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EXPERIMENT DATA REPORT FOR 1-1/2-LOOP SEMISCALE SYSTEM ISOTHERMAL TEST 1011

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Light-Water Reactor Technology
TID-4500

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ISOTHERMAL TEST 1011

by

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AEROJET NUCLEAR COMPANY

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ABSTRACT

Recorded test data are presented for Test 1011 of the isothermal portion of the Semiscale Blowdown and Emergency Core Cooling (ECC) Project. The data represent the results of a test in the isothermal test series in which a break nozzle area 80% that of other test configurations was used with no simulated ECC injection. 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 Test 1011 for use by others and for support of subsequent interpretive reports and analyses.

SUMMARY

Test 1011 was 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. This decompression test utilized a break area nozzle area 80% that of other test configurations and thus provided data for determining system response to a variation in break area. 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; and a pressure suppression system with header and pressure suppression tank.

Test 1011 was initiated from isothermal conditions of 2258 psig and 577°F by a simulated instantaneous large cold leg pipe break. In addition to the smaller break area, the Test 1011 configuration utilized an enlarged downcomer gap (1.69 inch). Simulated ECC was not injected.

In general, instrumentation used in Test 1011 functioned as intended and data loss was minimal. Of more than 150 measurements attempted during the test, more than 90% were accomplished. The data appear to be satisfactory for subsequent analysis.

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EXPERIMENT DATA REPORT FOR 1-1/2-LOOP SEMISCALE SYSTEM

ISOTHERMAL TEST 1011

I. INTRODUCTION

The isothermal blowdown 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 during an LOCA.

Although the major emphasis in the isothermal blowdown experiments was on ECC delivery, Test 1011 was conducted without simulated ECC injection and with a smaller break nozzle area (80%) relative to that used in other semiscale isothermal tests. Test 1011 provided data for determining system response to a variation in break area size; the data provide the means to assess analytical predictions of system response to break size variation.

The test configuration and conditions for Test 1011 are as follows:

- (1) Initial isothermal conditions were 2258 psig and 577°F
- (2) An enlarged downcomer gap size of 1.69 inch was used
- (3) The standard (long) lower plenum configuration ($L/D = 2.8:1$) was used with the thermal shield installed
- (4) The 80% break area nozzles were used.

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 and initial test conditions that are applicable to Test 1011. Section III presents the data graphs and provides comments and supporting information necessary for interpretation of the data.

Reference 1 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 TEST 1011

The system configuration and initial test conditions that are specific to Test 1011 are presented.

1. SYSTEM CONFIGURATION

The 1-1/2-loop isothermal semiscale system used for Test 1011 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; and a pressure suppression tank and a header.

For Test 1011 the standard lower plenum ($L/D = 2.8:1$) was used. This plenum consists of the standard (long) lower head and the downcomer filler extension. The lower plenum was thermally insulated with the thermal shield, which consists of the thermal sleeve and the bottom thermal liner plate. The vessel downcomer filler piece was removed to provide a 1.69-inch downcomer gap for the test. The system was subjected to a double-ended offset cold leg break by means of two rupture disc assemblies each employing 80% break area nozzles.

2. INITIAL TEST CONDITIONS

Conditions in the semiscale system at initiation of blowdown and the primary system water chemistry prior to blowdown are given in Tables I and II, respectively.

TABLE I
CONDITIONS AT BLOWDOWN INITIATION

<u>Conditions</u>	<u>Test 1011</u>
Core outlet temperature (°F)	577
System flow rate (gpm)	172
System pressure at vessel outlet (psig)	2258
Pump differential pressure (psid)	37
Suppression tank water level (in.)	47.5
Suppression tank water temperature (°F)	85
Suppression tank pressure	Atmospheric
Pressurizer water volume (ft ³)	0.48
Suppression tank water level after blowdown (in.)	86
Suppression tank water pressure after blowdown (psig)	53 ^[a]

[a] At 45 seconds following blowdown initiation.

