of its full sleeve travel. This definition for time of blowdown initiation (T_0) was used since (a) a flow area does not exist through each QOBV until the valve sleeve clears the huddle chamber at 17% of its full travel and (b) QOBV-1 commenced opening 2.5 msec sooner than QOBV-2. Determination of T_0 , along with valve opening time, is shown pictorially in Figure 13. It should be noted that, while this definition of time zero is adequate for measurement comparisons using time scales on the order of several seconds, the user may wish to utilize a different time zero definition for evaluation of shorter time phenomena. The data are presented prior to the defined time zero to allow for such a comparison.

Pressure data presented in this report are in gauge pressure (psig); barometric pressure at the time of test execution was 12.5 psia.

The scales selected for the graphs were chosen to provide an overview of the test and do not reflect the obtainable resolution of the data.

The volume of data contained in this report is large, and although every effort was made to prevent it, an error may have found its way into the report. In the event a user detects an error, prompt notification would be appreciated so that other users may be notified.

Fig. 13 Determination of time of rupture (T_0) and valve opening time.

TABLE VI
MEASURED PARAMETERS FOR LOFT TEST L1-3

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data [a] System		
VALVE OPENING							
Broken Loop CV-P138-1	Broken loop cold leg between break plane and suppression tank.	0-100%	0-100%	35 Hz	500 pps	14 15	QEUD.
Broken Loop CV-P138-15	Broken loop hot leg between break plane and suppression tank.	0-100%	0-100%	35 Hz	500 pps	14 16 270	QEUD.
CHORDAL DENSITY							
Broken Loop DE-BL-1A	Broken loop cold leg at DTT flange. Beam line 14° 21 min from -1B line [CW looking toward reactor vessel (RV)].	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	43 176 271	QEUD. Filtered to 4 Hz for 0 to 70 sec plots only.
Broken Loop DE-BL-1B	Broken loop cold leg at DTT flange. Beam line through C of pipe 45° from vertical (CCW looking toward RV).	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	43 176	QEUD. Filtered to 4 Hz for 0 to 70 sec plots only.
Broken Loop DE-BL-1C	Broken loop cold leg at DTT flange. Beam line 22° 7 min. from -1B line (CCW looking toward RV).	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	43 176	QEUD. Filtered to 4 Hz for 0 to 70 sec plots only.
Broken Loop DE-BL-2A	Broken loop hot leg at DTT flange. Beam line 14° 21 min from -2B line (CCW looking toward RV).	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	44 177	QEUD. Filtered to 4 Hz for 0 to 70 sec plots only.
Broken Loop DE-BL-2B	Broken loop hot leg at DTT flange. Beam line through C of pipe 45° from vertical (CW looking toward RV).	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	44 177	QEUD. Filtered to 4 Hz for 0 to 70 sec plots only.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
CHORDAL DENSITY							
Broken Loop DE-BL-2C	Broken loop hot leg at DTT flange. Beam line 22° 7 min from -2B line (CW looking toward RV).	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	44 177	QEUD. Filtered to 4 Hz for 0 to 70 sec plots only.
Intact Loop DE-PC-1A	Intact loop cold leg at DTT flange. Beam line 14° 21 min from -1B line (CW looking away from RV).	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	--	Channel failed.
Intact Loop DE-PC-1B	Intact loop cold leg at DTT flange. Beam line through C of pipe 45° from vertical (CCW looking away from RV).	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	46	QEUD. Filtered to 4 Hz.
Intact Loop DE-PC-1C	Intact loop cold leg at DTT flange. Beam line 22° 7 min from -1B line (CCW looking away from RV).	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	46	QEUD. Filtered to 4 Hz.
Intact Loop DE-PC-2A	Intact loop hot leg at DTT flange. Beam line 14° 21 min from -2B line (CW looking away from RV).	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	47	QEUD. Filtered to 4 Hz.
Intact Loop DE-PC-2B	Intact loop hot leg at DTT flange. Beam line through C of pipe 45° from vessel (CCW looking away from RV).	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	47	QEUD. Filtered to 4 Hz.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
CHORDAL DENSITY							
Intact Loop DE-PC-2C	Intact loop hot leg at DT flange. Beam line 22° 7 min from -2B line (CCW looking away from RV).	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	47	QEUD. Filtered to 4 Hz.
Intact Loop DE-PC-3A	Steam generator (SG) outlet at DTT flange. Beam line 14° 21 min from -3B line (CCW looking down).	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	48	QEUD. Filtered to 4 Hz.
Intact Loop DE-PC-3B	SG outlet at DTT flange. Beam line 65° from flange [C (CW looking down).	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	48	QEUD. Filtered to 4 Hz.
Intact Loop DE-PC-3C	SG outlet at DTT flange. Beam line 22° 7 min from -2B [C (CW looking down).	0.5-62.4 lb/ft ³	0.5-62.4 lb/ft ³	1,000 Hz 10 Hz	1,000 Hz 50 pps	48	QEUD. Filtered to 4 Hz.
FLUID VELOCITY, AVERAGED						All turbine meter measure- ments are unidirectional.	
Broken Loop FE-BL-1	Broken loop cold leg at DTT flange.	7.5-150 ft/sec	0-190 ft/sec	9 Hz	1,000 Hz 50 pps	50 52 178 272	Uninterpreted data. Filtered to 4 Hz for 0 to 70 sec plot only. Plot corrected to average.
Broken Loop FE-BL-2	Broken loop hot leg at DTT flange.	7.5-150 ft/sec	0-190 ft/sec	9 Hz	1,000 Hz 50 pps	51 52	Uninterpreted data. Filtered to 4 Hz, plot corrected to average.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data [a] System		
FLUID VELOCITY, AVERAGED							
Reactor Vessel FE-CS-1	Core simulator in instrument stalk above orifice.	1.5-30 ft/sec	0-60 ft/sec	9 Hz	1,000 Hz 50 pps	53	Uninterpreted data. Filtered to 4 Hz, plot corrected to average.
Intact Loop FE-PC-1	Intact loop cold leg at DTT flange.	7.5-150 ft/sec	0-180 ft/sec	9 Hz	1,000 Hz 50 pps	54 57	Uninterpreted data. Filtered to 4 Hz, plot corrected to average.
Intact Loop FE-PC-2	Intact loop hot leg at DTT flange.	7.5-150 ft/sec	0-200 ft/sec	9 Hz	1,000 Hz 50 pps	55 57	Uninterpreted data. Filtered to 4 Hz, plot corrected to average.
Intact Loop FE-PC-3	SG outlet at DTT flange.	7.5-150 ft/sec	0-210 ft/sec	9 Hz	1,000 Hz 50 pps	56 57	Uninterpreted data. Filtered to 4 Hz, plot corrected to average.
Reactor Vessel FE-1ST-1	Downcomer stalk 1, 47.1 in. from RV bottom.	1.5-30 ft/sec	0-60 ft/sec	9 Hz	1,000 Hz 50 pps	58 60 273	Uninterpreted data. Filtered to 4 Hz, plot corrected to average.
Reactor Vessel FE-2ST-1	Downcomer stalk 2, 47.1 in. from RV bottom.	1.5-30 ft/sec	0-64 ft/sec	9 Hz	1,000 Hz 50 pps	59 60 179	Uninterpreted data. Filtered to 4 Hz for 0 to 70 sec plot only. Plot corrected to average.
FLOW RATE							
Emergency core Cooling System FT-P120-36-1	Accumulator A in 6-in. line downstream of orifice.	0-60 in.	0-2000 gpm	5 Hz	50 pps	--	QEUJ. Not presented. Accu- mulator ACC-A injection failed to initiate.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data [a] System		
FLOW RATE							
Emergency Core Cooling System FT-P120-36-5	Accumulator A in 6-in. line downstream of orifice.	0-600 in.	0-600 gpm	5 Hz	50 pps	--	Channel failed.
Emergency Core Cooling System FT-P120-85	LPIS pump A in 4-in. line between heat exchanger and orifice.	40-800 gpm	0-400 gpm	5 Hz	50 pps	61 184 275	QEUD.
Emergency Core Cooling System FT-P128-104	HPIS pump A discharge.	2-30 gpm	0-30 gpm	5 Hz	50 pps	62 276	QEUD.
Blowdown Suppres- sion Tank Spray System FE-P138-138	Suppression tank spray flow rate in 60 gpm header.	0-100 gpm	0-100 gpm	7 Hz	50 pps	180	Uninterpreted data from T_0 to $T_0 + 94$ sec. QEUD from T_0 $+ 94$ sec to 175 sec.
Blowdown Suppres- sion Tank Spray System FE-P138-139	Suppression tank spray flow rate from pump discharge.	0-400 gpm	0-400 gpm	7 Hz	50 pps	181 274	QEUD after the initiation of spray flow at $\sim T_0 + 94$ sec.
Blowdown Suppres- sion Tank Spray System FE-P138-140	Suppression tank spray flow rate in the 220 gpm header.	0-300 gpm	0-300 gpm	7 Hz	50 pps	182	QEUD. Recorded flow rate be- tween T_0 and $T_0 + 15$ sec due to mechanical shock.
Blowdown Suppres- sion Tank Spray System FE-P138-153	Suppression tank spray flow rate in the spray pump recirculation line.	0-150 gpm	0-150 gpm	7 Hz	50 pps	183	QEUD after the initiation of spray flow at $\sim T_0 + 94$ sec.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data [a] System		
FLOW RATE							
Intact Loop FT-P139-27-1	Intact loop hot leg venturi flowmeter (right side facing SG).	0.5-5 mlbm/hr	0-5 mlbm/hr	5 Hz	1,000 Hz 50 pps	63	QEUD for initial conditions only; data not corrected for density changes after T ₀ .
Intact Loop FT-P139-27-2	Intact loop hot leg venturi flowmeter (left side facing SG).	0-760 in. H ₂ O	0-760 in. H ₂ O	5 Hz	1,000 Hz 50 pps	--	QEUD for initial conditions only. Channel failed after T ₀ (digital).
Intact Loop FT-P139-27-3	Intact loop hot leg venturi flowmeter (bottom).	0.5-5 mlbm/hr	0-5 mlbm/hr	5 Hz	50 pps	63 277	QEUD for initial conditions only; data not corrected for density changes after T ₀ .
LIQUID LEVEL							
Reactor Vessel LE-1ST-1 and -2	Downcomer 1 with stings between 200.4 in. and 8.4 in. above RV bottom.	0-162 in.	-1-+1 V	0.7 Hz	1,000 Hz	64	QEUD.
Reactor Vessel LE-2ST-1 and -2	Downcomer 2 with stings between 200.4 in. and 8.4 in. above RV bottom.	0-162 in.	-1-+1 V	0.7 Hz	1,000 Hz	65	QEUD. LE-2ST-2-2 channel failed.
Secondary Coolant System LT-P4-8B	SG secondary level.	-143-+57 in. H ₂ O	-143-+57 in. H ₂ O	5 Hz	50 pps 1,000 Hz	70	Good data - not qualified. Data display instrument ringing from T ₀ to ~ 5 sec.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
LIQUID LEVEL							
Emergency Core Cooling System LIT-P120-44	Accumulator A.	0-120 in.	0-120 in.	5 Hz	50 pps	--	QEUD. Not presented. Accumulator ACC-A injection failed to initiate.
Blowdown Suppression Tank LT-P138-33	Blowdown suppression tank level on north end of tank.	0-150 in.	0-132 in.	5 Hz	1,000 Hz 50 pps	66 185 204	QEUD. Data display instrument ringing from T_0 to $\sim T_0 + 2.5$ sec.
Blowdown Suppression Tank LT-P138-58	Blowdown suppression tank level on south end of tank.	0-132 in.	0-132 in.	5 Hz	1,000 Hz 50 pps	66 185 205 278	QEUD. Data display instrument ringing from T_0 to $\sim T_0 + 2.5$ sec.
Intact Loop LT-P139-6	Pressurizer level on southeast side.	0-75 in.	0-75 in.	5 Hz	1,000 Hz 50 pps	67	QEUD from T_0 to $T_0 + 13$ sec. Uninterpreted data after $T_0 + 13$ sec.
Intact Loop LT-P139-7	Pressurizer level on southwest side.	0-75 in.	0-75 in.	5 Hz	1,000 Hz 50 pps	68	QEUD from T_0 to $T_0 + 13$ sec. Uninterpreted data after $T_0 + 13$ sec.
Intact Loop LT-P139-8	Pressurizer level on north side.	0-75 in.	0-75 in.	5 Hz	50 pps	69 279	QEUD from T_0 to $T_0 + 13$ sec. Uninterpreted data after $T_0 + 13$ sec.
MOMENTUM FLUX, AVERAGED							
Broken Loop ME-BL-1	Broken loop cold leg at DTT flange.	2.0-50 10^3 lb/ft- sec ²	-460-+460 10^3 lb/ft- sec ²	35 Hz	1,000 Hz 50 pps	71 73 186 280	Uninterpreted data. Filtered to 4 Hz for 0 to 70 sec plot. Unfiltered for 0 to 175 sec plot. Plot corrected to average. Data temperature sensitive after $\sim T_0 + 50$ sec.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
MOMENTUM FLUX, AVERAGED							
Broken loop ME-BL-2	Broken loop hot leg at DTT flange.	2.0-5.0 10 ³ lb/ft- sec ²	-420-+460 10 ³ lbm/ft- sec ²	35 Hz	1,000 Hz 50 pps	72 73	Uninterpreted data. Fil- tered to 4 Hz for 0 to 70 sec plot; unfiltered for 0 to 190 sec plot. Plot corrected to average.
Reactor Vessel ME-CS-1	Core simulator stalk above orifice plates.	200-3,500 lb/ft-sec ²	-20-+20 10 ³ lbm/ft- sec ²	35 Hz	1,000 Hz 50 pps	74	Uninterpreted data. Filtered to 4 Hz, plot corrected to average for 0 to 70 sec.
Intact Loop ME-PC-1	Intact loop cold leg at DTT flange.	2.0-50 10 ³ lb/ft- sec ²	-510-+510 10 ³ lbm/ft- sec ²	35 Hz	1,000 Hz 50 pps	75 77	Uninterpreted data. Data tem- perature sensitive after T ₀ + 22 sec. Filtered to 4 Hz. Plot corrected to average.
Intact Loop ME-PC-2	Intact loop hot leg at DTT flange.	200-3,500 lb/ft-sec ²	-28-+28 10 ³ lbm/ft- sec ²	35 Hz	1,000 Hz 50 pps	--	Channel failed (digital).
Intact Loop ME-PC-3	SG outlet at DTT flange.	2.0-5.0 10 ³ lb/ft- sec ²	-440-+440 10 ³ lbm/ft- sec ²	35 Hz	1,000 Hz 50 pps	76 77	Uninterpreted data. Data temperature sensitive after T ₀ + 22 sec. Filtered to 4 Hz. Plot corrected to average.
Reactor Vessel ME-1ST-1	Downcomer 1, 45.5 in. above RV bottom.	200-3,500 lb/ft-sec ²	-19-+19 10 ³ lbm/ft- sec ²	35 Hz	1,000 Hz 50 pps	78 281	Uninterpreted data. Filtered to 4 Hz, plot corrected to average.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data [a] System		
MOMENTUM FLUX, AVERAGED							
Reactor Vessel ME-2ST-1	Downcomer 2, 45.5 in. above RV bottom.	200-3,500 lb/ft-sec ²	-19-+19 10 ³ lbm/ft- sec ²	35 Hz	1,000 Hz 50 pps	79 187	Uninterpreted data. Filtered to 4 Hz for 0 to 70 sec; un- filtered for 0 to 175 sec; plot corrected to average.
ELECTRICAL FREQUENCY							
Intact Loop PCP-1-F	Intact loop pump 1.	0-75 Hz	0-75 Hz	1,000 Hz	50 pps	238 239	QEUD.
ELECTRICAL CURRENT							
Intact Loop PCP-1-I	Intact loop pump 1.	0-1,000 amps	0-1,000 amps	---	500 pps	--	QEUD. Not presented.
ELECTRICAL VOLTAGE							
Intact Loop PCP-1-V	Intact loop pump 1.	0-600 V	0-600 V	---	500 pps	--	QEUD. Not presented.
ELECTRICAL FREQUENCY							
Intact Loop PCP-2-F	Intact loop pump 2.	0-75 Hz	0-75 Hz	1,000 Hz	50 pps	238 240	QEUD.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
ELECTRICAL CURRENT							
Intact Loop PCP-2-I	Intact loop pump 2.	0-1,000 amps	0-1,000 amps	---	500 pps	--	QEUD. Not presented.
ELECTRICAL VOLTAGE							
Intact Loop PCP-2-V	Intact loop pump 2.	0-600 V	0-600 V	---	500 pps	--	QEUD. Not presented.
DIFFERENTIAL PRESSURE							
Broken Loop PdE-BL-1	Broken loop hot leg from flange in front of SG simulator to pipe in front of reflood assist bypass system tee.	0-50 psid	-50-+50 psid	60 Hz	500 pps	80 282	Uninterpreted data. Filtered to 4 Hz.
Broken Loop PdE-BL-2	Broken loop cold leg from flange in front of spool piece to pipe in front of reflood assist bypass system tee.	0-1,500 psid	-50-+50 psid	60 Hz	500 pps	81 283	QEUD. Filtered to 4 Hz.
Broken Loop PdE-BL-3	Broken loop cold leg across break plane.	0-1,500 psid	-1,500 - +1,500 psid	1.2 Hz	50 pps	82 284	QEUD.
Broken Loop PdE-BL-4	Broken loop hot leg across break plane.	0-1,500 psid	-1,500 - +1,500 psid	1.2 Hz	50 pps	82	QEUD.
Broken Loop PdE-BL-5	Broken loop hot leg across pump simulator.	0-1,500 psid	-1,500 - +1,500 psid	1.2 Hz	1,000 Hz 50 pps	83	QEUD.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
DIFFERENTIAL PRESSURE							
Broken Loop PdE-BL-6	Broken loop hot leg across SG simulator outlet flange.	0-50 psid	-50-+50 psid	3.5 Hz	50 pps	84 285	QEUD.
Broken Loop PdE-BL-7	Broken loop hot leg across SG simulator.	0-100 psid	-50-+50 psid	3.5 Hz	1,000 Hz 50 pps	85	QEUD.
Broken Loop PdE-BL-8	Broken loop hot leg across SG simulator inlet flange.	0-50 psid	-50-+50 psid	3.5 Hz	50 pps	86	QEUD. Filtered to 4 Hz.
Reactor Vessel PdE-CS-1	RV between core simulator instrument stalk and downcomer 2, 24.5 in. from RV bottom.	+ 50 psid	-25-+25 psid	2.3 Hz	50 pps	87	QEUD. Filtered to 4 Hz.
Intact Loop PdE-PC-1	Intact loop cold leg across primary coolant pumps.	0-100 psid	-100-+100 psid	0.7 Hz	1,000 Hz 50 pps	88 286	QEUD.
Intact Loop PdE-PC-2	Intact loop across SG.	0-100 psid	-100-+100 psid	3.5 Hz	50 pps	89 287	QEUD prior to T ₀ . Uninter- preted data after T ₀ . Unex- plained long-term positive offset.
Intact Loop PdE-PC-3	Intact loop hot leg piping, RV to venturi.	+ 10 psid	+ 10 psid	2.3 Hz	50 pps	90 288	QEUD. Filtered to 4 Hz.
Intact Loop PdE-PC-4	Intact loop hot leg piping, venturi to SG.	+ 10 psid	+ 10 psid	2.3 Hz	50 pps	91	QEUD prior to T ₀ . Uninter- preted data after T ₀ . Unex- plained long-term negative offset. Filtered to 4 Hz.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data [a] System		
DIFFERENTIAL PRESSURE							
Intact Loop PdE-PC-5	Intact loop cold leg primary coolant pumps to RV nozzle.	± 10 psid	± 10 psid	2.3 Hz	50 pps	92	QEUD prior to T_0 . Uninterpreted data after T_0 . Unexplained long-term negative offset. Filtered to 4 Hz.
Intact Loop PdE-PC-7	Intact loop cold leg RV inlet to broken loop cold leg RV inlet.	± 10 psid	± 10 psid	2.3 Hz	50 pps	93	QEUD. Filtered to 4 Hz.
Reactor Vessel PdE-RV-1	Between downcomer stalk 1 and blowdown suppression tank.	0-1,500 psid	-1,500 - +1,500 psid	1.2 Hz	50 pps	94 289	QEUD. Differential pressure exceeds instrument range prior to T_0 .
Reactor Vessel PdE-RV-3	Intact loop cold leg inlet to bottom of downcomer.	± 10 psid	± 10 psid	2.3 Hz	50 pps	95	QEUD. Filtered to 4 Hz.
Reactor Vessel PdE-RV-4	Upper plenum to the RV outlet nozzle in the intact loop hot leg.	± 10 psid	± 10 psid	2.3 Hz	50 pps	96	QEUD prior to T_0 ; uninterpreted data after T_0 . Unexplained long-term positive offset.
Blowdown Suppres- sion Tank PdE-SV-9	Suppression tank across the vacuum breaker line.	0-200 in. H ₂ O	-100-+100 in.	5 Hz	50 pps	97	QEUD. Good data - not qualified.
Reactor Vessel PdE-2ST-2	Downcomer 2 between 209.4 in. and 24.5 in. above RV bottom.	0-25 psid	-25-+25 psid	60 Hz	50 pps	98	QEUD prior to T_0 ; uninterpreted data after T_0 . Unexplained long-term negative offset. Filtered to 4 Hz.
Intact Loop PdE-P139-30	Across RV just beyond intact loop inlet and outlet nozzles.	0-50 psid	0-50 psid	5 Hz	50 pps	99 290	QEUD.

