EXPERIMENT DATA REPORT FOR SEMISCALE ISOTHERMAL TEST PROGRAM HOT-WALL TESTS

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by

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ABSTRACT

Recorded test data are presented for five hot-wall tests conducted as part of the isothermal test series of the Semiscale Blowdown and Emergency Core Cooling (ECC) Project. These data represent the results of tests in which simulated ECC injection following blowdown was investigated with the semiscale system at ~ 40 psig to determine the effects of stored wall heat on simulated ECC delivery to the pressure vessel lower plenum. 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 correct. The intent of this report is to make available the uninterpreted data from the hot-wall tests for use by others and for support of subsequent interpretative reports and analyses.

SUMMARY

The hot-wall tests were performed in the isothermal portion of the Semiscale Blowdown and Emergency Core Cooling (ECC) Project conducted by Aerojet Nuclear Company for the Atomic Energy Commission. The tests were conducted to determine the effect of stored wall heat on simulated ECC delivery. The experimental system consisted of a pressure vessel with simulated reactor internals; an operating loop with pump, steam generator, and pressurizer; a blowdown loop with a simulated pump, a simulated steam generator, and rupture assemblies; a pressure suppression system with header and pressure suppression tank; and a simulated ECC system with accumulators and injection pumps.

Each of the five hot-wall tests (Tests 15.1, 15.2, 15.3, 15.4, and 15.7) was conducted immediately following completion of one of five isothermal blowdown tests (Tests 1001, 1004, 1010, 1011, and 1014, respectively) and rapid draining of the lower plenum of the pressure vessel. Each hot-wall test was initiated by injection of simulated ECC into the cold legs of the operating loop and the blowdown loop. The hot-wall tests provided (a) data for determining the time required for auxiliary cooling water (simulated ECC) to reach the vessel lower plenum and (b) information relative to the effects of steam generation in the vessel downcomer region on the time required for simulated ECC delivery.

In general, instrumentation used in the hot-wall tests functioned as intended and data loss was minimal. Of more than 700 measurements attempted during the five tests, more than 90% were accomplished. The data appear to be satisfactory for subsequent analysis.

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EXPERIMENT DATA REPORT FOR SEMISCALE ISOTHERMAL

TEST PROGRAM HOT-WALL TESTS

I. INTRODUCTION

The isothermal test program is part of the Semiscale Blowdown and Emergency Core Cooling (ECC) Project conducted by Aerojet Nuclear Company. The project is part of an overall AEC-sponsored research and development program directed at (a) quantifying the physical processes controlling system behavior during a postulated loss-of-coolant accident (LOCA) in a pressurized water reactor (PWR), and (b) providing an experimental data base for assessing reactor safety evaluation models.

The 1-1/2-loop semiscale system in which the isothermal test program was conducted includes both an intact operating loop and a broken, or blowdown, loop. The operating loop simulates three unbroken loops of a PWR, and the blowdown loop simulates one broken loop of a PWR. Relative to previous experimental systems, the 1-1/2-loop semiscale system provides a source of more representative coupled-system response data from which to obtain a correspondingly more comprehensive understanding of the thermal and hydraulic processes following an LOCA.

The major emphasis in the isothermal experiments was on ECC delivery. The hot-wall tests were conducted to determine the effects of stored wall heat on simulated ECC delivery. The purpose of the hot-wall tests was (a) to determine the time required for auxiliary cooling water (simulated ECC) to reach and fill the lower plenum of the pressure vessel and (b) to investigate the effect of steam generation in the vessel downcomer region on the time required for simulated ECC delivery. As an initial condition for these tests, the semiscale pressure vessel and associated piping had to be relatively hot, 350 to 550°F. This prerequisite was fulfilled in the normal course of events that accompanied isothermal blowdown tests in which simulated ECC injection was not used. Consequently, each of the five hot-wall tests was conducted following an isothermal blowdown test which did not utilize simulated ECC injection or in which the ECC injection locations were such that the temperatures of the walls of the pressure vessel and related piping were maintained above 350°F.

The five hot-wall tests and the corresponding isothermal tests which preceded the hot-wall tests are as follows:

<u>Hot-Wall Test</u>	<u>Blowdown Test</u>
15.1	1001
15.2	1004
15.3	1010
15.4	1011
15.7	1014

References 1, 2, 3, 4, and 5 provide information and data on the isothermal tests that preceded the hot-wall tests and Reference 6 provides a description of the isothermal test program, test configuration, and instrumentation.

The test configuration and conditions for each hot-wall test are summarized briefly as follows:

Test 15.1

- (1) Test 15.1 was initiated by injection of simulated ECC into the cold legs of the operating loop and blowdown loop at 42.5 sec following blowdown initiation during isothermal blowdown Test 1001.
 - (a) Simulated ECC injection flow in the operating loop was ~ 21 gpm average for at least 167 sec.
 - (b) Simulated ECC injection flow in the blowdown loop was calculated to be ~ 7 gpm^[a] average for at least 167 sec.
- (2) Other test configuration elements were identical to those for isothermal blowdown Test 1001^[1]; that is, the downcomer gap size was 0.5 inch, the standard (long) lower plenum configuration (L/D = 2.8:1) was used with the thermal shield installed, and the 100% break area nozzles were used.

Test 15.2

- (1) Test 15.2 was initiated by injection of simulated ECC into the cold legs of the operating loop and blowdown loop at 58 sec following blowdown initiation during isothermal blowdown Test 1004.
 - (a) Simulated ECC injection flow in the operating loop was ~ 52 gpm average for ~ 62.5 sec.
 - (b) Simulated ECC injection flow in the blowdown loop was ~ 7 gpm average for ~ 62.5 sec.
- (2) Other test configuration elements were identical to those for isothermal blowdown Test 1004^[2]; that is, the downcomer gap size was 0.5 inch, the standard (long) lower plenum configuration (L/D = 2.8:1) was used with the thermal shield installed, and the 100% break area nozzles were used.

[a] Data were not available for simulated ECC injection flow in the blowdown loop for Test 15.1; indicated flow of ~ 7 gpm was calculated from data taken during other hot-wall tests.

Test 15.3

- (1) Test 15.3 was initiated by injection of simulated ECC into the cold legs of the operating loop and blowdown loop at 86 sec following blowdown initiation during isothermal blowdown Test 1010.
 - (a) Simulated ECC injection flow in the operating loop was ~ 51 gpm average for ~ 47 sec.
 - (b) Simulated ECC injection flow in the blowdown loop was ~ 7 gpm average for ~ 47 sec.
- (2) Other test configuration elements were identical to those for isothermal blowdown Test 1010^[3]; that is, the downcomer gap size was 1.0 inch, the standard (long) lower plenum configuration (L/D = 2.8:1) was used with the thermal shield installed, and the 100% break area nozzles were used.

Test 15.4

- (1) Test 15.4 was initiated by injection of simulated ECC into the cold legs of the operating loop and blowdown loop at 23 sec following blowdown initiation during isothermal blowdown Test 1011.
 - (a) Simulated ECC injection flow in the operating loop was ~ 66 gpm average for at least 57 sec.
 - (b) Simulated ECC injection flow in the blowdown loop was ~ 7 gpm average for at least 57 sec.
- (2) Other test configuration elements were identical to those for isothermal blowdown Test 1011^[4]; that is, the downcomer gap size was 1.69 inches, the standard (long) lower plenum configuration (L/D = 2.8:1) was used with the thermal shield installed, and the 80% break area nozzles were used.

Test 15.7

- (1) Test 15.7 was initiated by injection of simulated ECC into the cold legs of the operating loop and blowdown loop at 81 sec following blowdown initiation during isothermal blowdown Test 1014.
 - (a) Simulated ECC injection flow in the operating loop was ~ 50 gpm average for ~ 45 sec.
 - (b) Simulated ECC injection flow in the blowdown loop was ~ 7 gpm average for ~ 45 sec.

- (2) Other test configuration elements were identical to those for isothermal blowdown Test 1014^[5]; that is, the downcomer gap size was 1.0 inch, the standard (long) lower plenum configuration ($L/D = 2.8:1$) was used with the thermal shield installed, and the flow path was through one 100% break area nozzle (on the simulated pump discharge side in the blowdown loop) as a result of actuation of only one of the two rupture assemblies during Test 1014.

The purpose of this report is to present the uninterpreted test data in a readily usable form for use by the nuclear community in advance of detailed analysis and interpretation. Section II briefly describes the system configuration and initial test conditions and events that are applicable to the hot-wall tests. Section III presents the data graphs and provides comments and supporting information necessary for interpretation of the data. Reference 6 is recommended as an additional source of information regarding the isothermal experimental system and program; test conditions and procedures; instrument locations, nomenclature, and accuracies; and methods of obtaining and processing the data.