TABLE II
WATER CHEMISTRY PRIOR TO BLOWDOWN

<u>Conditions</u>	<u>Test 1011</u>
pH	9.4
Conductivity (μmhos)	33
Suspended solids (ppm)	0.8
H ₂ (cc/l)	0.03
O ₂ (cc/l)	50.7
N ₂ (cc/l)	200.8
CO ₂ (cc/l)	0.05
Total gas (cc/l)	253.9

III. DATA PRESENTATION

The data from semiscale isothermal Test 1011 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 nonhomogenous fluid conditions.

Figures 1 through 4 and Table III provide supporting information for interpretation of the data graphs shown in Figures 5 through 73. Figures 1 through 4 show the locations of all measurements in the isothermal system. Table III groups the measurements taken during Test 1011 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 to facilitate comparison of a given variable at several locations during the test. Zero seconds on all graphs is the time of blowdown initiation.

Reference 1 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)

Fig. 1 1-1/2-loop semiscale system and instrumentation -- isometric.

Fig. 2 1/1-2-loop semiscale system and instrumentation -- schematic.

Item	Description
1	Vessel
2	Main Core Barrel Assembly
3	Downcomer Filter, 1/2-in. Annulus
4	Inner Core Barrel Assembly
5	Flow Mixer Box Assembly
6	Turbine Meter (FT - C-1)
7	Mixer Plate and Inlet Plate Assembly
8	Short Bottom Head
9	10-in. Head Weldment, Top
10	Heater Rod Assembly
11	Mixer Box Cover
12	Downcomer Filter Extension
13	4-in. Top Head
14	Heater Element Lock Nut
15	Turbine Meter Cover
16	Thermal Shield
17	Inner Barrel Spacer Rings (1 typ)
18	Standard Head
19	Set Screw (core centering pin) (1 typ)
20	Heater Grounding Strap
21	Downcomer Filter, 1-in. Annulus (not shown)
22	Core Inlet
23	Dowel Pin
24	Grayloc Seal Ring, 4-in.
25	Grayloc Clamp and Bolts, 4-in.
26	Grayloc Seal Ring, 10-in.
27	Grayloc Clamp and Bolts, 10-in.
28	Scintillator Shielding Cask Support Bracket (rotated to 180°) (D-275V)

All Vessel Instrumentation Rotated to 0° or 180° for Clarity

△ Item Number

TM 94C 45°
 TM 94C 18
 Location
 Distance from Upper Flange Face

Fig. 3 Pressure vessel -- cross-sectional view showing instrumentation.

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	50°	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	50°	32.88		.250
211	1/2 NPT	45°	32.38		.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°	32.38		.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	1/4 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	135°	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	299°	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		
276				IN LOWER HEAD	DENSITY

Fig. 4 Pressure vessel -- isometric showing instrumentation.

