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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-1 TESTS S-03-A, S-03-B, S-03-C, AND S-03-D (REFLOOD HEAT TRANSFER TESTS)

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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-1

TESTS S-03-A, S-03-B, S-03-C, AND S-03-D

(Reflood Heat Transfer Tests)

by

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ABSTRACT

Recorded test data are presented for Tests S-03-A, S-03-B, S-03-C, and S-03-D of the Semiscale Mod-1 reflood heat transfer series (Test Series 3). The tests conducted in this series are separate effects core reflood tests performed to determine the reflood heat transfer characteristics of the 5.5 foot Mod-1 rod bundle. Tests S-03-A through S-03-D were forced-feed reflood tests in which the reflood rate was held constant during each test. The tests were conducted to investigate the effects on system response resulting from variations in operating conditions of pressure, temperature, core power, reflood coolant subcooling, and peak heater rod thermocouple temperature at reflood initiation.

Test S-03-A was conducted from an initial system temperature of about 230°F at a pressure of 20 psia. Tests S-03-B through S-03-D were conducted from an initial system temperature of about 290°F at a pressure of 60 psia. In all four tests, reflood coolant was injected directly into the core barrel by means of a specially designed core inlet manifold. The electrically heated core was used in the pressure vessel to simulate the effects of a nuclear core during reflood. All four tests were conducted with a flat radial power profile. During reflood, core power was reduced from the initial level according to the American Nuclear Society (ANS) decay heat curve plus 20% for pressurized water reactor (PWR) core decay heat. The cold leg broken loop piping was open to the pressure suppression system (PSS). A separate steam supply system connected to the PSS was controlled to maintain constant pressure during the tests.

The purpose of this report is to make available the uninterpreted data from Tests S-03-A through S-03-D 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 account for known nonlinearities in transducer calibrations and to obtain the appropriate engineering units.

SUMMARY

Tests S-03-A, S-03-B, S-03-C, and S-03-D were performed as part of the Semiscale Mod-1 portion of the Semiscale Program conducted by Aerojet Nuclear Company for the United States Government. These tests were part of the reflood heat transfer test series, which is the first Semiscale Mod-1 test series employing reflooding of the electrically heated core. Hardware configuration and test parameters were selected to yield a system response that simulates the response of a pressurized water reactor to the reflood portion of a hypothesized loss-of-coolant accident (LOCA). These tests utilized a pressure vessel with internals, including a core inlet manifold to permit direct injection of cooling water into the core; an intact loop with pump, heated steam generator, and phase separator; a partial broken loop (cold leg only); and a pressure suppression system with header, pressure suppression tank, and a heated steam supply system. The electrically heated core consisted of 40 heater rods with a 5.5 ft heated length.

The test objectives specific to Tests S-03-A through S-03-D were: (a) to determine the basic reflood characteristics of the Mod-1 core; and (b) to determine whether methods for calculating heat transfer coefficients based on previous reflood tests with longer cores at constant injection rates are applicable to the shorter Mod-1 core. These tests were based on Test S-03-2 (Reference 1), with one major parameter being changed for each test. The major parameter changes being investigated were: (a) reduced initial pressure and temperature; (b) reduced maximum heater rod temperature at reflood initiation; (c) increased heatup rate (core power); and (d) higher reflood coolant temperature (reduced subcooling).

In general, the Semiscale Mod-1 system performed in an adequate manner to meet the test objectives. Specified operating conditions were met within acceptable tolerances, while data loss was also held to an acceptable level. During none of these four tests did more than 13 of the approximately 200 measurements taken fail to yield data suitable to be reported. However, most of the 32 differential pressure measurements taken during Tests S-03-A through S-03-D were of questionable value due to difficulties encountered in maintaining the sense lines in a liquid full condition when hot steam drained from the steam generator secondary backed up through the drain lines of the cooled probes on the differential pressure sense lines.

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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-1

TESTS S-03-A, S-03-B, S-03-C, AND S-03-D

(Reflood Heat Transfer Tests)

I. INTRODUCTION

The Semiscale Mod-1 experiments represent the current phase of the Semiscale Program conducted by Aerojet Nuclear Company for the United States Government. The Program, which is sponsored by the Nuclear Regulatory Commission through the Energy Research and Development Administration, is part of the overall program designed to investigate the response of a water-cooled nuclear reactor system to a hypothesized loss-of-coolant accident (LOCA). The underlying objectives of the Semiscale 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.

Tests S-03-A through S-03-D were conducted in the Semiscale Mod-1 system as part of the reflood heat transfer test series to obtain thermal-hydraulic response data from a reflood transient in a simulated nuclear reactor with a heated core to provide an experimental basis for analytical model development and evaluation.

For these tests, the pressure vessel was equipped with a core inlet manifold to allow reflood coolant to be injected directly into the bottom of the 40-electric-heater-rod heated core. Reflood was initiated at an initial core power level of 97 kW (172 kW for Test S-03-B) and a peak initial heater rod temperature of 1,400°F (1,100°F for Tests S-03-B and S-03-C). During reflood, the core heater power was adjusted to simulate the response characteristics of nuclear rods. The broken loop cold leg piping was open to the pressure suppression system header to allow for pressure control and system heatup using the pressure suppression system steam supply.

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 these tests. 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 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 2.

II. SYSTEM, PROCEDURES, CONDITIONS, AND EVENTS FOR TESTS S-03-A, S-03-B, S-03-C, AND S-03-D

The following system configuration, procedures, initial test conditions, and events are specific to Tests S-03-A through S-03-D as indicated.

1. SYSTEM CONFIGURATION AND TEST PROCEDURES

The Semiscale Mod-1 system used for these tests consisted of: a pressure vessel with internals, including a 40-electric-heater-rod heated core, and a core inlet manifold; an intact loop with steam generator, pump, and phase separator; a partial broken loop (cold leg only); and a pressure suppression system with a header, suppression tank, and a heated steam supply system. The core inlet manifold was attached to the core barrel inlet plate and allowed reflood coolant to be injected directly into the heated core. The phase separator was installed in the intact loop hot leg to allow determination of the vessel outlet fluid quality. The broken loop cold leg piping was attached directly to the pressure suppression header without a restricting nozzle or rupture discs. The pressure suppression system was equipped with a steam supply system for system heatup and for regulating system pressure. The Semiscale Mod-1 experimental system is described in more detail in Reference 2.

In preparation for each test, the steam generator feedwater and low pressure injection supply tanks were filled with treated demineralized water and heated to operating temperature. Prior to warmup, system instrumentation was checked and transducer readings were initialized. Warmup to initial test conditions was accomplished by introducing saturated steam from the pressure suppression system steam supply; the condensate was drained periodically during warmup.

Prior to the initiation of reflood the initial liquid level in the vessel was set at the bottom of the core heated length. This was accomplished by observation of the response of a density detector near the bottom of the core and thermocouples located at Grid Spacer 10. As soon as acceptable initial conditions were established, power was applied to the heated core. When the peak measured initial heater rod temperature reached 1,400°F (1,100°F for Tests S-03-B and S-03-C), core power control was switched to the preprogrammed decay power transient, and reflood was initiated (at 1.84 gpm). Tests were terminated after all core heater thermocouples indicated quenching had occurred.