II. SYSTEM AND CONDITIONS FOR HOT-WALL TESTS

The system configuration, initial test conditions, and events and conditions following blowdown initiation that are specific to the hot-wall tests are presented in this section.

1. SYSTEM CONFIGURATION

The 1-1/2-loop isothermal semiscale system used for the hot-wall tests consisted of a pressure vessel with internals; an operating loop with a steam generator, pump, and pressurizer; a blowdown loop with a simulated steam generator, a simulated pump, and two rupture assemblies; a pressure suppression system with a suppression tank and a header; and a simulated ECC system with accumulators and injection pumps.

The standard lower plenum ($L/D = 2.8:1$) was used in the pressure vessel for all hot-wall tests. This plenum configuration consists of the standard (long) lower head and the downcomer filler extension. The vessel lower plenum was thermally insulated with the thermal shield, which consists of the thermal sleeve and the bottom thermal liner plate. Two vessel downcomer filler pieces were used to vary the downcomer gap; the 0.5-inch downcomer gap was used for Tests 15.1 and 15.2 and the 1.0-inch downcomer gap was used for Tests 15.3 and 15.7. The vessel downcomer filler piece was removed to provide the 1.69-inch downcomer gap for Test 15.4.

The simulated ECC injection system was used for the hot-wall tests. For all hot wall tests except Test 15.4, the operating loop ECC injection pump supplied water to the cold leg of the operating loop, and the blowdown loop ECC injection pump supplied water to the blowdown loop at the simulated pump discharge side of the break. For Test 15.4, only the two ECC accumulators supplied water to the operating loop. The ECC accumulators were connected in series. The outlet flow was split into two parallel paths to facilitate measurement. The flows were recombined prior to injection into the operating loop. Air or steam pressure in the pressure suppression tank was regulated at ~ 40 psig to maintain about this pressure in the system during each hot-wall test; three check valves in the upper portion of the pressure suppression tank downcomer facilitated system pressurization while precluding water flow from the tank back into the blowdown loop.

2. INITIAL TEST CONDITIONS AND SEQUENCE OF EVENTS

Each hot-wall test was conducted following completion of an isothermal blowdown test and rapid draining of the lower plenum of the pressure vessel. The hot-wall tests were begun at times varying from 23 to 86 sec after the isothermal blowdown tests were initiated. Simulated ECC, as cold as practicable (50 to 60°F), was injected into the cold legs of the operating loop and the blowdown loop for durations which varied from ~ 45 sec to at least 167 sec. Air pressure in the pressure suppression tank was regulated at ~ 40 psig to maintain about this pressure in the system throughout each hot-wall test.

Table I gives the metal temperatures in several regions of the pressure vessel at the time each hot-wall test was initiated ($t = 0$ sec), which was the time at which injection of simulated ECC was begun. Figures 1 through 5 show profiles of the average initial metal temperatures at different locations in the pressure vessel. A significantly different temperature profile is shown for Test 15.7, which was a single-ended break test.

TABLE I

INITIAL METAL TEMPERATURES IN PRESSURE VESSEL
DOWNCOMER FILLER PIECE, CORE BARREL, AND VESSEL WALL

Measurement Location[a]	Detector Designation[b]	Initial Metal Temperatures (°F)				
		Test 15.1	Test 15.2	Test 15.3	Test 15.4	Test 15.7
48	TM-48D-0	530	530	500	---	491
48	TM-48D-180	520	520	---	---	491
47	TM-47C-0	495	502	500	492	482
47	TM-47C-180	508	502	445	---	503
63	TM-63D-45	535	530	490	517	520
63	TM-63D-225	522	---	---	512	---
62	TM-62C-45	505	493	485	460	478
78	TM-78D-0	532	530	485	502	535
78	TM-78D-180	530	530	485	500	529
77	TM-77C-0	490	490	475	430	470
77	TM-77C-180	505	490	478	470	500
95	TM-94C-45	468	468	450	360	470
95	TM-94C-16-45	462	465	450	360	445
95	TM-95D-45	505	510	455	457	---
95	TM-95D-225	520	520	460	460	530
116	TM-116D-45	460	365	362	---	525
116	TM-116D-225	480	415	376	---	525
116	TM-116V-0	---	---	---	382	---
116	TM-116V-180	---	---	---	380	---

[a] Measurement location denotes approximate distance (in.) below pressure vessel upper flange face.

[b] Detector designations are defined in Reference 6.

Fig. 1 Average temperature profiles in pressure vessel at start of Test 15.1.

Fig. 2 Average temperature profiles in pressure vessel at start of Test 15.2.

Fig. 3 Average temperature profiles in pressure vessel at start of Test 15.3.

Fig. 4 Average temperature profiles in pressure vessel at start of Test 15.4.

Fig. 5 Average temperature profiles in pressure vessel at start of Test 15.7.

III. DATA PRESENTATION

The data from semiscale isothermal program hot-wall tests are presented with brief comment. Processing and analysis have been performed only to the extent necessary to obtain appropriate engineering units and to assure that the data are reasonable and correct. 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 in the isothermal tests may have subjected the measurement devices to nonhomogeneous fluid conditions.

Figures 6 through 9 and Table II provide supporting information for interpretation of the data shown in Figures 10 through 370. Figures 6 through 9 show the locations of all measurements in the hot-wall test system. Table II groups the measurements taken during the hot-wall tests according to measurement type; identifies the specific measurements, their locations, and the range over which the data are considered valid; provides brief comments regarding the data; and references the measurements and comments to the corresponding figure on which the data are presented. The data are presented in many instances in the form of composite graphs of a given variable at several locations during a single test. Zero seconds on all graphs is the time of initiation of simulated ECC injection.

Reference 6 provides more detailed information regarding the isothermal experimental system and program; test conditions and procedures; instrument locations, nomenclature, and accuracies; and methods of obtaining and processing the data.

Number Suffixes or Encircled Numbers Alone Identify System Locations (pipe spools, vessel ports, stations)

11

13

Encircled Letter Symbols Denote Measurement Types

Number Suffixes or Encircled Numbers Alone Identify System Locations (vessel ports, stations)

Degrees Indicate Clockwise Orientation Around Vessel as Viewed from Vessel Top with 0° at Centerline of Operating Loop Inlet Cold Leg Nozzle

Nozzles Receding from View Plane are Omitted for Clarity

Pressure Vessel Instruments not Installed in Ports are Shown on ANC-R-2188

ANC-R-2281

PENETRATION CODE	SIZE (IN.)	ANGULAR LOCATION FROM COLD LEG (CLOCKWISE)	DISTANCE FROM TOP FACE OF VESSEL (IN.)	PRIMARY USAGE	VESSEL WALL PENETRATION DIAMETER (IN.)
200	3/4 NPT	150°	7.88		.750
201	3/4 NPT	30°	7.13		.750
202	1/2 NPT	0°	5.00		.703
203			9.88	DENSITY, SOURCE	.500
204	1/2 NPT	45°	11.88		.560
205	1/4 NPT	5°	14.88		.250
206	1/2 NPT	0°	25.38		.750
207	3/4 NPT	30°	28.38		.750
208	3/4 NPT	150°	28.38		.750
209			30.38	DENSITY, SOURCE	.500
210	1/4 NPT	5°	32.88		.250
211	1/2 NPT	45°	32.88		.560
212	1 NPT	135°	49.88		1.000
213	1/4 NPT	40°	47.88		.750
214	3/4 NPT	315°	55.62	DOWNCOMER SUPPORT	
215	3/4 NPT	75°	55.62	DOWNCOMER SUPPORT	
216	3/4-16-UNF	45°	49.88		.687
217	1/4 NPT	135°	81.859		.250
218	1/4 NPT	75°	81.859		.250
219	1/4 NPT	15°	81.859		.250
220	1/4 NPT	135°	105.859		.250
221	1/4 NPT	75°	105.859		.250
222	1/4 NPT	15°	105.859		.250
223	3/4 NPT	135°	109.989		.750
224	3/4 NPT	315°	109.989		.750
225	1-1/4 NPT	0°	109.989	DENSITY	1.438
226	1 NPT	45°	116.989	TURBINE PROBE	1.000
227	1 NPT	45°	121.297	FILL LINE	1.000
228	1-1/4 NPT	0°	122.370		1.500
229	1 NPT	315°	121.297		1.000
230	3/4-16-UNF	225°	7.13		.687
231			9.88	DENSITY	.3125
232	1/4 NPT	125°	14.88		.250
233	1/4 NPT	245°	14.88		.250
234	3/4-16-UNF	225°	28.38		.687
235			30.38	DENSITY	.3125
236	1/4 NPT	125°	32.88		.250
237	1/4 NPT	230°	32.88		.250
238	1/4 NPT	330°	47.88		.250
239	1 NPT	225°	47.88	ECC	1.000
240	1/4 NPT	165°	47.88		.250
241	1-1/4 NPT	270°	47.88		.250
242	3/4 NPT	270°	49.88		.750
243	3/4 NPT	195°	55.62	DOWNCOMER SUPPORT	
244	1/2 NPT	225°	59.562		.500
245	1/4 NPT	315°	81.859		.250
246	1/4 NPT	255°	81.859		.250
247	1/4 NPT	195°	81.859		.250
248	1/4 NPT	315°	105.859		.250
249	1/4 NPT	255°	105.859		.250
250	1/4 NPT	135°	105.859		.250
251	1-1/4 NPT	180°	110.010	DENSITY	1.438
252	1 NPT	315°	116.989	TURBINE PROBE	1.000
253	1 NPT	225°	119.234		1.000
254	1 NPT	15°	119.234	ECC	1.000
255	3/4 NPT	240°	121.297		.750
256	3/4 NPT	120°	122.672		.750
257	1/4 NPT	80°	47.88		.250
258	3/4-16-UNF			IN LOWER HEAD	.687
259	1/2 NPT			IN LOWER HEAD	.703
260	3/4 NPT			IN LOWER HEAD	.921
261	3/4 NPT			IN LOWER HEAD	.921
262	3/4 NPT			IN LOWER HEAD	.921
263	1 NPT			IN LOWER HEAD	.921
264	1/4 NPT	45°	39.88	PRESSURE TRANSDUCER	.840
265	1/2 NPT	45°	37.88	RESISTANCE BULB	.540
266	1/2 NPT	299°	37.88		.840
267	1/4 NPT	259°	39.88		.540
268	1 NPT	0°	94.43		
269	1 NPT	90°	94.43		
270	1 NPT	180°	94.43		
271	1 NPT	0°	65.63		
272	1-1/4 NPT	180°	122.37		1.500
273	1-1/4 NPT	315°	7.88		1.500
274	1-1/4 NPT	315°	28.38		1.500
275			114.50	DENSITY	
276				IN LOWER HEAD	

