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for U.S. Nuclear Regulatory Commission

**EXPERIMENT DATA REPORT FOR SEMISCALE MOD-1
TEST S-05-5
(ALTERNATE ECC INJECTION TEST)**

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MASTER

April 1977

EG&G Idaho, Inc.

IDAHO NATIONAL ENGINEERING LABORATORY

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

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

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(ALTERNATE ECC INJECTION TEST)

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TEST S-05-5

(ALTERNATE ECC INJECTION TEST)

by

Brent L. Collins
Morris L. Patton, Jr.
Kenneth F. Sackett

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

ABSTRACT

Recorded test data are presented for Test S-05-5 of the Semiscale Mod-1 alternate ECC injection test series. These tests are among several Semiscale Mod-1 experiments conducted to investigate the thermal and hydraulic phenomena accompanying a hypothesized loss-of-coolant accident in a pressurized water reactor (PWR) system.

Test S-05-5 was conducted from initial conditions of 2263 psia and 537°F to investigate the response of the Semiscale Mod-1 system to a depressurization and reflood transient following a simulated double-ended offset shear of the cold leg broken loop piping. During the test, cooling water was injected into the cold leg of the intact and broken loops to simulate emergency core coolant injection in a PWR. The upper plenum was vented through a reflood bypass line interconnecting the hot and cold legs of the broken loop.

The purpose of this report is to make available the uninterpreted data from Test S-05-5 for future data analysis and test results reporting activities. The data, presented in the form of graphs in engineering units, have been analyzed only to the extent necessary to assure that they are reasonable and consistent.

SUMMARY

Test S-05-5 was performed as part of the Semiscale Mod-1 portion of the Semiscale Program conducted by EG&G Idaho, Inc. for the United States Government. This test was part of the alternate ECC injection test series (Test Series 5) performed to investigate the response of the Mod-1 system to specific variations in coolant injection location. The test objective specific to Test S-05-5 was to provide data which can be used to assess the influence of an added flow path, provided by a reflood bypass line interconnecting the hot and cold legs of the broken loop, on core heat transfer during blowdown and reflood. Hardware configuration and test parameters were selected to yield a system response that simulates the response of a pressurized water reactor to a hypothesized loss-of-coolant accident (LOCA) with subsequent refill and reflood.

Test S-05-5 utilized the Semiscale Mod-1 system equipped with a pressure vessel with a 40-rod electrically heated core; an intact loop with pump, steam generator, and pressurizer; a broken loop with simulated pump, simulated steam generator, and rupture assemblies; and a pressure suppression system with header, pressure suppression tank, and a heated steam supply system. Low pressure coolant injection pumps and a coolant injection accumulator were provided for each system loop. For Test S-05-5, four heater rods were intentionally unpowered to simulate the effects of control rod guide tubes and the power in three heater rods was increased to produce a slightly peaked profile. In addition, a reflood bypass line interconnecting the hot and cold legs of the broken loop was used to equalize the pressure between the vessel upper plenum and downcomer annulus during blowdown and reflood.

The test was conducted from initial conditions of 2263 psia and 537°F (at the intact loop cold leg vessel inlet) with a simulated full size (200%) double-ended offset shear of the cold leg broken loop piping at an initial core power level of 1.48 MW, and an initial core inlet flow rate of 140 gpm. The instantaneous offset shear of the broken loop cold leg piping was simulated by simultaneous (within 10 msec) actuation of the rupture assemblies. After initiation of blowdown, power to the heated core was reduced to simulate the predicted heat flux response of nuclear fuel rods during a LOCA. Blowdown was accompanied by simulated emergency core coolant injection into the cold leg piping of both the intact and broken loops.

Test S-05-5 was generally conducted as specified. Conditions which did not conform to the specified test configuration were considered acceptable for analysis purposes within the test objectives. The instrumentation used generally functioned as intended. Of 219 measurements taken, 213 produced usable data.

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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-1

TEST S-05-5

(ALTERNATE ECC INJECTION TEST)

I. INTRODUCTION

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

Test S-05-5 was conducted January 11, 1977, in the Semiscale Mod-1 system as part of the alternate ECC injection test series (Test Series 5), which was designed to obtain thermal-hydraulic response data from blowdown, refill, and reflood transients in a simulated nuclear reactor with a heated core to study system response to changes in ECC injection location.

The purpose of this report is to present the test data in an uninterpreted but readily usable form for use by the nuclear community in advance of detailed analysis and interpretation. Section II briefly describes the system configuration, procedures, initial test conditions, and events that are applicable to Test S-05-5; Section III presents the data graphs and provides comments and supporting information necessary for interpretation of the data. A description of the overall Semiscale Program and test series, a more detailed description of the Semiscale Mod-1 system, and a description of the measurement and data processing techniques and uncertainties can be found in Reference 1.

II. SYSTEM, PROCEDURES, CONDITIONS, AND EVENTS FOR TEST S-05-5

The following system configuration, procedures, initial test conditions, and events are specific to Test S-05-5 as indicated.

1. SYSTEM CONFIGURATION AND TEST PROCEDURES

The Semiscale Mod-1 system used for this test consisted of a pressure vessel with internals, including a 40-rod core with 36 electrically heated rods; an intact loop with steam generator, pump, and pressurizer; a broken loop with simulated steam generator, simulated pump, and two rupture assemblies; coolant injection accumulators for both the intact and broken loops; low pressure coolant injection pumps for both the intact and broken loops; and a pressure suppression system with a suppression tank, header, and a steam supply system. For Test S-05-5, the volume of the lower plenum was reduced to 0.529 ft³ by the addition of a metal filler piece. Also, a 3-in. (Schedule 160 Grade 316 stainless steel) reflood bypass line with a control valve and a check valve (allowing flow from the hot leg to the cold leg only) was installed interconnecting the hot and cold legs of the broken loop. Semiscale Mod-1 experimental system configuration information is provided in Reference 1. Figures 1, 2, and 3 provide the system configuration for Test S-05-5.

For Test S-05-5, 33 rods of the 40-rod electrically heated core were operated at a peak power density of approximately 11.5 kW/ft, three rods (Rods D-4, E-4, and E-5) were operated at a peak power density of approximately 12.1 kW/ft to yield a slightly peaked power profile, and four rods (Rods C-3, D-5, F-3, and F-6) were unpowered to simulate the effect of control rod guide tubes. The resulting total core power was approximately 1.48 MW.

In preparation for the test, the accumulators were filled with treated demineralized water, drained to the specified initial level, and pressurized with nitrogen to 600 psig. The system was filled with treated demineralized water and vented at strategic points to assure a liquid full system. Prior to warmup the system was pressurized to check for leakage, system instrumentation was checked, and transducer readings were initialized. Warmup to initial test conditions was accomplished with the heaters in the vessel core. Heatup of the broken loop piping was accomplished with bypass lines which served to allow circulation through the broken loop. During warmup, the purification and sampling systems were valved into the primary system to maintain water chemistry requirements and to provide a water sample at system conditions for subsequent analysis. At 100-°F temperature intervals during warmup, detector readings were sampled to allow the integrity of the measurement instrumentation and the operability of the data acquisition system to be checked.

Prior to the initial core power level being established, the pressure suppression system was pressurized to 35 psia with saturated steam from the steam supply system. After the

Fig. 2 Cross section of vessel with lower plenum filler.

INEL-A-1511

Fig. 3 Three-in. broken loop reflood bypass line.

core power was increased to 1.48 MW, initial test conditions were held for 10 minutes to establish equilibrium in the system. At the end of this period all auxiliary systems including the bypass lines were isolated to prevent blowdown through those systems.

The system was successfully subjected to a simulated double-ended cold leg break through two rupture assemblies and two blowdown nozzles, each having a break area of 0.00262 ft². Pressure to operate the rupture assemblies and initiate blowdown was taken from an accumulator system filled with water and pressurized to 2250 psig with gaseous nitrogen. Immediately (within 0.02 sec) after initiation of blowdown, the lines to the accumulator were again isolated. The effluent from the primary system was ejected into the pressure suppression system which was vented to maintain a constant pressure of 35 psia. However, a faulty drain valve allowed the water to begin to drain from the pressure suppression tank prior to blowdown. This lack of total fluid to absorb the energy released during blowdown caused the pressure and temperature within the pressure suppression system to vary from the anticipated values. At blowdown, power to the primary coolant circulation pump was reduced and the pump was allowed to coast down to a speed of 1680 rpm which was maintained for the duration of the test. During the blowdown transient, power to the electrically heated core was automatically controlled to simulate the thermal response of nuclear heated fuel rods.

For Test S-05-5, the coolant injection systems were arranged to discharge into both system loops at the cold leg injection points (Spool 14 and Spool 42). Coolant injection was initiated from the intact and broken loop accumulators after the system was depressurized to 600 psig and continued until depletion. At approximately 150 psig, the low pressure injection pumps were also started. Coolant injection from the low pressure injection pumps continued until the test was terminated at 300 sec after initiation of blowdown.

2. INITIAL TEST CONDITIONS AND SEQUENCE OF EVENTS

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

TABLE I
CONDITIONS AT BLOWDOWN INITIATION

	Test S-05-5	
	Measured ^[a]	Specified
Core power (MW)	1.481	1.444 $\pm$ 0.03
Intact loop cold leg fluid temperature (°F)	537	544 $\pm$ 2
Hot leg to cold leg temperature differential (°F)	72	66 $\pm$ 1
Pressurizer pressure (psia)	2263	2263 $\pm$ 25
Pressurizer water level (in.) ^[b]	24.2 ^[c]	27.1
Steam generator feedwater temperature (°F)	445	435 $\pm$ 10
Steam generator liquid level (from bottom of tube sheet) (in.)	117	116 $\pm$ 2
Fluid temperature in broken loop (pump side) (°F)	561	572
Fluid temperature in broken loop (vessel side) (°F)	538	Not Specified
Intact loop cold leg flow (gpm)	140	[d]
Pressure suppression tank water level (in.)	47.5 ^[e]	47.5 $\pm$ 0.5
Pressure suppression tank pressure (psia)	35	35 $\pm$ 1
Pressure suppression tank water temperature (°F) ^[f]	62	Ambient

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

[b] Pressurizer water level measured down from inside of top head. Level was specified in terms of differential pressure in the liquid level measuring system.

[c] Level shown corresponds to a pressurizer system liquid volume of 0.60 ft³ (including surge line).

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

[e] Data are questionable due to slow leak in pressure suppression tank.

[f] Process instrumentation not used. Data taken from last digital scan 360 sec prior to blowdown initiation.

TABLE II
PRIMARY COOLANT TEMPERATURE DISTRIBUTION PRIOR TO RUPTURE^[a]

	<u>Test S-05-5</u>	
	<u>Detector</u>	<u>Temperature (°F)</u>
Vessel lower plenum (upper portion above filler block)	TFV-LP-7	544
Intact loop hot leg (near vessel)	RBU-2	607
Intact loop cold leg (near pump inlet)	TFU-10	544
Intact loop cold leg (near vessel)	RBU-14A	542
Broken loop cold leg (near nozzle)	TFB-23	538
Broken loop hot leg (near vessel)	TFB-30	606
Broken loop cold leg (near nozzle)	TFB-42	585
Reflood bypass line	TFB-RFB	529

[a] Data taken from final digital scan 360 sec before blowdown.

TABLE III
WATER CHEMISTRY PRIOR TO BLOWDOWN^[a]

	<u>Test S-05-5</u>
pH	10.80
Conductivity ($\mu\text{mho/cm}$)	172.0
Lithium (ppm)	5.1
Chlorides (ppm)	<0.1
Fluorides (ppm) ^[b]	<0.4
Oxygen (ppm)	0.05
Total Gas (cc/l)	161.0
Suspended solids (ppm)	1.45

[a] Water sample taken at a system pressure of approximately 2263 psia and a system temperature of approximately 540°F (cold leg).

[b] Present analytical methods prevent accurate determination of fluorides at concentrations of less than 0.4 ppm.

TABLE IV
SEQUENCE OF EVENTS DURING TEST S-05-5^[a]

<u>Event</u>	<u>Time Relative To Rupture</u>
Core power level established (min)	-10
Bypass lines valved out of system (sec)	-2.5
Blowdown initiated (sec)	0
Pump power reduced (sec)	0
High pressure injection system pumps started (sec) ^[b]	0
ECC accumulators valved in (sec)	0
Steam generator feedwater and discharge valves closed (sec)	1
Core power decay transient started (sec)	2.7
Low pressure injection system pumps started (sec) ^[b]	30
Core power tripped off (sec) ^[c]	300

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

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

[c] Core power tripped manually at termination of test.

III. DATA PRESENTATION

The data from Semiscale Mod-1 Test S-05-5 are presented with brief comment. Processing analysis has been performed only to the extent necessary to obtain appropriate engineering units and to assure that the data are reasonable and consistent. In all cases, in converting transducer output to engineering units, a homogeneous fluid was assumed. Further interpretation and analysis should consider that sudden decompression processes such as those occurring during blowdown may have subjected the measurement devices to nonhomogeneous fluid conditions.

The performance of the system during Test S-05-5 was monitored by 219 detectors. The data obtained were recorded on both digital and analog data acquisition systems. The digital system was used to process the data presented in this report. The digital data were recorded at a sample rate of 57.5 points per second. Long term plots ((-20 to 300 sec) were compressed at a 20 to 1 ratio giving an effective sample rate of 2.875 points per sec. Short term plots (-6 to 42 sec) were compressed at a 3 to 1 ratio giving an effective sample rate of 19.17 points per sec. The analog system was used to provide better resolution capability (needed as input to various data analysis codes) and to provide redundancy.