During these tests the drain for discharge of the feedwater used to heat the steam generator secondary shared a common manifold with the drains of the differential pressure sense line cooled probes. The hot water drained from the steam generator caused the drain manifold to become pressurized with hot steam which flowed back into the sense line cooled probes. The steam heated the probes and vaporized the water in the sense lines, rendering many of the differential pressure readings unreliable.

2. INITIAL TEST CONDITIONS AND SEQUENCE OF EVENTS

A matrix of specified variable test conditions for Tests S-03-A through S-03-D is given in Table I; conditions in the Semiscale Mod-1 system at initiation of reflood are given in Table II; the water chemistry from samples of injection coolant drained from the core after reflood are given in Table III; and the sequence of events relative to initiation of reflood is given in Table IV.

TABLE I

SPECIFIED VARIABLE TEST CONDITIONS

Parameter	Specified Value			
	Test S-03-A	Test S-03-B	Test S-03-C	Test S-03-D
System Pressure (psia)	20	60	60	60
System Temperature (°F)	228	293	293	293
Reflood Coolant Temperature (°F)	90	153	153	253
Peak Heater Rod Temperature at Reflood Initiation (°F)	1,400	1,100	1,100	1,400
Core Power (kW)	97	172	97	97

TABLE II
CONDITIONS AT REFLOOD INITIATION

	<u>Specified</u>	<u>Measured</u>			
		<u>Test S-03-A</u>	<u>Test S-03-B</u>	<u>Test S-03-C</u>	<u>Test S-03-D</u>
System Pressure (psia) (PV + 10)	[a]	20.5	60.3	60.2	60.7
Core Power (kW)	[a]	96	166	96.5	97
Peak Core Temperature (°F)	[a]	1,400	1,090	1,095	1,385
PSS Tank Water Temperature (°F) (TF-PSS-33)	[a]	229	293	290	294
PSS Tank Water Level (in.)	46.5+1	46	46	46	46
Steam Generator Feedwater Temperature (°F)	550 +10	540	540	540	540
Steam Generator Secondary Liquid Level (in.)	116 +2	116	116	116	116
Core Barrel Metal Temperature (°F) (TMV-CO-35A)	[a]	220	311	291	290
Intact Loop Hot Leg Metal Temperature (°F) (TMU-5B16)	[a]	220	293	290	292
Broken Loop Cold Leg Metal Temperature (°F) (TMB-20T16)	[a]	230	300	295	295
[a] See Table I.					

TABLE III
WATER CHEMISTRY AT COMPLETION OF TESTS
S-03-A THROUGH S-03-D

	Test S-03-A	Test S-03-B	Test S-03-C	Test S-03-D
pH	8.45	[b]	7.25	[c]
Conductivity (μ mhos/cm)	4.5		2.95	[c]
Lithium (ppm)	2.9		1.6	[c]
Chloride (ppm)	<0.2		0.07	[c]
Fluoride (ppm)	<0.4 ^[a]		<0.4	[c]
Oxygen (ppm)	73.9		38.6	8.4
Total gas (ppm)	392.6		207.0	49.9
Suspended Solids (ppm)	0.672		0.588	[c]

[a] Present analytical methods prevent accurate determination of less than 0.4 ppm.

[b] Water chemistry not available for Test S-03-B.

[c] Water sample lost during chemical analysis.

TABLE IV
SEQUENCE OF EVENTS DURING TEST

Event	Time Relative to Reflood Initiation			
	S-03-A	S-03-B	S-03-C	S-03-D
Initial Fluid Level Established in Core (min)	-10	-10	-14	-13
Core Power Level Established (sec)	-170	-40	-103	-95
Heater Rod Temperatures Reaches 1,400°F (sec)	0	0 ^[a]	0 ^[a]	0
Initiation of Reflood	0	0	0	0
Test Terminated (sec)	286	286	137	211

[a] Core power trip set for 1,100°F.

III. DATA PRESENTATION

The data from Semiscale Mod-1 Tests S-03-A through S-03-D are presented with brief comment. Processing analysis has been performed only to the extent necessary to account for known nonlinearities in transducer calibrations and to obtain appropriate engineering units.

The performance of the system during these tests was monitored by about 200 detectors. The data obtained were recorded on both digital and analog data acquisition systems; the digital system was used to process the data presented in this report, while the analog system was used primarily to provide redundancy.

The data are presented, in most instances, in the form of composite graphs to facilitate comparison of a given variable in different tests. In cases for which composite graphs might be difficult to interpret, data for a given variable have been plotted on multiple figures. The scales selected for the graphs do not reflect the obtainable resolution of the data. Time zero on the graphs is the time of reflood initiation. (The data processing techniques are described in greater detail in Reference 2).

Figures 1 through 6 and Table V provide supporting information for interpretation of the data graphs shown in Figures 7 through 235. Figures 1 through 6 show the relative locations of all detectors used during the Semiscale Mod-1 reflood heat transfer test series. Table V groups the measurements taken during these tests according to measurement type; identifies the specific measurement location and the range of the detector and actual recording range of the data acquisition system; provides brief comments regarding the data; and references the measurements and comments to the corresponding figure(s). Figures 7 through 235 present the reflood data obtained. Data have, however, not been presented for measurements for which the detector or data acquisition system is known to have failed during a specific test. Neither have data been presented for some differential pressure measurements, which, due to the presence of steam in the sense lines, remained in a saturated condition. The fewest data are available for Test S-03-B, for which 13 measurements are not reported.

Fig. 1 Semiscale Mod-1 system and instrumentation for partial cold leg break with phase separator -- isometric.

Fig. 2 Semiscale Mod-1 system and instrumentation for partial cold leg break with phase separator -- schematic.