TABLE III
DATA PRESENTATION FOR ISOTHERMAL TEST 1011

TABLE III DATA PRESENTATION FOR ISOTHERMAL TEST 1011				
Measurement ^[a]	Location ^[b]	Range ^[c,d]	Figure ^[d]	Comment ^[d]
FLUID TEMPERATURE				
Chromel-Alumel thermocouples; estimated accuracy to within $\pm 7^{\circ}\text{F}$.				
<u>Operating Loop</u>		33-650°F	5	
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
<u>Blowdown Loop</u>		33-650°F	6	
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-96	Simulated steam generator discharge, Spool 96			
<u>Pressure Suppression System</u>			7	
TF-86-3	Suppression vessel, Station 86-3	33-300°F		
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	8	Eight 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			
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-260-14	14-inch level from inside bottom of lower head			
TF-260-16	16-inch level from inside bottom of lower head			
TF-263	In lower plenum head, Station 263			TF-263 data are questionable and not presented for Test 1011
<u>Downcomer Gap</u>		33-650°F	9	
TF-48C-180	~48 inches, 180°, extending 1/8 inch into fluid from core barrel			
TF-214	55.62 inches, 315°			
TF-215	55.62 inches, 75°			
TF-217	81.86 inches, 135°			
TF-219	81.86 inches, 15°			
TF-245	81.86 inches, 315°			
TF-247	81.86 inches, 195°			
TF-268	94.43 inches, 0°			
TF-269	94.43 inches, 90°			
<u>Outlet Plenum</u>		33-650°F	9	
TF-211	32.4 inches, 45°			
METAL TEMPERATURE				
Chromel-Alumel thermocouples; estimated accuracy to within $\pm 7^{\circ}\text{F}$				
<u>Core Barrel</u>		33-650°F	10	TM-47C-0 failed during Test 1011
TM-47C-0	~47 inches, 0°, 1/8 inch from OD			
TM-47C-180	~47 inches, 180°, 1/8 inch from OD			
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-16-45	~95 inches, 45°, 1/16 inch from ID			
<u>Vessel Wall</u>		33-650°F	11	
TM-63V-45	~63 inches, 45°, 1/4 inch from ID			
TM-63V-225	~63 inches, 225°, 1/4 inch from ID			
TM-78V-0	~78 inches, 0°, 1/4 inch from ID			
TM-78V-90	~78 inches, 90°, 1/4 inch from ID			
TM-78V-180	~78 inches, 180°, 1/4 inch from ID			
TM-95V-45	~95 inches, 45°, 1/2 inch from OD			TM-95V-45 failed during Test 1011
TM-95V-225	~95 inches, 225°, 1/4 inch from ID			
TM-95V-25-45	~95 inches, 45°, 1/4 inch from ID			
TM-116V-0	~116 inches, 0°, 1/4 inch from ID			
TM-116V-180	~116 inches, 180°, 1/4 inch from ID			

TABLE III (contd.)
DATA PRESENTATION FOR ISOTHERMAL TEST 1011

Measurement ^[a]	Location ^[b]	Range ^[c,d]	Figure ^[d]	Comment ^[d]
<u>Lower Plenum Vessel Wall</u>				
TM-LH-276	In lower plenum head	33-650°F	12	
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-VOD	On vessel OD 5.0 inches above lower plenum upper Grayloc flange face, 270° from cold leg centerline			
<u>Operating Loop</u>				
TM-1B	Hot leg, Spool 1, 1/8 inch from ID (bottom)	33-650°F		No calibration step available for TM-1B
TM-11	Hot leg, Spool 1, 1/8 inch from ID (top)		13	
TM-19I	Cold leg, Spool 19, 1/8 inch ID (top)		14	
TM-19S	Cold leg, Spool 19, outside surface (top)		14	
TM-19B	Cold leg, Spool 19, 1/8 inch from ID (bottom)		14	
TM-19H	Cold leg, Spool 19, 1/8 inch from ID (middle)		14	
TM-22B	Cold leg, Spool 22, 1/8 inch from ID (bottom)		15	
TM-22H	Cold leg, Spool 22, 1/8 inch from ID (middle)		15	
TM-22I	Cold leg, Spool 22, 1/8 inch from ID (top)		15	
TM-22S	Cold leg, Spool 22, outside surface (top)		15	
<u>Blowdown Loop</u>				
TM-96	Simulated pump suction, Spool 96, 1/16 inch from ID	33-650°F	16	
MOMENTUM FLUX				
				Obtained by drag discs which, through a strain gage network, measure force exerted by moving fluid stream. Fluid force is relatable to momentum flux through calibration curve.
<u>Operating Loop</u>				
		± 100 to $\pm 2.0 \times 10^4$ lb/ft-sec ²		
FD-1	Hot leg, Spool 1		17	
FD-5	Hot leg, Spool 5		17	
FD-15	Pump suction, Spool 15		18	
FD-19	Pump discharge, Spool 19		18	
FD-22	Cold leg, Spool 22		18	
<u>Blowdown Loop</u>				
FD-50	Cold leg, Spool 50	± 430 to $\pm 5.0 \times 10^4$ lb/ft-sec ²	19	
FD-70	Hot leg, Spool 70	± 500 to $\pm 6.0 \times 10^4$ lb/ft-sec ²		
FD-76	Cold leg, Spool 76	± 500 to $\pm 6.0 \times 10^4$ lb/ft-sec ²		
<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	20	
VOLUMETRIC FLOW RATE				
				Obtained by turbine flowmeters
<u>Operating Loop</u>				
FT-1	Hot leg, Spool 1	± 40 to ± 800 gpm	21	FT-1 failed during Test 1011
FT-19	Pump discharge, Spool 19			FT-19 failed during Test 1011
FT-22	Cold leg, Spool 22			
<u>Blowdown Loop</u>				
FT-70	Hot leg, Spool 70	± 20 to ± 500 gpm	22	
<u>Core Barrel Inlet</u>				
FT-C-1	110 inches from upper vessel flange face	± 40 to ± 300 gpm	23	
<u>Pressurizer</u>				
FT-41	Outlet, Spool 41	± 8 to ± 200 gpm	24	
FLUID VELOCITY				
<u>Vessel Downcomer Gap</u>				
FT-212	49.88 inches, 135°F	± 1 to ± 10 ft/sec	25	
FT-239	47.88 inches, 225°			No calibration step available for FT-239
FT-253	119.23 inches, 225°			No calibration step available for FT-253
FT-270	94.43 inches, 180°		25	