The data are presented, in some instances, in the form of composite graphs to facilitate comparison of the values of given variables at several locations. The scales selected for the graphs do not reflect the obtainable resolution of the data. (The data processing techniques are described further in Reference 1.)

Figures 4 through 9 and Table V provide supporting information for interpretation of the data graphs shown in Figures 10 through 345, and provide relative locations of all detectors used during Test S-05-5. Table V groups the measurements according to measurement type; identifies the specific measurement location and range of the detector and actual recording range of the data acquisition system; provides brief comments regarding the data; and references the measurements and comments to the corresponding figure. Figures 10 through 345 present all the blowdown and reflood data obtained. Time zero on the graphs is the time of rupture initiation. Appendix A provides information explaining posttest data processing for data conversion into engineering units and data adjustments.

Fig. 4 Semiscale Mod-1 system and instrumentation for cold leg break configuration - isometric.

Fig. 7 Semiscale Mod-1 pressure vessel -- isometric showing instrumentation.

Fig. 8 Semiscale Mod-1 pressure vessel -- penetrations and instrumentation.

Test S-05-5
INEL-A-1514

Fig. 9 Semiscale Mod-1 heated core -- plan view.

TABLE V
DATA PRESENTATION FOR SEMISCALE MOD-1 TEST S-05-5

Range ^[a]					
Measurement	Location and Comments ^[a]	Detector	Data Acquisition System	Figure ^[a]	Measurement Comments ^[b]
FLUID TEMPERATURE					
Chromel-Alumel thermocouples unless specified otherwise.					
<u>Intact Loop</u>					
		0 to 2300°F	0 to 591°F		
RRII-2	Hot leg, Spool 2, 46 in. from vessel center (platinum resistance bulb).	0 to 1000°F	0 to 1000°F	10, 11	
TSU-7	Cold leg, Spool 7, 243 in. from vessel center (shielded).			12, 13	
TFU-10	Cold leg, Spool 10, 144 in. from vessel center.			12, 13	
RBU-14A	Cold leg, Spool 14, 43 in. from vessel center, upstream of cold leg injection port (platinum resistance bulb).	0 to 1000°F	0 to 1000°F	12, 13	
TFII-14R	Cold leg, Spool 14, 99 in. from vessel center, downstream of cold leg injection port.				Used for process control only
<u>Broken Loop</u>					
		0 to 2300°F	0 to 1017°F		
TFB-20	Cold leg, Spool 20, 21 in. from vessel center.			14, 15	
TFB-23	Cold leg, Spool 23, 91 in. from vessel center, upstream of vessel-side nozzle.			14, 15	
TFB-30	Hot leg, Spool 30, 16 in. from vessel center.			16, 17	
TFB-37	Cold leg, Spool 37, 276 in. from vessel center along hot leg, discharge of simulated steam generator.			16, 17	
TFB-42	Cold leg, Spool 42, 414 in. from vessel center along hot leg, upstream of pump-side nozzle.			16, 17	
TFB-RFB	Reflood bypass line, hot leg to cold leg 66 in. from vessel center along hot leg.			18, 19	
<u>Inlet Annulus</u>					
	4 in. below cold leg centerline, 0.2 in. from vessel wall, Type J iron-constantan thermocouples.	0 to 1400°F	0 to 803°F		
TFV-ANN-4A	0°.			20, 21	
TFV-ANN-4H	180°.			20, 21	
<u>Downcomer Annulus</u>					
	Centered in annulus, Type J iron-constantan thermocouples.	0 to 1400°F	0 to 803°F		
TFV-ANN-35A	35 in. below cold leg centerline, 0°.			22, 23	
TFV-ANN-70A	70 in. below cold leg centerline, 0°.			22, 23	
TFV-ANN-115A	115 in. below cold leg centerline, 0°.			22, 23	
TFV-ANN-156A	156 in. below cold leg centerline, 0°.	0 to 2300°F	0 to 591°F	22, 23	
<u>Upper Plenum</u>					
		0 to 2300°F	0 to 1017°F		
FV-UP-13	In upper plenum, 13.5 in. above cold leg centerline at 180°.			24, 25	
<u>Lower Plenum</u>					
	On fluid thermocouple rack, 1 in. from vessel center, 45°.	0 to 2300°F	0 to 1017°F		
TFV-LP-2	2.0 in. above top of lower plenum filler.			26, 27	
TFV-LP-7	7.0 in. above top of lower plenum filler.			26, 27	

TABLE V (continued)

		Range [a]			
Measurement	Location and Comments [a]	Detector	Data Acquisition System	Figure [a]	Measurement Comments [b]
<u>Core</u>					
TFV-CORE-IN	In core flow mixer box, 150 in. below cold leg centerline (a part of FDV-CORE-IN).	0 to 2300°F	0 to 1017°F	28, 29	
<u>Core Grid Spacers</u>					
Grid Spacer 5	55 in. below cold leg centerline, 21.5 in. above top of heated length.	0 to 2300°F	0 to 2382°F		
TFG-5CD-45	Thermocouple in space defined by Columns C and D, rows 4 and 5.			30, 31	
Grid Spacer 6	76 in. below cold leg centerline 0.5 in. above top of heated length.				
TFG-6CD-45	Thermocouple in space defined by Columns C and D, rows 4 and 5.			32, 33	
<u>Core Barrel Insulation Gap</u>					
TFV-CIG-70A	70 in. below cold leg centerline, 0°.	0 to 1400°F	0 to 803°F	34, 35	
<u>Vessel Filler Insulation Gap</u>					
TFV-FIG-156A	156 in. below cold leg centerline, 0°.	0 to 2300°F	0 to 1017°F	36, 37	
<u>ECC System</u>					
TFU-ECC-14	On centerline of ECC line at junction with Spool 14.	0 to 2300°F	0 to 591°F	38, 39	
TFB-ECC-42	In line leading to broken loop Spool 42.			40, 41	
<u>Steam Generator</u>					
TFU-SGFV	In feedwater line leading to steam generator.	0 to 2300°F	0 to 591°F	42, 43	
TFU-SG1	Secondary side, 12 in. above bottom of tube sheet.			44, 45	
TFU-SG2	Secondary side, 24 in. above bottom of tube sheet.				Detector failed.
TFU-SG3	Secondary side, 48 in. above bottom of tube sheet.			44, 45	
<u>Pressurizer</u>					
TFU-PRIZC	In surge line, near pressurizer exit, between turbine flowmeter and pressurizer.	0 to 2300°F	0 to 1017°F	46, 47	
<u>Pressure Suppression System</u>					
TF-PSS-33	33 in. from bottom of tank.	0 to 2300°F	0 to 591°F	48, 49	
TF-PSS-130	130 in. from bottom of tank.			48, 49	
<u>MATERIAL TEMPERATURE</u>					
Chromel-Alumel thermocouples unless specified otherwise					
<u>Hot Leg</u>					
TMU-1T16	Hot leg, Spool 1, top, 1/16 in. from pipe ID, 29 in. from vessel center.	0 to 2300°F	0 to 591°F	50, 51	
TMU-15T16	Cold leg, Spool 15, top, 1/16 in. from pipe ID, 17 in. from vessel center.			50, 51	
<u>Broken Loop</u>					
TMG-20B16	Cold leg, Spool 20, bottom, 1/16 in. from pipe ID, 21 in. from vessel center.	0 to 2300°F	0 to 591°F	52, 53	
TMG-RFB	Reflood bypass line, top, 1/16 in. from pipe ID, 67 in. from vessel center along hot leg.			54, 55	
<u>Vessel Filler</u>					
TMV-FI-4M	Type J iron-constantan. 4 in. below cold leg centerline, 1/16 in. from filler ID, 180°.	0 to 1400°F	0 to 803°F	56, 57	
TMV-FI-15A	15 in. below cold leg centerline, 1/16 in. from filler ID, 0°.			56, 57	

TABLE V (continued)

		Range [a]			
Measurement	Location and Comments [a]	Detector	Data Acquisition System	Figure [a]	Measurement Comments [b]
Vessel Filler (continued)					
TMV-FI-35A	35 in. below cold leg centerline, 1/16 in. from filler ID, 0°.			56, 57	
TMV-FI-115A	115 in. below cold leg centerline, 1/16 in. from filler ID, 0°.			58, 59	
TMV-FI-156A	156 in. below cold leg centerline, 1/16 in. from filler ID, 0°.	0 to 2300°F	0 to 1017°F	58, 59	External junction formed; reading low.
TMV-FO-156A	156 in. below cold leg centerline, 0.65 in. from filler OD, 0°.	0 to 2300°F	0 to 1017°F	60, 61	
Vessel Filler Insulator	Outer surface of insulator; Type J iron-constantan thermocouples.	0 to 1400°F	0 to 803°F		
TIV-FO-35A	35 in. below cold leg centerline, 0°.			62, 63	
TIV-FO-35B	35 in. below cold leg centerline, 180°.			62, 62	
TIV-FO-70A	70 in. below cold leg centerline, 0°.			62, 60	
TIV-FO-115A	115 in. below cold leg centerline, 0°.			62, 63	
Core Barrel	Type J iron-constantan thermocouples	0 to 1400°F	0 to 803°F		
TMV-CI-70A	70 in. below cold leg centerline, 1/16 in. from core barrel ID, 0°.			64, 65	
TMV-CI-115A	115 in. below cold leg centerline, 1/16 in. from core barrel ID, 0°.			64, 65	
TMV-CO-70A	70 in. below cold leg centerline, 1/16 in. from core barrel OD, 0°.			66, 67	
TMV-CO-115A	115 in. below cold leg centerline, 1/16 in. from core barrel OD, 0°.			66, 67	
Core Housing Filler		0 to 2300°F	0 to 1017°F		
TMV-HF-115W	Un. core housing filler, 115 in. below cold leg centerline, 0.20 in. from outer surface, 315°.			68, 69	
TMV-HF-138W	Un. core housing filler, 138 in. below cold leg centerline, 0.20 in. from outer surface, 315°.			68, 69	
Steam Generator		0 to 2300°F	0 to 591°F		
TMU-SG1	On steam generator tubes, 12 in. above bottom of tube sheet, on OD of tube.			70, 71	
TMU-SG2	On steam generator tubes, 24 in. above bottom of tube sheet, on OD of tube.			70, 71	
TMU-SG3	On steam generator tubes, 48 in. above bottom of tube sheet, on OD of tube.			70, 71	
CORE HEATER-CLADDING TEMPERATURES	Chromel-Alumel thermocouples.				
High Power Heaters		0 to 2300°F	0 to 2382°F		
TH-04-14 TH-04-29	Heater at Column D, Row 4. Thermocouples 14 in. (270°) and 29 in. (315°) above bottom of core.			72, 73	
TH-05-29	Heater at Column D, Row 5. Thermocouple 29 in. (225°) above bottom of core.			74, 75	
TH-E4-09 TH-E4-28 TH-E4-55	Heater at Column E, Row 4. Thermocouples 9 in. (180°), 28 in. (90°), and 55 in. (0°) above bottom of core.			76, 77	
TH-E5-25	Heater at Column E, Row 5. Thermocouple 25 in. (90°) above bottom of core.			78, 79	
Low Power Heaters		0 to 2300°F	0 to 2382°F		
TH-A4-09 TH-A4-29 TH-A4-39	Heater at Column A, Row 4. Thermocouples 9 in. (105°), 29 in. (240°) and 39 in. (300°) above bottom of core.			80, 81	

TABLE V (continued)