Fig. 9 Pressure vessel -- isometric showing instrumentation.

TABLE II
DATA PRESENTATION FOR ISOTHERMAL HOT-WALL TESTS

Measurement ^[a]	Location ^[b]	Range ^[c,d]	Figure ^[d]	Comment ^[d]
FLUID TEMPERATURE				
<u>Operating Loop</u>		33-650°F	10 - 14	Chromel-Alumel thermocouples; estimated accuracy to within $\pm 7^\circ\text{F}$.
TF-1	Hot leg, Spool 1			
TF-15	Pump suction, Spool 15			
TF-19	Pump discharge, Spool 19			
TF-22	Cold leg, Spool 22			
TF-40	Pressurizer outlet, Spool 40			
TS-3	Hot leg, Spool 3			TS-3 is a shielded thermocouple
TS-20	Cold leg, Spool 20			TS-20, a shielded thermocouple, failed during Tests 15.1, 15.3, and 15.7. TS-20 was not used during Test 15.4
<u>Blowdown Loop</u>		33-650°F	15 - 19	
TF-50	Cold leg, Spool 50			
TF-51	Cold leg downstream of vessel-side nozzle			
TF-70	Hot leg, Spool 70			
TF-76	Cold leg, Spool 76			TF-76 failed during Test 15.2
TF-96	Simulated steam generator discharge, Spool 96			TF-96 was not used during Tests 15.1 and 15.2
<u>Pressure Suppression System</u>				
TF-83	Header near downcomer entrance (1 inch from ID of header on bottom)	33-650°F	20 - 24	TF-83 was not used during Test 15.4
TF-86-3	Suppression vessel, Station 86-3	33-300°F		
TF-86-4	Suppression vessel, Station 86-4	33-300°F		TF-86-4 failed during Tests 15.3, 15.4, and 15.7
TF-88	Suppression vessel vapor chamber, 2 inches from tank wall	33-650°F		
RB-86-6	Suppression vessel water, Station 86-6	0-1000°F		RB-86-6 is a resistance bulb fluid temperature detector
<u>Lower Plenum (Vertical Thermocouple Rack)</u>		33-650°F		Nine thermocouples spaced at 2-inch intervals upward from ~1.75 inches above bottom of the lower head
TF-260-2	2-inch level from inside bottom of lower head		25 - 29	
TF-260-4	4-inch level from inside bottom of lower head			
TF-260-6	6-inch level from inside bottom of lower head			
TF-260-8	8-inch level from inside bottom of lower head			
TF-260-10	10-inch level from inside bottom of lower head			
TF-260-12	12-inch level from inside bottom of lower head			TF-260-12 data could not be digitized for Test 15.2. TF-260-12 failed during Tests 15.3 and 15.7
TF-260-14	14-inch level from inside bottom of lower head			
TF-260-16	16-inch level from inside bottom of lower head			
TF-260-18	18-inch level from inside bottom of lower head			TF-260-18 was not used during Test 15.4. TF-260-18 failed during Tests 15.3 and 15.7
<u>Downcomer Gap</u>		33-650°F		
TF-47D-180	~48 inches, 180°, extending 1/8 inch into fluid from vessel wall side		30,31,32, 34	TF-47D-180 was not used during Test 15.4
TF-48C-180	~48 inches, 180°, extending 1/8 inch into fluid from core barrel		30 - 34	
TF-48D-0	~48 inches, 0°, extending 1/8 inch into fluid from vessel wall side		30,31,32, 34	TF-48D-0 was not used during Test 15.4
TF-78D-0	~78 inches, 0°		35,36,37,39	TF-78D-0 was not used during Test 15.4
TF-78D-180	~78 inches, 180°		35,36,37,39	TF-78D-180 was not used during Test 15.4
TF-95D-45	~95 inches, 45°		35,37	TF-95D-45 failed during Tests 15.2 and 15.7. TF-95D-45 was not used during Test 15.4
TF-95D-225	~95 inches, 225°		35,36,37,39	TF-95D-225 was not used during Test 15.4
TF-214	55.62 inches, 315°		33	TF-214 was used only during Test 15.4
TF-215	55.62 inches, 75°		33	TF-215 was used only during Test 15.4
TF-217	81.86 inches, 135°		38	TF-217 was used only during Test 15.4
TF-219	81.86 inches, 15°		38	TF-219 was used only during Test 15.4
TF-245	81.86 inches, 315°		38	TF-245 was used only during Test 15.4
TF-247	81.86 inches, 195°		38	TF-247 was used only during Test 15.4
TF-268	94.43 inches, 0°		38	TF-268 was used only during Test 15.4
TF-269	94.43 inches, 90°		38	TF-269 was used only during Test 15.4
<u>Outlet Plenum</u>		33-650°F	40 - 43	
TF-211	32.4 inches, 45°			TF-211 failed during Test 15.3
TF-263	In lower plenum head, Station 263			TF-263 failed during Test 15.4 and was not used during Tests 15.1, 15.2, 15.3, and 15.7
TF-274	28.38 inches, 315°			TF-274 was not used during Tests 15.3, 15.4, and 15.7
<u>ECC System</u>		33-300°F	44 - 46	
TF-ECC-BLP	In line from blowdown loop ECC injection pump			TF-ECC-BLP was not used during Test 15.1. TF-ECC-BLP failed during Test 15.4
TF-ECC-OLP	In line from operating loop ECC injection pump			TF-ECC-OLP was not used during Tests 15.1, 15.3, and 15.4
TF-BDO-OLA	In line from generating loop ECC injection accumulator			TF-ECC-OLA failed during Test 15.4 and was not used during Tests 15.1, 15.3, 15.4, and 15.7

TABLE II (contd.)