TABLE III (contd.)
DATA PRESENTATION FOR ISOTHERMAL TEST 1011

Measurement [a]	Location [b]	Range [c,d]	Figure [d]	Comment [d]
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		26	FT-1 failed during Test 1011
FT-1 D-1V	Hot leg, Spool 5		26	
FD-5 D-5V	Pump suction, Spool 15		27	
FD-15 D-15V	Pump discharge, Spool 19		27	
FD-19 D-19V				FT-19 failed during Test 1011
FT-19 D-19V				
FD-22 D-22V	Cold leg, Spool 22		28	
FT-22 D-22V				
<u>Blowdown Loop</u>		Momentum flux: ± 500 to $\pm 5.0 \times 10^4$ lb/ft-sec ² volumetric flow: ± 40 to ± 300 gpm density: 0.05 to 62.4 lbm/ft ³		
FD-70 D-70V	Hot leg, Spool 70		29	
FT-70 D-70V			29	
FD-50 D-50V	Cold leg, Spool 50		30	
FD-76 D-76V	Cold leg, Spool 76		30	
<u>Core Barrel Inlet</u>		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°		31	
FT-C-1 D-225H	FT-C-1: 110.0 inches		31	
DENSITY, FLUID				
		0.05 to 62.4 lbm/ft ³		Obtained by gamma attenuation technique (densitometer).
<u>Operating Loop</u>				
D-1V	Hot leg, Spool 1		32	
D-5V	Hot leg, Spool 5		32	
D-15V	Pump suction, Spool 15		33	
D-19V	Pump discharge, Spool 19		33	
D-22H				
D-22V	Cold leg, Spool 22		34	
<u>Blowdown Loop</u>			35	
D-50V	Cold leg, Spool 50			
D-70V	Hot Leg, Spool 70			
D-76V	Cold leg, Spool 76			
<u>Vessel</u>			36	
D-225H	Core barrel inlet 110.0 inches, 0°			
D-228H	Lower plenum 122.4 inches, 0°			
D-275V	Lower plenum 114.5 inches, 315°			Gamma beam diagonally across lower plenum D-275V system was not calibrated
PRESSURE				
				Obtained by Norwood strain gage type transducers accurate to within $\pm 1\%$ of full scale.
<u>Operating Loop</u>		0-3000 psig	37	
P-1	Hot leg, Spool 1			
P-15	Pump suction, Spool 15			
P-19	Pump discharge, Spool 19			
P-40	Pressurizer outlet, Spool 40			
<u>Blowdown Loop</u>		60-3000 psig	38	
P6-HN2	Simulated pump side, nozzle throat, Port 2			
P-50	Cold leg, Spool 50			
P-51	Cold leg, downstream of vessel-side nozzle, Station 51			
P-61	Downstream of hot leg nozzle, Station 61			
P-62	Pump side, rupture assembly inner disc cavity, Spool 62			
P-70	Hot leg, Spool 70			
P-76	Cold leg, Spool 76			
<u>Vessel</u>		60-3000 psig	39	
P-207	Outlet plenum, 28.4 inches, 30°			
P-255	Lower plenum, 121.3 inches, 240°			