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

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

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

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

TABLE V
DATA PRESENTATION FOR SEMISCALE MOD-1 TESTS
S-03-A THROUGH S-03-D

Measurement	Location and Comments [a]	Range [a]		Figure [a]	Measurement Comments [b]
		Detector	Data Acquisition System		
FLUID TEMPERATURE					
Chromel-Alumel thermocouples unless specified otherwise					
<u>Intact Loop</u>		0-2,300°F	0-1,017°F		
TFU-1	Hot leg, Spool 1, 31 in. from vessel center			7, 8	
TFU-PHSEP-W	In hot leg at bottom of phase separator well			9	Data not recorded for Test S-03-A
TSU-6	Hot leg, Spool 6, 114 in. from vessel center (shielded)			10, 11	
TSU-7	Cold leg, Spool 7, 243 in. from vessel center (shielded)			12, 13	
TFU-8	Cold leg, Spool 8, 195 in. from vessel center			14, 15	
TFU-10	Cold leg, Spool 10, 144 in. from vessel center		0-591°F	16, 17	
TSU-12	Cold leg, Spool 12, 80 in. from vessel center (shielded)		0-591°F	18, 19	
RBV-14A	Cold leg, Spool 14, 43 in. from vessel center, downstream of cold leg injection port (platinum resistance bulb)	0-1,000°F	0-1,000°F	20, 21	
<u>Broken Loop</u>		0-2,300°F	0-591°F		
TFB-20	Cold leg, Spool 20, 21 in. from vessel center			22, 23	
TFB-23	Cold leg, Spool 23, 91 in. from vessel center, upstream of vessel-side nozzle			24, 25	
<u>Downcomer Annulus</u>		0-1,400°F	0-803°F		
TFV-ANN-35A	35 in. below cold leg centerline, 0°			26	
<u>Upper Plenum</u>		0-2,300°F	0-1,017°F		
TFV-UP+13	In upper plenum 13.5 in. above cold leg centerline at 180°			27	
<u>Core Grid Spacers</u>		0-2,300°F	0-2,382°F		
Chromel-Alumel thermocouples unless specified otherwise					
<u>Grid Spacer 5</u>					
	55 in. below cold leg centerline, 21.5 in. above top of heated length				
TFG-5CD-45	Thermocouple in space defined by Columns C and D, Rows 4 and 5			28, 29	
<u>Grid Spacer 6</u>					
	76 in. below cold leg centerline, 1/2 in. above top of heated length				
TFG-6AB-45	Thermocouple in space defined by Columns A and B, Rows 4 and 5			30, 31	
TFG-6CD-45	Thermocouple in space defined by Columns C and D, Rows 4 and 5			32, 33	
TFG-6DE-45	Thermocouples in space defined by Columns D and E, Rows 4 and 5, and 6 and 7			34, 35	
TFG-6DE-67				36, 37	
<u>Grid Spacer 8</u>					
	109 in. below cold leg centerline at center of heated length				
TFG-8CD-45	Thermocouple in space defined by Columns C and D, Rows 4 and 5			38, 39	
TFG-8EF-45	Thermocouple in space defined by Columns E and F, Rows 4 and 5			—	Thermocouple failed
<u>Grid Spacer 10</u>					
	143 in. below cold leg centerline at bottom of heated length				
TFG-10CD-45	Thermocouple in space defined by Columns C and D, Rows 4 and 5			40	
TFG-10DE-67	Thermocouple in space defined by Columns D and E, Rows 6 and 7			41	
TFG-10EF-45	Thermocouple in space defined by Columns E and F, Rows 4 and 5			42	
TFG-10GH-45	Thermocouple in space defined by Columns G and H, Rows 4 and 5			43	Data acquisition channel failed for Test S-03-B

TABLE V (contd.)

Measurement	Location and Comments [a]	Range [a]		Figure [a]	Measurement Comments [b]
		Detector	Data Acquisition System		
<u>Steam Generator</u>					
TFU-SG1	Secondary side, 12 in. above bottom of tube sheet	0-2,300°F	0-591°F	44	
TFU-SG2	Secondary side, 24 in. above bottom of tube sheet			45	
TFU-SG3	Secondary side, 48 in. above bottom of tube sheet			46	
TFU-SG4	Secondary side, 96 in. above bottom of tube sheet			47	
<u>Pressure Suppression System</u>		0-2,300°F	0-591°F		
TF-PSS-33	33 in. from bottom of tank			48	
TF-PSS-170	170 in. from bottom of tank			49	
MATERIAL TEMPERATURE		0-2,300°F	0-591°F		
Chromel-Alumel thermocouples unless specified otherwise					
<u>Intact Loop</u>					
TMU-1T16	Hot leg, Spool 1, top, 1/16 in. from pipe ID, 29 in. from vessel center			50	
TMU-5B16	Hot leg, Spool 5, bottom, 1/16 in. from pipe ID, 102 in. from vessel center			51	
TMU-7S16	Cold leg, Spool 7, side, 1/16 in. from pipe ID, 242 in. from vessel center (vertical pipe)			52	
TMU-8S16	Cold leg, Spool 8, side, in pump trap, 1/16 in. from pipe ID, 195 in. from vessel center			53	
TMU-15B16	Cold leg, Spool 15, bottom, 1/16 in. from pipe ID, 17 in. from vessel center			54	Data acquisition channel failed at t=188 sec on Test S-03-B
<u>Broken Loop</u>					
TMB-20T16	Cold leg, Spool 20, top, 1/16 in. from pipe ID, 21 in. from vessel center			55	
<u>Core Bays</u>		0-1,400°F	0-803°F		
Type 1 Inconel thermocouples					
TMV-CO-35A	35 in. below cold leg centerline, 1/16 in. from core barrel OD, 0°			56	
TMV-CO-115A	115 in. below cold leg centerline, 1/16 in. from core barrel OD, 0°			57	
TMV-CO-115M	115 in. below cold leg centerline, 1/16 in. from core barrel OD, 180°			58	
TMV-CO-127A	127 in. below cold leg centerline, 1/16 in. from core barrel OD, 0°			59	
TMV-CI-70A	70 in. below cold leg centerline, 1/16 in. from core barrel ID, 0°			60	
TMV-CI-95M	95 in. below cold leg centerline, 1/16 in. from core barrel ID, 180°			61	
TMV-CI-115A	115 in. below cold leg centerline, 1/16 in. from core barrel ID, 0°			62	
<u>Core Housing Filler</u>		0-2,300°F	0-591°F		
TMV-HF-115W	On core housing filler, 115 in. below cold leg centerline, 0.20 in. from outer surface, 315°			63	
TMV-HF-127W	On core housing filler, 127 in. below cold leg centerline, 0.20 in. from outer surface, 315°			64	
TMV-HF-138W	On core housing filler, 138 in. below cold leg centerline, 0.20 in. from outer surface, 315°			65	

TABLE V (contd.)

Measurement	Location and Comments [a]	Range [a]		Figure [a]	Measurement Comments [b]
		Detector	Data Acquisition System		
Core Heater Cladding Temperatures					
High Power Heaters	Chromel-Alumel thermocouples unless specified otherwise	0-2,300°F	0-2,382°F		
TH-D4-14	Heater at Column D Row 4. Thermocouples 14 in. (270°) and 29 in. (315°) above bottom of core			66	
-29				67	
TH-D5-09	Heater at Column D Row 5. Thermocouples 9 in. (45°), 29 in. (225°) and 39 in. (135°) above bottom of core			68	
-29				69	
-39				70	
TH-E4-23	Heater at Column E Row 4. Thermocouples 23 in. (90°) and 27 in. (0°) above bottom of core			71	
-27				72	
TH-E5-21	Heater at Column E Row 5. Thermocouples 21 in. (180°) and 25 in. (90°) above bottom of core			73	
-25				74	
Low Power Heaters		0-2,300°F	0-2,382°F		
TH-A4-09	Heater at Column A Row 4. Thermocouples 9 in. (105°), 29 in. (240°) and 39 in. (300°) above bottom of core			75	
-29				76	
-39				77	
TH-A5-29	Heater at Column A Row 5. Thermocouples 29 in. (180°) and 44 in. (255°) above bottom of core			78	
-44				79	
TH-B3-32	Heater at Column B Row 3. Thermocouples 32 in. (135°) and 52 in. (195°) above bottom of core			80	
-52				---	Data acquisition channel failed for TH-B3-52
TH-B5-29	Heater at Column B Row 5. Thermocouples 29 in. (150°) and 38 in. (240°) above bottom of core			81	
-38				82	
TH-B6-29	Heater at Column B Row 6. Thermocouple 29 in. (45°) above bottom of core			83	Erratic readings near temperature peak may be due to faulty heater grounds
TH-C2-28	Heater at Column C Row 2. Thermocouples 28 in. (135°) and 38 in. (225°) above bottom of core			84	
-38				85	See above comment
TH-C3-13	Heater at Column C Row 3. Thermocouples 13 in. (285°), 28 in. (0°) and 60 in. (150°) above bottom of core			86	
-28				87	
-60				88	
TH-C4-26	Heater at Column C Row 3. Thermocouples 26 in. (75°) and 53 in. (300°) above bottom of core			89	
-53				90	
TH-C5-28	Heater at Column C Row 5. Thermocouples 28 in. (315°), 44 in. (45°), and 60 in. (105°) above bottom of core			91	
-44				92	
-60				---	Thermocouple failed
TH-C6-32	Heater at Column C Row 6. Thermocouples 32 in. (255°) and 53 in. (270°) above bottom of core			93	
-53				---	Thermocouple failed
TH-C7-15	Heater at Column C Row 7. Thermocouple 15 in. (255°) above bottom of core			94	
TH-D1-21	Heater at Column D Row 1. Thermocouple 21 in. (330°) above bottom of core			95	
TH-D2-14	Heater at Column D Row 2. Thermocouples 14 in. (0°) and 61 in. (270°) above bottom of core			96	
-61				97	
TH-D3-29	Heater at Column D Row 3. Thermocouples 29 in. (150°), 33 in. (45°), and 39 in. (225°) above bottom of core			98	
-33				99	
-39				100	TH-D3-33 failed for all tests except S-03-C TH-D3-39 failed for Test S-03-A
TH-D6-15	Heater at Column D Row 6. Thermocouples 15 in. (90°) and 25 in. (255°) above bottom of core			101	
-25				102	
TH-D7-20	Heater at Column D Row 7. Thermocouple 20 in. (60°) above bottom of core			103	
TH-D8-26	Heater at Column D Row 8. Thermocouple 26 in. (180°) above bottom of core			104	