DATA PRESENTATION FOR ISOTHERMAL HOT-WALL TESTS

Measurement [a]	Location [b]	Range [c,d]	Figure [d]	Comment [d]
METAL TEMPERATURE				
<u>Core Barrel</u>		33-650°F	47 - 51	Chromel-Alumel thermocouples; estimated accuracy to within $\pm 7^\circ\text{F}$
TM-47C-0	~47 inches, 0°, 1/8 inch from OD			TM-47C-0 failed during Test 15.4
TM-47C-180	~47 inches, 180°, 1/8 inch from OD			TM-47C-180 data for Test 15.2 could not be digitized
TM-62C-45	~62 inches, 45°, 1/8 inch from OD			
TM-77C-0	~77 inches, 0°, 1/8 inch from OD			
TM-77C-180	~77 inches, 180°, 1/8 inch from OD			
TM-94C-45	~95 inches, 45°, 1/8 inch from OD			TM-94C-45 failed about 46 sec after blowdown during Test 15.2
TM-94C-16-45	~95 inches, 45°, 1/16 inch from ID			
<u>Downcomer Filler</u>		33-650°F	52 - 56	4 downcomer filler was not used during Test 15.4
TM-48D-0	~48 inches, 0°, 1/16 inch from ID			
TM-48D-180	~48 inches, 180°, 1/16 inch from ID			TM-48D-180 failed during Test 15.3
TM-63D-45	~63 inches, 45°, 1/16 inch from ID			
TM-63D-225	~63 inches, 225°, 1/8 inch from OD			TM-63D-225 failed during Tests 15.2, 15.3, and 15.7
TM-78D-0	~78 inches, 0°, 1/16 inch from ID			
TM-78D-180	~78 inches, 180°, 1/16 inch from ID			
TM-95D-45	~95 inches, 45°, 1/16 inch from ID			
TM-95D-225	~95 inches, 225°, 1/16 inch from ID			
TM-116D-0	~116 inches, 0° 1/16 inch from ID			TM-116D-0 was not used during Tests 15.1 and 15.2
TM-116D-45	~116 inches, 45°, 1/16 inch from ID			
TM-116D-225	~116 inches, 225°, 1/16 inch from ID			
<u>Vessel Wall</u>		33-650°F		
TM-95V-45	~95 inches, 45°, 1/2 inch from OD		57,58,59,61	TM-95V-45 was not used during Test 15.4
TM-95D-45	~95 inches, 45°, 1/16 inch from ID		57,58,59,61	TM-95D-45 was not used during Test 15.4
TM-95D-18-45	~95 inches, 45°, 0.176 inch from OD		59, 61	TM-95D-18-45 was not used during Tests 15.1, 15.2, and 15.4
TM-63V-45	~63 inches, 45°, 1/4 inch from ID		56	TM-63V-45 was used only during Test 15.4
TM-63V-225	~63 inches, 225°, 1/4 inch from ID		56	TM-63V-225 was used only during Test 15.4
TM-78V-0	~78 inches, 0°, 1/4 inch from ID		56	TM-78V-0 was used only during Test 15.4
TM-78V-90	~78 inches, 90°, 1/5 inch from ID		56	TM-78V-90 was used only during Test 15.4
TM-95V-25-45	~95 inches, 45°, 1/4 inch from ID		56, 60	TM-95V-25-45 was used only during Test 15.4
TM-95V-225	~95 inches, 225°, 1/4 inch from ID		56, 60	TM-95V-225 was used only during Test 15.4
TM-116V-0	~116 inches, 0°, 1/4 inch from ID		56	TM-116V-0 was used only during Test 15.4
TM-116V-180	~116 inches, 180°, 1/4 inch from ID		56	TM-116V-180 was used only during Test 15.4
<u>Lower Plenum Vessel Wall</u>		33-650°F	62 - 66	
TM-LH-276	In lower plenum head			
TM-LP-IDL	4.9 inches below lower plenum upper Grayloc flange face. 270° from cold leg centerline, 1/16 inch from ID of filler piece			
TM-LP-IDU	5.0 inches above lower plenum upper Grayloc flange face. 270° from cold leg centerline, 1/16 inch from ID of filler piece			TM-LP-IDU failed during Test 15.3
TM-LP-VOD	On vessel OD 5.0 inches above lower plenum upper Grayloc flange face, 270° from cold leg centerline			
<u>Operating Loop</u>		33-650°F		
TM-1B	Hot leg, Spool 1, 1/8 inch from ID (bottom)		67 - 71	TM-1B system was not calibrated for Tests 15.4 and 15.7. Data prior to 0.5 sec are not physical result for Test 15.7
TM-1I	Hot leg, Spool 1, 1/8 inch from ID (top)		67 - 71	
TM-19B	Cold leg, Spool 19, 1/8 inch from ID (bottom)		72 - 76	TM-19B failed during Tests 15.2 and 15.3
TM-19H	Cold leg, Spool 19, 1/8 inch from ID (middle)		72 - 76	
TM-19I	Cold leg, Spool 19, 1/8 inch ID (top)		72 - 76	
TM-19M	Cold leg, Spool 19, 1/4 inch from ID (top)		72 - 76	TM-19M was not used during Test 15.4
TM-19S	Cold leg, Spool 19, outside surface (top)		72 - 76	
TM-22B	Cold leg, Spool 22, 1/8 inch from ID (bottom)		77 - 81	
TM-22H	Cold leg, Spool 22, 1/8 inch from ID (middle)		77 - 81	
TM-22I	Cold leg, Spool 22, 1/8 inch from ID (top)		77 - 81	TM-22I failed during Test 15.7. TM-22I was not used during Tests 15.1 and 15.2
TM-22M	Cold leg, Spool 22, 1/4 inch from ID (top)		77 - 81	TM-22M was not used during Test 15.4
TM-22S	Cold leg, Spool 22, outside surface (top)		77 - 81	
<u>Blowdown Loop</u>		33-650°F		
TM-96	Simulated pump suction, Spool 96, 1/16 inch		82 - 84	TM-96 was not used during Tests 15.1 and 15.2
<u>Pressure Suppression System</u>			85 - 86	
TM-83	Header, on surface near first elbow			TM-83 was used only during Test 15.2
TM-PSH-EL	Header, on surface near first elbow			TM-PSH-EL was used only during Tests 15.1 and 15.2

TABLE II (contd.)

DATA PRESENTATION FOR ISOTHERMAL HOT-WALL TESTS

Measurement [a]	Location [b]	Range [c,d]	Figure [d]	Comment [e]
MOMENTUM FLUX				
		Obtained by drag discs which, through a strain gage network, measure force exerted by moving fluid stream. Fluid force is related to momentum flux through calibration curve. The data as presented show magnitude only; direction can be determined from the mass flow rate data		
<u>Operating Loop</u>		± 100 to $\pm 2.0 \times 10^4$ lb/ft-sec ²		
FD-1	Hot leg, Spool 1		87 - 91	
FD-5	Hot leg, Spool 5		87 - 91	
FD-15	Pump suction, Spool 15		92 - 96	
FD-19	Pump discharge, Spool 19		92 - 96	FD-19 failed during Test 15.1
FD-22	Cold leg, Spool 22		92 - 96	
<u>Blowdown Loop</u>			97 - 101	
FD-50	Cold leg, Spool 50	± 430 to $\pm 5.0 \times 10^4$ lb/ft-sec ²		
FD-70	Hot leg, Spool 70	± 500 to $\pm 6.0 \times 10^4$ lb/ft-sec ²		FD-70 failed during Test 15.7
FD-76	Cold leg, Spool 76	± 500 to $\pm 6.0 \times 10^4$ lb/ft-sec ²		
<u>Pressure Suppression System</u>				
FD-83	Header near downcomer			Not reported; system was not calibrated.
<u>Core Barrel Inlet</u>				
FD-224	110 inches, 315° (target centered in gap)	± 140 to $\pm 3.0 \times 10^4$ lb/ft-sec ²	102 - 106	
VOLUMETRIC FLOW RATE				
		Obtained by turbine flowmeters		
<u>Operating Loop</u>		± 40 to ± 800 gpm	107 - 111	
FT-1	Hot leg, Spool 1			FT-1 failed during Test 15.4. FT-1 detector capability exceeded at 4 sec during Test 15.3
FT-19	Pump discharge, Spool 19			FT-19 failed during Tests 15.1 and 15.4
FT-22	Hot leg, Spool 70			FT-22 failed during Tests 15.2 and 15.3
<u>Blowdown Loop</u>				
FT-70	Hot leg, Spool 70	± 20 to ± 500 gpm	112 - 115	FT-70 failed during Test 15.2
<u>Core Barrel Inlet</u>				
FT-C-1	110 inches from upper vessel flange face	± 40 to ± 300 gpm	116 - 120	FT-C-1 detector capability was exceeded at ± 300 gpm
<u>Pressurizer</u>				
FT-41	Outlet, Spool 41	± 8 to ± 200 gpm	121	Not reported for Tests 15.1, 15.2, 15.3, and 15.4; data are essentially zero
<u>ECC System</u>			122 - 126	
FT-ECC-OLAI	In ECC line from operating loop ECC injection accumulator	± 4.0 to ± 50 gpm		FT-ECC-OLAI was used only during Test 15.4 to measure flow in one leg of a parallel flow path from the accumulator. The indicated flow from FT-ECC-OLAI2 must be added to obtain the total accumulator flow
FT-ECC-OLP	In ECC line from operating loop ECC injection pump	± 4.0 to ± 100 gpm		FT-ECC-OLP was not used during Test 15.4
FT-ECC-BLP	In line from blowdown loop ECC injection pump	± 2.5 to ± 20 gpm		FT-ECC-BLP data were inadvertently lost during Test 15.1
FT-ECC-OLAI2	In ECC line from operating loop ECC injection accumulator	± 4.0 to ± 50 gpm		FT-ECC-OLAI2 was used only during Test 15.4 to measure flow in one leg of a parallel flow path from the accumulator. The indicated flow from FT-ECC-OLAI must be added to obtain the total accumulator flow
FLUID VELOCITY				
<u>Vessel Downcomer Cap</u>		± 1 to ± 10 ft/sec	127 - 131	
FT-212	49.88 inches, 135°			FT-212 was not used during Tests 15.3 and 15.7. FT-212 failed during Test 15.2
FT-239	47.88 inches, 225°			FT-239 detector capability was exceeded at 10 ft/sec during Test 15.2
FT-253	119.23 inches, 225°			
FT-270	94.43 inches, 180°			FT-270 appeared to have a zero shift in calibration at approximately 18 sec during Test 15.3. FT-270 failed during Test 15.2
MASS FLOW RATE				
		Mass flow rate obtained by combining density (gamma attenuation technique) with volumetric flow rate (turbine flowmeters) or with momentum flux (drag disc)		
<u>Operating Loop</u>		Momentum flux: ± 100 to $\pm 2.0 \times 10^4$ lb/ft-sec ² volumetric flow: ± 40 to ± 800 gpm Density: 0.05 to 62.4 lbm/ft ³		
FD-1 D-1V	Hot leg, Spool 1		132 - 136	
FT-1 D-1V			132 - 136	FT-1 failed during Test 15.4. FT-1 detector capability was exceeded at 4 sec during Test 15.3; analog-to-digital conversion process inverted the data to a positive value during the period of detector saturation.
FD-19 D-19V	Pump discharge, Spool 19		137 - 140	FD-19 failed during Test 15.1
FT-19 D-19V			137 - 140	FT-19 failed during Tests 15.1 and 15.4
FD-22 D-22V	Cold leg, Spool 22		141 - 145	
FT-22 D-22V			141 - 145	FT-22 failed during Tests 15.2 and 15.3
FD-5 D-5V	Hot leg, Spool 5		146 - 150	
FD-15 D-15V	Pump suction, Spool 15		146 - 150	