Measurement	Location and Comments ^[a]	Range ^[a]		Figure ^[a]	Measurement Comments ^[b]
		Detector	Data Acquisition System		
Low Power Heaters (continued)					
TH-A5-29 TH-A5-45	Heater at Column A, Row 5. Thermo- couples 29 in. (180°) and 45 in. (255°) above bottom of core.			82, 83	
TH-B3-32	Heater at Column B, Row 3. Thermo- couple 32 in. (135°) above bottom of core.			84, 85	
TH-B5-29 TH-B5-33	Heater at Column B, Row 5. Thermo- couples 29 in. (150°) and 33 in. (45°) above bottom of core.			86, 87	
TH-B6-29	Heater at Column B, Row 6. Thermo- couple 29 in. (45°) above bottom of core.			88, 89	
TH-C2-38	Heater at Column C, Row 2. Thermo- couple 38 in. (225°) above bottom of core.			90, 91	
TH-C4-26 TH-C4-53	Heater at Column C, Row 4. Thermo- couples 26 in. (75°) and 53 in. (300°) above bottom of core.			92, 93	
TH-C5-28	Heater at Column C, Row 5. Thermo- couple 28 in. (315°) above bottom of core.			94, 95	
TH-C7-07 TH-C7-15	Heater at Column C, Row 7. Thermo- couples 7 in. (345°) and 15 in. (255°) above bottom of core.			96, 97	
TH-D1-21	Heater at Column D, Row 1. Thermo- couple 21 in. (330°) above bottom of core.			98, 99	
TH-D2-14 TH-D2-61	Heater at Column D, Row 2. Thermo- couple 14 in. (0°) and 61 in. (270°) above bottom of core.			100, 101	
TH-D3-29 TH-D3-39	Heater at Column D, Row 3. Thermo- couples 29 in. (150°) and 39 in. (210°) above bottom of core.			102, 103	
TH-D6-15 TH-D6-25	Heater at Column D, Row 6. Thermo- couples 15 in. (90°) and 25 in. (225°) above bottom of core.			104, 105	
TH-D7-20	Heater at Column D, Row 7. Thermo- couple 20 in. (60°) above bottom of core.			106, 107	
TH-D8-27 TH-D8-57	Heater at Column D, Row 8. Thermo- couples 27 in. (180°) and 57 in. (15°) above bottom of core.			108, 109	
TH-E1-33	Heater at Column E, Row 1. Thermo- couple 33 in. (60°) above bottom of core.			110, 111	
TH-E2-20 TH-E2-33	Heater at Column E, Row 2. Thermo- couples 20 in. (210°) and 33 in. (315°) above bottom of core.			112, 113	
TH-E3-05 TH-E3-20 TH-E3-24	Heater at Column E, Row 3. Thermo- couples 5 in. (15°), 20 in. (165°), and 24 in. (75°) above bottom of core.			114, 115	
TH-E6-08 TH-E6-28 TH-E6-31	Heater at Column E, Row 6. Thermo- couples 8 in. (150°), 28 in. (285°), and 31 in. (330°) above bottom of core.			116, 117	
TH-E7-44	Heater at Column E, Row 7. Thermo- couple 44 in. (195°) above bottom of core.			118, 119	
TH-E8-14 TH-E8-29 TH-E8-45	Heater at Column E, Row 8. Thermo- couples 14 in. (150°), 29 in. (225°), and 45 in. (300°) above bottom of core.			120, 121	
TH-F2-07 TH-F2-22 TH-F2-25	Heater at Column F, Row 2. Thermo- couples 7 in. (255°), 22 in. (105°), and 25 in. (0°) above bottom of core.			122, 123	
TH-F4-14 TH-F4-29 TH-F4-44	Heater at Column F, Row 4. Thermo- couples 14 in. (90°), 29 in. (165°), and 44 in. (210°) above bottom of core.			124, 125	

TABLE V (continued)

Measurement	Location and Comments [a]	Detector	Range [a]	Data Acquisition System	Figure [a]	Measurement Comments [b]
Low Power Heaters (continued)						
TH-F5-20 TH-F5-26 TH-F5-33 TH-F5-53	Heater at Column F, Row 5. Thermocouples 20 in. (255°), 26 in. (165°), 33 in. (315°), and 53 in. (30°) above bottom of core.	0 to 2300°F		0 to 2382°F	126, 127	
TH-G3-13	Heater at Column G, Row 3. Thermocouple 13 in. (150°) above bottom of core.				128, 129	
TH-G4-29 TH-G4-33 TH-G4-38	Heater at Column G, Row 4. Thermocouples 29 in. (300°), 33 in. (225°), and 38 in. (30°) above bottom of core.				130, 131	
TH-G5-14 TH-G5-24	Heater at Column G, Row 5. Thermocouples 14 in. (45°) and 24 in. (330°) above bottom of core.				132, 133	
TH-H5-32	Heater at Column H, Row 5. Thermocouple 32 in. (45°) above bottom of core.				134, 135	
PRESSURE						
Intact Loop		0 to 3000 psi				
PU-13	Cold leg, Spool 13, 54 in. from vessel center.			0 to 4590	136, 137	
PU-15L	Cold leg, Spool 15, 16 in. from vessel center, to atmosphere (low range).	0 to 500 psi		0 to 557 psia	136, 137	Detector saturated to t=19 sec.
Broken Loop		0 to 3,000 psi				
PB-23	Cold leg, Spool 23, 92 in. from vessel center, upstream of nozzle (tee off DP tap).			0 to 4310 psia	138, 139	
PB-37	Cold leg, Spool 37, 282 in. from vessel center along hot leg.			0 to 4358 psia	140, 141	
PB-42	Cold leg, Spool 42, 415 in. from vessel center along hot leg, upstream of pump-side nozzle (tee off DP tap).			0 to 4778 psia	140, 141	
PB-HN1	Pump-side nozzle, nozzle throat, 419 in. from vessel center along hot leg (tee off DP tap).			0 to 4623 psia	142, 143	
PB-HN1	Cold leg, Spool 23, pump-side nozzle, nozzle throat, 96 in. from vessel center along cold leg, 45°.	0 to 2600 psi		0 to 3106 psia	144, 145	
Vessel		0 to 3000 psi				
PV-HP+10	In upper plenum, 10 in. above cold leg centerline, mounted on standoff, 30°.			0 to 2430 psia	146, 147	
PV-LP-166	In upper part of lower plenum, 166 in. below cold leg centerline, mounted on standoff, 225°.			0 to 2192 psia	146, 147	
ECC System		0 to 750 psi				
PU-ACC	In intact loop accumulator			0 to 773 psia	148, 149	
PB-ACC	In broken loop accumulator			0 to 746 psia	150, 151	
Steam Generator						
PU-SGSD	Secondary side steam drum.	0 to 3000 psi		0 to 2024 psia	160, 161	
Pressurizer						
PU-PRIZ	Pressurizer steam drum.	0 to 2500 psi		0 to 2190 psia	164, 165	
Pressure Suppression System						
P-PSS	Suppression tank top.	0 to 250 psi		0 to 347 psia	156, 157	

TABLE V (continued)

Measurement	Location and Comments ^[a]	Detector	Range ^[a]		Figure ^[a]	Measurement Comments ^[b]
			Data Acquisition System			
DIFFERENTIAL PRESSURE						
Elevation difference between transducer taps is zero unless otherwise specified.						
<u>Intact Loop</u>						
DPU-UP-3	Upper plenum 10.5 in. above cold leg centerline at 30° to hot leg, Spool 3, 62 in. from vessel center. Upper plenum tap is approximately 2 in. above Spool 3 tap.	+50 in. water	+2.4 psid			Detector failed.
DPU-3-7	Across steam generator, hot leg Spool 3, 62 in. from vessel center to cold leg Spool 7, 231 in. from vessel center. Spool 3 tap is approximately 18 in. above Spool 7 tap.	+500 in. water	+25 psid	158, 159		
DPU-7-10	Steam generator outlet to pump inlet, cold leg Spool 7, 231 in. from vessel center, to cold leg Spool 10, 141 in. from vessel center.	+50 in. water	+5.0 psid	160, 161		
DPU-12-10	Pump outlet to pump inlet, cold leg Spool 12, 75 in. from vessel center, to cold leg Spool 10, 141 in. from vessel center. Spool 10 tap is 10 in. below Spool 12 tap.	+50 psi	+50 psid	162, 163		Questionable data, Spool 12 sense line leaked.
DPU-12-10L	Pump outlet to pump inlet, cold leg Spool 12, 75 in. from vessel center, to cold leg Spool 10, 141 in. from vessel center. Spool 10 tap is 10 in. below Spool 12 tap (low range).	+100 in. water	+4.9 psid	164, 165		Questionable data, Spool 12 sense line leaked.
DPU-12-15	Across cold leg injection point, cold leg Spool 12, 75 in. from vessel center, to cold leg Spool 15, 16 in. from vessel center.	+100 in. water	+5.0 psid	166, 167		Questionable data, Spool 12 sense line leaked.
DPU-15-1	Cold leg to hot leg; cold leg Spool 15, 16 in. from vessel center, to hot leg Spool 1, 31 in. from vessel center. Spool 15 tap is 8.5 in. below Spool 1 tap.	+500 in. water	+24.5 psid	168, 169		
DPU-15-1L	Cold leg to hot leg, cold leg Spool 15, 16 in. from vessel center, to hot leg Spool 1, 31 in. from vessel center. Spool 15 tap is 8.5 in. below Spool 1 tap (low range).	+100 in. water	+2.4 psid	170, 171		Detector saturated prior to t=0 sec and intermittently from t=50 to t=80 sec.
DPU-15-IANN	Cold leg Spool 15, 16 in. from vessel center, to inlet annulus, 9 in. below cold leg centerline at 225°. Spool 15 tap is 9 in. above inlet annulus tap.	+100 in. water	+4.9 psid	172, 173		
DPU-PRESLL	Pressurizer water level. Elevation difference between taps is 53 in. Lower tap is 3.5 in. above pressurizer exit.	+50 in. water	+2.5 psid	174, 175		
DPU-PR-4	Pressurizer bottom to Spool 4. Elevation difference between taps is 62 in. Spool 4 tap is 55 in. below pressurizer exit.	+1000 psi	+1339 psid	176, 177		Questionable data, Spool 4 sense line leaked.
<u>Broken Loop</u>						
DPB-UP-30	Vessel upper plenum, 10.5 in. above cold leg centerline at 30°, to hot leg Spool 30, 18 in. from vessel center. Upper plenum tap is 2 in. above Spool 30 tap.	+100 in. water	+4.8 psid	178, 179		
DPB-21-IANN	Cold leg Spool 21, 49 in. from vessel center, to vessel inlet annulus, 9 in. below cold leg centerline at 225°. Inlet annulus tap is 9 in. below Spool 21 tap.	+100 in. water	+4.8 psid	180, 181		
DPB-30-21	Hot leg, Spool 30, 18 in. from vessel center to cold leg Spool 21, 49 in. from vessel center. Spool 30 tap 8 in. above Spool 21 tap.	+50 psi	+50 psid	182, 183		
NPR-30-36L	Across entire simulated steam generator assembly, hot leg Spool 30, 18 in. from vessel center, to cold leg Spool 36 lower tap, 242 in. from vessel center. Spool 30 tap is 19 in. below Spool 36 lower tap.	+500 psi	+500 psid	184, 185		

TABLE V (continued)

Measurement	Location and Comments ^[a]	Range ^[a]		Figure ^[a]	Measurement Comments ^[b]
		Detector	Data Acquisition System		
Broken Loop (continued)					
DPB-32U-36L	Across simulated steam generator orifice assembly, hot leg Spool 32 upper tap, 73 in. from vessel center, to Spool 36 lower tap, 242 in. from vessel center. Spool 32 upper tap is 16 in. above Spool 36 lower tap.	+500 psi	+500 psid	186, 187	
DPB-36L-37	Across nozzle assembly, Spool 36 lower tap, 242 in. from vessel center along hot leg, to Spool 37, 282 in. from vessel center along hot leg. Spool 37 tap is 40 in. below Spool 36 lower tap.	+50 psi	+50 psid	188, 189	
DPB-37-36	Across turbine flowmeter and drag disc, cold leg Spool 37, 282 in. from vessel center along hot leg, to cold leg Spool 38, 305 in. from vessel center along hot leg. Spool 37 tap is 23 in. above Spool 38 tap.	+50 in. water	+2.6 psid	190, 191	
DPB-38-40	Across simulated pump, cold leg Spool 38, 305 in. from vessel center along hot leg, to cold leg Spool 40, 365 in. from vessel center along hot leg.	+1000 psi	+1000 psid	192, 193	
DPB-40-42	Across elbow leading to spool upstream of pump-side nozzle. Cold leg Spool 40, 365 in. from vessel center along hot leg, to Spool 42, 415 in. from vessel center along hot leg. Spool 40 tap is 40 in. below Spool 42 tap.	+50 in. water	+2.4 psid	194, 195	Data acquisition system saturated from t=0 to t=1 sec and from t=37 to t=39 sec.
DPB-RFD-FI	Across reflood bypass turbine flowmeter, 55 in. to 91 in. from vessel center along hot leg.	+300 in. water	+7.5 psid	196, 197	Data acquisition system saturated from t=65 to t=82 sec.
Vessel					
DPV-UP-1ANN	Upper plenum, 10.5 in. above cold leg centerline at 30° to inlet annulus, 9 in. below cold leg centerline at 225°. Elevation difference between taps is 19 in.	+300 in. water	+14.8 psid	198, 199	
DPV-0-9GQ	Inlet annulus cold leg centerline at 90°, to 9 in. below cold leg centerline at 225°. Elevation difference between taps is 9 in.	+50 in. water	+2.7 psid	200, 201	
DPV-9-26Q	Inlet annulus, 9 in. below cold leg centerline at 225°, to downcomer gap, 26 in. below cold leg centerline at 225°. Elevation difference between taps is 17 in.	+50 in. water	+2.4 psid	202, 203	
DPV-9-166Q	Inlet annulus, 9 in. below cold leg centerline at 225°, to lower plenum, 166 in. below cold leg centerline at 225°. Elevation difference between taps is 157 in.	+300 in. water	+14.6 psid	204, 205	
DPV-26-55QM	Across part of downcomer, 26 in. (225°), to 55 in. (180°), below cold leg centerline. Elevation difference between taps is 29 in.	+50 in. water	+2.8 psid	206, 207	
DPV-55-110QM	Across part of downcomer, 55 in. (180°), to 110 in. (180°), below cold leg centerline. Elevation difference between taps is 55 in.	+100 in. water	+4.9 psid	208, 209	
DPV-110-156HQ	Across part of downcomer, 110 in. (180°), to 156 in. (225°), below cold leg centerline. Elevation difference between taps is 46 in.	+100 in. water	+4.9 psid	210, 211	
DPV-166-1730Q	Across part of lower plenum, 166 in. (225°), to 173 in. (225°), below cold leg centerline. Elevation difference between taps is 7 in.	+20 in. water	+1.0 psid	212, 213	
DPV-166Q-UP	Lower plenum, 166 in. below cold leg centerline at 225°, to upper plenum, 10.5 in. above cold leg centerline at 30°. Elevation difference between taps is 177 in.	+300 in. water	+14.7 psid	214, 215	