TABLE V (contd.)

Measurement	Location and Comments ^[a]	Range ^[a]		Figure ^[a]	Measurement Comments ^[b]
		Detector	Data Acquisition System		
Low Power Heaters (contd.)					
TH-E1-33	Heater at Column E Row 1. Thermocouples 33 in. (60°) and 54 in. (0°) above bottom of core			105	
-54				106	
TH-E2-21	Heater at Column E Row 2. Thermocouples 21 in. (210°) and 33 in. (315°) above bottom of core			107	
-33				108	
TH-E3-05	Heater at Column E Row 3. Thermocouples 5 in. (15°), 20 in. (165°), and 24 in. (150°) above bottom of core			109	
-20				110	
-74				111	
TH-EA-11H	Heater at Column E Row 8. Thermocouples 8 in. (150°), 28 in. (285°), and 37 in. (330°) above bottom of core			112	
-28				113	
37				114	
TH-E7-13	Heater at Column E Row 7. Thermocouples 13 in. (45°) and 44 in. (195°) above bottom of core			115	
-44				116	
TH-E8-14	Heater at Column E Row 8. Thermocouples 14 in. (150°), 29 in. (225°) and 45 in. (300°) above bottom of core			117	
-29				118	
-45				119	
TH-F2-22	Heater at Column F Row 2. Thermocouples 22 in. (105°) and 25 in. (0°) above bottom of core			120	
-25				121	
TH-F3-15	Heater at Column F Row 3. Thermocouples 15 in. (240°), 22 in. (105°), and 25 in. (30°) above bottom of core			122	
-22				123	
-25				124	Amplifier failed in data acquisition system for Tests S-03-B and S-03-C
TH-F4-14	Heater at Column F Row 4. Thermocouples 14 in. (90°), 28 in. (165°), 44 in. (210°), and 60 in. (285°) above bottom of core			125	
-28				126	
-44				127	
-60				128	
TH-F5-20	Heater at Column F Row 5. Thermocouples 20 in. (255°), 26 in. (165°), 33 in. (315°) and 53 in. (30°) above bottom of core			129	
-26				130	
-33				131	
-53				132	
TH-F6-08	Heater at Column F Row 6. Thermocouples 8 in. (60°) and 28 in. (135°) above bottom of core			133	
-28				134	
TH-F7-29	Heater at Column F Row 7. Thermocouples 29 in. (150°) and 39 in. (210°) above bottom of core			135	
-39				136	
TH-G3-13	Heater at Column G Row 3. Thermocouples 13 in. (150°) and 45 in. (270°) above bottom of core			137	
-45				138	
TH-G4-09	Heater at Column G Row 4. Thermocouples 9 in. (150°), 29 in. (300°), 33 in. (225°) and 38 in. (30°) above bottom of core			139	Thermocouple failed for Tests S-03-A, S-03-B, and S-03-D
-29				140	
-33				141	
-38				142	
TH-G5-14	Heater at Column G Row 5. Thermocouples 14 in. (45°) and 24 in. (330°) above bottom of core			143	
-24				144	
TH-G6-21	Heater at Column G Row 6. Thermocouples 21 in. (60°) and 33 in. (135°) above bottom of core			145	
-33				146	
TH-H4-14	Heater at Column H Row 4. Thermocouple 14 in. (105°) above bottom of core			---	Thermocouple failed
TH-H5-28	Heater at Column H Row 5. Thermocouple 28 in. (150°) above bottom of core			147	
Steam Generator		0-2,300°F	0-591°F		
TMU-SG1	On steam generator tubes, 12 in. above bottom of tube sheet, on OD of tube			148	
TMU-SG2	On steam generator tubes, 24 in. above bottom of tube sheet, on OD of tube			149	
TMU-SG3	On steam generator tubes, 48 in. above bottom of tube sheet, on OD of tube			150	
TMU-SG4	On steam generator tubes, 96 in. above bottom of tube sheet, on OD of tube			151	

TABLE V (contd.)