TABLE II (contd.)

DATA PRESENTATION FOR ISOTHERMAL HOT-WALL TESTS

Measurement [a]	Location [b]	Range [c,d]	Figure [d]	Comment [d]
Blowdown Loop				
		Momentum flux: ± 500 or (430) to ± 6.0 (or $5.0) \times 10^4$ lb/ft-sec ² volumetric flow ± 40 to ± 300 gpm density: 0.05 to 62.4 lbm/ft ³		
FD-70 D-70V			151 - 155	FD-70 failed during Test 15.7
FT-70 D-70V	Hot leg, Spool 70		151 - 155	FT-70 failed during Test 15.2
FD-50 D-50V	Cold leg, Spool 50		156 - 160	
FD-76 D-76V	Cold leg, Spool 76		156 - 160	
Core Barrel Inlet				
		Momentum flux: ± 140 to $\pm 3.0 \times 10^4$ lb/ft-sec ² volumetric flow: ± 40 to ± 300 gpm density: 0.5 to 62.4 lbm/ft ³		
FD-224 D-225H	D-225H: 110.0 inches, 0° FD-224: 110.0 inches, 315°		161 - 165	
FT-C-1 D-225H	FT-C-1: 110.0 inches		161 - 165	
DENSITY, FLUID		0.05 to 62.4 lbm/ft ³		Obtained by gamma attenuation technique (densitometer).
Operating Loop				
D-1V	Hot leg, Spool 1		166 - 170	
D-5V	Hot leg, Spool 5		166 - 170	
D-15V	Pump suction, Spool 15		171 - 175	
D-19V	Pump discharge, Spool 19		171 - 175	
D-22H			176 - 180	
D-22V	Cold leg, Spool 22		176 - 180	
Blowdown Loop				
D-50V	Cold leg, Spool 50		181 - 185	
D-70V	Hot leg, Spool 70			
D-76V	Cold leg, Spool 76			
Vessel				
D-225H	Core barrel inlet 110.0 inches, 0°		186 - 190	
D-228H	Lower plenum 122.4 inches, 0°			
D-275V	Lower plenum 114.5 inches, 315°			Gamma beam diagonally across lower plenum D-275V failed during Test 15.1 D-275V system not calibrated
Pressure Suppression Header				
D-83V	Near suppression tank downcomer		191 - 194	D-83V was not used during Test 15.4
PRESSURE				
				Obtained by Morwood strain gage type transducers accurate to within $\pm 1\%$ of full scale.
Operating Loop				
P-1	Hot leg, Spool 1	0-3000 psig	195 - 199	P-1 failed during Tests 15.1 and 15.3
P-15	Pump suction, Spool 15			
P-19	Pump discharge, Spool 19			
P-40	Pressurizer outlet, Spool 40			P-40 failed during Test 15.3
Blowdown Loop				
P6-MN2	Simulated pump side, nozzle throat, Port 2	0-3000 psig	200 - 204	
P-50	Cold leg, Spool 50			
P-51	Cold leg, downstream of vessel-side nozzle, Station 51			P-51 failed during Test 15.2
P-61	Downstream of hot leg nozzle, Station 61			
P-67	Pump side, rupture assembly inner disc cavity, Spool 62			
P-70	Hot leg, Spool 70			
P-76	Cold leg, Spool 76			P-76 failed during Test 15.2
Vessel				
P-207	Outlet plenum, 28.4 inches, 30°	0-3000 psig	205 - 209	P-207 failed during Test 15.4
P-255	Lower plenum, 121.3 inches, 240°			
Pressure Suppression System				
P-53	Blowdown loop cold leg, Spool 53	0-1000 psig	210 - 214	
P-80	Pressure suppression header between elbows	0-200 psig		P-80 was not used during Tests 15.2, 15.3, and 15.7
P-81	Pressure suppression header, Spool 81	0-200 psig		P-81 was not used during Tests 15.1, 15.3, and 15.4
P-83	Pressure suppression chamber downcomer entrance	0-200 psig		P-83 was used only during Test 15.1
P-89	Vapor chamber of pressure suppression vessel	0-200 psig		

TABLE II (contd.)