TABLE VI (contd)

PARAMETER System Detector	Location	Range		Frequency Response			Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System	Data Fig. No.	
PRESSURE							
Broken Loop PE-BL-1	Broken loop cold leg at DT flange.	0-3,000 psig	0-3,000 psig	>500 Hz	1,000 Hz 50 pps	17 100 101	QEUD.
Broken Loop PE-BL-2	Broken loop hot leg at DT flange.	0-3,000 psig	0-3,000 psig	>500 Hz	1,000 Hz 50 pps	18 100 102 291	QEUD.
Broken Loop PE-BL-3	Broken loop hot leg just upstream of SG simulator.	0-3,000 psig	0-3,000 psig	>500 Hz	1,000 Hz 50 pps	18 102	QEUD.
Broken Loop PE-BL-4	Broken loop cold leg at inlet of spool piece.	0-3,000 psig	0-3,000 psig	>500 Hz	1,000 Hz 50 pps	17 101	QEUD.
Broken Loop PE-BL-6	Broken loop hot leg at outlet of SG simulator.	0-3,000 psig	0-3,000 psig	>500 Hz	1,000 Hz 50 pps	18 102	QEUD.
Broken Loop PE-BL-8	Broken loop cold leg at center of spool piece.	0-3,000 psig	0-3,000 psig	>500 Hz	1,000 Hz 50 pps	17 101	QEUD.
Reactor Vessel PE-CS-1A	Core simulator stalk above orifice plate (wide ranged-3,000 psi).	0-3,000 psig	0-3,000 psig	45 Hz	1,000 Hz 50 pps	103 108 112 292	QEUD.
Reactor Vessel PE-CS-1B	Core simulator stalk above orifice plate (narrow ranged-200 psi).	0-200 psig	0-200 psig	45 Hz	1,000 Hz 50 pps	104 188 293	QEUD. Pressure beyond instrument range until $T_0 + 31$ sec.
Reactor Vessel PE-CS-1FF	Core simulator stalk above orifice plate.	0-3,000 psig	0-2,500 psig	4,100 Hz	1,000 Hz 50 pps	20 111	QEUD to $T_0 + 10$ sec. Instrument temperature sensitive after $\sim T_0 + 10$ sec.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data [a] System		
PRESSURE							
Reactor Vessel PE-CS-2FF	Core simulator stalk above orifice plate.	0-3,000 psig	0-2,500 psig	4,100 Hz	1,000 Hz 50 pps	20 114 294 295	QEUD to T ₀ + 10 sec. Instru- ment temperature sensitive after ~ T ₀ + 10 sec.
Intact Loop PE-PC-1	Intact loop cold leg at DTT flange.	0-3,000 psig	0-3,000 psig	>500 Hz	1,000 Hz 50 pps	19 105 107	QEUD.
Intact Loop PE-PC-2	Intact loop hot leg at DTT flange.	0-3,000 psig	0-3,000 psig	>500 Hz	1,000 Hz 50 pps	19 105 107	QEUD.
Intact Loop PE-PC-3A	SG outlet at DTT flange, wide range (0-3,000 psi).	0-3,000 psig	0-3,000 psig	>500 Hz	1,000 Hz 50 pps	19 105	QEUD.
Intact Loop PE-PC-3B	SG outlet at DTT flange, narrow range (0-200 psi).	0-200 psig	0-200 psig	>500 Hz	50 pps	106 188	QEUD. Pressure beyond instru- ment range until T ₀ + 31 sec.
Intact Loop PE-PC-4	Intact loop pressurizer vapor space.	0-3,000 psig	0-3,000 psig	>500 Hz	1,000 Hz 50 pps	19 107	QEUD.
Blowdown Suppres- sion System PE-SV-01	Blowdown suppression tank bottom under downcomer 4 (north end), 180° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	1,000 Hz 500 pps	21 32 115 125	QEUD. Filtered to 60 Hz. . All BDST pressure instrument initial values are adjusted to 0 psig. Use PT-138-56 to obtain the initial pressure for all [PE-SV-] except PE-SV-30, -31, -45, and -46.
Blowdown Suppres- sion System PE-SV-2	Blowdown suppression tank across from downcomer 4 (north end), 112.5 from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	500 pps	23 32	QEUD.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data [a] System		
PRESSURE							
Blowdown Suppres- sion System PE-SV-3	Blowdown suppression tank across from downcomer 1 (south end), 157.5° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	1,000 Hz 500 pps	22 36 116 189 206	QEUJ. All BDST Pressure instru- ment initial values are adjusted to 0 psig. Use PT-P138-56 to obtain the initial pressure for all [PE-SV-] except PE-SV-30, -31, -45, and -46.
Blowdown Suppres- sion System PE-SV-4	Blowdown suppression tank across from downcomer 1 (south end), 112.5° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	500 pps	24 36	QEUJ.
Blowdown Suppres- sion System PE-SV-10	Blowdown suppression tank A-end (north end), 10° from tank horizontal ϕ (CW looking west) (vertex of angle at intersection of downcomer 4 ϕ and tank hori- zontal ϕ).	0-100 psig	0-100 psig	500 Hz	500 pps	31	QEUJ.
Blowdown Suppres- sion System PE-SV-11	Blowdown suppression tank B-end (south end), 10° from tank horizontal ϕ (CCW looking west) (vertex of angle at intersection of downcomer 1 ϕ and tank ϕ).	0-100 psig	0-100 psig	500 Hz	500 pps	30	QEUJ. Filtered to 60 Hz.
Blowdown Suppres- sion System PE-SV-12	Blowdown suppression tank A-end (north end), 45° from tank horizontal ϕ (CW looking west) (vertex of angle at intersection of downcomer 4 ϕ and tank hori- zontal ϕ).	0-100 psig	0-100 psig	500 Hz	500 pps	31	QEUJ.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data [a] System		
PRESSURE							
Blowdown Suppres- sion System PE-SV-13	Blowdown suppression tank B-end (south end), 45° from tank horizontal ϕ (CCW looking west) (vertex of angle at intersection of downcomer 1 ϕ and tank hori- zontal ϕ).	0-100 psig	0-100 psig	500 Hz	500 pps	30	QEUD. All BDST pressure instru- ment initial values are adjusted to 0 psig. Use PT-P138-56 to obtain the initial pressure for all [PE-SV-] except PE-SV-30, -31, -45, and -46.
Blowdown Suppres- sion System PE-SV-14	Blowdown suppression tank header above downcomer 4, 327° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	500 pps	29 117 127 296 297	QEUD.
Blowdown Suppres- sion System PE-SV-15	Blowdown suppression tank across from downcomer 4, 230° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	500 pps	28 33	QEUD.
Blowdown Suppres- sion System PE-SV-16	Blowdown suppression tank across from downcomer 1, 230° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	500 pps	28 36	QEUD.
Blowdown Suppres- sion System PE-SV-17	Blowdown suppression tank, 54-1/2 in. north of down- comer 3 ϕ , 327° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	500 pps	27 35 118 126	QEUD.
Blowdown Suppres- sion System PE-SV-18	Blowdown suppression tank header above downcomer 1.	0-100 psig	0-100 psig	500 Hz	500 pps	29 119 127	Uninterpreted data.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data System		
PRESSURE							
Blowdown Suppres- sion System PE-SV-22	Blowdown suppression tank bottom, 54-1/2 in. north of down- comer 3 c̄.	0-100 psig	0-100 psig	500 Hz	1,000 Hz 500 pps	21 34 120 125 189	QEUD. All BDST pressure instru- ment initial values are adjusted to 0 psig. Use PT-P138-56 to obtain the initial pressure for all [PE-SV-] except PE-SV-30, -31, -45, and -46.
Blowdown Suppres- sion System PE-SV-23	Blowdown suppression tank 54-1/2 in. north of down- comer 3 c̄, 112.5° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	500 pps	23 34	QEUD.
Blowdown Suppres- sion System PE-SV-24	Blowdown suppression tank bottom, 136.5 in. north of down- comer 3 c̄.	0-100 psig	0-100 psig	500 Hz	500 pps	21 31	QEUD.
Blowdown Suppres- sion System PE-SV-25	Blowdown suppression tank, 136.5 in. north of down- comer 3 c̄, 112.5° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	500 pps	23	QEUD.
Blowdown Suppres- sion System PE-SV-26	Blowdown suppression tank bottom, 54.3 in. south of down- comer 2 c̄.	0-100 psig	0-100 psig	500 Hz	1,000 Hz 500 pps	22 121 125 207	QEUD.
Blowdown Suppres- sion System PE-SV-27	Blowdown suppression tank bottom, 136.5 in. south of down- comer 2 c̄.	0-100 psig	0-100 psig	500 Hz	1,000 Hz 500 pps	22 30	QEUD.
Blowdown Suppres- sion System PE-SV-28	Blowdown suppression tank, 54.5 in. south of down- comer 2 c̄, 112.5° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	500 pps	24	QEUD.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
PRESSURE							
Blowdown Suppres- sion System PE-SV-29	Blowdown suppression tank, 136.5 in. south of down- comer 2, 112.5° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	500 pps	24	QEUD. All BEST pressure instru- ment initial values are adjusted to 0 psig. Use PT-P138-56 to obtain the initial pressure for all [PE-SV-] except PE-SV-30, -31, -45, and -46.
Blowdown Suppres- sion System PE-SV-30	Blowdown suppression tank header snubber (end).	0-3,000 psig	0-3,000 psig	100 Hz	500 pps	37	Good data - not qualified.
Blowdown Suppres- sion System PE-SV-31	Blowdown suppression tank header snubber (end).	0-3,000 psig	0-3,000 psig	100 Hz	500 pps	38	Good data - not qualified.
Blowdown Suppres- sion System PE-SV-43	Blowdown suppression tank bottom under downcomer 2.	0-100 psig	0-100 psig	500 Hz	1,000 Hz 500 pps	22 122 125 208	QEUD.
Blowdown Suppres- sion System PE-SV-44	Blowdown suppression tank bottom under downcomer 3.	0-100 psig	0-100 psig	500 Hz	1,000 Hz 500 pps	21 208	QEUD.
Blowdown Suppres- sion System PE-SV-45	Blowdown suppression tank header snubber (bend).	0-3,000 psig	0-3,000 psig	100 Hz	500 pps	39	Good data - not qualified.
Blowdown Suppres- sion System PE-SV-46	Blowdown suppression tank header snubber (bend).	0-3,000 psig	0-3,000 psig	100 Hz	500 pps	40	Good data - not qualified.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data [a] System		
PRESSURE							
Blowdown Suppres- sion System PE-SV-54	Blowdown vacuum relief system rupture disc standpipe.	0-100 psig	0-100 psig	500 Hz	500 pps	41	QEUD. All BDST pressure instru- ment initial values are adjusted to 0 psig. Use PT-P138-56 to obtain the initial pressure for all [PE-SV-] except PE-SV-30, -31, -45, and -46.
Blowdown Suppres- sion System PE-SV-55	Blowdown suppression tank top, 6 in. north of downcomer 4 C.	0-100 psig	0-100 psig	500 Hz	500 pps	27 33 123 126 190	QEUD.
Blowdown Suppres- sion System PE-SV-57	Blowdown suppression tank across from downcomer 4, 45° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	500 pps	26 33	QEUD.
Blowdown Suppres- sion System PE-SV-58	Blowdown suppression tank across from downcomer 4, 67.5° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	500 pps	25 32	QEUD.
Blowdown Suppres- sion System PE-SV-59	Blowdown suppression tank, 63.5 in. north of down- comer 3, 45° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	500 pps	26 35	QEUD.
Blowdown Suppres- sion System PE-SV-60	Blowdown suppression tank top above downcomer 1.	0-100 psig	0-100 psig	500 Hz	500 pps	27 36 124 126 190	QEUD.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
PRESSURE							
Blowdown Suppres- sion System PE-SV-61	Blowdown suppression tank across from downcomer 1 67.5° from top vertical (CW looking north).	0-100 psig	0-100 psig	500 Hz	500 pps	25 36	QEUD. All BDST pressure instru- ment initial values are adjusted to 0 psig. Use PT-P138-56 to obtain the initial pressure for all [PE-SV-] except PE-SV-30, -31, -45, and -46.
Blowdown Suppres- sion System PE-SV-70	Bellows between broken loop and blowdown suppression tank header.	0-500 psig	0-500 psig	30 Hz	500 pps	42	QEUD.
Reactor Vessel PE-1ST-1A	Downcomer stalk 1, 24.5 in. above RV bottom, wide range (0-3,000 psi).	0-3,000 psig	0-3,000 psig	30 Hz	1,000 Hz 50 pps	108 129	QEUD.
Reactor Vessel PE-1ST-1B	Downcomer stalk 1, 24.5 in. above RV bottom, narrow range (0-200 psi).	0-200 psig	0-200 psig	30 Hz	50 pps	109	QEUD. Pressure beyond instru- ment range until $\sim T_0 + 31$ sec.
Reactor Vessel PE-1ST-1FF	Downcomer stalk 1, 21.6 in. above RV bottom.	0-3,000 psig	0-2,500 psig	4,100 Hz	1,000 Hz 50 pps	111	QEUD (digital) to $T_0 + 10$ sec. Instrument temperature sensitive after $\sim T_0 + 10$ sec. Channel failed (analog).
Reactor Vessel PE-1ST-3A	Downcomer stalk 1, 209.4 in. above RV bottom, wide range (0-3,000 psi).	0-3,000 psig	0-3,000 psig	47 Hz	1,000 Hz 50 pps	108	QEUD.
Reactor Vessel PE-1ST-3B	Downcomer stalk 1, 209.4 in. above RV bottom, narrow range (0-200 psi).	0-200 psig	0-200 psig	47 Hz	50 pps	110	QEUD. Pressure beyond instrument range until $\sim T_0 + 30$ sec.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
PRESSURE							