Measurement	Location and Comments [a]	Range [a]		Figure [a]	Measurement Comments [b]
		Detector	Data Acquisition System		
PRESSURE					
Vessel					
PV-UP+10	In upper plenum, 10 in. above cold leg centerline, mounted on stand-off, 30°	0-250 psi	0-330.7 psia	152	
PV-IANN-9	In vessel inlet annulus, 9 in. below cold leg centerline, mounted on standoff, 225°	0-250 psi	0-345.5 psia	153	
Steam Generator					
PU-SGSD	Secondary side, steam dome	0-3,000 psi	0-1,521 psia	154	Data have not been corrected to match saturation pressure; use for transient response only.
Pressure Suppression System					
P-PSS	Suppression tank top	0-750 psi	0-321 psia	155	
P-PSS-HD	In suppression tank header	0-200 psi	0-380 psia	156	Detector failed on Test S-03-B
DIFFERENTIAL PRESSURE	Elevation difference between transducer taps is zero unless otherwise specified				Differential pressure readings were set to zero with the sense lines full and the system empty. The sense lines may not have remained full during the test, particularly during Test S-03-A; questionable data
Intact Loop					
DPU-UP-1L	Upper plenum, 10.5 in. above cold leg centerline at 30° to hot leg, Spool 1, 31 in. from vessel center, upper plenum tap approximately 2 in. above Spool 1 tap (low range)	+20 in. water	+1.0 psid	157	Liquid may have boiled from sense lines
DPU-UP-9	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	+15 psid	158	
DPU-1-3	Hot leg Spool 1, 31 in. from vessel center to hot leg Spool 3, 62 in. from vessel center	+50 in. water	+2.5 psid	159	
DPU-1-3L	Hot leg Spool 1, 31 in. from vessel center to hot leg Spool 3, 62 in. from vessel center (low range)	+20 in. water	+1.0 psid	160	
DPU-PSEP-W	Phase separator liquid level, hot leg, Spool 2, elevation difference between taps is 84 in.	+100 in. water	+5.0 psid	229	Steam may have been present in sense lines
DPU-PSEP-WL	Phase separator liquid level, hot leg, Spool 2, elevation difference between taps is 84 in. (low range)	+50 in. water	+2.5 psid	---	Data not recorded for Test S-03-A; detector remained saturated for other tests
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 approximately 18 in. above Spool 7 tap	+500 in. water	+25 psid	161	
DPU-3-7L	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 approximately 18 in. above Spool 7 tap (low range)	+50 in. water	+2.5 psid	162	
DPU-3-SGIP	Across inlet orifice of steam generator; hot leg, Spool 3, 62 in. from vessel center to steam generator inlet plenum, 145 in. from vessel center, Spool 3 tap is 16 in. below SGIP tap	+50 in. water	+2.5 psid	163	
DPU-SGIP-SG1	Steam generator inlet plenum, 145 in. from vessel center to 12.25 in. above bottom of tube sheet, SG1 tap is 24 in. above SGIP tap	+300 in. water	+15 psid	164	Sense lines from tap at SG1 may have drained
DPU-SG1-SG2	Across primary side tubes, 12 to 24 in. above bottom of tube sheet, SG1 tap is 12 in. below SG2 tap	+20 in. water	+1.0 psid	165	Sense lines may have drained; detector saturated for Tests S-03-A, S-03-B, and S-03-C
DPU-SG2-SG3	Across primary side tubes, 24 to 48 in. above bottom of tube sheet, SG2 tap is 24 in. below SG3 tap	+50 in. water	+2.5 psid	166	Sense lines may have drained
DPU-SG3-SG4	Across primary side tubes, 48 to 96 in. above bottom of tube sheet, SG3 tap is 48 in. below SG4 tap	+100 in. water	+5.0 psid	167	Sense lines may have drained

TABLE V (contd.)

Measurement	Location and Comments [a]	Range [a]		Figure [a]	Measurement Comments [b]
		Detector	Data Acquisition System		
<u>Intact Loop (contd.)</u>					
DPV-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	+20 in. water	+1.0 psid	168	
DPV-8C-7	From pump trap, cold leg Spool 8, tap 8C, 197 in. from vessel center to steam generator outlet, cold leg Spool 7, 231 in. from vessel center, tap 8C is 32 in. below Spool 7 tap	+100 in. water	+5.0 psid	169	
DPV-8C-8D	In pump trap, cold leg Spool 8. Tap 8C, 197 in. from vessel center to Tap 8D, 184 in. from vessel center, Tap 8C is 10 in. below Tap 8D	+20 in. water	+1.0 psid	170	
DPV-12-10L	Pump outlet to pump inlet, cold leg Spool 12, 73 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	+3.0 psid	171, 177	
DPV-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	+30 in. water	+2.5 psid	173	
DPV-15-IANN	Cold leg Spool 15, 16 in. from vessel center to inlet annulus 9 in. below cold leg centerline at 225°, Spool 15 tap is 9 in. above inlet annulus tap	+100 in. water	+5.0 psid	174	
DPV-15-ATM	Cold leg Spool 15, 16 in. from vessel center to atmosphere	+100 psi	+100 psid	175	
<u>Broken Loop</u>					
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, 9 in. below Spool 21 tap	+100 in. water	+5.0 psid	176, 177	Liquid may have boiled from the sense lines
DPB-21-23	Cold leg Spool 21, 49 in. from vessel center to cold leg Spool 23, 92 in. from vessel center	+20 in. water	+1.0 psid	178, 179	
<u>Vessel</u>					
DPB-21-IANN	Broken loop 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	+5.0 psid	176, 177	
DPV-9-180QQ	Inlet annulus, 9 in. below cold leg centerline at 225° to lower plenum, 180 in. below cold leg centerline at 225°, elevation difference between taps is 171 in.	+500 in. water	+2.5 psid	180	
DPV-166-191QT	Across lower plenum, 166 in. (225°) to 191 in. (270°) below cold leg centerline, elevation difference between taps is 25 in.	+50 in. water	+2.5 psid	181	
<u>Vessel Core</u>					
DPVC-CBI-UP	From core barrel injection point 17 in. below lower head, to upper plenum 10.5 in. above cold leg centerline (30°). Elevation difference between taps is 222.5 in.	+300 in. water	+15 psid	182	
DPVC-CBM-UP	From core barrel manifold 152 in. below cold leg centerline to upper plenum 10.5 in. above cold leg centerline (30°). Elevation difference between taps is 162.5 in.	+100 in. water	+5.0 psid	---	Differential pressure cell failed
DPVC-83U-UP	Upper segment of active core region 89 in. below cold leg centerline (315°) to upper plenum core tube 10.5 in. above cold leg centerline (30°). Elevation difference between taps is 100 in.	+100 in. water	+5.0 psid	183	
DPVC-83-100WQ	In active core region, upper segment, 89 in. below cold leg centerline (315°) to 106 in. below cold leg centerline (225°). Elevation difference between taps is 17 in.	+50 in. water	+2.5 psid	184	

TABLE V (contd.)

Measurement	Location and Comments ^[a]	Range ^[a]		Figure ^[a]	Measurement Comments ^[b]
		Detector	Data Acquisition System		
<u>Vessel Core (contd.)</u>					
DPVC-100-117QJ	Across center segment of active core region 106 in. below cold leg centerline (225°) to 122 in. below cold leg centerline (135°). Elevation difference between taps is 16 in.	+100 in. water	+5.0 psid	185	
DPVC-117-133JD	In active core region, lower segment, 122 in. below cold leg centerline (135°) to 140 in. below cold leg centerline (45°). Elevation difference between taps is 18 in.	+100 in. water	+5.0 psid	186	
DPVC-133-191DT	Lower segment of active core region 140 in. below cold leg centerline (45°) to 191 in. below cold leg centerline (270°). Elevation difference between taps is 51 in.	+100 in. water	+5.0 psid	187, 188	
<u>Steam Generator</u>					
DPU-SG-SEC	Secondary side, differential pressure taps at 45 and 126 in. above bottom of tube sheet, elevation difference between taps is 81 in.	+100 in. water	+5.0 psid	230	Sense lines may have been heated
<u>VOLUMETRIC FLOW RATE</u>					
<u>Intact Loop</u>					
FTU-1	Hot leg, Spool 1, 18 in. from vessel center	+20-+400 gpm	+1,800 gpm	189	
FTU-9	Cold leg, Spool 9, 154 in. from vessel center	+80-+800 gpm	+1,800 gpm	190	
FTU-15	Cold leg, Spool 15, 29 in. from vessel center	+20-+800 gpm	+1,800 gpm	191	
<u>Broken Loop</u>					
FTB-21	Cold leg, Spool 21, 58 in. from vessel center	+20-+400 gpm	+1,800 gpm	192	
<u>Core</u>					
FTV-CRM	In core barrel manifold. ECC injection point	+5.0-+50 gpm	+25.0 gpm	193, 194, 195, 196	
<u>ECC System</u>					
FTU-LPIS	In line leading from LPIS for intact loop, 1/2-in. line	+0.75-+7.5 gpm	+5.0 gpm	---	Failed due to AC interference
<u>MOMENTUM FLUX</u>					
<u>Intact Loop</u>					
FDU-1	Hot leg, Spool 1, 29 in. from vessel center, target size 1.0 in.	+1-+2,000 lbm/ft-sec ²	+2,000 lbm/ft-sec ²	197, 198, 199, 200	
<u>DENSITY</u>					
<u>Intact Loop</u>		0.1-100 lbm/ft ³	0-100 lbm/ft ³		Some vertical density measurements indicate presence of condensate in system piping near t=0
GU-1VR	Hot leg, Spool 1, 24 in. from vessel center, vertical			201, 202, 203, 204	
GU-1HZ	Hot leg, Spool 1, 26 in. from vessel center, horizontal			205, 206, 207, 208	
GU-5VR	Hot leg, Spool 5, 96 in. from vessel center, vertical			209, 210, 211, 212	
GU-10VR	Cold leg, Spool 10, 141 in. from vessel center, vertical			213, 214, 215, 216	
GU-15VR	Cold leg Spool 15, 20 in. from vessel center, vertical			217, 218, 219, 220	
<u>Broken Loop</u>		0.1-100 lbm/ft ³	0-100 lbm/ft ³		
GB-21VR	Cold leg, Spool 21, 49 in. from vessel center, vertical			221, 222, 223, 224	
GB-23VR	Cold leg, Spool 23, 97 in. from vessel center, vertical			225, 226, 227, 228	