DATA PRESENTATION FOR ISOTHERMAL HOT-WALL TESTS

Measurement (a)	Location (b)	Range (c,d)	Figure (d)	Comment (d)
<u>Outlet Plenum</u>			215 - 218	
P-LFF-HL (LOFT Pressure Transducer)	Hot leg stub in outlet plenum			P-LFF-HL failed during Test 15.4
<u>ECC Accumulator</u>		0-3000 psig	219, 220	
P-ECC-BLA	Blowdown loop ECC accumulator			P-ECC-BLA was used only during Test 15.2
P-ECC-OLA	Operating loop ECC accumulator			P-ECC-OLA was used only during Test 15.4
P-ECC-LP	Lower plenum ECC accumulator			P-ECC-LP was used only during Test 15.2
<u>DIFFERENTIAL PRESSURE</u>				Obtained by differential pressure transducers accurate to within $\pm 1\%$ of full range. Transducers zeroed under ambient liquid-full system conditions. Initial conditions shown in the data are the result of flow-induced pressure gradients and density changes from ambient to operating conditions.
<u>Operating Loop</u>				
DP-22-1	Across pressure vessel, operating loop cold leg to hot leg, Spool 22 to Spool 1	+28.9 psid +50.0 psid (15.1) [e]	221 - 224	DP-22-1 failed during Test 15.4
DP-1-5	Hot leg, Spool 1 to Spool 5	+0.72 psid	225 - 229	
DP-5-13	Across steam generator, Spool 5 to Spool 13	+28.9 psid	230 - 234	
DP-8-13	Pump suction orifice, Spool 8 to Spool 13	+10.8 psid +28.8 psid (15.1)	235 - 239	
DP-13-15	Spool 13 to Spool 15	+3.6 psid	240 - 243	DP-13-15 data below reliable range of detector for Test 15.2
DP-19-15	Across pump, Spool 19 to Spool 15	+50.0 psid	244 - 248	
DP-19-15L	Across pump, Spool 19 to Spool 15	+3.6 psid +1.8 psid (15.1)	249 - 252	DP-19-15L failed during Test 15.4
DP-19-22	Spool 19 to Spool 22	+10.8 psid +18.0 psid (15.1)	253 - 257	
DP-22-255	Cold leg to lower plenum, Spool 22 to Station 255	+10.8 psid	258 - 262	
<u>Vessel</u>				
DP-255-207	Vessel lower plenum to vessel upper plenum, Station 255 to Station 207	+18.0 psid +50.0 psid (15.1)	263 - 267	
<u>Downcomer</u>				
DP-213-246	Station 213 to Station 246	+1.8 psid	268, 269	DP-213-246 used only during Tests 15.1 and 15.2
DP-216-246	Station 216 to Station 246	+1.8 psid	270 - 272	DP-216-246 used only during Tests 15.3, 15.4, and 15.7
DP-246-249	Station 246 to Station 249	+1.8 psid	273 - 277	
DP-249-255	Station 249 to Station 255	+0.72 psid	278 - 282	
<u>Lower Plenum</u>				
DP-261-255	Station 261 to Station 255	+0.72 psid	283 - 287	DP-261-255 detector capability exceeded at 1 psid during Test 15.1
<u>Core</u>				
DP-LOFT	Lower plenum to upper plenum of vessel	+50.0 psid +200 psid (15.1)	288 - 292	
<u>Blowdown Loop</u>				
DP-207-70	Vessel upper plenum to blowdown loop hot leg, Station 207 to Spool 70	+3.6 psid	293 - 297	
DP-264-50	Vessel inlet annulus to blowdown loop cold leg, Station 264 to Spool 50	+18.0 psid +100 psid (15.1) +500 psid (15.4)	298 - 302	
DP-76-61	Across hot leg nozzle, Spool 76 to Station 61	+1000.0 psid +500.0 psid (15.1)	303 - 307	
DP-76-HN2	Spool 76 to hot leg nozzle downstream throat (Port 2)	+500.0 psid +1500.0 psid (15.1)	308 - 310	DP-76-HN2 failed during Test 15.1 and data were below reliable range of detector for Test 15.3
DP-96-76	Across simulated pump, Spool 96 to Spool 76	+100.0 psid +200.0 psid (15.4)	311 - 315	
DP-70-96	Across simulated steam generator, Spool 70 to Spool 96	+100.0 psid +50.0 psid (15.1)	316 - 320	
DP5-HN2-HN4	Vessel side, downstream nozzle throat (Port 2) to downstream nozzle expansion section (Port 4)	+1000.0 psid +1500.0 psid (15.1)	321 - 323	DP5-HN2-HN4 data below reliable range of detector for Tests 15.1 and 15.7
DP6-HN2-HN4	Simulated pump side, downstream nozzle throat (Port 2) to downstream nozzle expansion section (Port 4)	+1000.0 psid +200.0 psid (15.1)	324	DP6-HN2-HN4 data were below reliable range of detectors for all Tests except Test 15.7
DP-HN4-61	Across hot leg nozzle outlet, downstream nozzle expansion section (Port 4) to Station 61	+18.0 psid +18.3 psid (15.1) +375 psid (15.4)	325 - 327	DP-HN4-61 data were below reliable range of detectors for Tests 15.1 and 15.4
<u>Pressure Suppression System</u>				
DP-207-89	Vessel upper plenum to vapor chamber of pressure suppression tank	+500.0 psid	328 - 332	
DP-81-83	Header to downcomer entrance	+10.8 psid	333	DP-81-83 was used only during Test 15.1
DP-81-89	Header to tank vapor chamber	+50.0 psid	334 - 337	DP-81-89 was not used during Test 15.1
DP-83-85	Downcomer entrance to downcomer exit	+10.8 psid	338	DP-83-85 was used only during Test 15.1
DP-81-85	Header to downcomer exit	+10.8 psid	339 - 343	DP-81-85 was not used during Test 15.1
DP-83-89	Downcomer entrance to vapor chamber of pressure suppression tank	+50.0 psid	343	DP-83-89 was used only during Test 15.1

TABLE II (contd.)

DATA PRESENTATION FOR ISOTHERMAL HOT-WALL TESTS

Measurement [a]	Location [b]	Range [c,d]	Figure [d]	Comment [d]
LIQUID LEVEL				
<u>Lower Plenum</u>	Port 259			Liquid level in lower plenum is indicated by density measurements D-228II and D-275V and by differential pressure measurement DP-261-255
LL-LFTA-259				System not calibrated, data not digitized.
LL-LFTD-259				
<u>Pressure Suppression System</u>				
LL-PSS	Suppression tank	3.64 psid	344 - 348	Obtained by differential pressure cell having one leg connected to a standpipe and the other leg attached to a port in the bottom of the pressure suppression tank
PUMP CHARACTERISTICS				
<u>Pump Speed</u>	Operating loop pump			
FS-RPM		--	349 - 353	
<u>Pump Power</u>				
PW-PMP		--	354 - 358	
<u>Pump Torque</u>				
T-PMP		--	359 - 362	T-PMP failed during Test 15.3
TIME OF BREAK				
				Data not presented; measurement established time of rupture as indicated by t=0 seconds on all data plots
<u>Blowdown Loop</u>				
BW-52	Cold leg, vessel side			
BW-62	Cold leg, simulated pump side			
FLOW DIRECTION				
<u>Downcomer Gap</u>				
S-271	65.6 inches, 0°, Station 271		363 - 365	S-271 was not used for Tests 15.1 and 15.2
DISPLACEMENT				
<u>Pressure Suppression System</u>			366 - 370	System not calibrated, data useful only for relative motion indication.
LDT-PSH	Header first elbow (horizontal deflection)			
LDT-PSV	Beneath suppression vessel (vessel vertical deflection)			
STRAIN				
<u>Pressure Suppression System</u>				No calibration step available; data signal extremely low.
SCI-PSH-HL-0	Header, outside first elbow at impingement from cold leg, simulated pump side, 0°			
SU1-PSH-HL-60	Header, outside first elbow at impingement from cold leg, simulated pump side, 60°			
SCI-PSH-HL-120	Header, outside first elbow at impingement from cold leg, simulated pump side, 120°			
SCT-PSH-HL	On top of header near first elbow			

[a] Measurement nomenclature is defined in Reference 6.

[b] Measurement locations are shown in Figures 6 through 9.

[c] The range indicated is that over which the measurement is considered valid.

[d] Ranges, figure numbers, and comments apply to all measurements within a category unless indicated otherwise. The figure numbers correspond to the data plots presented.

[e] The number in parentheses indicates the specific test for which the range applies; ranges without tests specified apply to all other tests.

Fig. 10 Fluid temperatures in operating loop -- Test 15.1.

Fig. 11 Fluid temperatures in operating loop -- Test 15.2.

Fig. 12 Fluid temperatures in operating loop -- Test 15.3.

Fig. 13 Fluid temperatures in operating loop -- Test 15.4.

Fig. 14 Fluid temperatures in operating loop -- Test 15.7.

Fig. 15 Fluid temperatures in blowdown loop -- Test 15.1.

Fig. 16 Fluid temperatures in blowdown loop -- Test 15.2.

Fig. 17 Fluid temperatures in blowdown loop -- Test 15.3.

Fig. 18 Fluid temperatures in blowdown loop -- Test 15.4.

Fig. 19 Fluid temperatures in blowdown loop -- Test 15.7.

Fig. 20 Fluid temperatures in pressure suppression system -- Test 15.1.

Fig. 21 Fluid temperatures in pressure suppression system -- Test 15.2.

Fig. 22 Fluid temperatures in pressure suppression system -- Test 15.3.

Fig. 23 Fluid temperatures in pressure suppression system -- Test 15.4.

Fig. 24 Fluid temperatures in pressure suppression system -- Test 15.7.

Fig. 25 Fluid temperatures in lower plenum at thermocouple rack -- Test 15.1.

Fig. 26 Fluid temperatures in lower plenum at thermocouple rack -- Test 15.2.

Fig. 27 Fluid temperatures in lower plenum at thermocouple rack -- Test 15.3.

Fig. 28 Fluid temperatures in lower plenum at thermocouple rack -- Test 15.4.

Fig. 29 Fluid temperatures in lower plenum at thermocouple rack -- Test 15.7.

Fig. 30 Fluid temperatures in upper portion of downcomer gap -- Test 15.1.

Fig. 31 Fluid temperatures in upper portion of downcomer gap -- Test 15.2.

Fig. 32 Fluid temperatures in upper portion of downcomer gap -- Test 15.3.

Fig. 33 Fluid temperatures in upper portion of downcomer gap -- Test 15.4.

Fig. 34 Fluid temperatures in upper portion of downcomer gap -- Test 15.7.

Fig. 35 Fluid temperatures in lower portion of downcomer gap -- Test 15.1.

Fig. 36 Fluid temperatures in lower portion of downcomer gap -- Test 15.2.

Fig. 37 Fluid temperatures in lower portion of downcomer gap -- Test 15.3.

Fig. 38 Fluid temperatures in lower portion of downcomer gap -- Test 15.4.

Fig. 39 Fluid temperatures in lower portion of downcomer gap -- Test 15.7.

Fig. 40 Fluid temperatures in outlet plenum -- Test 15.1.

Fig. 41 Fluid temperatures in outlet plenum -- Test 15.2.

Fig. 42 Fluid temperatures in outlet plenum -- Test 15.4.

Fig. 43 Fluid temperatures in outlet plenum -- Test 15.7.

Fig. 44 Fluid temperatures in ECC lines from blowdown loop pump and operating loop pump -- Test 15.2.

Fig. 45 Fluid temperatures in ECC lines from blowdown loop pump and operating loop pump -- Test 15.3.