TABLE III (contd.)
DATA PRESENTATION FOR ISOTHERMAL TEST 1011

Measurement (a)	Location (b)	Range (c,d)	Figure (d)	Comment (d)
<u>Pressure Suppression System</u>				
P-53	Blowdown loop cold leg, Spool 53	0-1000 psig	40	
P-81	Straight section of pressure suppression header between elbows, Spool 80	0-200 psig		Electronic noise imposed on P-80 data.
P-89	Vapor chamber of pressure suppression vessel	0-200 psig		
<u>Outlet Plenum</u>				
P-LFF-HL (LOFT Pressure Transducer)	Hot leg stub in outlet plenum		41	
DIFFERENTIAL PRESSURE				
				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		No calibration step available for DP-22-1
DP-1-5	Hot leg, Spool 1 to Spool 5	± 0.72 psid	42	No calibration step available for DP-1-5. Data presented without calibration correction.
DP-5-13	Across steam generator, Spool 5 to Spool 13	± 28.9 psid	43	
DP-8-13	Pump suction orifice, Spool 8 to Spool 13	± 10.8 psid	44	
DP-13-15	Spool 13 to Spool 15	± 1.6 psid	45	
DP-19-15	Across pump, Spool 19 to Spool 15	± 50.0 psid	46	
DP-19-15L	Across pump, Spool 19 to Spool 15	± 3.6 psid		DP-19-15L failed during Test 1011
DP-19-22	Spool 19 to Spool 22	± 10.8 psid	47	
DP-22-255	Cold leg to lower plenum, Spool 22 to Station 255	± 10.8 psid	48	
<u>Vessel</u>				
DP-255-207	Vessel lower plenum to vessel upper plenum, Station 255 to Station 207	± 18.0 psid	49	
<u>Downcomer</u>				
DP-216-246	Station 216 to Station 246	± 1.8 psid	50	
DP-246-249	Station 246 to Station 249	± 1.8 psid	51	
DP-249-255	Station 249 to Station 255	± 0.72 psid	52	
<u>Lower Plenum</u>				
DP-261-255	Station 261 to Station 255	± 0.72	53	
<u>Core</u>				
DP-LOFT	Lower plenum to upper plenum of vessel	± 50.0	54	
<u>Blowdown Loop</u>				
DP-207-70	Vessel upper plenum to blowdown loop hot leg, Station 207 to Spool 70	± 3.6 psid	55	
DP-264-50	Vessel inlet annulus to blowdown loop cold leg, Station 264 to Spool 50	± 500.0 psid	56	
DP-52-62	Across rupture discs, Spool 52 to Spool 62	± 500.0 psid	57	
DP-76-61	Across hot leg nozzle, Spool 76 to Station 61	± 1000.0 psid	58	
DP-76-HN2	Spool 76 to hot leg nozzle downstream throat (Port 2)	± 500.0 psid	59	
DP-96-76	Across simulated pump, Spool 96 to Spool 76	± 200.0 psid	60	
DP-70-96	Across simulated steam generator, Spool 70 to Spool 96	± 100.0 psid	61	
DP5-HN2-HN4	Vessel side, downstream nozzle throat (Port 2) to downstream nozzle expansion section (Port 4)	± 1000.0 psid	62	
DP6-HN2-HN4	Simulated pump side, downstream nozzle throat (Port 2) to downstream nozzle expansion section (Port 4)	± 1000.0 psid	63	
DP-HN4-61	Across hot leg nozzle outlet, downstream nozzle expansion section (Port 4) to Station 61	± 500.0 psid	64	
<u>Pressure Suppression System</u>				
DP-207-89	Vessel upper plenum to vapor chamber of pressure suppression tank	± 500.0 psid	65	DP-207-89 detector capability exceeded
DP-81-89	Header to tank vapor chamber	± 50.0 psid	66	
DP-81-85	Header to downcomer entrance	± 10.8 psid	67	
LIQUID LEVEL				
				Liquid level in lower plenum is indicated by density measurements D-228H and D-275V and by differential pressure measurement DP-261-255
<u>Lower Plenum</u>				
LL-LFTA-259	Port 259			System not calibrated, data not digitized.
LL-LFTD-259				
<u>Pressure Suppression System</u>				
LL-PSS	Suppression tank	3.64 psid	68	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