Reactor Vessel PE-1ST-3FF	Downcomer stalk 1, 212.1 in. above RV bottom.	0-3,000 psig	0-2,500 psig	4,100 Hz	1,000 Hz 50 pps	20 111 113	QEJD to T ₀ + 10 sec. Instrument temperature sensitive after ~ T ₀ + 10 sec.
Reactor Vessel PE-2ST-1A	Downcomer stalk 2, 24.5 in. above RV bottom, wide range (0-3,000 psi).	0-3,000 psig	0-3,000 psig	30 Hz	1,000 Hz 50 pps	112	QEUD.
Reactor Vessel PE-2ST-1B	Downcomer stalk 2, 24.5 in. above RV bottom, narrow range (0-200 psi).	0-200 psig	0-200 psig	30 Hz	50 pps	--	Channel failed (digital).
Reactor Vessel PE-2ST-1FF	Downcomer stalk 2, 21.6 in. above RV bottom.	0-3,000 psig	0-2,500 psig	4,100 Hz	1,000 Hz 50 pps	--	Channel failed (digital and analog).
Reactor Vessel PE-2ST-3FF	Downcomer stalk 2, 212.1 in. above RV bottom.	0-3,000 psia	0-2,500 psig	4,100 Hz	1,000 Hz 50 pps	113 114	QEUD to T ₀ + 10 sec (digital). Instrument temperature sensi- tive after ~ T ₀ + 10 sec. Channel failed ⁰ (analog).
Emergency Core Cooling System PT-P120-43	Accumulator A, 27 in. above water outlet.	0-1,000 psig	0-1,000 psig	5 Hz	50 pps	--	QEUD. Not presented. Accumu- lator ACC-A injection failed to initiate.
Emergency Core Cooling System PT-P120-54	Emergency core cooling injection into lower plenum.	0-3,000 psig	0-3,000 psig	5 Hz	50 pps	128 129 191 298	Good data - not qualified.
Emergency Core Cooling System PT-P120-83	LPIS pump A discharge line.	0-1,000 psig	0-1,000 psig	5 Hz	50 pps	130 192 299	Good data - not qualified.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data [a] System		
PRESSURE							
Blowdown Suppres- sion System PT-P138-23	Blowdown header, 35 in. south of downcomer 1, 5° from bottom vertical (CCW looking south).	0-200 psig	0-200 psig	5 Hz	50 pps	131	QEUD. Initial pressure value adjusted to 0 psig. Use PT-P138-56 to obtain the initial pressure.
Blowdown Suppres- sion System PT-138-55	Blowdown suppression tank top, 48 in. north of downcomer 1.	0-100 psig	0-100 psig	5 Hz	1,000 Hz 50 pps	132 193 209 300	QEUD for initial conditions only.
Blowdown Suppres- sion System PT-P138-56	Blowdown suppression tank top, 49 in. north of downcomer 2.	0-100 psig	0-100 psig	5 Hz	1,000 Hz 50 pps	132 193 209	QEUD for initial conditions only.
Blowdown Suppres- sion Tank Spray System PT-P138-136	Spray pump BS-P-83 discharge pressure.	0-500 psig	0-500 psig	5 Hz	50 pps	194 302	QEUD.
Blowdown Suppres- sion Tank Spray System PT-P138-151	Spray system cool down heat exchanger outlet pressure.	0-500 psig	0-500 psig	5 Hz	50 pps	194	QEUD.
Broken Loop PT-P138-111	Broken loop cold leg QOBV inlet between isolation valve and QOBV.	0-2,000 psig	-2,000 - +2,000 psig	5 Hz	1,000 Hz 500 pps	15 301	QEUD analog data only.
Broken Loop PT-P138-112	Broken loop hot leg QOBV inlet between isolation valve and QOBV.	0-2,000 psig	-2,000 - +2,000 psig	5 Hz	1,000 Hz 500 pps	16	QEUD analog data only.
Intact Loop PT-P139-2	Intact loop hot leg at venturi on bottom.	0-3,000 psig	0-3,000 psig	5 Hz	1,000 Hz 50 pps	133	QEUD except during sub- cooled blowdown.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
PRESSURE							
Intact Loop PT-P139-3	Intact loop hot leg at verturi on left side when looking toward SG.	0-3,000 psig	0-3,000 psig	5 Hz	1,000 Hz 5C pps	133	QEUD for initial condi- tions. Uninterpreted data after T ₀ .
PUMP SPEED							
Intact Loop RPE-PC-1	Intact loop pump 1 speed.	0-4,500 rpm	0-10,000 rpm	3.5 Hz	50 pps	134	QEUD.
Intact Loop RPE-PC-2	Intact loop pump 2 speed.	0-4,500 rpm	0-10,000 rpm	3.5 Hz	50 pps	134 303	QEUD.
TEMPERATURE							
Broken Loop TE-BL-1	Broken loop cold leg at DTT flange.	32-2,300°F	0-600°F	1.8 Hz	50 pps	135 195	QEUD while instrument immersed. Data display hot wall effects after ~ T ₀ + 53 sec.
Broken Loop TE-BL-2	Broken loop hot leg at DTT flange.	32-2,300°F	0-600°F	1.8 Hz	50 pps	135 195 304	QEUD while instrument immersed. Data display hot wall effects after ~ T ₀ + 40 sec.
Broken Loop TE-BL-3	Reflood assist bypass system near CV-P138-71.	32-2,300°F	0-600°F	1.8 Hz	50 pps	135	QEUD.
Broken Loop TE-CL-1	Broken loop cold leg warm-up line.	32-2,300°F	0-600°F	1.8 Hz	50 pps	136	Good data - not qualified.
Reactor Vessel TE-CS-1	Core simulator in instrument stalk above orifice plate.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	137 196	QEUD while instrument immersed. Data display hot wall effects after ~ 102 sec.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
PUMP SPEED							
Broken Loop TE-HL-2	Broken loop hot leg warm-up line.	32-2,300°F	0-600°F	1.8 Hz	50 pps	136	Good data - not qualified.
TEMPERATURE							
Intact Loop TE-PC-1	Intact loop cold leg at DTT flange.	32-2,300°F	0-1,300°F	1.8 Hz	1,000 Hz 50 pps	138 197	QEUD while instrument immersed. Displays hot wall effects after ~ T ₀ + 30 sec.
Intact Loop TE-PC-2	Intact loop hot leg at DTT flange.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	138 197	QEUD while instrument immersed. Data display hot wall effects after ~ T ₀ + 135 sec.
Intact Loop TE-PC-3	Intact loop at SG outlet DTT flange.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	138 197	QEUD while instrument immersed. Displays hot wall effects after ~ T ₀ + 30 sec.
Emergency Core Cooling System TE-P120-41	Accumulator A temperature.	0-200°F	0-200°F	7 Hz	50 pps	--	QEUD. Not presented since accumulator ACC-A injection failed to initiate.
Blowdown Suppres- sion System TE-P138-22	Blowdown suppression tank bottom, 24.0 in. north of downcomer 1.	50-300°F	50-300°F	7 Hz	50 pps	139 305	Uninterpreted data. Thermo- couple located in a stagnant fluid zone.
Blowdown Suppres- sion System TE-P138-34	Blowdown suppression tank top, 51 in. south of downcomer 4.	50-400°F	50-400°F	1.8 Hz	50 pps	140 306	Good data - not qualified.
Broken Loop TE-P138-62	Broken loop cold leg QOBV inlet.	32-1400°F	50-650°F	1.8 Hz	50 pps	141 307	Good data - not qualified.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
TEMPERATURE							
Broken Loop TE-P138-63	Broken loop cold leg isolation valve inlet.	50-650°F	50-650°F	0.06 Hz	50 pps	141 308	Good data - not qualified.
Broken Loop TE-P138-65	Broken loop hot leg isolation valve inlet.	50-650°F	50-650°F	0.06 Hz	50 pps	142	Good data - not qualified.
Broken Loop TE-P138-66	Broken loop hot leg QOBV inlet.	32-1400°F	50-650°F	1.8 Hz	50 pps	142	Good data - not qualified.
Blowdown Suppres- sion Tank Spray System TE-P138-141	Temperature of spray in the 60 gpm header.	0-400°F	0-400°F	7 Hz	50 pps	199 309	Good data - not qualified.
Blowdown Suppres- sion Tank Spray System TE-P138-142	Temperature of spray at spray pump BS-P-83 discharge.	0-400°F	0-400°F	7 Hz	50 pps	198	Good data - not qualified.
Blowdown Suppres- sion Tank Spray System TE-P138-143	Temperature of spray in the 220 gpm header.	0-400°F	0-400°F	7 Hz	50 pps	199	Good data - not qualified.
Intact Loop TE-P139-19	Pressurizer vapor temperature, 34 in. above the heater rods.	600-700°F	600-700°F	7 Hz	50 pps	143	QEUJ for initial conditions only. Temperature below instrument range after 23 sec.
Intact Loop TE-P139-20	Pressurizer liquid temperature, 14 in. above heater rods.	50-700°F	50-700°F	7 Hz	50 pps	143 310	QEUJ for initial conditions only.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
TEMPERATURE							
Intact Loop TE-P139-29	Intact loop cold leg just upstream of DTT flange.	50-650°F	50-650°F	0.06 Hz	50 pps	144	QEUD for initial conditions only.
Intact Loop TE-P139-32	Intact loop hot leg in elbow near venturi.	50-650°F	50-650°F	0.06 Hz	1,000 Hz 50 pps	145	QEUD for initial conditions only.
Intact Loop TE-P139-33	Intact loop hot leg in elbow near venturi.	50-650°F	50-650°F	0.06 Hz	1,000 Hz 50 pps	145	QEUD for initial conditions only.
Intact Loop TE-SG-1	Intact loop cold leg SG outlet.	32-2,300°F	0-1,300°F	0.35 Hz	50 pps	146 311	QEUD for initial conditions only.
Intact Loop TE-SG-2	Intact loop hot leg SG inlet.	32-2,300°F	0-1,300°F	0.35 Hz	50 pps	146	QEUD for initial conditions only.
Secondary Coolant System TE-SG-3	SG secondary side.	-330 - +1,130°F	0-600°F	0.07 Hz	50 pps	146	QEUD for initial conditions only.
Blowdown Suppres- sion System TE-SV-1	Blowdown suppression tank, 12 in. north of downcomer 1, 21 in. east of tank C, 107.2 in. from tank bottom.	-150 - +700°F	0-400°F	1.8 Hz	1,000 Hz 50 pps	147 151 200 210	QEUD while instrument immersed. Designed to measure liquid temperature.
Blowdown Suppres- sion System TE-SV-2	Blowdown suppression tank, 12 in. north of downcomer 1, 21 in. east of tank C, 93.0 in. from tank bottom.	-150 - +700	0-400°F	1.8 Hz	1,000 Hz 50 pps	147 152 200 210	QEUD while instrument immersed. Designed to measure liquid temperature.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data [a] System		
TEMPERATURE							
Blowdown Suppres- sion System TE-SV-3	Blowdown suppression tank, 12 in. north of downcomer 1, 21 in. east of tank C, 74.7 in. from tank bottom.	-150 - +700°F	0-400°F	1.8 Hz	1,000 Hz 50 pps	147 153 200 210	QEUD while instrument immersed. Designed to measure liquid temperature.
Blowdown Suppres- sion System TE-SV-4	Blowdown suppression tank, 12 in. north of downcomer 1, 21 in. east of tank C, 57.2 in. from tank bottom.	-150 - +700°F	0-400°F	1.8 Hz	1,000 Hz 50 pps	148 154 201 211	QEUD while instrument immersed. Designed to measure liquid temperature.
Blowdown Suppres- sion System TE-SV-5	Blowdown suppression tank, 12 in. north of downcomer 1, 21 in. east of tank C, 39.0 in. from tank bottom.	-150 - +700°F	0-400°F	1.8 Hz	1,000 Hz 50 pps	148 155 201	QEUD for digital channel. Channel failed for analog.
Blowdown Suppres- sion System TE-SV-6	Blowdown suppression tank, 12 in. north of downcomer 1, 21 in. east of tank C, 14.7 in. from tank bottom.	-150 - +700°F	0-400°F	1.8 Hz	1,000 Hz 50 pps	148 156 201 211 312	QEUD.
Blowdown Suppres- sion System TE-SV-7	Blowdown suppression tank, 12 in. north of downcomer 3, 21 in. east of tank C, 107.2 in. from tank bottom.	-150 - +700°F	0-400°F	1.8 Hz	50 pps	149 151 202	QEUD while instrument immersed. Designed to measure liquid temperature.
Blowdown Suppres- sion System TE-SV-8	Blowdown suppression tank, 12 in. north of downcomer 3, 21 in. east of tank C, 93.0 in. from tank bottom.	-150 - +700°F	0-400°F	1.8 Hz	50 pps	149 152 202	QEUD while instrument immersed. Designed to measure liquid temperature.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data [a] System		
TEMPERATURE							
Blowdown Suppres- sion System TE-SV-9	Blowdown suppression tank, 12 in. north of downcomer 3, 21 in. east of tank C, 74.7 in. from tank bottom.	-150 - +700°F	0-400°F	1.8 Hz	1,000 Hz 50 pps	149 153 202	QEUD while instrument immersed. Designed to measure liquid temperature.
Blowdown Suppres- sion System TE-SV-10	Blowdown suppression tank, 12 in. north of downcomer 3, 21 in. east of tank C, 57.2 in. from tank bottom.	-150 - +700°F	0-400°F	1.8 Hz	1,000 Hz 50 pps	150 154 203 212	QEUD while instrument immersed. Designed to measure liquid temperature.
Blowdown Suppres- sion System TE-SV-11	Blowdown suppression tank, 12 in. north of downcomer 3, 21 in. east of tank C, 39.0 in. from tank bottom.	-150 - +700°F	0-400°F	1.8 Hz	50 pps	150 155 203	QEUD.
Blowdown Suppres- sion System TE-SV-12	Blowdown suppression tank, 12 in. north of downcomer 3, 21 in. east of tank C, 14.7 in. from tank bottom.	-150 - +700°F	0-400°F	1.8 Hz	50 pps	150 156 203	QEUD.
Reactor Vessel TE-1ST-1	Downcomer 1, 189.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	157 162	QEUD.
Reactor Vessel TE-1ST-2	Downcomer 1, 165.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	157 163	QEUD.
Reactor Vessel TE-1ST-3	Downcomer 1, 141.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	157 164	QEUD.
Reactor Vessel TE-1ST-4	Downcomer 1, 117.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	157 165	QEUD.