TABLE V (contd.)

Measurement	Location and Comments [a]	Range [a]		Figure [a]	Measurement Comments [b]
		Detector	Data Acquisition System		
LIQUID LEVEL					
<u>Phase Separator</u>					
DPU-PSEP-W	Phase separator liquid level, hot leg, Spool 2 elevation difference between taps is 84 in.	±100 in. water	±5.0 psid	229	Steam may have been present in sense lines
DPU-PSEP-WL	Phase separator liquid level, hot leg, Spool 2, elevation difference between taps is 84 in. (low range)	±50 in. water	±2.5 psid	---	Data not recorded for Test S-03-A; detector remained saturated for other tests
<u>Steam Generator</u>					
DPU-SG-SEC	Secondary side, differential pressure taps at 45 and 126 in. above tube sheet, elevation difference between taps is 81 in.	±100 in. water	±5.0 psid	230	Sense lines may have been heated
CORE CHARACTERISTICS					
PWRCOR T-1	Core power		1,600 kW	231, 232	
PWRCOR T-2	Core power		1,600 kW	233	
VOLTCORE-T	Core voltage		200 V	234	
AMPCORE-T	Core current		10,000 A	235	

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

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

Fig. 7 Fluid temperature in intact loop, Tests S-03-A and S-03-D (TFU-1).

Fig. 8 Fluid temperature in intact loop, Tests S-03-B and S-03-C (TFU-1).

Fig. 9 Fluid temperature in phase separator (TFU-PHSEP-W).

Fig. 10 Fluid temperature in intact loop, Tests S-03-A and S-03-D (TSU-6).

Fig. 11 Fluid temperature in intact loop, Tests S-03-B and S-03-C (TSU-6).

Fig. 12 Fluid temperature in intact loop, Tests S-03-A and S-03-D (TSU-7).

Fig. 13 Fluid temperature in intact loop, Tests S-03-B and S-03-C (TSU-7).

Fig. 14 Fluid temperature in intact loop, Tests S-03-A and S-03-D (TFU-8).

Fig. 15 Fluid temperature in intact loop, Tests S-03-B and S-03-C (TFU-8).

Fig. 16 Fluid temperature in intact loop, Tests S-03-A and S-03-D (TFU-10).

Fig. 17 Fluid temperature in intact loop, Tests S-03-B and S-03-C (TFU-10).

Fig. 18 Fluid temperature in intact loop, Tests S-03-A and S-03-D (TSU-12).

Fig. 19 Fluid temperature in intact loop, Tests S-03-B and S-03-C (TSU-12).

Fig. 20 Fluid temperature in intact loop, Tests S-03-A and S-03-D (RBU-14A).

Fig. 21 Fluid temperature in intact loop, Tests S-03-B and S-03-C (RBU-14A).

Fig. 22 Fluid temperature in broken loop, Tests S-03-A and S-03-D (TFB-20).

Fig. 23 Fluid temperature in broken loop, Tests S-03-B and S-03-C (TFB-20).

Fig. 24 Fluid temperature in broken loop, Tests S-03-A and S-03-D (TFB-23).

Fig. 25 Fluid temperature in broken loop, Tests S-03-B and S-03-C (TFB-23).

Fig. 26 Fluid temperature in downcomer annulus (TFV-ANN-35A).

Fig. 27 Fluid temperature in upper plenum (TFV-UP+13).

Fig. 28 Fluid temperature in core, Grid Spacer 5, Tests S-03-A and S-03-D (TFG-5CD-45).

Fig. 29 Fluid temperature in core, Grid Spacer 5, Tests S-03-B and S-03-C (TFG-5CD-45).

Fig. 30 Fluid temperature in core, Grid Spacer 6, Tests S-03-A and S-03-D (TFG-6AB-45).

Fig. 31 Fluid temperature in core, Grid Spacer 6, Tests S-03-B and S-03-C (TFG-6AB-45).

Fig. 32 Fluid temperature in core, Grid Spacer 6, Tests S-03-A and S-03-D (TFG-6CD-45).

Fig. 33 Fluid temperature in core, Grid Spacer 6, Tests S-03-B and S-03-C (TFG-6CD-45).

Fig. 34 Fluid temperature in core, Grid Spacer 6, Tests S-03-A and S-03-D (TFG-6DE-45).

Fig. 35 Fluid temperature in core, Grid Spacer 6, Tests S-03-B and S-03-C (TFG-6DE-45).

Fig. 36 Fluid temperature in core, Grid Spacer 6, Tests S-03-A and S-03-D (TFG-6DE-67).

Fig. 37 Fluid temperature in core, Grid Spacer 6, Tests S-03-B and S-03-C (TFG-6DE-67).

Fig. 38 Fluid temperature in core, Grid Spacer 8, Tests S-03-A and S-03-D (TFG-8CD-45).

Fig. 39 Fluid temperature in core, Grid Spacer 8, Tests S-03-B and S-03-C (TFG-8CD-45).

Fig. 40 Fluid temperature in core, Grid Spacer 10 (TFG-10CD-45).

Fig. 41 Fluid temperature in core, Grid Spacer 10 (TFG-10DE-67).

Fig. 42 Fluid temperature in core, Grid Spacer 10 (TFG-10EF-45).

Fig. 43 Fluid temperature in core, Grid Spacer 10 (TFG-10GH-45).

Fig. 44 Fluid temperature in steam generator (TFU-SG1).

Fig. 45 Fluid temperature in steam generator (TFU-SG2).

Fig. 46 Fluid temperature in steam generator (TFU-SG3).

Fig. 47 Fluid temperature in steam generator (TFU-SG4).

Fig. 48 Fluid temperature in pressure suppression tank (TF-PSS-33).

Fig. 49 Fluid temperature in pressure suppression tank (TF-PSS-130).

Fig. 50 Material temperature in intact loop, Spool 1 (TMU-1T16).

Fig. 51 Material temperature in intact loop, Spool 5 (TMU-5B16).

Fig. 52 Material temperature in intact loop, Spool 7 (TMU-7S16).