TABLE V (continued)

Measurement	Location and Comments ^[a]	Range ^[a]		Figure ^[a]	Measurement Comments ^[b]
		Detector	Data Acquisition System		
<u>Vessel (continued)</u>					
DPU-UP-3	Vessel upper plenum, 10.5 in. above cold leg centerline at 30°, to intact loop hot leg Spool 3, 62 in. from vessel center. Upper plenum tap is ~2 in. above Spool 3 tap.	+50 in. water	+2.4 psid		Detector failed
DPB-21-IANN	Cold leg Spool 21, 49 in. from vessel center, to vessel inlet annulus, 9 in. below cold leg centerline at 225°. Inlet annulus tap is 9 in. below Spool 21 tap.	+100 in. water	+4.8 psid	180, 181	
<u>ECC SYSTEM</u>					
DPU-ACC-TB	Top to bottom of intact loop accumulator. Elevation difference between taps is 108 in.	+500 in. water	+25 psid	216, 217	
DPB-ACC-TB	Top to bottom of broken loop accumulator. Elevation difference between taps is 84 in.	+50 in. water	+2.5 psid	218, 219	
<u>Steam Generator</u>					
DPU-SG-SEC	Secondary side, differential pressure taps at 45 in. and 126 in. above bottom of tube sheet. Elevation difference between taps is 81 in.	+100 in. water	+4.9 psid		Detector failed
DPU-SG-DISC	Across venturi tube, 66 in. downstream from steam generator discharge.	+500 in. water	+24.6 psid	220, 221	
VOLUMETRIC FLOW RATE	Turbine flowmeter, bidirectional.				Data acquisition system range may exceed rated detector range; however, turbine response is linear to flow rates well beyond the rated range.
<u>Intact Loop</u>					
FTU-1	Hot leg, Spool 1, 18 in. from vessel center	+20 to +400 gpm	+1200 gpm	221, 223	
FTU-9	Cold leg, Spool 9, 154 in. from vessel center.	+80 to +800 gpm	+1200 gpm	221, 223	
FTU-13	Cold leg, Spool 13, 64 in. from vessel center.	+20 to +800 gpm	+1200 gpm	224, 225	Data acquisition system saturated intermittently from t=48 to t=68 sec.
FTU-15	Cold leg, Spool 15, 29 in. from vessel center.	+20 to +800 gpm	+1000 gpm	224, 225	
<u>Broken Loop</u>					
FTB-21	Cold leg, Spool 21, 58 in. from vessel center; 3-in. pipe.	+20 to +400 gpm	+1200 gpm	226, 227	
FTB-30	Hot leg, Spool 30, 25 in. from vessel center; 3-in. pipe.	+20 to +400 gpm	+800 gpm	228, 229	Data acquisition system saturated intermittently from t=33 to t=70 sec.
FTB-37	Cold leg, Spool 37, 290 in. from vessel center along hot leg; 2-in. pipe.	+20 to +800 gpm	+800 gpm	228, 229	
FTB-RFB	Reflood bypass line 71 in. from vessel center along hot leg.	+20 to +400 gpm	+1200 gpm	230, 231	Data acquisition system saturated from t=57 to t=60 sec.
<u>Core</u>					
FTV-CORE-IN	Entrance to core, ~158 in. below cold leg centerline.	+2 to +200 gpm	+900 gpm	232, 233	
<u>ECC System</u>					
FTU-LPIS	In line leading from LPIS pump for intact loop; 1/2-in. line. Pump discharge routed to Spool 14.	+0.75 to +7.5 gpm	+10 gpm	234, 235	Data acquisition system saturated near t=0 sec and t=31 sec.
FTB-LPIS	In line leading from LPIS pump for broken loop; 3/4-in. line. Pump discharge routed to Spool 42.	+0.75 to +7.5 gpm	+2.0 gpm	236, 237	
FTU-ACC	In injection line from intact loop accumulator; 1-in. line. Injection point is Spool 14.	+5 to +50 gpm	+75 gpm	238, 239	
FTB-ACC	In injection line from broken loop accumulator; 1-in. line. Injection point is Spool 42.	+2 to +20 gpm	+25 gpm	240, 241	Data acquisition system saturated from t=43 to t=52 sec.

TABLE V (continued)

Measurement	Location and Comments ^[a]	Range ^[a]		Figure ^[a]	Measurement Comments ^[b]
		Detector	Data Acquisition System		
<u>Pressurizer</u>	1-1/2 in. turbine.				
FTU-PRIZE	Surge line.	+5 to +50 gpm	+100 gpm		Detector failed.
<u>FLUID VELOCITY</u>	Turbine flowmeter, bidirectional.				
<u>Downcomer</u>					
FTV-40A	40 in. below cold leg centerline, 0°.	+2.5 to 50 ft/sec	+50 ft/sec	242, 243	
FTV-40M	40 in. below cold leg centerline, 180°.	+2.5 to 50 ft/sec	+50 ft/sec		
<u>MOMENTUM FLUX</u>	Drag disc, bidirectional.				Drag disc data may exhibit significant temperature dependence.
<u>Intact Loop</u>	3-in. pipe				
FDU-1	Hot leg, Spool 1, 29 in. from vessel center; target size 0.875 in.	+200 to +11,500 lbm/ft-sec ²	+20,000 lbm/ft-sec ²	244, 245	
FDU-6	Hot leg, Spool 5, 100 in. from vessel center; target size 1.0 in.	+1 to +2000 lbm/ft-sec ²	+4700 lbm/ft-sec ²	246, 247	Detector saturated prior to t=1 sec.
FDU-10	Cold leg, Spool 10, 137 in. from vessel center; target size 0.875 in.	+200 to +104,000 lbm/ft-sec ²	+23,750 lbm/ft-sec ²	248, 249	
FDU-13	Cold leg, Spool 13, 54 in. from vessel center; target size 0.875 in.	+200 to +14,800 lbm/ft-sec ²	+19,750 lbm/ft-sec ²	250, 251	
FDU-15	Cold leg, Spool 15, 19 in. from vessel center; target size 0.875 in.	+200 to +14,500 lbm/ft-sec ²	+19,750 lbm/ft-sec ²	252, 253	
<u>Broken Loop</u>					
FDB-21	Cold leg, Spool 21, 53 in. from vessel center, 3-in. pipe; target size 0.486 in.	+200 to +70,500 lbm/ft-sec ²	+44,432 lbm/ft-sec ²	254, 255	
FDB-23	Cold leg, Spool 23, 93 in. from vessel center, upstream from vessel side nozzle, 2.0-in. pipe; target size 0.406 in.	+200 to +125,000 lbm/ft-sec ²	+127,760 lbm/ft-sec ²		Detector failed.
FDB-30	Hot leg, Spool 30, 21 in. from vessel center, 3-in. pipe; target size 0.656 in.	+200 to +60,000 lbm/ft-sec ²	+49,450 lbm/ft-sec ²	256, 257	
FDB-37	Cold leg, Spool 37, 284 in. from vessel center along hot leg, steam generator outlet vertical pipe, 2-in. pipe; target size 0.406 in.	+200 to +121,000 lbm/ft-sec ²	+203,210 lbm/ft-sec ²	258, 259	
FDB-42	Cold leg, Spool 42, 416 in. from vessel center along hot leg, upstream of pump-side nozzle, downstream of injection point, 2-in. pipe; target size 0.406 in.	+200 to +116,000 lbm/ft-sec ²	+101,780 lbm/ft-sec ²	260, 261	
FDB-RFB	Ratlood bypass line, 65 in. from vessel center along hot leg, 3-in. pipe; target size 0.406 in.	+200 to +200,000 lbm/ft-sec ²	+127,660 lbm/ft-sec ²	262, 263	
<u>Vessel</u>					
FDB-CORE-IN	In core flow mixer box 150 in. below cold leg centerline; target size 1.0 in.	+1 to +2000 lbm/ft-sec ²	+1220 lbm/ft-sec ²	264, 265	
<u>DENSITY</u>					
<u>Intact Loop</u>		0.1 to 100 lbm/ft ³	0 to 100 lbm/ft ³		
GU-1VR	Hot leg, Spool 1, 24 in. from vessel center, vertical.			266, 267	
GU-1HZ	Hot leg, Spool 1, 26 in. from vessel center, horizontal.			266, 267	
GU-5VR	Hot leg, Spool 5, 96 in. from vessel center, vertical.			268, 269	
GU-10 VR	Cold leg, Spool 10, 141 in. from vessel center, vertical.			268, 269	
GU-13VR	Cold leg, Spool 13, 59 in. from vessel center, vertical.			270, 271	
GU-15VR	Cold leg, Spool 15, 23 in. from vessel center, vertical.			272, 273	Data values above 62.4 lbm/ft ³ do not reflect actual system density and were the result of detector photomultiplier tube nonlinearity.
GU-15HZ	Cold leg, Spool 15, 20 in. from vessel center, horizontal.			272, 273	

TABLE V (continued)

Measurement	Location and Comments [a]	Range [a]		Figure [a]	Measurement Comments [b]
		Detector	Data Acquisition System		
Broken Loop					
		0.1 to 100 lbm/ft ³	0 to 100 lbm/ft ³		
GB-21T GB-21B GB-21C	Cold leg Spool 21, 49 in. from vessel center. T(top) ranges 270 to 360 degrees. B(bottom) ranges 30 to 330 degrees. C, mathematical composite of T and B.			274, 275 276, 277 278, 279	During blowdown, between t=1 and t=5 sec, flow patterns resulting from a bend in the upstream piping increased the uncertainty in the average density obtained by the data processing model by approximately ± 2 lbm/ft ³ .
GB-23VR	Cold leg, Spool 23, 92 in. from vessel center, vertical.			280, 281	
GB-30T GB-30B GB-30C	Hot leg Spool 30, 18 in. from vessel center. T(top) ranges 270 to 360 degrees. B(bottom) ranges 30 to 330 degrees. C, mathematical composite of T and B.			282, 283 284, 285 286, 287	
GB-42VR	Cold leg, Spool 42, 415 in. from vessel center along hot leg, vertical.			288, 289	
GB-RFB-T GB-RFB-B	Reflood bypass line 60 in. from vessel center along hot leg. T(top) ranges 270 to 360 degrees. B(bottom) ranges 30 to 330 degrees.			290, 291 292, 293	
Vessel					
		0.1 to 100 lbm/ft ³	0 to 100 lbm/ft ³		
GV-COR-150HZ	Core flow mixer box, 152 in. below cold leg centerline, horizontal, 0 to 180°.			294, 295	
GVL-165HZ	Upper part of lower plenum, 165 in. below cold leg centerline, 1.724 in. below downcomer exit, horizontal, 0 to 180°.			296, 297	
GVL-172HZ	Lower plenum, 172 in. below cold leg centerline, 8.729 in. below downcomer exit, horizontal, 90 to 270°.			296, 297	
Pressurizer					
GU-PRIZE	Surge line.	0.1 to 100 lbm/ft ³	0 to 100 lbm/ft ³	298, 299	
MASS FLOW RATE					
	Mass flow rate obtained by combining density (gamma attenuation technique) with volumetric flow rate (turbine flowmeter) or momentum flux (drag disc).	Range for mass flow is determined from range of individual detectors used in calculation.			
Intact Loop					
FDU-1, GU-1VR FTU-1, GU-1VR	Hot leg, Spool 1.			300, 301 302, 303	
FDU-5, GU-5VR	Hot leg, Spool 5.			304, 305	Detector FDU-5 saturated until t=1 sec.
FTU-9, GU-10VR	Cold leg, Spool 9.			306, 307	
FDU-10, GU-10VR	Cold leg, Spool 10.			308, 309	
FDU-13, GU-13VR FTU-13, GU-13VR	Cold leg, Spool 13.			310, 311 312, 213	
FDU-15, GU-15VR FTU-15, GU-15VR	Cold leg, Spool 15.			314, 315 316, 317	
Broken Loop					
FDB-21, GB-21C FTB-21, GB-21C	Cold leg, Spool 21.			318, 319 320, 321	During blowdown, between t=1 and t=5 sec, flow patterns resulting from a bend in the upstream piping increased the uncertainty in the average density obtained by the data processing model by approximately ± 2 lbm/ft ³ .
FDB-23, GB-23VR	Cold leg Spool 23.				
FDB-30, GB-30C FTB-30, GB-30C	Hot leg, Spool 30.			322, 323 324, 325	
FDB-42, GB-42VR	Cold leg, Spool 42.			326, 327	FDB-23 failed.
FDB-RFB, GB-RFB-B FTB-RFB, GB-RFB-B	Reflood bypass.			328, 329 330, 331	

TABLE V (continued)

Measurement	Location and Comments [a]	Range [a]		Figure [a]	Measurement Comments [b]
		Detector	Data Acquisition System		
<u>Vessel</u>					
FDV-CORE-IN, GV-COR-150HZ	Entrance to core.			332, 333	
FTV-CORE-IN, GV-COR-150HZ	Entrance to core.			334, 335	
<u>Pressurizer</u>					
FTU-PRIZE GU-PRIZE	Pressurizer surge line.				FTU-PRIZE failed.
CORE CHARACTERISTICS					
PWRCOR T-1	Core power.		1600 kW	336, 337	
PWRCOR T-2	Core power.		1600 kW	336, 337	
VOLTCOR-T	Core voltage.		0 to 200 Vdc	338, 339	
AMPCOR-T	Core current.		0 to 10,000 A	340, 341	
PUMP CHARACTERISTICS					
PUMPV-RPM	Pump speed.		0 to 3600 rpm	342, 343	
PUMPU-CUR	Pump current.		0 to 25 A	344, 345	

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

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

Fig. 10 Fluid temperature in intact loop hot leg (RBU-2), from -20 to 300 sec.