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data [a] System		
TEMPERATURE							
Reactor Vessel TE-1ST-5	Downcomer 1, 93.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	--	Channel failed (digital).
Reactor Vessel TE-1ST-6	Downcomer 1, 69.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	158 166	QEUD.
Reactor Vessel TE-1ST-7	Downcomer 1, 33.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	--	Channel failed (digital).
Reactor Vessel TE-1ST-8	Downcomer 1, 29.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	158 168	QEUD.
Reactor Vessel TE-1ST-9	Downcomer 1, 25.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	158 169	QEUD.
Reactor Vessel TE-1ST-10	Downcomer 1, 21.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	158 170	QEUD.
Reactor Vessel TE-1ST-11	Downcomer 1, 17.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	159 171	QEUD.
Reactor Vessel TE-1ST-12	Downcomer 1, 13.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	159 172	QEUD.
Reactor Vessel TE-1ST-13	Downcomer 1, 9.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	159 173	QEUD.
Reactor Vessel TE-1ST-14	Downcomer 1, 45.9 in. from RV bottom (inside of DTT).	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	159 174	QEUD.
Reactor Vessel TE-2ST-1	Downcomer 2, 189.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	1,000 Hz 50 pps	--	Channel failed (digital).

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
TEMPERATURE							
Reactor Vessel TE-2ST-2	Downcomer 2, 165.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	160 163	QEUD.
Reactor Vessel TE-2ST-3	Downcomer 2, 141.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	1,000 Hz 50 pps	--	Channel failed (digital).
Reactor Vessel TE-2ST-4	Downcomer 2, 117.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	160 165	QEUC.
Reactor Vessel TE-2ST-5	Downcomer 2, 93.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	1,000 Hz 50 pps	--	Channel failed (digital).
Reactor Vessel TE-2ST-6	Downcomer 2, 69.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	--	Channel failed (digital).
Reactor Vessel TE-2ST-7	Downcomer 2, 33.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	1,000 Hz 50 pps	160 167	QEUD.
Reactor Vessel TE-2ST-8	Downcomer 2, 29.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	--	Channel failed (digital).
Reactor Vessel TE-2ST-9	Downcomer 2, 25.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	1,000 Hz 50 pps	160 169	QEUD.
Reactor Vessel TE-2ST-10	Downcomer 2, 21.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	161 170	QEUD.
Reactor Vessel TE-2ST-11	Downcomer 2, 17.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	1,000 Hz 50 pps	--	Channel failed (digital)

TABLE VI (contd.)

PARAMETER System Detector	Location	Range		Frequency Response		Data Fig. No.	Measurement Comments
		Detector	Data Acquisition System	Detector	Data ^[a] System		
TEMPERATURE							
Reactor Vessel TE-2ST-12	Downcomer 2, 13.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	161 172	QEUD.
Reactor Vessel TE-2ST-13	Downcomer 2, 9.3 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	--	Channel failed (digital).
Reactor Vessel TE-2ST-14	Downcomer 2, 45.9 in. from RV bottom.	32-2,300°F	0-1,300°F	1.8 Hz	50 pps	161 174	QEUD.
Emergency Core Cooling System TT-P120-65	Lower plenum injection in 4-in. line upstream of injection point.	50-650°F	50-650°F	0.07 Hz	50 pps	175	Good data - not qualified.

[a] pps = points per second sample rate of the digital system.

TABLE VII
COMPUTED PARAMETERS FOR LOFT TEST L1-3

PARAMETER	Location	Detectors	Units	Calculation Method	Fig. No.	Remarks	
85	DENSITY, AVERAGE		1bm/ft ³	Density, Average $\bar{\rho} = K_1\rho_A + K_2\rho_B + K_3\rho_C$	45	The individual beam densities were filtered with a 4 Hz filter prior to being used in the averaging calculation.	
	Broken Loop Cold Leg		1bm/ft ³				
	DE-BL-1A (ρ_A)						
	DE-BL-1B (ρ_B)						
	DE-BL-1C (ρ_C)						
	Broken Loop Hot Leg		1bm/ft ³	where: ρ_A, ρ_B, ρ_C = average density along gamma densitometer beam lines A, B, and C.	45	Not presented. DE-PC-1A failed.	
	DE-BL-2A (ρ_A)						
	DE-BL-2B (ρ_B)						
	DE-BL-2C (ρ_C)						
	Intact Loop Cold Leg		1bm/ft ³	For stratified flow, $\bar{\rho} = 0.437\rho_A + 0.417\rho_B + 0.146\rho_C$ --			
	DE-PC-1A (ρ_A)			For other flow regimes, $\bar{\rho} = 0.345\rho_A + 0.401\rho_B + 0.254\rho_C$.			
	DE-PC-1B (ρ_B)						
	DE-PC-1C (ρ_C)						
	Intact Loop Hot Leg		1bm/ft ³		49		
DE-PC-2A (ρ_A)							
DE-PC-2B (ρ_B)							
DE-PC-2C (ρ_C)							
Intact Loop Steam Generator Outlet		1bm/ft ³		49			
DE-PC-3A (ρ_A)							
DE-PC-3B (ρ_B)							
DE-PC-3C (ρ_C)							

TABLE VII (contd.)

PARAMETER Location Detectors	Units	Calculation Method	Fig. No.	Remarks
FLOW REGIME AND DENSITY	lbm/ft ³	Homogeneous flow regimes are indicated by (H) when $\rho_A = \rho_B = \rho_C$.	213	Rapid fluctuation back and forth between flow regimes usually indicated slug flow. The logic table and mathematical model for this regime have not yet been developed.
Broken Loop Cold Leg DE-BL-1A (ρ_A) DE-BL-1B (ρ_B) DE-BL-1C (ρ_C)	lbm/ft ³	Annular flow regimes are indicated by (A) when $\rho_C > \rho_B$.		
Broken Loop Hot Leg DE-BL-2A (ρ_A) DE-BL-2B (ρ_B) DE-BL-2C (ρ_C)	lbm/ft ³	Stratified flow regimes are indicated by (S) when $\rho_A > \rho_C$.	214	Broken loop hot leg should be inverted annular after ~24 sec.
Intact Loop Cold Leg DE-PC-1A (ρ_A) DE-PC-1B (ρ_B) DE-PC-1C (ρ_C)	lbm/ft ³	Inverted annular flow regimes are indicated by (I) when $\rho_A < \rho_B$.	--	Intact loop cold leg not presented due to failure of DE-PC-1A.
Intact Loop Hot Leg DE-PC-2A (ρ_A) DE-PC-2B (ρ_B) DE-PC-2C (ρ_C)	lbm/ft ³	Unmodeled flow regimes are indicated by default (C) when none of the above conditions are satisfied.	215	Intact loop hot leg should be stratified after ~18 sec.
ENTHALPY	Btu/lbm	Enthalpy = $H = h_f + x_{flow} h_{fg}$	216	Data before T_0 is invalid due to the saturated fluid assumption.
Broken Loop Cold Leg PE-BL-1 (P: h_f, h_{fg})	psig; Btu/lbm			

TABLE VII (contd.)

PARAMETER Location Detectors	Units	Calculation Method	Fig. No.	Remarks
ENTHALPY (contd.)	Btu/lbm	where:		Data before T_0 is invalid due to saturated fluid assumption.
Broken Loop Hot Leg PE-BL-2 (P: h_f , h_{fg})	psig:Btu/lbm	h_f = saturated fluid enthalpy from ASME steam tables using the pressure at the measurement location	217	
Intact Loop Cold Leg PE-PC-1 (P: h_f , h_{fg})	psig:Btu/lbm		218	
Intact Loop Hot Leg PE-PC-2 (P: h_f , h_{fg})	psig:Btu/lbm	h_{fg} = latent heat of vaporization from the ASME steam tables using the pressure at the measurement location	219	
Intact Loop, Steam Generator Outlet PE-PC-3A (P: h_f , h_{fg})	psig:Btu/lbm		220	
		x_{flow} = flow quality (see "QUALITY, FLOW" entry in this table).		
MASS FLOW RATE/SYSTEM VOLUME	lbm/ft ³ -sec	Mass flow rate/vol _{sys} Type A =		The output from the drag discs, the turbine flowmeters, and the gamma densitometers were filtered to 4 Hz prior to performing calculations. The measured point values for the fluid velocity and momentum flux from the turbine flowmeters and the drag discs, respectively, were converted to average values prior to performing the calculations.
Broken Loop Cold Leg Type A: FE-BL-1 (v) ME-BL-1 (ρv^2)	ft/sec lbm/ft-sec ²	$m_A = \frac{\rho v^2 A}{v \times vol_{sys}}$	221	
Type B: FE-BL-1 (v) PE-BL-1 (P: ρ_ℓ)	ft/sec psig:lbm/ft ³	Mass flow rate/vol _{sys} Type B = $m_B = \frac{[(1 - \langle \alpha \rangle)/(1 - x)] \rho_\ell VA}{vol_{sys}}$	--	

TABLE VII (contd.)