Fig. 53 Material temperature in intact loop, Spool 8 (TMU-8S-16).

Fig. 54 Material temperature in intact loop, Spool 15 (TMU-15B16).

Fig. 55 Material temperature in broken loop, Spool 20 (TMB-20T16).

Fig. 56 Material temperature in core barrel (TMV-CO-35A).

Fig. 57 Material temperature in core barrel (TMV-CO-115A).

Fig. 58 Material temperature in core barrel (TMV-CO-115M).

Fig. 59 Material temperature in core barrel (TMV-CO-127A).

Fig. 60 Material temperature in core barrel (TMV-CI-70A).

Fig. 61 Material temperature in core barrel (TMV-CI-95M).

Fig. 62 Material temperature in core barrel (TMV-CI-115A).

Fig. 63 Material temperature in core housing filler (TMV-HF-115W).

Fig. 64 Material temperature in core housing filler (TMV-HF-127W).

Fig. 65 Material temperature in core housing filler (TMV-HF-138W).

Fig. 66 Core heater temperature, Rod D-4 (TH-D4-14).

Fig. 67 Core heater temperature, Rod D-4 (TH-D4-29).

Fig. 68 Core heater temperature, Rod D-5 (TH-D5-09).

Fig. 69 Core heater temperature, Rod D-5 (TH-D5-29).

Fig. 70 Core heater temperature, Rod D-5 (TH-D5-39).

Fig. 71 Core heater temperature, Rod E-4 (TH-E4-23).

Fig. 72 Core heater temperature, Rod E-4 (TH-E4-27).

Fig. 73 Core heater temperature, Rod E-5 (TH-E5-21).

Fig. 74 Core heater temperature, Rod E-5 (TH-E5-25).

Fig. 75 Core heater temperature, Rod A-4 (TH-A4-09).

Fig. 76 Core heater temperature, Rod A-4 (TH-A4-29).

Fig. 77 Core heater temperature, Rod A-4 (TH-A4-39).

Fig. 78 Core heater temperature, Rod A-5 (TH-A5-29).

Fig. 79 Core heater temperature, Rod A-5 (TH-A5-44).

Fig. 80 Core heater temperature, Rod B-3 (TH-B3-32).

Fig. 81 Core heater temperature, Rod B-5 (TH-B5-29).

Fig. 82 Core heater temperature, Rod B-5 (TH-B5-38).

Fig. 83 Core heater temperature, Rod B-6 (TH-B6-29).

Fig. 84 Core heater temperature, Rod C-2 (TH-C2-28).

Fig. 85 Core heater temperature, Rod C-2 (TH-C2-38).

Fig. 86 Core heater temperature, Rod C-3 (TH-C3-13).

Fig. 87 Core heater temperature, Rod C-3 (TH-C3-28).

Fig. 88 Core heater temperature, Rod C-3 (TH-C3-60).

Fig. 89 Core heater temperature, Rod C-4 (TH-C4-26).

Fig. 90 Core heater temperature, Rod C-4 (TH-C4-53).

Fig. 91 Core heater temperature, Rod C-5 (TH-C5-28).

Fig. 92 Core heater temperature, Rod C-5 (TH-C5-44).

Fig. 93 Core heater temperature, Rod C-6 (TH-C6-32).

Fig. 94 Core heater temperature, Rod C-7 (TH-C7-15).

Fig. 95 Core heater temperature, Rod D-1 (TH-D1-21).

Fig. 96 Core heater temperature, Rod D-2 (TH-D2-14).

Fig. 97 Core heater temperature, Rod D-2 (TH-D2-61).

Fig. 98 Core heater temperature, Rod D-3 (TH-D3-29).

Fig. 99 Core heater temperature, Rod D-3 (TH-D3-33).

Fig. 100 Core heater temperature, Rod D-3 (TH-D3-39).

Fig. 101 Core heater temperature, Rod D-6 (TH-D6-15).

Fig. 102 Core heater temperature, Rod D-6 (TH-D6-25).

Fig. 103 Core heater temperature, Rod D-7 (TH-D7-20).

Fig. 104 Core heater temperature, Rod D-8 (TH-D8-26).

Fig. 105 Core heater temperature, Rod E-1 (TH-E1-33).

Fig. 106 Core heater temperature, Rod E-1 (TH-E1-54).

Fig. 107 Core heater temperature, Rod E-2 (TH-E2-21).

Fig. 108 Core heater temperature, Rod E-2 (TH-E2-33).

Fig. 109 Core heater temperature, Rod E-3 (TH-E3-05).

Fig. 110 Core heater temperature, Rod E-3 (TH-E3-20).

Fig. 111 Core heater temperature, Rod E-3 (TH-E3-24).

Fig. 112 Core heater temperature, Rod E-6 (TH-E6-08).

Fig. 113 Core heater temperature, Rod E-6 (TH-E6-28).

Fig. 114 Core heater temperature, Rod E-6 (TH-E6-37).

Fig. 115 Core heater temperature, Rod E-7 (TH-E7-13).

Fig. 116 Core heater temperature, Rod E-7 (TH-E7-44).

Fig. 117 Core heater temperature, Rod E-8 (TH-E8-14).

Fig. 118 Core heater temperature, Rod E-8 (TH-E8-29).

Fig. 119 Core heater temperature, Rod E-8 (TH-E8-45).

Fig. 120 Core heater temperature, Rod F-2 (TH-F2-22).

Fig. 121 Core heater temperature, Rod F-2 (TH-F2-25).

Fig. 122 Core heater temperature, Rod F-3 (TH-F3-15).

Fig. 123 Core heater temperature, Rod F-3 (TH-F3-22).

Fig. 124 Core heater temperature, Rod F-3 (TH-F3-25).

Fig. 125 Core heater temperature, Rod F-4 (TH-F4-14).

Fig. 126 Core heater temperature, Rod F-4 (TH-F4-28).

Fig. 127 Core heater temperature, Rod F-4 (TH-F4-44).

Fig. 128 Core heater temperature, Rod F-4 (TH-F4-60).

Fig. 129 Core heater temperature, Rod F-5 (TH-F5-20).

Fig. 130 Core heater temperature, Rod F-5 (TH-F5-26).

Fig. 131 Core heater temperature, Rod F-5 (TH-F5-33).

Fig. 132 Core heater temperature, Rod F-5 (TH-F5-53).

Fig. 133 Core heater temperature, Rod F-6 (TH-F6-08)

Fig. 134 Core heater temperature, Rod F-6 (TH-F6-28).

Fig. 135 Core heater temperature, Rod F-7 (TH-F7-29).

Fig. 136 Core heater temperature, Rod F-7 (TH-F7-39).

Fig. 137 Core heater temperature, Rod G-3 (TH-G3-13).

Fig. 138 Core heater temperature, Rod G-3 (TH-G3-45).

Fig. 139 Core heater temperature, Rod G-4 (TH-G4-09).

Fig. 140 Core heater temperature, Rod G-4 (TH-G4-29).

Fig. 141 Core heater temperature, Rod G-4 (TH-G4-33).

Fig. 142 Core heater temperature, Rod G-4 (TH-G4-38).

Fig. 143 Core heater temperature, Rod G-5 (TH-G5-14).

Fig. 144 Core heater temperature, Rod G-5 (TH-G5-24).