Fig. 46 Fluid temperatures in ECC lines from blowdown loop pump and operating loop pump -- Test 15.7.

Fig. 47 Metal temperatures in core barrel -- Test 15.1.

Fig. 48 Metal temperatures in core barrel -- Test 15.2.

Fig. 49 Metal temperatures in core barrel -- Test 15.3.

Fig. 50 Metal temperatures in core barrel -- Test 15.4.

Fig. 51 Metal temperatures in core barrel -- Test 15.7.

Fig. 52 Metal temperatures in downcomer filler -- Test 15.1.

Fig. 53 Metal temperatures in downcomer filler -- Test 15.2.

Fig. 54 Metal temperatures in downcomer filler -- Test 15.3.

Fig. 55 Metal temperatures in downcomer filler -- Test 15.7.

Fig. 56 Metal temperatures in vessel wall -- Test 15.4.

Fig. 57 Metal temperatures in vessel wall 95 inches from vessel upper flange face -- Test 15.1.

Fig. 58 Metal temperatures in vessel wall 95 inches from vessel upper flange face -- Test 15.2.

Fig. 59 Metal temperatures in vessel wall 95 inches from vessel upper flange face -- Test 15.3.

Fig. 60 Metal temperatures in vessel wall 95 inches from vessel upper flange face -- Test 15.4.

Fig. 61 Metal temperatures in vessel wall 95 inches from vessel upper flange face -- Test 15.7.

Fig. 62 Metal temperatures in lower plenum vessel wall -- Test 15.1.

Fig. 63 Metal temperatures in lower plenum vessel wall -- Test 15.2.

Fig. 64 Metal temperatures in lower plenum vessel wall -- Test 15.3.

Fig. 65 Metal temperatures in lower plenum vessel wall -- Test 15.4.

Fig. 66 Metal temperatures in lower plenum vessel wall -- Test 15.7.

Fig. 67 Metal temperatures in operating loop hot leg Spool 1 -- Test 15.1.

Fig. 68 Metal temperatures in operating loop hot leg Spool 1 -- Test 15.2.

Fig. 69 Metal temperatures in operating loop hot leg Spool 1 -- Test 15.3.

Fig. 70 Metal temperatures in operating loop hot leg Spool 1 -- Test 15.4.

Fig. 71 Metal temperatures in operating loop hot leg Spool 1 -- Test 15.7.

Fig. 72 Metal temperatures in operating loop cold leg Spool 19 -- Test 15.1.

Fig. 73 Metal temperatures in operating loop cold leg Spool 19 -- Test 15.2.

Fig. 74 Metal temperatures in operating loop cold leg Spool 19 -- Test 15.3.

Fig. 75 Metal temperatures in operating loop cold leg Spool 19 -- Test 15.4.

Fig. 76 Metal temperatures in operating loop cold leg Spool 19 -- Test 15.7.

Fig. 77 Metal temperatures in operating loop cold leg Spool 22 -- Test 15.1.

Fig. 78 Metal temperatures in operating loop cold leg Spool 22 -- Test 15.2.

Fig. 79 Metal temperatures in operating loop cold leg Spool 22 -- Test 15.3.

Fig. 80 Metal temperatures in operating loop cold leg Spool 22 -- Test 15.4.

Fig. 81 Metal temperatures in operating loop cold leg Spool 22 -- Test 15.7.

Fig. 82 Metal temperatures in blowdown loop -- Test 15.3.

Fig. 83 Metal temperatures in blowdown loop -- Test 15.4.

Fig. 84 Metal temperatures in blowdown loop -- Test 15.7.

Fig. 85 Metal temperatures in pressure suppression system -- Test 15.1.

Fig. 86 Metal temperatures in pressure suppression system -- Test 15.2.

Fig. 87 Momentum flux from drag discs in operating loop hot leg -- Test 15.1.

Fig. 88 Momentum flux from drag discs in operating loop hot leg -- Test 15.2.

Fig. 89 Momentum flux from drag discs in operating loop hot leg -- Test 15.3.

Fig. 90 Momentum flux from drag discs in operating loop hot leg -- Test 15.4.

Fig. 91 Momentum flux from drag discs in operating loop hot leg -- Test 15.7.

Fig. 92 Momentum flux from drag discs in operating loop cold leg -- Test 15.1.

Fig. 93 Momentum flux from drag discs in operating loop cold leg -- Test 15.2.

Fig. 94 Momentum flux from drag discs in operating loop cold leg -- Test 15.3.

Fig. 95 Momentum flux from drag discs in operating loop cold leg -- Test 15.4.

Fig. 96 Momentum flux from drag discs in operating loop cold leg -- Test 15.7.

Fig. 97 Momentum flux from drag discs in blowdown loop -- Test 15.1.

Fig. 98 Momentum flux from drag discs in blowdown loop -- Test 15.2.

Fig. 99 Momentum flux from drag discs in blowdown loop -- Test 15.3.

Fig. 100 Momentum flux from drag discs in blowdown loop -- Test 15.4.

Fig. 101 Momentum flux from drag discs in blowdown loop -- Test 15.7.

Fig. 102 Momentum flux from drag discs at core barrel inlet -- Test 15.1.

Fig. 103 Momentum flux from drag discs at core barrel inlet -- Test 15.2.

Fig. 104 Momentum flux from drag discs at core barrel inlet -- Test 15.3.

Fig. 105 Momentum flux from drag discs at core barrel inlet -- Test 15.4.

Fig. 106 Momentum flux from drag discs at core barrel inlet -- Test 15.7.

Fig. 107 Volumetric flow rate from turbine meters in operating loop -- Test 15.1.

Fig. 108 Volumetric flow rate from turbine meters in operating loop -- Test 15.2.

Fig. 109 Volumetric flow rate from turbine meters in operating loop -- Test 15.3.

Fig. 110 Volumetric flow rate from turbine meters in operating loop -- Test 15.4.

Fig. 111 Volumetric flow rate from turbine meters in operating loop -- Test 15.7.

Fig. 112 Volumetric flow rate from turbine meter in blowdown loop hot leg -- Test 15.1.

Fig. 113 Volumetric flow rate from turbine meter in blowdown loop hot leg -- Test 15.3.

Fig. 114 Volumetric flow rate from turbine meter in blowdown loop hot leg -- Test 15.4.

Fig. 115 Volumetric flow rate from turbine meter in blowdown loop hot leg -- Test 15.7.

Fig. 116 Volumetric flow rate from turbine meter at core barrel inlet -- Test 15.1.

Fig. 117 Volumetric flow rate from turbine meter at core barrel inlet -- Test 15.2.

Fig. 118 Volumetric flow rate from turbine meter at core barrel inlet -- Test 15.3.

Fig. 119 Volumetric flow rate from turbine meter at core barrel inlet -- Test 15.4.

Fig. 120 Volumetric flow rate from turbine meter at core barrel inlet -- Test 15.7.

Fig. 121 Volumetric flow rate from turbine meter at pressurizer outlet -- Test 15.7.

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Fig. 124 Volumetric flow rate from ECC injection pumps in operating and blowdown loops (turbine meters) -- Test 15.3.

Fig. 125 Volumetric flow rate from ECC injection pump in blowdown loop and ECC accumulators in operating loop (turbine meters) -- Test 15.4.

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Fig. 128 Fluid velocity from turbine meters in downcomer gap -- Test 15.2.

Fig. 129 Fluid velocity from turbine meters in downcomer gap -- Test 15.3.

Fig. 130 Fluid velocity from turbine meters in downcomer gap -- Test 15.4.

Fig. 131 Fluid velocity from turbine meters in downcomer gap -- Test 15.7.

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Fig. 133 Mass flow rate in operating loop hot leg Spool 1 -- Test 15.2.

Fig. 134 Mass flow rate in operating loop hot leg Spool 1 -- Test 15.3.

Fig. 135 Mass flow rate in operating loop hot leg Spool 1 -- Test 15.4.

Fig. 136 Mass flow rate in operating loop hot leg Spool 1 -- Test 15.7.

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Fig. 138 Mass flow rate in operating loop at pump discharge (Spool 19) -- Test 15.3.

Fig. 139 Mass flow rate in operating loop at pump discharge (Spool 19) -- Test 15.4.

Fig. 140 Mass flow rate in operating loop at pump discharge (Spool 19) -- Test 15.7.

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Fig. 142 Mass flow rate in operating loop cold leg Spool 22 -- Test 15.2.

Fig. 143 Mass flow rate in operating loop cold leg Spool 22 -- Test 15.3.

Fig. 144 Mass flow rate in operating loop cold leg Spool 22 -- Test 15.4.

Fig. 145 Mass flow rate in operating loop cold leg Spool 22 -- Test 15.7.

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Fig. 147 Mass flow rate in operating loop Spools 5 and 15 -- Test 15.2.