PARAMETER Location Detectors	Units	Calculation Method	Fig. No.	Remarks
MASS FLOW RATE/SYSTEM VOLUME (contd.)	lbm/ft ³ -sec	Mass flow rate/vol _{sys} Type C =		Broken loop cold leg Type B mass flow rate/system volume not presented.
Type C: ME-BL-1 (ρv^2) DE-BL-1 (ρ)	lbm/ft ³ sec ² lbm/ft ³	$m_C = \frac{[\bar{\rho}(\rho v^2)]^{1/2} A}{\text{vol}_{\text{sys}}}$	222	
Type D: FE-BL-1 (v) DE-BL-1 (ρ)	ft/sec ³ lbm/ft ³	Mass flow rate/vol _{sys} Type D = $m_D = \frac{\bar{\rho} v A}{\text{vol}_{\text{sys}}}$	223	
Type E: PDE-BL-2 (ΔP) DE-BL-1 (ρ)	psid lbm/ft ³		224	
Broken Loop Hot Leg Type A: FE-BL-2 (v) ME-BL-2 (ρv^2)	ft/sec lbm/ft-sec ²	Mass flow rate/vol _{sys} Type E = $m_E = \frac{\bar{\rho} [(K\Delta P)/\bar{\rho}]^{1/2} A}{\text{vol}_{\text{sys}}}$	--	Not presented.
Type B: FE-BL-2 (v) PE-BL-2 ($P: \rho_\ell$)	ft/sec psig:lbm/ft ³	where: $\bar{\rho}$ = average fluid density at measurement location	--	Not presented.
Type C: ME-BL-2 (ρv^2) DE-BL-2 (ρ)	lbm/ft ³ sec ² lbm/ft ³	ρ_ℓ = saturated liquid density from ASME steam tables	225	

TABLE VII (contd.)

PARAMETER Location Detectors	Units	Calculation Method	Fig. No.	Remarks
MASS FLOW RATE/SYSTEM VOLUME (contd.)	lbm/ft ³ -sec	ρv^2 = momentum flux [ME...]		
Type D: FE-BL-2 (v) DE-BL-2 (ρ)	ft/sec ₃ lbm/ft ³	$\langle \alpha \rangle$ = void fraction (see "VOID FRACTION" entry in this table)	226	
Type E: PDE-BL-1 (ΔP) DE-BL-2 (ρ)	psid lbm/ft ³		227	
Intact Loop Cold Leg Type A: FE-PC-1 (v) ₂ ME-PC-1 (ρv^2)	ft/sec lbm/ft-sec ²	A = flow area for the measurement location	228	
Type B: FE-PC-1 (v) PE-PC-1 ($P: \rho_L$)	ft/sec psig:lbm/ft ³	$A_{\text{pipes}} = 0.6485 \text{ ft}^2$ in the plane of the DTTs	229	
Type C: ME-PC-1 (ρv^2) DE-PC-1 (ρ)	lbm/ft ³ -sec ² lbm/ft ³	K = conversion constant	230	Type C and Type D mass flow rate per system volume were calculated using DE-PC-1B since DE-PC-1A failed and average density could not be calculated.
Type D: FE-PC-1 (v) DE-PC-1 (ρ)	ft/sec ₃ lbm/ft ³	v = velocity of fluid at measurement location [FE.....]	231	
Intact Loop Hot Leg Type A: FE-PC-2 (v) ₂ ME-PC-2 (ρv^2)	ft/sec lbm/ft-sec ²	x = flow quality (see "QUALITY, FLOW" this table).	--	Not presented; ME-PC-2 failed.

TABLE VII (contd.)

PARAMETER Location Detectors	Units	Calculation Method	Fig. No.	Remarks
MASS FLOW RATE/SYSTEM VOLUME (contd.)	lbm/ft ³ -sec			
Type B: FE-PC-2 ($\dot{v}$) PE-PC-2 ($P: \rho_L$)	ft/sec psig: lbm/ft ³		232	
Type C: ME-PC-2 ($\rho \dot{v}^2$) DE-PC-2 (ρ)	lbm/ft ³ sec ² lbm/ft		--	Not presented; ME-PC-2 failed.
Type D: FE-PC-2 ($\dot{v}$) DE-PC-2 (ρ)	ft/sec ³ lbm/ft		233	
Intact Loop, Steam Generator Outlet				
Type A: FE-PC-3 ($\dot{v}$) ₂ ME-PC-3 ($\rho \dot{v}^2$)	ft/sec lbm/ft-sec ²		--	Not presented.
Type B: FE-PC-3 ($\dot{v}$) PE-PC-3A ($P: \rho_L$)	ft/sec psig: lbm/ft ³		234	
Type C: ME-PC-3 ($\rho \dot{v}^2$) DE-PC-3 (ρ)	lbm/ft ³ sec ² lbm/ft		235	
Type D: FE-PC-3 ($\dot{v}$) DE-PC-3 (ρ)	ft/sec ³ lbm/ft		236	

TABLE VII (contd.)

PARAMETER Location Detectors	Units	Calculation Method	Fig. No.	Remarks
MASS FLOW RATE/SYSTEM VOLUME (contd.)	lbm/ft ³ -sec			
Pressurizer PE-PC-4 (P: ρ_g) LT-P139-6 (ΔP)	psig:lbm/ft ³	Mass flow rate/vol _{sys} pres- surizer = $\dot{m} = -0.067269 \frac{dL}{dT}$	--	Not presented.
PE-PC-4 (P: ρ_g) LT-P139-8 (ΔP)	psig:lbm/ft ³ psid	- 0.011677 $\frac{d\rho_g}{dt}$ - 0.011026 $\frac{d\rho_L}{dt}$	237	
where: ρ_g = density of saturated steam corresponding to the pressure from PE-PC-4 ρ_L = density of saturated liquid remaining in pressurizer corresponding to the pressure from PE-PC-4 L = level in pressurizer in inches.				
PUMP SPEED, ELECTRICAL	rpm			
Intact Loop, Primary Coolant Pump 1 PCP-1-F	Hz	Pump speed, electrical = $N_G = 60$ (PSMG frequency).	238 239	Pump 1 PSMG set field breakers were opened at ~24 sec.

TABLE VII (contd.)

PARAMETER Location Detectors	Units	Calculation Method	Fig. No.	Remarks
PUMP SPEED, ELECTRICAL (contd.)	rpm			
Primary Coolant Pump 2 PCP-2-F	Hz		238 240	Pump 2 PSMG set field breakers were opened at ~24 sec.
PUMP MOTOR SLIP	None			
Intact Loop, Primary Coolant Pump 1 RPE-PC-1	rpm	Pump motor slip =	241	Pumps 1 and 2 PSMG set field breakers were opened at ~24 sec.
Primary Coolant Pump 2 RPE-PC-2	rpm	$S_{\text{pump}} = \frac{N_G - (\text{RPE-PC-1, -2})}{N_G}$	241	
		where: N_G = pump speed, electrical (see "PUMP SPEED, ELEC- TRICAL" above).		
PUMP ELECTRICAL HORSE- POWER	hp	Pump electrical horsepower =		
Intact Loop, Primary Coolant Pump 1 PCP-1-I (I_1) PCP-1-V (V_1)	amp V	$P_{\text{ehp}_1} = 0.00132 (V_1 I_1)$	242	
Primary Coolant Pump 2 PCP-2-I (I_2) PCP-2-V (V_2)	amp V	$P_{\text{ehp}_2} = 0.00132 (V_2 I_2)$	242	

TABLE VII (contd.)

PARAMETER Location Detectors	Units	Calculation Method	Fig. No.	Remarks
PUMP ELECTRICAL HORSE- POWER, TOTAL	hp			
Intact Loop, Primary Coolant Pumps 1 and 2		Pump electrical horsepower =	243	
PCP-1-I (I_1)	amp	$P_{ehp_{tot}} = 0.00132(V_1 I_1 + V_2 I_2)$		
PCP-1-V (V_1)	V			
PCP-2-I (I_2)	amp	where:		
PCP-2-V (V_2)	V	I_1, I_2 are the instantaneous current values as defined in Column 1		
		V_1, V_2 are the instantaneous voltage values as defined in Column 1.		
PUMP WATER HORSEPOWER	hp	Pump water horsepower =		
Intact Loop, Primary Coolant Pumps 1 and 2		$P_{whp} = A_p V \Delta P (0.2618)$	244	
PdE-PC-1 (ΔP)	psid	where:		
FE-PC-3(V)	ft/sec	$A_p = 0.6485 \text{ ft}^2$		

TABLE VII (contd.)

PARAMETER Location Detectors	Units	Calculation Method	Fig. No.	Remarks
PUMP EFFICIENCY	None	Primary coolant pump efficiency = $\eta = P_{whp} / P_{ehp_{tot}}$ where: P_{whp} = pump water horsepower (see "PUMP WATER HORSEPOWER" in this table). $P_{ehp_{tot}}$ = pump electrical horsepower total (see "PUMP ELECTRICAL HORSEPOWER" in this table).	245	
Intact Loop, Primary Coolant Pumps 1 and 2				
PRESSURE, CLOSURE	psid	Pressure, closure =		
Broken Loop Cold Leg				Not presented.
PDE-RV-1 (P_1)	psid	$P_1 = \sum_{i=2}^n P_i$		
PDE-BL-2 (P_2)	psid			
PDE-BL-3 (P_3)	psid			

TABLE VII (contd.)

PARAMETER Location Detectors	Units	Calculation Method	Fig. No.	Remarks
PRESSURE, CLOSURE (contd.)				
Broken Loop Hot Leg		where:		Not presented.
PDE-RV-1 (P_1)	psid	P_1 and P_i are the		
PDE-BL-1 (P_1)	psid	differential pressure		
PDE-BL-4 (P_2)	psid	readings for each calcu-		
PDE-BL-5 (P_3)	psid	lation as assigned in		
PDE-BL-6 (P_4)	psid	Column 1.		
PDE-BL-7 (P_5)	psid			
PDE-BL-8 (P_6)	psid			
Intact Loop			246	
PDE-PC-1 (P_1)	psid			
PDE-PC-2 (P_1)	psid			
PDE-PC-3 (P_2)	psid			
PDE-PC-4 (P_3)	psid			
PDE-PC-5 (P_4)	psid			
PDT-P139-30 (P_5)	psid			
QUALITY, STATIC	None	Quality static =		
Broken Loop Cold Leg		$x_{\text{static}} = 1 - [(1-\langle\alpha\rangle)(\rho_l/\bar{\rho})]$	247	
PE-BL-1 ($P: \rho_l, \rho_g$)	psig:lbm/ft ³	where:		
Broken Loop Hot Leg		$\langle\alpha\rangle$ = void fraction (see		
PE-BL-2 ($P: \rho_l, \rho_g$)	psig:lbm/ft ³	"VOID FRACTION" entry).	248	

TABLE VII (contd.)

PARAMETER Location Detectors	Units	Calculation Method	Fig. No.	Remarks
QUALITY, STATIC (contd.)	None	ρ_l = saturated liquid density from the ASME steam tables using the pressure at the measurement location		Static quality data are restricted between values of 0.0 and 1.0 in the computer program.
Intact Loop Cold Leg PE-PC-1 (P: ρ_l, ρ_g)	psig:lbm/ft ³		249	
Intact Loop Hot Leg PE-PC-2 (P: ρ_l, ρ_g)	psig:lbm/ft ³	$\bar{\rho}$ = average density from gamma densitometer.	250	Static quality in the intact loop cold leg was calculated using DE-PC-1B since DE-PC-1A failed and average density could not be calculated.
Intact Loop, Steam Generator Outlet PE-PC-3A (P: ρ_l, ρ_g)	psig:lbm/ft ³		251	
QUALITY, FLOW (Lockhart and Martinelli Correlation)	None	Quality, flow = $x_{flow} = \left(\frac{1}{1+N} \right)$		Flow quality data are restricted between values of 0.0 and 1.0 in the computer program.
Broken Loop Cold Leg PE-BL-1 (P: ρ_l, ρ_g) TE-BL-1 (T: μ_l, μ_g)	psig:lbm/ft ³ °F:lbm/ft-hr	$N = (1/A)^{1/P} [(1-\langle\alpha\rangle)/\langle\alpha\rangle]^{1/P}$	252	
Broken Loop Hot Leg PE-BL-2 (P: ρ_l, ρ_g) TE-BL-2 (T: μ_l, μ_g)	psig:lbm/ft ³ °F:lbm/ft-hr	$(\rho_g/\rho_l)^{-Q/P} (\mu_l/\mu_g)^{-R/P}$	253	
Intact Loop Cold Leg PE-PC-1 (P: ρ_l, ρ_g) TE-PC-1 (T: μ_l, μ_g)	psig:lbm/ft ³ °F:lbm/ft-hr	where: $\langle\alpha\rangle$ = void fraction (see "VOID FRACTION" entry)	254	Flow quality was calculated using DE-PC-1B since DE-PC-1A failed and average density could not be calculated.
Intact Loop Hot Leg PE-PC-2 (P: ρ_l, ρ_g) TE-PC-2 (T: μ_l, μ_g)	psig:lbm/ft ³ °F:lbm/ft-hr	ρ_l = saturated liquid density from the ASME steam tables using the pressure at the measurement location	255	

TABLE VII (contd.)

PARAMETER Location Detectors	Units	Calculation Method	Fig. No.	Remarks
QUALITY, FLOW (Lockhart and Martinelli Correlation) (contd.)	None	ρ_g = saturated vapor density from the ASME steam tables using the temperature at the measurement location	256	
Intact Loop, Steam Generator Outlet PE-PC-3A (P: ρ_ℓ , ρ_g) TE-PC-3 (T: μ_ℓ , μ_g)	psig: lbm/ft ³ °F: lbm/ft-hr	μ_ℓ = saturated liquid viscosity from temperature μ_g = saturated vapor viscosity from temperature.		
Lockhart and Martinelli Coefficients:				
A = 0.28 P = 0.64 Q = 0.36 R = 0.07				
TEMPERATURE, SATURATION	°F	Saturation temperatures are taken from ASME steam tables for measured pressures. Temperatures are measured by the detectors in parentheses.	257	Saturation temperature data are not valid prior to T _o . TE-BL-1 displays hot wall effects after ~53 sec.
Broken Loop Cold Leg PE-BL-1 (TE-BL-1)	psig °F			
Broken Loop Hot Leg PE-BL-2 (TE-BL-2)	psig °F		258	TE-BL-2 displays hot wall effects after ~40 sec.