Fig. 11 Fluid temperature in intact loop hot leg (RBU-2), from -6 to 42 sec.

Fig. 12 Fluid temperature in intact loop cold leg (TSU-7, TFU-10, and RBU-14A), from -20 to 300 sec.

Fig. 13 Fluid temperature in intact loop cold leg (TSU-7, TFU-10, and RBU-14A), from -6 to 42 sec.

Fig. 14 Fluid temperature in broken loop, vessel side (TFB-20 and TFB-23), from -20 to 300 sec.

Fig. 15 Fluid temperature in broken loop, vessel side (TFB-20 and TFB-23), from -6 to 42 sec.

Fig. 16 Fluid temperature in broken loop, pump side (TFB-30, TFB-37, and TFB-42), from -20 to 300 sec.

Fig. 17 Fluid temperature in broken loop, pump side (TFB-30, TFB-37, and TFB-42), from -6 to 42 sec.

Fig. 18 Fluid temperature in broken loop, reflood bypass line (TFB-RFB), from -20 to 300 sec.

Fig. 19 Fluid temperature in broken loop, reflood bypass line (TFB-RFB), from -6 to 42 sec.

Fig. 20 Fluid temperature in inlet annulus (TFV-ANN-4A and TFV-ANN-4M), from -20 to 300 sec.

Fig. 21 Fluid temperature in inlet annulus (TFV-ANN-4A and TFV-ANN-4M), from -6 to 42 sec.

Fig. 22 Fluid temperature in downcomer annulus (TFV-ANN-35A, TFV-ANN-70A, TFV-ANN-115A, and TFV-ANN-156A), from -20 to 300 sec.

Fig. 23 Fluid temperature in downcomer annulus (TFV-ANN-35A, TFV-ANN-70A, TFV-ANN-115A, and TFV-ANN-156A), from -6 to 42 sec.

Fig. 24 Fluid temperature in upper plenum (TFV-UP+13), from -20 to 300 sec.

Fig. 25 Fluid temperature in upper plenum (TFV-UP+13), from -6 to 42 sec.

Fig. 26 Fluid temperature in lower plenum (TFV-LP-2 and TFV-LP-7), from -20 to 300 sec.

Fig. 27 Fluid temperature in lower plenum (TFV-LP-2 and TFV-LP-7), from -6 to 42 sec.

Fig. 28 Fluid temperature in core inlet (TFV-CORE-IN), from -20 to 300 sec.

Fig. 29 Fluid temperature in core inlet (TFV-CORE-IN), from -6 to 42 sec.

Fig. 30 Fluid temperature in core, Grid Spacer 5 (TFG-5CD-45), from -20 to 300 sec.

Fig. 31 Fluid temperature in core, Grid Spacer 5 (TFG-5CD-45), from -6 to 42 sec.

Fig. 32 Fluid temperature in core, Grid Spacer 6 (TFG-6CD-45), from -20 to 300 sec.

Fig. 33 Fluid temperature in core, Grid Spacer 6 (TFG-6CD-45), from -6 to 42 sec.

Fig. 34 Fluid temperature in core barrel insulation gap (TFV-CIG-70A), from -20 to 300 sec.

Fig. 35 Fluid temperature in core barrel insulation gap (TFV-CIG-70A), from -6 to 42 sec.

Fig. 36 Fluid temperature in vessel filler insulation gap (TFV-FIG-156A), from -20 to 300 sec.

Fig. 37 Fluid temperature in vessel filler insulation gap (TFV-FIG-156A), from -6 to 42 sec.

Fig. 38 Fluid temperature in intact loop coolant injection line (TFU-ECC-14), from -20 to 300 sec.

Fig. 39 Fluid temperature in intact loop coolant injection line (TFU-ECC-14), from -6 to 42 sec.

Fig. 40 Fluid temperature in broken loop coolant injection line (TFB-ECC-42), from -20 to 300 sec.

Fig. 41 Fluid temperature in broken loop coolant injection line (TFB-ECC-42), from -6 to 42 sec.

Fig. 42 Fluid temperature in steam generator feedwater line (TFU-SGFW), from -20 to 300 sec.

Fig. 43 Fluid temperature in steam generator feedwater line (TFU-SGFW), from -6 to 42 sec.

Fig. 44 Fluid temperature in steam generator, secondary side (TFU-SG1 and TFU-SG3), from -20 to 300 sec.

Fig. 45 Fluid temperature in steam generator, secondary side (TFU-SG1 and TFU-SG3), from -6 to 42 sec.

Fig. 46 Fluid temperature in pressurizer surge line (TFU-PRIZE), from -20 to 300 sec.

Fig. 47 Fluid temperature in pressurizer surge line (TFU-PRIZE), from -6 to 42 sec.

Fig. 48 Fluid temperature in pressure suppression tank (TF-PSS-33 and TF-PSS-130), from -20 to 300 sec.

Fig. 49 Fluid temperature in pressure suppression tank (TF-PSS-33 and TF-PSS-130), from -6 to 42 sec.

Fig. 50 Material temperature in intact loop (TMU-1T16 and TMU-15T16), from -20 to 300 sec.

Fig. 51 Material temperature in intact loop (TMU-1T16 and TMU-15T16), from -6 to 42 sec.

Fig. 52 Material temperature in broken loop (TMB-20B16), from -20 to 300 sec.

Fig. 53 Material temperature in broken loop (TMB-20B16), from -6 to 42 sec.

Fig. 54 Material temperature in reflood bypass line (TMB-RFB), from -20 to 300 sec.

Fig. 55 Material temperature in reflood bypass line (TMB-RFB), from -6 to 42 sec.

Fig. 56 Material temperature in vessel filler (TMV-FI-4M, TMV-FI-15A, and TMV-FI-35A), from -20 to 300 sec.

Fig. 57 Material temperature in vessel filler (TMV-FI-4M, TMV-FI-15A, and TMV-FI-35A), from -6 to 42 sec.

Fig. 58 Material temperature in vessel filler (TMV-FI-115A and TMV-FI-156A), from -20 to 300 sec.

Fig. 59 Material temperature in vessel filler (TMV-FI-115A and TMV-FI-156A), from -6 to 42 sec.

Fig. 60 Material temperature in vessel filler (TMV-F0-156A), from -20 to 300 sec.

Fig. 61 Material temperature in vessel filler (TMV-F0-156A), from -6 to 42 sec.

Fig. 62 Material temperature in vessel filler insulator (TIV-F0-35A, TIV-F0-35M, TIV-F0-70A, and TIV-F0-115A), from -20 to 300 sec.

Fig. 63 Material temperature in vessel filler insulator (TIV-F0-35A, TIV-F0-35M, TIV-F0-70A, and TIV-F0-115A), from -6 to 42 sec.

Fig. 64 Material temperature in core barrel inner diameter (TMV-CI-70A and TMV-CI-115A), from -20 to 300 sec.

Fig. 65 Material temperature in core barrel inner diameter (TMV-CI-70A and TMV-CI-115A), from -6 to 42 sec.

Fig. 66 Material temperature in core barrel outer diameter (TMV-CO-70A and TMV-CO-115A), from -20 to 300 sec.

Fig. 67 Material temperature in core barrel outer diameter (TMV-CO-70A and TMV-CO-115A), from -6 to 42 sec.

Fig. 68 Material temperature on core housing filler (TMV-HF-115W and TMV-HF-138W), from -20 to 300 sec.

Fig. 69 Material temperature on core housing filler (TMV-HF-115W and TMV-HF-138W), from -6 to 42 sec.

Fig. 70 Material temperature in steam generator (TMU-SG1, TMU-SG2, and TMU-SG3), from -20 to 300 sec.

Fig. 71 Material temperature in steam generator (TMU-SG1, TMU-SG2, and TMU-SG3), from -6 to 42 sec.

Fig. 72 Core heater temperature, Rod D-4 (TH-D4-14 and TH-D4-29), from -20 to 300 sec.

Fig. 73 Core heater temperature, Rod D-4 (TH-D4-14 and TH-D4-29), from -6 to 42 sec.

Fig. 74 Core heater temperature, Rod D-5 (TH-D5-29), from -20 to 300 sec.

Fig. 75 Core heater temperature, Rod D-5 (TH-D5-29), from -6 to 42 sec.

Fig. 76 Core heater temperature, Rod E-4 (TH-E4-09, TH-E4-28, and TH-E4-55), from -20 to 300 sec.

Fig. 77 Core heater temperature, Rod E-4 (TH-E4-09, TH-E4-28, and TH-E4-55), from -6 to 42 sec.

Fig. 78 Core heater temperature, Rod E-5 (TH-E5-25), from -20 to 300 sec.

Fig. 79 Core heater temperature, Rod E-5 (TH-E5-25), from -6 to 42 sec.

Fig. 80 Core heater temperature, Rod A-4 (TH-A4-09, TH-A4-29, and TH-A4-39), from -20 to 300 sec.

Fig. 81 Core heater temperature, Rod A-4 (TH-A4-09, TH-A4-29, and TH-A4-39), from -6 to 42 sec.

Fig. 82 Core heater temperature, Rod A-5 (TH-A5-29 and TH-A5-45), from -20 to 300 sec.

Fig. 83 Core heater temperature, Rod A-5 (TH-A5-29 and TH-A5-45), from -6 to 42 sec.

Fig. 84 Core heater temperature, Rod B-3 (TH-B3-32), from -20 to 300 sec.

Fig. 85 Core heater temperature, Rod B-3 (TH-B3-32), from -6 to 42 sec.

Fig. 86 Core heater temperature, Rod B-5 (TH-B5-29 and TH-B5-33), from -20 to 300 sec.

Fig. 87 Core heater temperature, Rod B-5 (TH-B5-29 and TH-B5-33), from -6 to 42 sec.

Fig. 88 Core heater temperature, Rod B-6 (TH-B6-29), from -20 to 300 sec.

Fig. 89 Core heater temperature, Rod B-6 (TH-B6-29), from -6 to 42 sec.

Fig. 90 Core heater temperature, Rod C-2 (TH-C2-38), from -20 to 300 sec.

Fig. 91 Core heater temperature, Rod C-2 (TH-C2-38), from -6 to 42 sec.

Fig. 92 Core heater temperature, Rod C-4 (TH-C4-26 and TH-C4-53), from -20 to 300 sec.

Fig. 93 Core heater temperature, Rod C-4 (TH-C4-26 and TH-C4-53), from -6 to 42 sec.

Fig. 94 Core heater temperature, Rod C-5 (TH-C5-28), from -20 to 300 sec.

Fig. 95 Core heater temperature, Rod C-5 (TH-C5-28), from -6 to 42 sec.

Fig. 96 Core heater temperature, Rod C-7 (TH-C7-07 and TH-C7-15), from -20 to 300 sec.

Fig. 97 Core heater temperature, Rod C-7 (TH-C7-07 and TH-C7-15), from -6 to 42 sec.

Fig. 98 Core heater temperature, Rod D-1 (TH-D1-21), from -20 to 300 sec.

Fig. 99 Core heater temperature, Rod D-1 (TH-D1-21), from -6 to 42 sec.

Fig. 100 Core heater temperature, Rod D-2 (TH-D2-14 and TH-D2-61), from -20 to 300 sec.

Fig. 101 Core heater temperature, Rod D-2 (TH-D2-14 and TH-D2-61), from -6 to 42 sec.

Fig. 102 Core heater temperature, Rod D-3 (TH-D3-29 and TH-D3-39), from -20 to 300 sec.

Fig. 103 Core heater temperature, Rod D-3 (TH-D3-29 and TH-D3-39), from -6 to 42 sec.

Fig. 104 Core heater temperature, Rod D-6 (TH-D6-15 and TH-D6-25), from -20 to 300 sec.

Fig. 105 Core heater temperature, Rod D-6 (TH-D6-15 and TH-D6-25), from -6 to 42 sec.

Fig. 106 Core heater temperature, Rod D-7 (TH-D7-20), from -20 to 300 sec.

Fig. 107 Core heater temperature, Rod D-7 (TH-D7-20), from -6 to 42 sec.

Fig. 108 Core heater temperature, Rod D-8 (TH-D8-27 and TH-D8-57), from -20 to 300 sec.

Fig. 109 Core heater temperature, Rod D-8 (TH-D8-27 and TH-D8-57), from -6 to 42 sec.

Fig. 110 Core heater temperature, Rod E-1 (TH-E1-33), from -20 to 300 sec.

Fig. 111 Core heater temperature, Rod E-1 (TH-E1-33), from -6 to 42 sec.

Fig. 112 Core heater temperature, Rod E-2 (TH-E2-20 and TH-E2-33), from -20 to 300 sec.

Fig. 113 Core heater temperature, Rod E-2 (TH-E2-20 and TH-E2-33), from -6 to 42 sec.