Fig. 145 Core heater temperature, Rod G-6 (TH-G6-21).

Fig. 146 Core heater temperature, Rod G-6 (TH-G6-33).

Fig. 147 Core heater temperature, Rod H-5 (TH-H5-28).

Fig. 148 Material temperature in steam generator (TMU-SG1).

Fig. 149 Material temperature in steam generator (TMU-SG2).

Fig. 150 Material temperature in steam generator (TMU-SG3).

Fig. 151 Material temperature in steam generator (TMU-SG4).

Fig. 152 Pressure in vessel, upper plenum (PV-UP+10).

Fig. 153 Pressure in vessel, inlet annulus (PV-IANN-9).

Fig. 154 Pressure in steam generator, secondary side (PU-SGSD).

Fig. 155 Pressure in pressure suppression tank (P-PSS).

Fig. 156 Pressure in pressure suppression tank header (P-PSS-HD).

Fig. 157 Differential pressure in intact loop, low range (DPU-UP-IL).

Fig. 158 Differential pressure in intact loop (DPU-UP-9).

Fig. 159 Differential pressure in intact loop (DPU-1-3).

Fig. 160 Differential pressure in intact loop, low range (DPU-1-3L).

Fig. 161 Differential pressure in intact loop, (DPU-3-7).

Fig. 162 Differential pressure in intact loop, low range (DPU-3-7L).

Fig. 163 Differential pressure in intact loop (DPU-3-SGIP).

Fig. 164 Differential pressure in steam generator primary (DPU-SGIP-SG1).

Fig. 165 Differential pressure in steam generator primary (DPU-SG1-SG2).

Fig. 166 Differential pressure in steam generator primary (DPU-SG2-SG3).

Fig. 167 Differential pressure in steam generator primary (DPU-SG3-SG4).

Fig. 168 Differential pressure in intact loop (DPU-7-10).

Fig. 169 Differential pressure in intact loop (DPU-8C-7).

Fig. 170 Differential pressure in intact loop, pump trap (DPU-8C-8D).

Fig. 171 Differential pressure in intact loop, low range, Tests S-03-A and S-03-D (DPU-12-10L).

Fig. 172 Differential pressure in intact loop, low range, Tests S-03-B and S-03-C (DPU-12-10L).

Fig. 173 Differential pressure in intact loop (DPU-15-1).

Fig. 174 Differential pressure in intact loop (DPU-15-IANN).

Fig. 175 Differential pressure in intact loop (DPU-15-ATM).

Fig. 176 Differential pressure in broken loop, Tests S-03-A and S-03-D (DPB-21-IANN).

Fig. 177 Differential pressure in broken loop, Tests S-03-B and S-03-C (DPB-21-IANN).

Fig. 178 Differential pressure in broken loop, Tests S-03-A and S-03-D (DPB-21-23).

Fig. 179 Differential pressure in broken loop, Tests S-03-B and S-03-C (DPB-21-23).

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

Fig. 181 Differential pressure in vessel (DPV-166-191QT).

Fig. 182 Differential pressure in vessel core (DPVC-CBI-UP).

Fig. 183 Differential pressure in vessel core (DPVC-83W-UP).

Fig. 184 Differential pressure in vessel core (DPVC-83-100WQ).

Fig. 185 Differential pressure in vessel core (DPVC-100-117QJ).

Fig. 186 Differential pressure in vessel core (DPVC-117-133JD).

Fig. 187 Differential pressure in vessel core, Tests S-03-A and S-03-D (DPVC-133-191DT).

Fig. 188 Differential pressure in vessel core, Tests S-03-B and S-03-C (DPVC-133-191DT).

Fig. 189 Volumetric flow in intact loop (FTU-1).

Fig. 190 Volumetric flow in intact loop (FTU-9).

Fig. 191 Volumetric flow in intact loop (FTU-15).

Fig. 192 Volumetric flow in broken loop (FTB-21).

Fig. 193 Volumetric flow in core barrel manifold, Test S-03-A (FTV-CBM).

Fig. 194 Volumetric flow in core barrel manifold, Test S-03-B (FTV-CBM).

Fig. 195 Volumetric flow in core barrel manifold, Test S-03-C (FTV-CBM).

Fig. 196 Volumetric flow in core barrel manifold, Test S-03-D (FTV-CBM).

Fig. 197 Momentum flux in intact loop, Test S-03-A (FDU-1).

Fig. 198 Momentum flux in intact loop, Test S-03-B (FDU-1).

Fig. 199 Momentum flux in intact loop, Test S-03-C (FDU-1).

Fig. 200 Momentum flux in intact loop, Test S-03-D (FDU-1).

Fig. 201 Density in intact loop, Test S-03-A (GU-1VR).

Fig. 202 Density in intact loop, Test S-03-B (GU-1VR).

Fig. 203 Density in intact loop, Test S-03-C (GU-1VR).

Fig. 204 Density in intact loop, Test S-03-D (GU-1VR).

Fig. 205 Density in intact loop, Test S-03-A (GU-1HZ).

Fig. 206 Density in intact loop, Test S-03-B (GU-1HZ).

Fig. 207 Density in intact loop, Test S-03-C (GU-1HZ).

Fig. 208 Density in intact loop, Test S-03-D (GU-1HZ).

Fig. 209 Density in intact loop, Test S-03-A (GU-5VR).

Fig. 210 Density in intact loop, Test S-03-B (GU-5VR).

Fig. 211 Density in intact loop, Test S-03-C (GU-5VR).

Fig. 212 Density in intact loop, Test S-03-D (GU-5VR).

Fig. 213 Density in intact loop, Test S-03-A (GU-10VR).

Fig. 214 Density in intact loop, Test S-03-B (GU-10VR).

Fig. 215 Density in intact loop, Test S-03-C (GU-10VR).

Fig. 216 Density in intact loop, Test S-03-D (GU-10VR).

Fig. 217 Density in intact loop, Test S-03-A (GU-15VR).

Fig. 218 Density in intact loop, Test S-03-B (GU-15VR).

Fig. 219 Density in intact loop, Test S-03-C (GU-15VR).

Fig. 220 Density in intact loop, Test S-03-D (GU-15VR).

Fig. 221 Density in broken loop, Test S-03-A (GB-21VR).

Fig. 222 Density in broken loop, Test S-03-B (GB-21VR).

Fig. 223 Density in broken loop, Test S-03-C (GB-21VR).

Fig. 224 Density in broken loop, Test S-03-D (GB-21VR).

Fig. 225 Density in broken loop, Test S-03-A (GB-23VR).

Fig. 226 Density in broken loop, Test S-03-B (GB-23VR).

Fig. 227 Density in broken loop, Test S-03-C (GB-23VR).

Fig. 228 Density in broken loop, Test S-03-D (GB-23VR).

Fig. 229 Differential pressure in intact loop (phase separator liquid level) (DPU-PSEP-W).

Fig. 230 Differential pressure in steam generator secondary (DPU-SG-SEC).

Fig. 231 Core heater Pin total power, Tests S-03-A and S-03-D (PWRCOR T-1).

Fig. 232 Core heater Pin total power, Tests S-03-B and S-03-C (PWRCOR T-1).

Fig. 233 Core heater Pin total power (PWRCOR T-2).

Fig. 234 Core heater voltage (VOLT-COR-T).

Fig. 235 Core heater total current (AMPCOR-T).

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