TABLE III (contd.)
DATA PRESENTATION FOR ISOTHERMAL TEST 1011

Measurement ^[a]	Location ^[b]	Range ^[c,d]	Figure ^[d]	Comment ^[d]
PUMP CHARACTERISTICS				
Operating loop pump				
<u>Pump Speed</u>				
PS-RPM		--	69	
<u>Pump Power</u>				
PH-PMP		--	70	
<u>Pump Torque</u>				
T-PMP		--	71	
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 Guy</u>				
S-271	65.6 inches, 0°, Station 271		72	S-271 data are questionable
DISPLACEMENT				
				System not calibrated, data useful only for relative motion indication.
<u>Pressure Suppression System</u>			73	
LDT-PSH	Header first elbow (horizontal deflection)			
LDT-PSV	Beneath suppression vessel (vessel vertical deflection)			
<p>[a] Measurement nomenclature is defined in Reference 1.</p> <p>[b] Measurement locations are shown in Figures 1 through 4.</p> <p>[c] The range indicated is that over which the measurement is considered valid.</p> <p>[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.</p>

Fig. 5 Fluid temperatures in operating loop.

Fig. 6 Fluid temperatures in blowdown loop.

Fig. 7 Fluid temperatures in pressure suppression system.

Fig. 8 Fluid temperatures in lower plenum at thermocouple rack.

Fig. 9 Fluid temperatures in downcomer gap and outlet plenum.

Fig. 10 Metal temperatures in core barrel.

Fig. 11 Metal temperatures in vessel wall.

Fig. 12 Metal temperatures in lower plenum vessel wall.

Fig. 13 Metal temperatures in operating loop hot leg Spool 1.

Fig. 14 Metal temperatures in operating loop cold leg Spool 19.

Fig. 15 Metal temperatures in operating loop cold leg Spool 22.

Fig. 16 Metal temperatures in blowdown loop.

Fig. 17 Momentum flux from drag discs in operating loop hot leg.

Fig. 18 Momentum flux from drag discs in operating loop cold leg.

Fig. 19 Momentum flux from drag discs in blowdown loop.

Fig. 20 Momentum flux from drag discs at core barrel inlet.

Fig. 21 Volumetric flow rate from turbine meters in operating loop.

Fig. 22 Volumetric flow rate from turbine meter in blowdown loop hot leg.

Fig. 23 Volumetric flow rate from turbine meter at core barrel inlet.

Fig. 24 Volumetric flow rate from turbine meter at pressurizer outlet.

Fig. 26 Mass flow rate in operating loop hot leg Spools 1 and 5.