Fig. 114 Core heater temperature, Rod E-3 (TH-E3-05, TH-E3-20, and TH-E3-24), from -20 to 300 sec.

Fig. 115 Core heater temperature, Rod E-3 (TH-E3-05, TH-E3-20, and TH-E3-24), from -6 to 42 sec.

Fig. 116 Core heater temperature, Rod E-6 (TH-E6-08, TH-E6-28, and TH-E6-37), from -20 to 300 sec.

Fig. 117 Core heater temperature, Rod E-6 (TH-E6-08, TH-E6-28, and TH-E6-37), from -6 to 42 sec.

Fig. 118 Core heater temperature, Rod E-7 (TH-E7-44), from -20 to 300 sec.

Fig. 119 Core heater temperature, Rod E-7 (TH-E7-44), from -6 to 42 sec.

Fig. 120 Core heater temperature, Rod E-8 (TH-E8-14, TH-E8-29, and TH-E8-45), from -20 to 300 sec.

Fig. 121 Core heater temperature, Rod E-8 (TH-E8-14, TH-E8-29, and TH-E8-45), from -6 to 42 sec.

Fig. 122 Core heater temperature, Rod F-2 (TH-F2-07, TH-F2-22, and TH-F2-25), from -20 to 300 sec.

Fig. 123 Core heater temperature, Rod F-2 (TH-F2-07, TH-F2-22, and TH-F2-25), from -6 to 42 sec.

Fig. 124 Core heater temperature, Rod F-4 (TH-F4-14, TH-F4-29, and TH-F4-44), from -20 to 300 sec.

Fig. 125 Core heater temperature, Rod F-4 (TH-F4-14, TH-F4-29, and TH-F4-44), from -6 to 42 sec.

Fig. 126 Core heater temperature, Rod F-5 (TH-F5-20, TH-F5-26, TH-F5-33, and TH-F5-53), from -20 to 300 sec.

Fig. 127 Core heater temperature, Rod F-5 (TH-F5-20, TH-F5-26, TH-F5-33, and TH-F5-53), from -6 to 42 sec.

Fig. 128 Core heater temperature, Rod G-3 (TH-G3-13), from -20 to 300 sec.

Fig. 129 Core heater temperature, Rod G-3 (TH-G3-13), from -6 to 42 sec.

Fig. 130 Core heater temperature, Rod G-4 (TH-G4-29, TH-G4-33, and TH-G4-38), from -20 to 300 sec.

Fig. 131 Core heater temperature, Rod G-4 (TH-G4-29, TH-G4-33, and TH-G4-38), from -6 to 42 sec.

Fig. 132 Core heater temperature, Rod G-5 (TH-G5-14 and TH-G5-24), from -20 to 300 sec.

Fig. 133 Core heater temperature, Rod G-5 (TH-G5-14 and TH-G5-24), from -6 to 42 sec.

Fig. 134 Core heater temperature, Rod H-5, (TH-H5-32), from -20 to 300 sec.

Fig. 135 Core heater temperature, Rod H-5, (TH-H5-32), from -6 to 42 sec.

Fig. 136 Pressure in intact loop (PU-13 and PU-15L), from -20 to 300 sec.

Fig. 137 Pressure in intact loop (PU-13 and PU-15L), from -6 to 42 sec.

Fig. 138 Pressure in broken loop, vessel side, Spool 23 (PB-23), from -20 to 300 sec.

Fig. 139 Pressure in broken loop, vessel side, Spool 23 (PB-23), from -6 to 42 sec.

Fig. 140 Pressure in broken loop, pump side (PB-37 and PB-42), from -20 to 300 sec.

Fig. 141 Pressure in broken loop, pump side (PB-37 and PB-42), from -6 to 42 sec.

Fig. 142 Pressure in broken loop, pump-side nozzle (PB-HN1), from -20 to 300 sec.

Fig. 143 Pressure in broken loop, pump-side nozzle (PB-HN1), from -6 to 42 sec.

Fig. 144 Pressure in broken loop, vessel-side nozzle (PB-CN1), from -20 to 300 sec.

Fig. 145 Pressure in broken loop, vessel-side nozzle (PB-CN1), from -6 to 42 sec.

Fig. 146 Pressure in vessel (PV-UP+10 and PV-LP-166), from -20 to 300 sec.

Fig. 147 Pressure in vessel (PV-UP+10 and PV-LP-166), from -6 to 42 sec.

Fig. 148 Pressure in intact loop accumulator (PU-ACC), from -20 to 300 sec.

Fig. 149 Pressure in intact loop accumulator (PU-ACC), from -6 to 42 sec.

Fig. 150 Pressure in broken loop accumulator (PB-ACC), from -20 to 300 sec.

Fig. 151 Pressure in broken loop accumulator (PB-ACC), from -6 to 42 sec.

Fig. 152 Pressure in steam generator, secondary side (PU-SGSD), from -20 to 300 sec.

Fig. 153 Pressure in steam generator, secondary side (PU-SGSD), from -6 to 42 sec.

Fig. 154 Pressure in pressurizer (PU-PRIZE), from -20 to 300 sec.

Fig. 155 Pressure in pressurizer (PU-PRIZE), from -6 to 42 sec.

Fig. 156 Pressure in pressure suppression tank (P-PSS), from -20 to 300 sec.

Fig. 157 Pressure in pressure suppression tank (P-PSS), from -6 to 42 sec.

Fig. 158 Differential pressure in intact loop (DPU-3-7), from -20 to 300 sec.

Fig. 159 Differential pressure in intact loop (DPU-3-7), from -6 to 42 sec.

Fig. 160 Differential pressure in intact loop (DPU-7-10), from -20 to 300 sec.

Fig. 161 Differential pressure in intact loop (DPU-7-10), from -6 to 42 sec.

Fig. 162 Differential pressure in intact loop (DPU-12-10), from -20 to 300 sec.

Fig. 163 Differential pressure in intact loop (DPU-12-10), from -6 to 42 sec.

Fig. 164 Differential pressure in intact loop, low range (DPU-12-10L), from -20 to 300 sec.

Fig. 165 Differential pressure in intact loop, low range (DPU-12-10L), from -6 to 42 sec.

Fig. 166 Differential pressure in intact loop (DPU-12-15), from -20 to 300 sec.

Fig. 167 Differential pressure in intact loop (DPU-12-15), from -6 to 42 sec.

Fig. 168 Differential pressure in intact loop (DPU-15-1), from -20 to 300 sec.

Fig. 169 Differential pressure in intact loop (DPU-15-1), from -6 to 42 sec.

Fig. 170 Differential pressure in intact loop, low range (DPU-15-1L), from -20 to 300 sec.

Fig. 171 Differential pressure in intact loop, low range (DPU-15-1L), from -6 to 42 sec.

Fig. 172 Differential pressure in intact loop (DPU-15-IANN), from -20 to 300 sec.

Fig. 173 Differential pressure in intact loop (DPU-15-IANN), from -6 to 42 sec.

Fig. 174 Differential pressure in intact loop (DPU-PRESLL), from -20 to 300, sec.

Fig. 175 Differential pressure in intact loop (DPU-PRESLL), from -6 to 42 sec.

Fig. 176 Differential pressure in intact loop (DPU-PR-4), from -20 to 300 sec.

Fig. 177 Differential pressure in intact loop (DPU-PR-4), from -6 to 42 sec.

Fig. 178 Differential pressure in broken loop (DPB-UP-30), from -20 to 300 sec.

Fig. 179 Differential pressure in broken loop (DPB-UP-30), from -6 to 42 sec.

Fig. 180 Differential pressure in broken loop (DPB-21-IANN), from -20 to 300 sec.

Fig. 181 Differential pressure in broken loop (DPB-21-IANN), from -6 to 42 sec.

Fig. 182 Differential pressure in broken loop (DPB-30-21), from -20 to 300 sec.

Fig. 183 Differential pressure in broken loop (DPB-30-21), from -6 to 42 sec.

Fig. 184 Differential pressure in broken loop (DPB-30-36L), from -20 to 300 sec.

Fig. 185 Differential pressure in broken loop (DPB-30-36L), from -6 to 42 sec.

Fig. 186 Differential pressure in broken loop (DPB-32U-36L), from -20^x to 300 sec.

Fig. 187 Differential pressure in broken loop (DPB-32U-36L), from -6 to 42 sec.

Fig. 188 Differential pressure in broken loop (DPB-36L-37), from -20 to 300 sec.

Fig. 189 Differential pressure in broken loop (DPB-36L-37), from -6 to 42 sec.

Fig. 190 Differential pressure in broken loop (DPB-37-38), from -20 to 300 sec.

Fig. 191 Differential pressure in broken loop (DPB-37-38), from -6 to 42 sec.

Fig. 192 Differential pressure in broken loop (DPB-38-40), from -20 to 300 sec.

Fig. 193 Differential pressure in broken loop (DPB-38-40), from -6 to 42 sec.

Fig. 194 Differential pressure in broken loop (DPB-40-42), from -20 to 300 sec.

Fig. 195 Differential pressure in broken loop (DPB-40-42), from -6 to 42 sec.

Fig. 196 Differential pressure in broken loop, reflood bypass (DPB-RFB-FT), from -20 to 300 sec.

Fig. 197 Differential pressure in broken loop, reflood bypass (DPB-RFB-FT), from -6 to 42 sec.

Fig. 198 Differential pressure in vessel (DPV-UP-IANN), from -20 to 300 sec.

Fig. 199 Differential pressure in vessel (DPV-UP-IANN), from -6 to 42 sec.

Fig. 200 Differential pressure in vessel (DPV-0-9GQ), from -20 to 300 sec.

Fig. 201 Differential pressure in vessel (DPV-0-9GQ), from -6 to 42 sec.

Fig. 202 Differential pressure in vessel (DPV-9-26QQ), from -20 to 300 sec.

Fig. 203 Differential pressure in vessel (DPV-9-26QQ), from -6 to 42 sec.

Fig. 204 Differential pressure in vessel (DPV-9-166QQ), from -20 to 300 sec.

Fig. 205 Differential pressure in vessel (DPV-9-166QQ), from -6 to 42 sec.

Fig. 206 Differential pressure in vessel (DPV-26-55QM), from -20 to 300 sec.

Fig. 207 Differential pressure in vessel (DPV-26-55QM), from -6 to 42 sec.

Fig. 208 Differential pressure in vessel (DPV-55-110MM), from -20 to 300 sec.

Fig. 209 Differential pressure in vessel (DPV-55-110MM), from -6 to 42 sec.

Fig. 210 Differential pressure in vessel (DPV-110-156MQ), from -20 to 300 sec.

Fig. 211 Differential pressure in vessel (DPV-110-156MQ), from -6 to 42 sec.

Fig. 212 Differential pressure in vessel (DPV-166-173QQ), from -20 to 300 sec.

Fig. 213 Differential pressure in vessel (DPV-166-173QQ), from -6 to 42 sec.

Fig. 214 Differential pressure in vessel (DPV-166Q-UP), from -20 to 300 sec.

Fig. 215 Differential pressure in vessel (DPV-166Q-UP), from -6 to 42 sec.

Fig. 216 Differential pressure in intact loop accumulator (DPU-ACC-TB), from -20 to 300 sec.

Fig. 217 Differential pressure in intact loop accumulator (DPU-ACC-TB), from -6 to 42 sec.

Fig. 218 Differential pressure in broken loop accumulator (DPB-ACC-TB), from -20 to 300 sec.

Fig. 219 Differential pressure in broken loop accumulator (DPB-ACC-TB), from -6 to 42 sec.

Fig. 220 Differential pressure across steam generator outlet orifice (DPU-SG-DISC), from -20 to 300 sec.

Fig. 221 Differential pressure across steam generator outlet orifice (DPU-SG-DISC), from -6 to 42 sec.

Fig. 222 Volumetric flow in intact loop (FTU-1 and FTU-9), from -20 to 300 sec.

Fig. 223 Volumetric flow in intact loop (FTU-1 and FTU-9), from -6 to 42 sec.

Fig. 224 Volumetric flow in intact loop (FTU-13 and FTU-15), from -20 to 300 sec.

Fig. 225 Volumetric flow in intact loop (FTU-13 and FTU-15), from -6 to 42 sec.

Fig. 226 Volumetric flow in broken loop (FTB-21), from -20 to 300 sec.

Fig. 227 Volumetric flow in broken loop (FTB-21), from -6 to 42 sec.

Fig. 228 Volumetric flow in broken loop (FTB-30 and FTB-37), from -20 to 300 sec.

Fig. 229 Volumetric flow in broken loop (FTB-30 and FTB-37), from -6. to 42 sec.

Fig. 230 Volumetric flow in broken loop, reflood bypass (FTB-RFB), from -20 to 300 sec.

Fig. 231 Volumetric flow in broken loop, reflood bypass (FTB-RFB), from -6 to 42 sec.

Fig. 232 Volumetric flow in core entrance (FTV-CORE-IN), from -20 to 300 sec.

Fig. 233 Volumetric flow in core entrance (FTV-CORE-IN), from -6 to 42 sec.

Fig. 234 Volumetric flow in intact loop low pressure injection line (FTU-LPIS), from -20 to 300 sec.

Fig. 235 Volumetric flow in intact loop low pressure injection line (FTU-LPIS), from -6 to 42 sec.

Fig. 236 Volumetric flow in broken loop low pressure injection line (FTB-LPIS), from -20 to 300 sec.