TABLE VII (contd.)

PARAMETER Location Detectors	Units	Calculation Method	Fig. No.	Remarks
TEMPERATURE, SATURATION (contd.)	°F			
Intact Loop Cold Leg PE-PC-1 (TE-PC-1)	psig °F		259	TE-PC-1 displays hot wall effects after ~30 sec.
Intact Loop Hot Leg PE-PC-2 (TE-PC-2)	psig °F		260	
Intact Loop, Steam Generator Outlet PE-PC-3A (TE-PC-3)	psig °F		261	TE-PC-3 displays hot wall effects after ~30 sec.
Reactor Vessel, Core Simulator PE-CS-1A (TE-CS-1)	psig °F		262	TE-CS-1 has ~4°F high offset at T ₀ .
Downcomer Instrument Stalk 1 PE-1ST-1A (TE-1ST-9)	psig °F		263	
Downcomer Instrument Stalk 2 PE-2ST-1A (TE-2ST-9)	psig °F		264	

TABLE VII (contd.)

PARAMETER Location Detectors	Units	Calculation Method	Fig. No.	Remarks
VOID FRACTION	None	Void fraction = $\frac{\rho_l - \bar{\rho}}{\rho_l - \rho_g}$		
Broken Loop Cold Leg PE-BL-1 (P: ρ_l, ρ_g) DE-BL-1 ($\bar{\rho}$)	psig lbm/ft ³	where:	255	Void fraction data are restricted between the values of 0.0 and 1.0 in the computer program.
Broken Loop Hot Leg PE-BL-2 (P: ρ_l, ρ_g) DE-BL-2 ($\bar{\rho}$)	psig lbm/ft ³	ρ_l = saturated liquid density from the ASME steam tables using the pressure at the measurement location	256	Void fraction for the intact loop cold leg was calculated using chordal density measured by DE-PC-1B due to the failure of DE-PC-1A. All subsequent calculations using void fraction at this location were also computed using DE-PC-13.
Intact Loop Cold Leg PE-PC-1 (P: ρ_l, ρ_g) DE-PC-1 ($\bar{\rho}$)	psig lbm/ft ³	ρ_g = saturated vapor density from the ASME steam tables using the pressure at the measurement location	267	
Intact Loop Hot Leg PE-PC-2 (P: ρ_l, ρ_g) DE-PC-2 ($\bar{\rho}$)	psig lbm/ft ³		268	
Intact Loop, Steam Generator Outlet PE-PC-3A (P: ρ_l, ρ_g) DE-PC-3 ($\bar{\rho}$)	psig lbm/ft ³	$\bar{\rho}$ = average density from gamma densitometer.	269	

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

1. TEST L1-3 MEASURED PARAMETERS --

SHORT-TERM PLOTS (1 SECOND OR LESS)

This section of presented data consists of Figures 14 through 42.

Fig. 14 Valve opening (%) for broken loop QOBV, cold leg valve (CV-P138-1), and hot leg valve (CV-P138-15).

Fig. 15 Valve opening (%) for broken loop cold leg QOBV (CV-P138-1) and cold leg QOBV inlet pressure (PT-P138-111).

Fig. 16 Valve opening (%) for broken loop hot leg QOBV (CV-P138-15) and hot leg QOBV inlet pressure (PT-P138-112).

Fig. 17 Pressure in broken loop cold leg (PE-BL-1, -4, and -8) (filtered to 250 Hz).

Fig. 18 Pressure in broken loop hot leg (PE-BL-2, -3, and -6) (filtered to 250 Hz).

Fig. 19 Pressure in intact loop cold leg, hot leg, steam generator outlet, and pressurizer (PE-PC-1, -2, -3A, and -4) (filtered to 250 Hz).

Fig. 20 Pressure in reactor vessel core simulator instrument stalk and downcomer instrument stalk 1 (PE-CS-1FF and -2FF and PE-1ST-3FF) (filtered to 250 Hz).

Fig. 21 Pressure in blowdown suppression tank bottom, 180° from top vertical reference (PE-SV-1, -22, -24, and -44).

Fig. 22 Pressure in blowdown suppression tank bottom, 180° from top vertical reference (PE-SV-3, -26, -27, and -43).

Fig. 23 Pressure in blowdown suppression tank submerged, 112.5° from top vertical reference (PE-SV-2, -23, and -25).

Fig. 24 Pressure in blowdown suppression tank submerged, 112.5° from top vertical reference (PE-SV-4, -28, and -29).

Fig. 25 Pressure in blowdown suppression tank vapor space, 67.5° from top vertical reference (PE-SV-58 and -61).

Fig. 26 Pressure in blowdown suppression tank vapor space, 45° from top vertical reference (PE-SV-57 and -59).

Fig. 27 Pressure in blowdown suppression tank top, 0° from top vertical reference (PE-SV-17, -55, and -60).

Fig. 28 Pressure in blowdown suppression tank submerged, 230° from top vertical reference (PE-SV-15 and -16).

Fig. 29 Pressure in blowdown suppression tank header (PE-SV-14 and -18).

Fig. 30 Pressure in blowdown suppression tank B-end submerged along vertical centerline (PE-SV-11, -13, and -27).

Fig. 31 Pressure in blowdown suppression tank A-end submerged along vertical centerline (PE-SV-10, -12, and -24).

Fig. 32 Pressure in blowdown suppression tank in a transverse plane, 316.5 in. from B-end reference (PE-SV-1, -2, and -58).

Fig. 33 Pressure in blowdown suppression tank in a transverse plane, 316.5 in. from B-end reference (PE-SV-15, -55, and -57).

Fig. 34 Pressure in blowdown suppression tank in a transverse plane, 263 in. from B-end reference (PE-SV-22 and -23).

Fig. 35 Pressure in blowdown suppression tank in a transverse plane, 263 in. from B-end reference (PE-SV-17 and -59).

Fig. 36 Pressure in blowdown suppression tank in a transverse plane, 28.5 in. from B-end reference (PE-SV-3, -4, -16, -60, and -61).

Fig. 37 Pressure in blowdown suppression tank header snubber (end) (PE-SV-30).

Fig. 38. Pressure in blowdown suppression tank header snubber (end) (PE-SV-31).

Fig. 39. Pressure in blowdown suppression tank header snubber (bend) (PE-SV-45).

Fig. 40 Pressure in blowdown suppression tank header snubber (bend) (PE-SV-46).

Fig. 41 Pressure in blowdown vacuum relief system rupture disc standpipe (PE-SV-54).

Fig. 42 Pressure in bellows between broken loop and blowdown suppression tank header (PE-SV-70).

2. TEST L1-3 MEASURED PARAMETERS --

MEDIUM - TERM PLOTS (-10 TO 70 SECONDS)

This section of presented data consists of Figures 43 through 175.

Fig. 43 Density in broken loop cold leg, chordal density (DE-BL-1A, -1B, and -1C) (filtered to 4 Hz).

Fig. 44 Density in broken loop hot leg, chordal density (DE-BL-2A, -2B, and -2C) (filtered to 4 Hz).

Fig. 45 Density in broken loop, average fluid densities (DE-BL-1 and -2) (filtered to 4 Hz).

Fig. 46 Density in intact loop cold leg, chordal density (DE-PC-1B and -1C) (filtered to 4 Hz).

Fig. 47 Density in intact loop hot leg, chordal density (DE-PC-2A, -2B, and -2C) (filtered to 4 Hz).

Fig. 48 Density in intact loop at steam generator outlet, chordal density (DE-PC-3A, -3B, and -3C) (filtered to 4 Hz).

Fig. 49 Density in intact loop, average fluid densities (DE-PC-2 and -3) (filtered to 4 Hz).

Fig. 50 Average fluid velocity in broken loop cold leg at DTT flange (FE-BL-1) (filtered to 4 Hz).

Fig. 51 Average fluid velocity in broken loop hot leg at DTT flange (FE-BL-2) (filtered to 4 Hz).

Fig. 52 Average fluid velocity in broken loop cold and hot legs at DTT flanges (FE-BL-1 and -2) (filtered to 4 Hz).

Fig. 53 Average fluid velocity in reactor vessel core simulator instrument stalk (FE-CS-1) (filtered to 4 Hz).

Fig. 54 Average fluid velocity in intact loop cold leg at DTT flange (FE-PC-1) (filtered to 4 Hz).

Fig. 55 Average fluid velocity in intact loop hot leg at DTT flange (FE-PC-2) (filtered to 4 Hz).

Fig. 56 Average fluid velocity in intact loop steam generator outlet at DTT flange (FE-PC-3) (filtered to 4 Hz).

Fig. 57 Average fluid velocity in intact loop cold leg, hot leg, and steam generator outlet at DTT flanges (FE-PC-1, -2, and -3) (filtered to 4 Hz).

Fig. 58 Average fluid velocity in reactor vessel downcomer stalk 1, 47.1 in. above reactor vessel bottom (FE-1ST-1) (filtered to 4 Hz).

Fig. 59 Average fluid velocity in reactor vessel downcomer stalk 2, 47.1 in. above reactor vessel bottom (FE-2ST-1) (filtered to 4 Hz).

Fig. 60 Average fluid velocity in reactor vessel downcomer stalks 1 and 2, 47.1 in. above reactor vessel bottom (FE-1ST-1 and FE-2ST-1) (filtered to 4 Hz).

Fig. 61 Flow rate in ECCS LPIS pump A discharge (FT-P120-85).

Fig. 62 Flow rate in ECCS HPIS pump A discharge (FT-P128-104).

Fig. 63 Flow rate in intact loop hot leg venturi (FT-P139-27-1 and -27-3).

Fig. 64 Liquid level in reactor vessel downcomer instrument stalk 1, bubble plot (LE-1ST-1 and -2).

Fig. 65 Liquid level in reactor vessel downcomer instrument stalk 2, bubble plot (LE-2ST-1 and -2).

Fig. 66 Liquid level in blowdown suppression tank (LT-P138-33 and -58).

Fig. 67 Liquid level in pressurizer, southeast side (LT-P139-6).

Fig. 68 Liquid level in pressurizer, southwest side (LT-P139-7).

Fig. 69 Liquid level in pressurizer, north side (LT-P139-8).

Fig. 70 Liquid level in steam generator secondary coolant system (LT-P4-8B).

Fig. 71 Average momentum flux in broken loop cold leg at DTT flange (ME-BL-1) (filtered to 4 Hz).

Fig. 72 Average momentum flux in broken loop hot leg at DTT flange (ME-BL-2) (filtered to 4 Hz).

Fig. 73 Average momentum flux in broken loop cold and hot legs at DTT flanges (ME-BL-1 and -2) (filtered to 4 Hz).

Fig. 74 Average momentum flux in reactor vessel core simulator stalk (ME-CS-1) (filtered to 4 Hz).

Fig. 75 Average momentum flux in intact loop cold leg at DTT flange (ME-PC-1) (filtered to 4 Hz).

Fig. 76 Average momentum flux in intact loop steam generator outlet at DTT flange (ME-PC-3) (filtered to 4 Hz).

Fig. 77 Average momentum flux in intact loop cold leg and steam generator outlet at DTT flanges (ME-PC-1 and -3) (filtered to 4 Hz).

Fig. 78 Average momentum flux in reactor vessel downcomer stalk 1, 44.5 in. above reactor vessel bottom (ME-1ST-1) (filtered to 4 Hz).

Fig. 79 Average momentum flux in reactor vessel downcomer stalk 2, 44.5 in. above reactor vessel bottom (ME-2ST-1) (filtered to 4 Hz).

Fig. 80 Differential pressure in broken loop hot leg across 14-to-5-in. contraction (PdE-BL-1) (filtered to 4Hz).

Fig. 81 Differential pressure in broken loop cold leg across 14-to-5-in. contraction (PdE-BL-2) (filtered to 4 Hz).

Fig. 82 Differential pressure in broken loop across break planes (PdE-BL-3 and -4).

Fig. 83 Differential pressure in broken loop hot leg across pump simulator (PdE-BL-5).

Fig. 84 Differential pressure in broken loop hot leg across steam generator simulator outlet flange (PdE-BL-6).

Fig. 85 Differential pressure in broken loop hot leg across the steam generator simulator (PdE-BL-7).

Fig. 86 Differential pressure in broken loop hot leg across steam generator simulator inlet flange (PdE-BL-8) (filtered to 4 Hz).

Fig. 87 Differential pressure in reactor vessel core simulator to downcomer instrument stalk 2, 24.5 in. from reactor vessel bottom (PdE-CS-1) (filtered to 4 Hz).

Fig. 88 Differential pressure in intact loop cold leg across primary coolant pumps 1 and 2 (PdE-PC-1).

Fig. 89 Differential pressure in intact loop across the steam generator (PdE-PC-2).

Fig. 90 Differential pressure in intact loop hot leg piping from reactor vessel outlet to the flow venturi (PdE-PC-3) (filtered to 4 Hz).

Fig. 91 Differential pressure in intact loop hot leg piping from flow venturi to steam generator inlet (PdE-PC-4) (filtered to 4 Hz).

Fig. 92 Differential pressure in intact loop cold leg primary coolant pump discharge to reactor vessel inlet nozzle (PdE-PC-5) (filtered to 4 Hz).

Fig. 93 Differential pressure in intact loop cold leg reactor vessel inlet to broken loop cold leg reactor vessel inlet (PdE-PC-7) (filtered to 4 Hz).

Fig. 94 Differential pressure in reactor vessel downcomer stalk 1 to the blowdown suppression tank (PdE-RV-1).

Fig. 95 Differential pressure in reactor vessel intact loop cold leg inlet to downcomer stalk 2 (PdE-RV-3) (filtered to 4 Hz).

Fig. 96 Differential pressure in reactor vessel upper plenum to the intact loop hot leg reactor vessel outlet nozzle (PdE-RV-4).

Fig. 97 Differential pressure in blowdown suppression tank across vacuum breaker line (PdE-SV-9).

Fig. 98 Differential pressure in reactor vessel downcomer stalk 2, between 209.4 and 24.5 in. above reactor vessel bottom (PdE-2ST-2) (filtered to 4 Hz).

Fig. 99 Differential pressure in intact loop across the reactor vessel inlet and outlet nozzles (PdT-P139-30).

Fig. 100 Pressure in broken loop cold and hot legs (PE-BL-1 and -2).