Fig. 25 Fluid velocity from turbine meters in downcomer gap.

Fig. 27 Mass flow rate in operating loop at pump inlet and outlet.

Fig. 28 Mass flow rate in operating loop cold leg Spool 22.

Fig. 29 Mass flow rate in blowdown loop Spool 70.

Fig. 30 Mass flow rate in blowdown loop Spools 50 and 76.

Fig. 31 Mass flow rate at core barrel inlet.

Fig. 32 Fluid density in operating loop hot leg.

Fig. 33 Fluid density at operating loop pump inlet and outlet.

Fig. 34 Fluid density in operating loop cold leg.

Fig. 35 Fluid density in blowdown loop.

Fig. 36 Fluid density in vessel.

Fig. 37 Pressure in operating loop.

Fig. 38 Pressure in blowdown loop.

Fig. 39 Pressure in vessel.

Fig. 40 Pressure in pressure suppression system.

Fig. 41 Pressure at hot leg stub in upper plenum (LOFT free field pressure transducer).

Fig. 42 Differential pressure, operating loop hot leg (DP-1-5).

Fig. 43 Differential pressure across steam generator (DP-5-13).

Fig. 44 Differential pressure across pump suction orifice (DP-8-13).

Fig. 45 Differential pressure across operating loop pump inlet (DP-13-15).

Fig. 46 Differential pressure across operating loop pump (DP-19-15).

Fig. 47 Differential pressure across operating loop cold leg (DP-19-22).

Fig. 48 Differential pressure between cold leg and lower plenum (DP-22-255).

Fig. 49 Differential pressure across core (DP-255-207).

Fig. 50 Differential pressure across upper portion of downcomer (DP-216-246).

Fig. 51 Differential pressure across middle portion of downcomer (DP-246-249).

Fig. 52 Differential pressure across lower portion of downcomer (DP-249-255).

Fig. 53 Differential pressure across lower plenum (DP-261-255).

Fig. 54 Differential pressure across vessel (DP-LOFT).

Fig. 55 Differential pressure between vessel upper plenum and blowdown loop hot leg (DP-207-70).

Fig. 56 Differential pressure between vessel inlet annulus and blowdown loop cold leg (DP-264-50).

Fig. 57 Differential pressure between inner disc cavities (DP-52-62).

Fig. 58 Differential pressure across blowdown loop hot leg nozzle (DP-76-61).

Fig. 59 Differential pressure between simulated pump and throat of blow-down loop hot leg nozzle (DP-76-HN2).

Fig. 60 Differential pressure across simulated pump (DP-96-76).

Fig. 61 Differential pressure across simulated steam generator (DP-70-96).

Fig. 62 Differential pressure across blowdown loop cold leg nozzle diverging section (DP5-HN2-HN4).

Fig. 63 Differential pressure across blowdown loop hot leg nozzle diverging section (DP6-HN2-HN4).

Fig. 64 Differential pressure across blowdown loop hot leg nozzle, Station 61 (DP-HN4-61).

Fig. 65 Differential pressure between vessel upper plenum and pressure suppression tank vapor chamber (DP-207-89).

Fig. 66 Differential pressure between pressure suppression header and pressure suppression tank vapor chamber (DP-81-89).

Fig. 67 Differential pressure between pressure suppression header and pressure suppression tank downcomer entrance (DP-81-85).

Fig. 68 Liquid level in pressure suppression tank (LL-PSS).

Fig. 69 Pump speed (PS-RPM).

Fig. 70 Pump power (PW-PMP).

Fig. 71 Pump torque (T-PMP).

Fig. 72 Flow direction in downcomer gap (S-271).

Fig. 73 Displacement of pressure suppression system.

IV. REFERENCE

1. R. S. Alder and P. A. Pinson, *1-1/2-Loop Semiscale Isothermal Test Program -- Program and System Description in Support of Experimental Data Reports*, ANCR-1143 (February 1974).