Fig. 237 Volumetric flow in broken loop low pressure injection line (FTB-LPIS), from -6 to 42 sec.

Fig. 238 Volumetric flow in intact loop accumulator discharge line (FTU-ACC), from -20 to 300 sec.

Fig. 239 Volumetric flow in intact loop accumulator discharge line (FTU-ACC), from -6 to 42 sec.

Fig. 240 Volumetric flow in broken loop accumulator discharge line (FTB-ACC), from -20 to 300 sec.

Fig. 241 Volumetric flow in broken loop accumulator discharge line (FTB-ACC), from -6 to 42 sec.

Fig. 242 Fluid velocity in vessel (FTV-40A and FTV-40M), from -20 to 300 sec.

Fig. 243 Fluid velocity in vessel (FTV-40A and FTV-40M), from -6 to 42 sec.

Fig. 244 Momentum flux in intact loop (FDU-1), from -20 to 300 sec.

Fig. 245 Momentum flux in intact loop (FDU-1), from -6 to 42 sec.

Fig. 246 Momentum flux in intact loop (FDU-5), from -20 to 300 sec.

Fig. 247 Momentum flux in intact loop (FDU-5), from -6 to 42 sec.

Fig. 248 Momentum flux in intact loop (FDU-10), from -20 to 300 sec.

Fig. 249 Momentum flux in intact loop (FDU-10), from -6 to 42 sec.

Fig. 250 Momentum flux in intact loop (FDU-13), from -20 to 300 sec.

Fig. 251 Momentum flux in intact loop (FDU-13), from -6 to 42 sec.

Fig. 252 Momentum flux in intact loop (FDU-15), from -20 to 300 sec.

Fig. 253 Momentum flux in intact loop (FDU-15), from -6 to 42 sec.

Fig. 254 Momentum flux in broken loop (FDB-21), from -20 to 300 sec.

Fig. 255 Momentum flux in broken loop (FDB-21), from -6 to 42 sec.

Fig. 256 Momentum flux in broken loop (FDB-30), from -20 to 300 sec.

Fig. 257 Momentum flux in broken loop (FDB-30), from -6 to 42 sec.

Fig. 258 Momentum flux in broken loop (FDB-37), from -20 to 300 sec.

Fig. 259 Momentum flux in broken loop (FDB-37), from -6 to 42 sec.

Fig. 260 Momentum flux in broken loop (FDB-42), from -20 to 300 sec.

Fig. 261 Momentum flux in broken loop (FDB-42), from -6 to 42 sec.

Fig. 262 Momentum flux in broken loop, reflood bypass (FDB-RFB), from -20 to 300 sec.

Fig. 263 Momentum flux in broken loop, reflood bypass (FDB-RFB), from -6 to 42 sec.

Fig. 264 Momentum flux in core entrance (FDV-CORE-IN), from -20 to 300 sec.

Fig. 265 Momentum flux in core entrance (FDV-CORE-IN), from -6 to 42 sec.

Fig. 266 Density in intact loop (GU-1VR and GU-1HZ), from -20 to 300 sec.

Fig. 267 Density in intact loop (GU-1VR and GU-1HZ), from -6 to 42 sec.

Fig. 268 Density in intact loop (GU-5VR and GU-10VR), from -20 to 300 sec.

Fig. 269 Density in intact loop (GU-5VR and GU-10VR), from -6 to 42 sec.

Fig. 270 Density in intact loop (GU-13VR), from -20 to 300 sec.

Fig. 271 Density in intact loop (GU-13VR), from -6 to 42 sec.

Fig. 272 Density in intact loop (GU-15VR and GU-15HZ), from -20 to 300 sec.

Fig. 273 Density in intact loop (GU-15VR and GU-15HZ), from -6 to 42 sec.

Fig. 274 Density in broken loop (GB-21T), from -20 to 300 sec.

Fig. 275 Density in broken loop (GB-21T), from -6 to 42 sec.

Fig. 276 Density in broken loop (GB-21B), from -20 to 300 sec.

Fig. 277 Density in broken loop (GB-21B), from -6 to 42 sec.

Fig. 278 Density in broken loop (GB-21C), from -20 to 300 sec.

Fig. 279 Density in broken loop (GB-21C), from -6 to 42 sec.

Fig. 280 Density in broken loop (GB-23VR), from -20 to 300 sec.

Fig. 281 Density in broken loop (GB-23VR), from -6 to 42 sec.

Fig. 282 Density in broken loop (GB-30T), from -20 to 300 sec.

Fig. 283 Density in broken loop (GB-30T), from -6 to 42 sec.

Fig. 284 Density in broken loop (GB-30B), from -20 to 300 sec.

Fig. 285 Density in broken loop (GB-30B), from -6 to 42 sec.

Fig. 286 Density in broken loop (GB-30C), from -20 to 300 sec.

Fig. 287 Density in broken loop (GB-30C), from -6 to 42 sec.

Fig. 288 Density in broken loop (GB-42VR), from -20 to 300 sec.

Fig. 289 Density in broken loop (GB-42VR), from -6 to 42 sec.

Fig. 290 Density in broken loop, reflood bypass (GB-RFB-T), from -20 to 300 sec.

Fig. 291 Density in broken loop, reflood bypass (GB-RFB-T), from -6 to 42 sec.

Fig. 292 Density in broken loop, reflood bypass (GB-RFB-B), from -20 to 300 sec.

Fig. 293 Density in broken loop, reflood bypass (GB-RFB-B), from -6 to 42 sec.

Fig. 294 Density in vessel (GV-COR-150HZ), from -20 to 300 sec.

Fig. 295 Density in vessel (GV-COR-150HZ), from -6 to 42 sec.

Fig. 296 Density in vessel (GVLP-165HZ and GVLP-172HZ), from -20 to 300 sec.

Fig. 297 Density in vessel (GVLP-165HZ and GVLP-172HZ), from -6 to 42 sec.

Fig. 298 Density in pressurizer (GU-PRIZE), from -20 to 300 sec.

Fig. 299 Density in pressurizer. (GU-PRIZE), from -6 to 42 sec.

Fig. 300 Mass flow in intact loop (FDU-1 and GU-1VR), from -20 to 300 sec.

Fig. 301 Mass flow in intact loop (FDU-1 and GU-1VR), from -6 to 42 sec.

Fig. 302 Mass flow in intact loop (FTU-1 and GU-1VR), from -20 to 300 sec.

Fig. 303 Mass flow in intact loop (FTU-1 and GU-1VR), from -6 to 42 sec.

Fig. 304 Mass flow in intact loop (FDU-5 and GU-5VR), from -20 to 300 sec.

Fig. 305 Mass flow in intact loop (FDU-5 and GU-5VR), from -6 to 42 sec.

Fig. 306 Mass flow in intact loop (FTU-9 and GU-10VR), from -20 to 300 sec.

Fig. 307 Mass flow in intact loop (FTU-9 and GU-10VR), from -6 to 42 sec.

Fig. 308 Mass flow in intact loop (FDU-10 and GU-10VR), from -20 to 300 sec.

Fig. 309 Mass flow in intact loop (FDU-10 and GU-10VR), from -6 to 42 sec.

Fig. 310 Mass flow in intact loop (FDU-13 and GU-13VR), from -20 to 300 sec.

Fig. 311 Mass flow in intact loop (FDU-13 and GU-13VR), from -6 to 42 sec.

Fig. 312 Mass flow in intact loop (FTU-13 and GU-13VR), from -20 to 300 sec.

Fig. 313 Mass flow in intact loop (FTU-13 and GU-13VR), from -6 to 42 sec.

Fig. 314 Mass flow in intact loop (FDU-15 and GU-15VR), from -20 to 300 sec.

Fig. 315 Mass flow in intact loop (FDU-15 and GU-15VR), from -6 to 42 sec.

Fig. 316 Mass flow in intact loop (FTU-15 and GU-15VR), from -20 to 300 sec.

Fig. 317 Mass flow in intact loop (FTU-15 and GU-15VR), from -6 to 42 sec.

Fig. 318 Mass flow in broken loop (FDB-21 and GB-21C), from -20 to 300 sec.

Fig. 319 Mass flow in broken loop (FDB-21 and GB-21C), from -6 to 42 sec.

Fig. 320 Mass flow in broken loop (FTB-21 and GB-21C), from -20 to 300 sec.

Fig. 321 Mass flow in broken loop (FTB-21 and GB-21C), from -6 to 42 sec.

Fig. 322 Mass flow in broken loop (FDB-30 and GB-30C), from -20 to 300 sec.

Fig. 323 Mass flow in broken loop (FDB-30 and GB-30C), from -6 to 42 sec.

Fig. 324 Mass flow in broken loop (FTB-30 and GB-30C), from -20 to 300 sec.

Fig. 325 Mass flow in broken loop (FTB-30 and GB-30C), from -6 to 42 sec.

Fig. 326 Mass flow in broken loop (FDB-42 and GB-42VR), from -20 to 300 sec.

Fig. 327 Mass flow in broken loop (FDB-42 and GB-42VR), from -6 to 42 sec.

Fig. 328 Mass flow in broken loop, reflood bypass (FDB-RFB and GB-RFB-B), from -20 to 300 sec.

Fig. 329 Mass flow in broken loop, reflood bypass (FDB-RFB and GB-RFB-B), from -6 to 42 sec.

Fig. 330 Mass flow in broken loop, reflood bypass (FTB-RFB and GB-RFB-B), from -20 to 300 sec.

Fig. 331 Mass flow in broken loop, reflood bypass (FTB-RFB and GB-RFB-B), from -6 to 42 sec.

Fig. 332 Mass flow in vessel (FDV-CORE-IN and GV-COR-150HZ), from -20 to 300 sec.

Fig. 333 Mass flow in vessel (FDV-CORE-IN and GV-COR-150HZ), from -6 to 42 sec.

Fig. 334 Mass flow in vessel (FTV-CORE-IN and GV-COR-150HZ), from -20 to 300 sec.

Fig. 335 Mass flow in vessel (FTV-CORE-IN and GV-COR-150HZ), from -6 to 42 sec.

Fig. 336 Core heater pin total power (PWRCOR T-1 and PWRCOR T-2), from -20 to 300 sec.

Fig. 337 Core heater pin total power (PWRCOR T-1 and PWRCOR T-2), from -6 to 42 sec.

Fig. 338 Core heater voltage (VOLT COR-T), from -20 to 300 sec.

Fig. 339 Core heater voltage (VOLT COR-T), from -6 to 42 sec.

Fig. 340 Core heater total current (AMPCOR-T), from -20 to 300 sec.

Fig. 341 Core heater total current (AMPCOR-T), from -6 to 42 sec.

Fig. 342 Primary pump speed (PUMPU-RPM), from -20 to 300 sec.

Fig. 343 Primary pump speed (PUMPU-RPM), from -6 to 42 sec.

Fig. 344 Primary pump current (PUMPU-CUR), from -20 to 300 sec.

Fig. 345 Primary pump current (PUMPU-CUR), from -6 to 42 sec.

IV. REFERENCE

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

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APPENDIX A

POSTTEST ADJUSTMENTS TO DATA FROM SEMISCALE MOD-1 TEST S-05-5

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APPENDIX A

POSTTEST ADJUSTMENTS TO DATA FROM SEMISCALE MOD-1 TEST S-05-5

Many of the transducers used in the Semiscale Mod-1 system exhibit significant sensitivity to one or more spurious inputs. Strain gage bridge circuits used in pressure transducers, differential pressure transducers, and drag discs are sensitive to changes in ambient temperature. Differential pressure cells are also sensitive to changes in system pressure. Photomultiplier tubes used as gamma ray detectors in the density transducers are sensitive to temperature changes, as well as to random variations in the locations of the radiation sources. Core power measurements depend on a calibrated resistor, which changes in value as a function of time and power level as it heats up.

Although the errors introduced into the data by spurious secondary inputs generally do not exceed the specified error ranges of the transducers, significant improvement in measurement accuracy can be achieved if the secondary sensitivity can be identified and removed. In the case of the drag discs, corrections are absolutely necessary since the signal due to temperature fluctuations can exceed that due to flow by several hundred percent. Since the exact values of the spurious inputs to which different transducers might be sensitive cannot often be easily predicted and are sometimes inconvenient to measure, secondary effects have been accounted for by correcting the data after the test rather than by using elaborate real time programs in the data acquisition system computer. The methods and results of the posttest data correction analysis for Test S-05-5 are presented in the following paragraphs and tables.

1. PRESSURE MEASUREMENTS

Corrections to pressure transducer measurements in the main system loop are based on data taken from the standard reference (Heise) gauge at Spool 4, taken 15 seconds before initiation of blowdown and at 300 sec after initiation of blowdown. The pressure readings are adjusted to account for pressure variations around the main loop, using the readings of nearby differential pressure cells. A linear correction is then applied to the pressure data to match the data to the calculated reference data at the two specified time points.

Correction of the steam generator secondary pressure (PU-SGSD) measurement is done in the same manner as for the main loop pressures using a Heise gauge installed expressly for this purpose. The data from the pressure transducer for the pressure suppression system (P-PSS) were corrected to match the process instrumentation at preblowdown conditions.

Pressure measurement corrections are performed using the data acquisition system (DAS) computer using the following equation:

$$F'(t) = C_0 + C_1 [F(t)]$$

where.

$F'(t)$ = corrected data.

$F(t)$ = raw data

C_0 = offset

C_1 = scaling factor:

The values of the offset and scaling factor are given in Table A-I.