Fig. 148 Mass flow rate in operating loop Spools 5 and 15 -- Test 15.3.

Fig. 149 Mass flow rate in operating loop Spools 5 and 15 -- Test 15.4.

Fig. 150 Mass flow rate in operating loop Spools 5 and 15 -- Test 15.7.

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Fig. 153 Mass flow rate in blowdown loop Spool 70 -- Test 15.3.

Fig. 154 Mass flow rate in blowdown loop Spool 70 -- Test 15.4.

Fig. 155 Mass flow rate in blowdown loop Spool 70 -- Test 15.7.

Fig. 156 Mass flow rate in blowdown loop Spools 50 and 76 -- Test 15.1.

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Fig. 158 Mass flow rate in blowdown loop Spools 50 and 76 -- Test 15.3.

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Fig. 162 Mass flow rate at core barrel inlet -- Test 15.2.

Fig. 163 Mass flow rate at core barrel inlet -- Test 15.3.

Fig. 164 Mass flow rate at core barrel inlet -- Test 15.4.

Fig. 165 Mass flow rate at core barrel inlet -- Test 15.7.

Fig. 166 Fluid density in operating loop hot leg -- Test 15.1.

Fig. 167 Fluid density in operating loop hot leg -- Test 15.2.

Fig. 168 Fluid density in operating loop hot leg -- Test 15.3.

Fig. 169 Fluid density in operating loop hot leg -- Test 15.4.

Fig. 170 Fluid density in operating loop hot leg -- Test 15.7.

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Fig. 175 Fluid density at operating loop pump inlet and outlet -- Test 15.7.

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Fig. 178 Fluid density in operating loop cold leg -- Test 15.3.

Fig. 179 Fluid density in operating loop cold leg -- Test 15.4.

Fig. 180 Fluid density in operating loop cold leg -- Test 15.7.

Fig. 181 Fluid density in blowdown loop -- Test 15.1.

Fig. 182 Fluid density in blowdown loop -- Test 15.2.

Fig. 183 Fluid density in blowdown loop -- Test 15.3.

Fig. 184 Fluid density in blowdown loop -- Test 15.4.

Fig. 185 Fluid density in blowdown loop -- Test 15.7.

Fig. 186 Fluid density in vessel -- Test 15.1.

Fig. 187 Fluid density in vessel -- Test 15.2.

Fig. 188 Fluid density in vessel -- Test 15.3.

Fig. 189 Fluid density in vessel -- Test 15.4.

Fig. 190 Fluid density in vessel -- Test 15.7.

Fig. 191 Fluid density in pressure suppression header -- Test 15.1.

Fig. 192 Fluid density in pressure suppression header -- Test 15.2.

Fig. 193 Fluid density in pressure suppression header -- Test 15.3.

Fig. 194 Fluid density in pressure suppression header -- Test 15.7.

Fig. 195 Pressure in operating loop -- Test 15.1.

Fig. 196 Pressure in operating loop -- Test 15.2.

Fig. 197 Pressure in operating loop -- Test 15.3.

Fig. 198 Pressure in operating loop -- Test 15.4.

Fig. 199 Pressure in operating loop -- Test 15.7.

Fig. 200 Pressure in blowdown loop -- Test 15.1.

Fig. 201 Pressure in blowdown loop -- Test 15.2.

Fig. 202 Pressure in blowdown loop -- Test 15.3.

Fig. 203 Pressure in blowdown loop -- Test 15.4.

Fig. 204 Pressure in blowdown loop -- Test 15.7.

Fig. 205 Pressure in vessel -- Test 15.1.

Fig. 206 Pressure in vessel -- Test 15.2.

Fig. 207 Pressure in vessel -- Test 15.3.

Fig. 208 Pressure in vessel -- Test 15.4.

Fig. 209 Pressure in vessel -- Test 15.7.

Fig. 210 Pressure in pressure suppression system -- Test 15.1.

Fig. 211 Pressure in pressure suppression system -- Test 15.2.

Fig. 212 Pressure in pressure suppression system -- Test 15.3.

Fig. 213 Pressure in pressure suppression system -- Test 15.4.

Fig. 214 Pressure in pressure suppression system -- Test 15.7.

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Fig. 217 Pressure at hot leg stub in upper plenum (LOFT free field pressure transducer) -- Test 15.3.

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Fig. 227 Differential pressure, operating loop hot leg (DP-1-5) -- Test 15.3.

Fig. 228 Differential pressure, operating loop hot leg (DP-1-5) -- Test 15.4.

Fig. 229 Differential pressure, operating loop hot leg (DP-1-5) -- Test 15.7.

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Fig. 239 Differential pressure across pump suction orifice (DP-8-13) -- Test 15.7.

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Fig. 242 Differential pressure across operating loop pump inlet (DP-13-15) -- Test 15.4.

Fig. 243 Differential pressure across operating loop pump inlet (DP-13-15) -- Test 15.7.

Fig. 244 Differential pressure across operating loop pump (DP-19-15) -- Test 15.1.

Fig. 245 Differential pressure across operating loop pump (DP-19-15) -- Test 15.2.

Fig. 246 Differential pressure across operating loop pump (DP-19-15) -- Test 15.3.

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Fig. 252 Differential pressure across operating loop pump, low range (DP-19-15L) -- Test 15.7.

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Fig. 254 Differential pressure across operating loop cold leg (DP-19-22) -- Test 15.2.

Fig. 255 Differential pressure across operating loop cold leg (DP-19-22) -- Test 15.3.

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Fig. 260 Differential pressure between cold leg and lower plenum (DP-22-255) -- Test 15.3.

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Fig. 264 Differential pressure across core (DP-255-207) -- Test 15.2.

Fig. 265 Differential pressure across core (DP-255-207) -- Test 15.3.

Fig. 266 Differential pressure across core (DP-255-207) -- Test 15.4.

Fig. 267 Differential pressure across core (DP-255-207) -- Test 15.7.

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Fig. 270 Differential pressure across upper portion of downcomer (DP-216-246) -- Test 15.3.

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Fig. 272 Differential pressure across upper portion of downcomer (DP-216-246) -- Test 15.7.

Fig. 273 Differential pressure across middle portion of downcomer (DP-246-249) -- Test 15.1.

Fig. 274 Differential pressure across middle portion of downcomer (DP-246-249) -- Test 15.2.

Fig. 275 Differential pressure across middle portion of downcomer (DP-246-249) -- Test 15.3.

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Fig. 277 Differential pressure across middle portion of downcomer (DP-246-249) -- Test 15.7.

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Fig. 300 Differential pressure between vessel inlet annulus and blowdown loop cold leg (DP-264-50) -- Test 15.3.

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Fig. 305 Differential pressure across blowdown loop hot leg nozzle (DP-76-61) -- Test 15.3.

Fig. 306 Differential pressure across blowdown loop hot leg nozzle (DP-76-61) -- Test 15.4.

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Fig. 318 Differential pressure across simulated steam generator (DP-70-96) -- Test 15.3.

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Fig. 324 Differential pressure across blowdown loop hot leg nozzle diverging section (DP6-HN2-HN4) -- Test 15.7.

Fig. 325 Differential pressure across blowdown loop hot leg nozzle, Station 61 (DP-HN4-61) -- Test 15.2.

Fig. 326 Differential pressure across blowdown loop hot leg nozzle, Station 61 (DP-HN4-61) -- Test 15.3.

Fig. 327 Differential pressure across blowdown loop hot leg nozzle, Station 61 (DP-HN4-61) -- Test 15.7.

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Fig. 329 Differential pressure between vessel upper plenum and pressure suppression tank vapor chamber (DP-207-89) -- Test 15.2.

Fig. 330 Differential pressure between vessel upper plenum and pressure suppression tank vapor chamber (DP-207-89) -- Test 15.3.

Fig. 331 Differential pressure between vessel upper plenum and pressure suppression tank vapor chamber (DP-207-89) -- Test 15.4.

Fig. 332 Differential pressure between vessel upper plenum and pressure suppression tank vapor chamber (DP-207-89) -- Test 15.7.

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Fig. 351 Pump speed -- Test 15.3.

Fig. 352 Pump speed -- Test 15.4.

Fig. 353 Pump speed -- Test 15.7.

Fig. 354 Pump power -- Test 15.1.

Fig. 355 Pump power -- Test 15.2.

Fig. 356 Pump power -- Test 15.3.

Fig. 357 Pump power -- Test 15.4.

Fig. 358 Pump power -- Test 15.7.

Fig. 359 Pump torque -- Test 15.1

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Fig. 361 Pump torque -- Test 15.4.

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Fig. 368 Displacement of pressure suppression header -- Test 15.3.

Fig. 369 Displacement of pressure suppression header -- Test 15.4.

Fig. 370 Displacement of pressure suppression header -- Test 15.7.

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