Fig. 101 Pressure in broken loop cold leg (PE-BL-1, -4, and -8).

Fig. 102 Pressure in broken loop hot leg (PE-BL-2, -3, and -6).

Fig. 103 Pressure in reactor vessel core simulator instrument stalk, wide range (PE-CS-1A).

Fig. 104 Pressure in reactor vessel core simulator instrument stalk, narrow range (PE-CS-1B).

Fig. 105 Pressure in intact loop cold leg, hot leg, and steam generator outlet (PE-PC-1, -2, and -3A).

Fig. 106 Pressure in intact loop steam generator outlet, narrow range (PE-PC-3B).

Fig. 107 Pressure in intact loop cold leg, hot leg, and pressurizer (PE-PC-1, -2, and -4).

Fig. 108 Pressure in reactor vessel downcomer instrument stalk 1 and core simulator (PE-CS-1A and PE-1ST-1A and -3A).

Fig. 109 Pressure in reactor vessel downcomer instrument stalk 1, 24.5 in. above reactor vessel bottom, narrow range (PE-1ST-1B).

Fig. 110 Pressure in reactor vessel downcomer instrument stalk 1, 209.4 in. above reactor vessel bottom, narrow range (PE-1ST-3B).

Fig. 111 Pressure in reactor vessel core simulator and downcomer instrument stalk 1 (PE-CS-1FF and PE-1ST-1FF and -3FF).

Fig. 112 Pressure in reactor vessel core simulator and downcomer instrument stalk 2 (PE-CS-1A and PE-2ST-1A).

Fig. 113 Pressure in reactor vessel downcomer instrument stalks 1 and 2 (PE-1ST-3FF and PE-2ST-3FF).

Fig. 114 Pressure in reactor vessel core simulator and downcomer instrument stalk 2 (PE-CS-2FF and PE-2ST-3FF).

Fig. 115 Pressure in blowdown suppression tank bottom under downcomer 4, 180° (PE-SV-1) (filtered to 60 Hz).

Fig. 116 Pressure in blowdown suppression tank across from downcomer 1, 157.5° (PE-SV-3).

Fig. 117 Pressure in blowdown suppression tank header above downcomer 4, 321° (PE-SV-14).

Fig. 118 Pressure in blowdown suppression tank 54.5 in. north of downcomer 2, 327° (PE-SV-17).

Fig. 119 Pressure in blowdown suppression tank header above downcomer 1 (PE-SV-18).

Fig. 120 Pressure in blowdown suppression tank bottom 54.5 in. north of downcomer 3, 180° (PE-SV-22).

Fig. 121 Pressure in blowdown suppression tank bottom 54.3 in. north of downcomer 2, 180° (PE-SV-26).

Fig. 122 Pressure in blowdown suppression tank bottom under downcomer 2, 180° (PE-SV-43).

Fig. 123 Pressure in blowdown suppression tank top 6 in. north of downcomer 4, 0° (PE-SV-55).

Fig. 124 Pressure in blowdown suppression tank top above downcomer 1, 0° (PE-SV-60).

Fig. 125 Pressure in blowdown suppression tank bottom (PE-SV-1, -22, -26, and -43).

Fig. 126 Pressure in blowdown suppression tank top (PE-SV-17, -55, and -60).

Fig. 127 Pressure in blowdown suppression tank header above downcomers 4 and 1 (PE-SV-14 and -18).

Fig. 128 Pressure in ECCS lower plenum injection line (PT-P120-64).

Fig. 129 Pressure in ECCS lower plenum injection line and lower plenum (PT-P120-64 and PE-1ST-1A).

Fig. 130 Pressure in ECCS LPIS pump A discharge (PT-P120-83).

Fig. 131 Pressure in blowdown suppression tank header 35 in. south of downcomer 1 (PT-P138-23).

Fig. 132 Pressure in blowdown suppression tank top (PT-P138-55 and -56).

Fig. 133 Pressure in intact loop hot leg venturi (PT-P139-2 and -3).

Fig. 134 Pump speed for intact loop pumps 1 and 2 (RPE-PC-1 and -2).

Fig. 135 Temperature in broken loop cold leg, hot leg, and reflood assist bypass system (TE-BL-1, -2, and -3).

Fig. 136 Temperature in broken loop cold leg and hot leg warmup lines (TE-CL-1 and TE-HL-2).

Fig. 137 Temperature in reactor vessel core simulator instrument stalk (TE-CS-1).

Fig. 138 Temperature in intact loop cold leg, hot leg, and steam generator outlet (TE-PC-1, -2, and -3).

Fig. 139 Temperature in blowdown suppression tank liquid at tank bottom (TE-P138-22).

Fig. 140 Temperature in blowdown suppression tank vapor at tank top (TE-P138-34).

Fig. 141 Temperature in broken loop cold leg QOBV inlet and isolation valve inlet (TE-P138-62 and -63).

Fig. 142 Temperature in broken loop hot leg QOBV inlet and isolation valve inlet (TE-P138-66 and -65).

Fig. 143 Temperature in intact loop pressurizer vapor and liquid (TE-P139-19 and -20).

Fig. 144 Temperature in intact loop cold leg upstream of DTT flange (TE-P139-29).

Fig. 145 Temperature in intact loop hot leg in elbow near venturi (TE-P139-32 and -33).

Fig. 146 Temperature in steam generator intact loop cold leg, hot leg, and secondary side (TE-SG-1, -2, and -3).

Fig. 147 Temperature in blowdown suppression tank B-end thermocouple stalk (TE-SV-1, -2, and -3).

Fig. 148 Temperature in blowdown suppression tank B-end thermocouple stalk (TE-SV-4, -5, and -6).

Fig. 149 Temperature in blowdown suppression tank A-end thermocouple stalk (TE-SV-7, -8, and -9).

Fig. 150 Temperature in blowdown suppression tank A-end thermocouple stalk (TE-SV-10, -11, and -12).

Fig. 151 Temperature in blowdown suppression tank 107.2 in. from tank bottom (TE-SV-1 and -7).

Fig. 152 Temperature in blowdown suppression tank 93.0 in. from tank bottom (TE-SV-2 and -8).

Fig. 153 Temperature in blowdown suppression tank 74.7 in. from tank bottom (TE-SV-3 and -9).

Fig. 154 Temperature in blowdown suppression tank 57.2 in. from tank bottom (TE-SV-4 and -10).

Fig. 155 Temperature in blowdown suppression tank 39.0 in. from tank bottom (TE-SV-5 and -11).

Fig. 156 Temperature in blowdown suppression tank 14.7 in. from tank bottom (TE-SV-6 and -12).

Fig. 157 Temperature in reactor vessel downcomer instrument stalk 1 (TE-1ST-1, -2, -3, and -4).

Fig. 158 Temperature in reactor vessel downcomer instrument stalk 1 (TE-1ST-6, -8, -9, and -10).

Fig. 159 Temperature in reactor vessel downcomer instrument stalk 1 (TE-1ST-11, -12, -13, and -14).

Fig. 160 Temperature in reactor vessel downcomer instrument stalk 2 (TE-2ST-2, -4, -7, and -9).

Fig. 161 Temperature in reactor vessel downcomer instrument stalk 2 (TE-2ST-10, -12, and -14).

Fig. 162 Temperature in reactor vessel downcomer instrument stalk 1, 189.3 in. from reactor vessel bottom (TE-1ST-1).

Fig. 163 Temperature in reactor vessel downcomer instrument stalks 1 and 2, 165.3 in. above reactor vessel bottom (TE-1ST-2 and TE-2ST-2).

Fig. 164 Temperature in reactor vessel downcomer instrument stalk 1, 141.3 in. above reactor vessel bottom (TE-1ST-3).

Fig. 165 Temperature in reactor vessel downcomer instrument stalks 1 and 2, 117.3 in. above reactor vessel bottom (TE-1ST-4 and TE-2ST-4).

Fig. 166 Temperature in reactor vessel downcomer instrument stalk 1, 69.3 in. above reactor vessel bottom (TE-1ST-6).

Fig. 167 Temperature in reactor vessel downcomer instrument stalk 2, 33.3 in. above reactor vessel bottom (TE-2ST-7).

Fig. 168 Temperature in reactor vessel downcomer instrument stalk 1, 29.3 in. above reactor vessel bottom (TE-1ST-8).

Fig. 169 Temperature in reactor vessel downcomer instrument stalks 1 and 2, 25.3 in. above reactor vessel bottom (TE-1ST-9 and TE-2ST-9).

Fig. 170 Temperature in reactor vessel downcomer instrument stalks 1 and 2, 21.3 in. above reactor vessel bottom (TE-1ST-10 and TE-2ST-10).

Fig. 171 Temperature in reactor vessel downcomer instrument stalk 1, 17.3 in. above reactor vessel bottom (TE-1ST-11).

Fig. 172 Temperature in reactor vessel downcomer instrument stalks 1 and 2, 13.3 in. above reactor vessel bottom (TE-1ST-12 and TE-2ST-12).

Fig. 173 Temperature in reactor vessel downcomer instrument stalk 1, 9.3 in. above reactor vessel bottom (TE-1ST-13).

Fig. 174 Temperature in reactor vessel downcomer instrument stalks 1 and 2, 45.9 in. above reactor vessel bottom in DTTs (TE-1ST-14 and TE-2ST-14).

Fig. 175 Temperature in ECCS lower plenum injection line (TT-P120-65).

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

3. TEST L1-3 MEASURED PARAMETERS --

LONG - TERM PLOTS (175- AND 500-SECOND PLOTS)

This section of presented data consists of Figures 176 through 212.

Fig. 176 Density in broken loop cold leg, chordal density (DE-BL-1A, -1B, and -1C).

Fig. 177 Density in broken loop hot leg, chordal density (DE-BL-2A, -2B, and -2C).

Fig. 178 Fluid velocity in broken loop cold leg at DTT flanges (FE-BL-1).

Fig. 179 Fluid velocity in reactor vessel downcomer instrument stalk 2, 47.1 in. above reactor vessel bottom (FE-2ST-1).

Fig. 180 Flow rate in blowdown suppression tank spray system 60-gpm header (FE-P138-138).

Fig. 181 Flow rate in blowdown suppression tank spray system pump discharge (FE-P138-139).

Fig. 182 Flow rate in blowdown suppression tank spray system 220-gpm header (FE-P138-140).

Fig. 183 Flow rate in blowdown suppression tank spray system pump recirculation line (FE-P138-153).

Fig. 184 Flow rate in ECCS LPIS pump A discharge (FT-P120-85).

Fig. 185 Liquid level in blowdown suppression tank (LT-P138-33 and -58).

Fig. 186 Momentum flux in the broken loop cold leg at DTT flange (ME-BL-1).

EGG-A-973

Fig. 187 Momentum flux in reactor vessel downcomer instrument stalk 2, 44.5 in. above reactor vessel bottom (ME-2ST-1).

EGG-A-970

Fig. 188 Pressure in reactor vessel core simulator instrument stalk, narrow range, and intact loop steam generator outlet (PE-CS-1B and PE-PC-3B).

Fig. 189 Pressure in blowdown suppression tank across from downcomer 1, 157.5°, and bottom 54.5 in. north of downcomer 3, 180° (PE-SV-3 and -22).

Fig. 190 Pressure in blowdown suppression tank top north of downcomer 4 and above downcomer 1 (PE-SV-55 and -60).

Fig. 191 Pressure in ECCS lower plenum injection line (PT-P120-64).

Fig. 192 Pressure in ECCS LPIS pump A discharge (PT-P120-83).

Fig. 193 Pressure in blowdown suppression tank top 48 in. north of downcomer 1 and 49 in. north of downcomer 2 (PT-P138-55 and -56).

Fig. 194 Pressure in blowdown suppression tank spray system pump discharge and cooldown heat exchanger outlet (PT-P138-136 and -151).

Fig. 195 Temperature in broken loop cold leg and hot leg (TE-BL-1 and -2).

Fig. 196 Temperature in reactor vessel core simulator instrument stalk (TE-CS-1).

Fig. 197 Temperature in intact loop cold leg, hot leg, and steam generator outlet (TE-PC-1, -2, and -3).

Fig. 198 Temperature in blowdown suppression tank spray system pump discharge (TE-P138-142).

Fig. 199 Temperature in blowdown suppression tank spray system 60-gpm header and 220-gpm spray header (TE-P138-141 and -143).

Fig. 200 Temperature in blowdown suppression tank B-end thermocouple stalk (TE-SV-1, -2, and -3).

Fig. 201 Temperature in blowdown suppression tank B-end thermocouple stalk (TE-SV-4, -5, and -6).

Fig. 202 Temperature in blowdown suppression tank A-end thermocouple stalk (TE-SV-7, -8, and -9).

Fig. 203 Temperature in blowdown suppression tank A-end thermocouple stalk (TE-SV-10, -11, and -12).

Fig. 204 Liquid level in blowdown suppression tank north end (LT-P138-33).

Fig. 205 Liquid level in blowdown suppression tank south end (LT-P138-58).

Fig. 206 Pressure in blowdown suppression tank across from downcomer 1, 157.5° (PE-SV-3).

Fig. 207 Pressure in blowdown suppression tank bottom 54.3 in. south of downcomer 2, 180° (PE-SV-26).

Fig. 208 Pressure in blowdown suppression tank bottom under downcomer 2 and under downcomer 3, 180° (PE-SV-43 and -44).

Fig. 209 Pressure in blowdown suppression tank top 48 in. north of downcomer 1 and 49 in. north of downcomer 2 (PT-P138-55 and -56).

Fig. 210 Temperature in blowdown suppression tank B-end thermocouple stalk (TE-SV-1, -2, and -3).

Fig. 211 Temperature in blowdown suppression tank B-end thermocouple stalk (TE-SV-4 and -6).

Fig. 212 Temperature in blowdown suppression tank A-end thermocouple stalk (TE-SV-10).

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

4. TEST L1-3 COMPUTED PARAMETERS

This section of presented data consists of Figures 213 through 269.

[illegible]

Fig. 214 Flow regime and average density in broken loop hot leg.

Fig. 215 Flow regime and average density in intact loop hot leg.

Fig. 216 Enthalpy in broken loop cold leg.

Fig. 217 Enthalpy in broken loop hot leg.

Fig. 218 Enthalpy in intact loop cold leg.

Fig. 219 Enthalpy in intact loop hot leg.

Fig. 220 Enthalpy in intact loop at steam generator outlet.

Fig. 221 Mass flow rate per system volume in broken loop cold leg calculated from FE-BL-1 and ME-BL-1.

Fig. 222 Mass flow rate per system volume in broken loop cold leg calculated from DE-BL-1 and ME-BL-1.