TABLE A-I

CONSTANTS FOR PRESSURE MEASUREMENT
CORRECTIONS (TEST S-05-5)

<u>Detector Identification</u>	<u>C_0</u>	<u>C_1</u>
PU-15L	17.5	1
PU-SGSD	-74	1.0435
PV-UP+10	140	0.9202
PU-PRIZE	9.1	0.9975
PB-CNI	12	0.9943
PB-37	-9.1	1.0024
P-PSS	-2	1

2. DIFFERENTIAL PRESSURE MEASUREMENTS

Pressure sensitivity in the differential pressure cells in the main system loop is determined from the pretest system pressure check. Digital data are recorded for all measurements at ambient temperature, with no system flow, at pressures of ambient, 200, 500, 1000, 1500, 2000, and 2250 psig. The output of the differential pressure cells is plotted against system pressure, with the resulting plots used to describe the pressure response of the transducers.

The response of the differential pressure cells due to ambient temperature is determined from a digital data scan taken at 500°F and 1750 psig, with no system flow. The measured transducer outputs are corrected for pressure and compared with the values calculated due only to the density difference between the water inside the loop (500°F) and outside the loop in the sense lines (80 to 100°F).

The difference between the measured pressure corrected value and the calculated value is the thermal drift. After the data scan at 500°F is made, no more opportunities exist to obtain data with the pump stopped and the system full of liquid; therefore, for lack of later data, the thermal drift calculated from the 500°F data is assumed to be constant throughout the test.

In correcting differential pressure data for pressure sensitivity, the corrections are calculated for various times during the test by referring to nearby system pressure transducers. The thermal drift correction is then added to each pressure sensitivity correction and the combined value is added to the raw data using a computer program.

For some differential pressure measurements, the data scan at 500°F cannot be used as a reference for thermal drift; so other references are used. The liquid level measurements in the intact loop accumulator (DPU-ACC-TB) and the broken loop accumulator (DPB-ACC-TB) are referenced to calculated values based on geometrical considerations at the time when gas flow from the respective vessel is first noted. The reading from the steam generator discharge venturi (DPU-SG-DISC) is shifted to read zero after flow is stopped. For these detectors, and those having nonlinear pressure sensitivities, the corrections are performed according to the following equations:

$$F'(t) = KF(t) + C_1 \text{ for } t < t_1 \text{ or when no } t_i \text{ are listed}$$

for time points t , where $t_1 \leq t \leq t_n$

$$F'(t) = KF(t) + C_i + \frac{t - t_i}{t_{i+1} - t_i} (C_{i+1} - C_i) \text{ for } t_i \leq t \leq t_{i+1}$$

where i takes on values 1 to $n-1$

$$F'(t) = KF(t) + C_n \text{ for } t > t_n$$

where

t	=	time
$F'(t)$	=	corrected data
$F(t)$	=	raw data

K = scaling factor

C_i and t_i = corrections and time points.

The values of the constants are given in Table A-II.

TABLE A-II
CONSTANTS FOR DIFFERENTIAL PRESSURE
MEASUREMENT CORRECTIONS (TEST S-05-5)

Detector Identification	K	C_1	t_1	C_2	t_2	C_3	t_3
DPB-ACC-TB	1	0.04					
DPU-SG-DISC	-1	-0.2					
DPU-ACC-TB	1	-0.1					
DPV-166-173QQ	1	0.053					
DPV-110-156MQ	1	0.3456					
DPV-UP-IANN	1	0.061	0.01	-0.022	0.01	-0.028	30

	C_1	C_0	P_1	P(t)
DPV-9-26QQ	1	-0.002	-0.000029	PV-UP+10
DPV-26-55QM	1	0.184	0.000106	PV-UP+10
DPU-15-IANN	1	0.0065	-0.000024	PU-13
DPU-7-10	1	0.058	-0.000014	PU-13
DPU-9-166QQ	1	-0.0207	-0.000174	PV-UP+10
DPV-166Q-UP	1	-0.539	-0.000028	PV-UP+10
DPB-RFB-FT	1	0.496	-0.000034	PB-37
DPU-12-15	1	0.188	0.000035	PU-13
DPB-30-36L	1	-1.82	-0.001991	PB-37
DPU-PRESLL	1	0	-0.000011	PU-PRIZE
DPB-32U-36L	1	-2.92	-0.002577	PB-37
DPB-37-38	1	0.140	0.000075	PB-37
DPB-36L-37	1	-0.976	0.000104	PB-37
DPU-15-1	1	0.059	0.000099	PU-13
DPU-15-1L	1	0.120	0.000026	PU-13
DPB-30-21	1	0.045	0.000367	PB-37
DPB-40-42	1	0.123	0.000009	PB-42
DPU-12-10L	1	0.128	0.000034	PU-13
DPU-PR-4	-1	3.56	-0.002342	PU-PRIZE

The other differential pressure data are initially corrected for errors in amplification and ambient offsets. The pressure sensitivity is then subtracted from these corrected data to arrive at the final values. Corrections were made using the following equations:

$$F'(t) = C_1 [F(t)] + C_0$$

$$F''(t) = F'(t) - P_1 [P(t)]$$

where

C_0 = ambient offset

C_1 = amplification factor

$F(t)$ = raw data

$F'(t)$ = first data correction

$P(t)$ = pressure data

P_1 = pressure sensitivity

$F''(t)$ = final result.

The values for C_0 , C_1 , and P_1 are given in Table A-II.

3. MOMENTUM FLUX MEASUREMENTS

The temperature sensitivity of drag discs is determined from pretest warmup data taken at 200 and 500°F with no system flow. The temperature sensitivity is removed before the data are converted to momentum flux. The temperature of each transducer is taken from the signal of a nearby fluid or metal temperature thermocouple. Slight corrections for errors in setting the transducer output to zero at ambient conditions are also made at this time. Corrections are made using the following equation:

$$F'(t) = F(t) + D_0 - D_1 T(t)$$

where

$F'(t)$ = corrected data

$F(t)$ = raw data

$T(t)$ = temperature data from the transducer used for temperature correction sensitivity

D_0 = ambient offset

D_1 = temperature sensitivity.

Values of the constants are given in Table A-III.

TABLE A-III
CONSTANTS FOR MOMENTUM FLUX
MEASUREMENT CORRECTIONS (TEST S-05-5)

<u>Detector Identification</u>	<u>D_0</u>	<u>D_1</u>	<u>$T(t)$[a]</u>
FDV-CORE-IN	-0.014	0.000077	TFV-CORE-IN
FDU-10	0.013	0.000198	TMU-1T16
FDU-13	-0.297	0.001749	TMU-15T16
FDB-21	0.025	-0.000553	TMB-20B16
FDB-42	-0.115	-0.000791	TFR-42
FDB-30[b]	-0.165	-0.000816	TFB-30
FDB-37[b]	-0.068	0.000342	TFB-37
FDB-RFB	0.135	-0.001135	TMB-RFB
FDU-1	0.068	-0.000529	TMU-1T16
FDU-15	-0.172	-0.001259	TMU-15T16
FDU-5	-0.022	-0.000218	TMU-1T16

[a] $T(t)$ is the temperature data used for temperature sensitivity correction. The symbols listed identify the thermocouples from which the data were obtained.

[b] FDB-30 and FDB-37 are mounted horizontally and during blowdown were partially filled with subcooled water which affected the temperature sensitivity.

4. DENSITY MEASUREMENTS

Density calculations are based on the voltage output of the photomultiplier tubes in the gamma-attenuation densitometer assemblies. The equation used for converting voltage to density is as follows:

$$\rho = (1/C) \ln \left\{ D / [A F(t) + B] \right\}$$

where

- ρ = the density in lbm/ft³
- C = a constant based on the length of the gamma beam path
- D = a theoretical voltage for zero attenuation inside the vessel
- A = an amplification factor
- B = a biasing factor
- F(t) = the transducer voltage output.

Constants A and B are adjusted to match the final data to density values calculated from measured pressure and temperature values at the preblowdown and postdrain conditions, effectively giving the data an in-place calibration. The values of the constants for various transducers are given in Table A-IV.

TABLE A-IV
CONSTANTS FOR DENSITY MEASUREMENT
CONVERSIONS TO ENGINEERING UNITS (TEST S-05-5)

Detector Identification	A	B	C	D
GV-COR-150HZ	1.0005	0.0007	0.014	3.635
GB-42VR	0.7841	1.117	0.006	5.160
GU-1VR	1.0692	-0.2061	0.0095	3.100
GU-1HZ	1.0945	-0.8924	0.0095	9.530
GU-5VR	1.1102	-0.6341	0.0095	5.800
GU-10VR	1.0645	-0.4391	0.0095	6.980
GU-13VR	1.1515	-0.3733	0.0095	2.555
GU-15VR	1.1880	-1.870	0.0095	10.000
GU-15HZ	0.9640	0.1103	0.0095	2.688
GB-23VR	1.0016	-0.0033	0.0095	7.081
GU-PRIZE	1.0766	-0.0705	0.0095	1.207
GVLP-165HZ	1.0516	-0.3935	0.024	7.637
GB-RFB-B	0.9903	0.1625	0.008	8.09
GB-RFB-T	0.9612	0.2782	0.0057	7.00
GB-21-B	1.1101	-0.8762	0.008	8.04
GB-21-T	1.0213	-0.1327	0.0057	6.58
GB-30-B	1.0054	-0.0456	0.008	8.00
GB-30-T	1.1650	-1.1786	0.0057	7.19

The density measurement GVLP-172HZ uses an amplifier which precalculates the logarithm function, and hence has a simpler conversion formula:

$$\rho = -1.419 F(x) - 31.02$$

Some density measurements are obtained using a two-beam gamma densitometer which operates on the same basic principle of gamma attenuation as does the single-beam gamma densitometer. Each beam originates from the same gamma source and is allowed to pass through separate portions of the piping cross-sectional flow area to obtain an average density measurement in that particular region. The geometrical relationship of the gamma beam path through the piping and geometrically related variables used for processing of data from a two-beam gamma densitometer are shown in Figure A-1.

Fig. A-1 Geometry used for processing of density data obtained from two-beam gamma densitometers.

The average density measured by each individual gamma beam is obtained using the same equation as is used for the single-beam gamma densitometers:

$$\rho = (1/C) \ln \{D/[A F(t) + B]\} .$$

Values for the constants for the single-beam density measurements obtained with the two-beam gamma densitometers are presented in Table A-IV along with the constants for single-beam gamma densitometers.

In the Semiscale Mod-1 system, two-beam gamma densitometers provide added information which allows the calculation of a better average density than that obtained from a single beam. A mathematical model is used for processing the two-beam data to obtain the improved average density information. The processing method used is based on a froth-water model coupled with information from the two individual gamma beams and related beam path and piping cross-sectional geometry. The resulting information is recorded and reported under the density measurement identification ending with a "C", for example, GB-21C.

The use of the froth-water model for obtaining average density from a two-beam gamma densitometer is based on observations indicating that flow regimes in the Semiscale Mod-1 system can be modeled by a layer of water on the bottom of the pipe with a degree of froth on the surface. For homogeneous flow conditions such as all froth or all liquid the model remains valid. At any point in time slug flow is also modeled. The froth-water model does not model annular or inverted annular flows very well. However, these flows are not expected to exist for significant portions of a Semiscale Mod-1 system blowdown in horizontal piping. Density gradients from the top to the bottom of the pipe may exist showing no distinct location change from water to froth. This flow is neither totally homogeneous nor stratified, but the froth-water model does provide an adequate approximation of the average density characteristic of this flow pattern.

The average density obtained by using the gamma beam geometry shown in Figure A-1 and by applying the froth-water model is given by

$$\bar{\rho} = \alpha_f \rho_1 + (1 - \alpha_f) \rho_w \quad \text{lbm/ft}^3$$

where

$\bar{\rho}$ = average cross-sectional density

ρ_1 = average density measured by the upper gamma beam (measures the froth density)

ρ_w = density of liquid water (at local system conditions)

α_f = $1 + (1/2\pi) (\sin\beta - \beta)$ = froth fraction.

The angle which β represents is shown in Figure A-1. Values for β are obtained as follows:

$$\beta = 2 \cos^{-1} (1-2h)$$

where

$$h = \frac{H}{D} = \cos^2 \theta \left(\frac{\rho_2 - \rho_1}{\rho_w - \rho_1} \right)$$

where.

$$H = \ell_w \cos \theta, \ell_w, \text{ and } \theta \text{ are defined in Figure A-1}$$

$$D = \text{piping inside diameter}$$

$$\rho_2 = \text{the average density measured by the lower gamma beam:}$$

Average density is not calculated using the two-beam froth-water model when the angle θ is not favorable due to system hardware restrictions in positioning the source. The froth-water model requires separate density sampling in both the upper and lower portions of the piping cross section.

5. VOLUMETRIC FLOW MEASUREMENTS

The data obtained from the turbine flowmeter in Spool 30 (FTB-30) was opposite in magnitude to the known direction of flow. These data were corrected using the same formula as was used for the pressure measurements (Section 1), where $C_0 = 0$ and $C_1 = -1.0$.

6. PRIMARY PUMP MEASUREMENTS

Posttest, the amplifier gain setting for the pump current (PUMPU-CUR) was found to be in error. The data were corrected using the same formula as was used for the pressure measurements (Section 1), where $C_0 = 0$ and $C_1 = 100$.

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