Fig. 223 Mass flow rate per system volume in broken loop cold leg calculated from DE-BL-1 and FE-BL-1.

Fig. 224 Mass flow rate per system volume in broken loop cold leg calculated from DE-BL-1 and PdE-BL-2.

Fig. 225 Mass flow rate per system volume in broken loop hot leg calculated from DE-BL-2 and ME-BL-2.

Fig. 226 Mass flow rate per system volume in broken loop hot leg calculated from DE-BL-2 and FE-BL-2.

Fig. 227 Mass flow rate per system volume in broken loop hot leg calculated from DE-BL-2 and PdE-BL-1.

Fig. 228 Mass flow rate per system volume in intact loop cold leg calculated from FE-PC-1 and ME-PC-1.

Fig. 229 Mass flow rate per system volume in intact loop cold leg calculated from FE-PC-1, PE-PC-1, and DE-PC-1B.

Fig. 230 Mass flow rate per system volume in intact loop cold leg calculated from DE-PC-1B and ME-PC-1.

Fig. 231 Mass flow rate per system volume in intact loop cold leg calculated from DE-PC-1B and FE-PC-1.

Fig. 232 Mass flow rate per system volume in intact loop hot leg calculated from FE-PC-2 and PE-PC-2.

Fig. 233 Mass flow rate per system volume in intact loop hot leg calculated from DE-PC-2 and FE-PC-2.

Fig. 234 Mass flow rate per system volume in intact loop steam generator outlet calculated from FE-PC-3, PE-PC-3A, and DE-PC-3.

Fig. 235 Mass flow rate per system volume in intact loop steam generator outlet calculated from DE-PC-3 and ME-PC-3.

Fig. 236 Mass flow rate per system volume in intact loop steam generator outlet calculated from DE-PC-3 and FE-PC-3.

Fig. 237 Mass flow rate per system volume in intact loop pressurizer calculated from LT-P139-8 and PE-PC-4.

Fig. 238 Pump speed, electrical, in intact loop primary coolant pumps 1 and 2.

Fig. 239 Pump speed, electrical and mechanical, in intact loop primary coolant pump 1.

Fig. 240 Pump speed, electrical and mechanical, in intact loop primary coolant pump 2.

Fig. 241 Pump motor slip in intact loop primary coolant pumps 1 and 2.

Fig. 242 Pump motor inidividual electrical horsepower in intact loop primary coolant pumps 1 and 2.

Fig. 243 Pump motor total electrical horsepower in intact loop primary coolant pumps 1 and 2.

Fig. 244 Pump total water horsepower in intact loop primary coolant pumps 1 and 2.

Fig. 245 Pump combined efficiency in intact loop primary coolant pumps 1 and 2.

Fig. 246 Pressure, closure, in intact loop (filtered to 4 Hz).

Fig. 247 Static quality in broken loop cold leg.

Fig. 248 Static quality in broken loop hot leg.

Fig. 249 Static quality in intact loop cold leg.

Fig. 250 Static quality in intact loop hot leg.

Fig. 251 Static quality in intact loop at steam generator outlet.

Fig. 252 Flow quality in broken loop cold leg.

Fig. 253 Flow quality in broken loop hot leg.

Fig. 256 Flow quality in intact loop at steam generator outlet.

Fig. 257 Saturation temperature in broken loop cold leg overlaid with TE-BL-1.

Fig. 258 Saturation temperature in broken loop hot leg overlaid with TE-BL-2.

Fig. 259 Saturation temperature in intact loop cold leg overlaid with TE-PC-1.

Fig. 260 Saturation temperature in intact loop hot leg overlaid with TE-PC-2.

Fig. 261 Saturation temperature in intact loop steam generator outlet overlaid with TE-PC-3.

Fig. 262 Saturation temperature in reactor vessel core simulator instrument stalk overlaid with TE-CS-1.

Fig. 263 Saturation temperature in reactor vessel downcomer instrument stalk 1 overlaid with TE-1ST-9.

Fig. 264 Saturation temperature in reactor vessel downcomer instrument stalk 2 overlaid with TE-2ST-9.

Fig. 265 Void fraction in broken loop cold leg.

Fig. 266 Void fraction in broken loop hot leg.

Fig. 267 Void fraction in intact loop cold leg.

Fig. 268 Void fraction in intact loop hot leg.

Fig. 269 Void fraction in intact loop at steam generator outlet.

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

5. TEST L1-3 ERROR BAND PLOTS

This section of presented data consists of Figures 270 through 312.

Fig. 270 Valve opening (%) in broken loop hot leg QOBV with error bands (CV-P138-15).

Fig. 271 Chordal density in broken loop cold leg with error bands (DE-BL-1A) (filtered to 4 Hz).

Fig. 272 Average velocity in broken loop cold leg at DTT flange with error bands (FE-BL-1) (filtered to 4 Hz).

Fig. 273 Average velocity in reactor vessel downcomer instrument stalk 1 with error bands (FE-1ST-1) (filtered to 4 Hz).

Fig. 274 Flow rate in blowdown suppression tank spray system pump discharge with error bands (FE-P138-139).

Fig. 275 Flow rate in ECCS LPIS pump A discharge with error bands (FT-P120-85).

Fig. 276 Flow rate in ECCS HPIS pump A discharge with error bands (FT-P128-104).

Fig. 277 Flow rate in intact loop hot leg venturi with error bands (FT-P139-27-3).

Fig. 278 Liquid level in blowdown suppression tank south end with error bands (LT-P138-58).

Fig. 279 Liquid level in pressurizer north side with error bands (LT-P139-8).

Fig. 280 Momentum flux in broken loop cold leg at DTT flange with error bands (ME-BL-1) (filtered to 4 Hz).

Fig. 281 Momentum flux in reactor vessel downcomer instrument stalk 1 with error bands (ME-1ST-1) (filtered to 4 Hz).

Fig. 282 Differential pressure in broken loop hot leg at 14-to-5-in. reduction with error bands (PdE-BL-1) (filtered to 4 Hz).

Fig. 283 Differential pressure in broken loop cold leg at 14-to-5-in. reduction with error bands (PdE-BL-2) (filtered to 4 Hz).

Fig. 284 Differential pressure in broken loop cold leg across break plane with error bands (PdE-BL-3).

Fig. 285 Differential pressure in broken loop hot leg across steam generator simulator outlet flange with error bands (PdE-BL-6) (filtered to 4 Hz).

Fig. 286 Differential pressure in intact loop cold leg across primary coolant pumps 1 and 2 with error bands (PdE-PC-1).

Fig. 287 Differential pressure in intact loop across steam generator with error bands (PdE-PC-2).

Fig. 288 Differential pressure in intact loop hot leg reactor vessel outlet to flow venturi with error bands (PdE-PC-3).

Fig. 289 Differential pressure from reactor vessel downcomer stalk 1 to blowdown suppression tank with error bands (PdE-RV-1).

Fig. 290 Differential pressure in intact loop across the reactor vessel inlet and outlet nozzles with error bands (PdT-P139-30).

Fig. 291 Pressure in broken loop hot leg with error bands (PE-BL-2).

Fig. 292 Pressure in reactor vessel core simulator instrument stalk, wide range, with error bands (PE-CS-1A).

Fig. 293 Pressure in reactor vessel core simulator instrument stalk, narrow range, with error bands (PE-CS-1B).

Fig. 294 Pressure in reactor vessel core simulator instrument stalk, short-term plot, with error bands (PE-CS-2FF).

Fig. 295 Pressure in reactor vessel core simulator instrument stalk, 70-second plot, with error bands (PE-CS-2FF).

Fig. 296 Pressure in blowdown suppression tank header above downcomer 4, short-term plot, with error bands(PE-SV-14).

Fig. 297 Pressure in blowdown suppression tank header above downcomer 4, 70-second plot, with error bands (PE-SV-14).

Fig. 298 Pressure in ECCS lower plenum injection point with error bands (PT-P120-64).

Fig. 299 Pressure in ECCS LPIS pump A discharge with error bands (PT-P120-83).

Fig. 300 Pressure in blowdown suppression tank top with error bands (PT-P138-55).

Fig. 301 Pressure in broken loop cold leg QOBV inlet, short-term plot, with error bands (PT-P138-111).

Fig. 302 Pressure in blowdown suppression tank spray system pump discharge with error bands (PT-P138-136).

Fig. 303 Pump speed in intact loop operating pump 2 with error bands (RPE-PC-2).

Fig. 304 Temperature in broken loop hot leg with error bands (TE-BL-2).

Fig. 305 Temperature in blowdown suppression tank liquid at tank bottom with error bands (TE-P138-22).

Fig. 306 Temperature in blowdown suppression tank vapor at tank top with error bands (TE-P138-34).

Fig. 307 Temperature in broken loop cold leg at QOBV inlet with error bands (TE-P138-62).

Fig. 308 Temperature in broken loop cold leg isolation valve inlet with error bands (TE-P138-63).

Fig. 309 Temperature in blowdown suppression tank spray system 60-gpm header with error bands (TE-P138-141).

Fig. 310 Temperature in intact loop pressurizer liquid with error bands (TE-P139-20).

Fig. 311 Temperature in intact loop cold leg at steam generator inlet plenum with error bands (TE-SG-1).

Fig. 312 Temperature in blowdown suppression tank B-end thermocouple stalk with error bands (TE-SV-6).

VIII. REFERENCES

1. T. K. Samuels, Conformed Copy of LOFT Experimental Operating Specification, Volume 2, Nonnuclear Test Series L1 Experiment 3 and 3A, NNE L1-3 and 3A, Aerojet Nuclear Company, EOS Volume 2, NNE L1-3 and 3A Revision 2 (September 1976).
2. J. R. White, Experiment Prediction for LOFT Experiment L1-3, Aerojet Nuclear Company, EP L1-3 (June 1976).
3. J. R. Chappell, Quick Look Report on Loss of Coolant Experiment L1-3, Aerojet Nuclear Company, QLR-76-4 (July 1976).
4. H. C. Robinson, LOFT System and Test Description (Loss of Coolant Experiments Using a Core Simulator), TREE-NUREG-1019 (November 1976).
5. J. R. Chappell, Experiment Data Report for LOFT Nonnuclear Test L1-1, TREE-NUREG-1025 (December 1976).
6. H. C. Robinson, Experiment Data Report for LOFT Nonnuclear Test L1-2, TREE-NUREG-1026 (December 1976).
7. G. M. Millar, Experiment Data Report for LOFT Nonnuclear Test L1-3A, TREE-NUREG-1027 (December 1976).
8. F. S. Miyasaki, Digital Data Acquisition Program, ANCR-1250 (August 1975).
9. N. L. Norman, LOFT Data Reduction, ANCR-1251 (August 1975).
10. G. L. Biladeau et al, LOFT Experimental Measurements Uncertainty Analysis, Aerojet Nuclear Company, LTR 141-39 (September 1975).

11. S. N. Zender, Experimental Data Report for Semiscale MOD-1 Test S-01-03 (Isothermal Blowdown with Core Resistance Simulator), ANCR-1195 (March 1975).

IX. LIST OF ABBREVIATIONS AND ACRONYMS

ac	Alternating current	LP	Lower Plenum
Acc.	Accumulator	LPIS	Low-Pressure Injection System
BL	Broken Loop	LPWR	Large Pressurized Water Reactor (~1000 MW)
BDST	Blowdown Suppression Tank	msec	Milliseconds
BDSTSS	Blowdown Suppression Tank Spray System	MW	Megawatt
BWST	Borated Water Storage Tank	N ₂	Nitrogen
CL	Cold Leg	P	Pressure
CS	Core Simulator	PC	Primary Coolant
DAVDS	Data Acquisition and Visual Display System	PCP	Primary Coolant Pump
DC	Downcomer	PCS	Primary Coolant System
dc	Direct current	PCT	Percent
Deg.	Degree	ppm	Parts per million
DP	Differential Pressure	pps	Points per second
DTT	Drag Disc-Turbine Flowmeter	psi	Pounds per square inch
ECC	Emergency Core Cooling or Coolant	psia	Pounds per square inch - absolute
ECCS	Emergency Core Coolant System	psid	Pounds per square inch - differential
EOP	Experimental Operating Procedure	psig	Pounds per square inch - gauge
EOS	Experimental Operating Specification	PSMG	Primary System Motor Generator (Sets)
ESF	Engineered Safety Features	QEUD	Qualified Engineering Units Data
°F	Degrees Fahrenheit	QOBV	Quick-Opening Blowdown Valve
FF	Free Field	RABV	Reflood Assist Bypass Valve
Fig.	Figure	RMS	Root Mean Square
FM	Frequency Modulator	rpm	Revolutions per minute
Freq.	Frequency	RTD	Resistance Temperature Detector
ft	Feet	RV	Reactor Vessel
FTS2	Feet-second ²	SCS	Secondary Coolant System
g	Acceleration due to gravity	sec	Second(s)
gpm	Gallons per minute	SG	Steam Generator
HL	Hot Leg	Snub.	Snubber
HPIS	High-Pressure Injection System	TAN	Test Area North
hr	Hour	Temp.	Temperature
HX	Heat Exchanger	UP	Upper Plenum
Hz	Hertz	μsec	Microseconds
in.	Inch (s)	v	Velocity
INEL	Idaho National Engineering Laboratory	V	Volt(s)
Instr.	Instrument	vol _{sys}	Volume of system
lb	Pound(s)	ρ	Density
lbm	Pounds mass	$\bar{\rho}$	Average density
LOCA	Loss-of-Coolant Accident	ρ _g	Density of saturated vapor
LOCE	Loss-of-Coolant Experiment	ρ _l	Density of saturated liquid
LOFT	Loss of Fluid Test	<>	Averaged over a specified cross-sectional area

DISTRIBUTION RECORD FOR TREE-NUREG-1065

Internal Distribution

- 1 - Chicago Patent Group - ERDA
9800 South Cass Avenue
Argonne, Illinois 60439
- 2-4 - A. T. Morphew
Classification and Technical Information Officer
Idaho Operations Office - ERDA
Idaho Falls, ID 83401
- 5 - R. J. Beers, ID
- 6 - P. E. Litteneker, ID
- 7 - R. E. Tiller, ID
- 8 - R. E. Wood, ID
- 9 - H. P. Pearson, Supervisor
Technical Information
- 10-19 - INEL Technical Library
- 20-154 - Authors
- 155-274 - Special Internal

External Distribution

- 275-276 - Saul Levine, Director
Office of Nuclear Regulatory Research, NRC
Washington, DC 20555
- 277-321 - Special External
- 322-625 - Distribution under NRC-2, Water Reactor Safety Research
Systems Engineering