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EXPERIMENT DATA REPORT
FOR 1-1/2-LOOP SEMISCALE SYSTEM
ISOTHERMAL TESTS 1008 AND 1010

R.S. Alder
E.M. Feldman
P.A. Pinson

Aerojet Nuclear Company

NATIONAL REACTOR TESTING STATION

Idaho Falls, Idaho — 83401

MASTER

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ABSTRACT

Recorded test data are presented for Tests 1008 and 1010 of the isothermal portion of the Semiscale Blowdown and Emergency Core Cooling (ECC) Project. These data represent the results of the first isothermal tests utilizing an enlarged downcomer gap (1.0 inch) in the pressure vessel to investigate general system hydraulic response both with and without simulated ECC injection. The data, presented in the form of composite 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 Tests 1008 and 1010 for use by others and for support of subsequent interpretive reports and analysis.

SUMMARY

Tests 1008 and 1010 were performed in the isothermal portion of the Semi-scale Blowdown and Emergency Core Cooling (ECC) Project conducted by Aerojet Nuclear Company for the Atomic Energy Commission. These decompression tests are the first tests in the isothermal test series in which an enlarged downcomer gap (1.0 inch) was utilized in the pressure vessel. 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.

Tests 1008 and 1010 were initiated from isothermal conditions of about 2250 psig and 575°F by a simulated instantaneous large cold leg pipe break. Test 1008 provided data for use in determining the effects of a 1.0-inch downcomer gap in the pressure vessel on system hydraulic behavior with simulated ECC injection at 600 psig into the cold legs of the operating and blowdown loops. Test 1010 provided data for use in determining system general hydraulic response with the 1.0-inch downcomer gap but without ECC injection.

In general, instrumentation used in these tests functioned as intended and data loss was minimal. Of the more than 300 measurements attempted during the two tests, more than 95% 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 TESTS 1008 AND 1010

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.

The major emphasis in the isothermal blowdown experiments is on ECC delivery. Tests 1008 and 1010 were conducted to determine the hydraulic response of the isothermal system with an enlarged downcomer gap (1.0 inch) in the pressure vessel for comparison with results from earlier tests, which utilized a smaller downcomer gap (0.5 inch). In addition, these tests were conducted to obtain information on system behavior with simulated ECC injection (Test 1008) and without simulated ECC injection (Test 1010). Test 1008 was conducted to determine the general system hydraulic response to blowdown and subsequent ECC injection into the cold legs of the operating loop and blowdown loop at 600 psig system pressure. Test 1010 was conducted to investigate the effects of the larger gap size on system hydraulic behavior with no ECC injection.

The test configuration and conditions for Tests 1008 and 1010 are summarized briefly as follows.

Test 1008

- (1) Initial isothermal conditions were 2258 psig and 576°F at the outlet of the pressure vessel.
- (2) The downcomer gap was 1.0 inch.

- (3) The standard (long) lower plenum configuration ($L/D = 2.8:1$) was used with the thermal shield installed.
- (4) The 100% break area nozzles were used.
- (5) ECC injection into the cold leg of each loop was initiated at a primary system pressure of ~ 600 psig.
 - (a) Operating loop accumulator injection flow was ~ 53 gpm average; subsequent ECC pump injection flow was ~ 51 gpm average.
 - (b) Blowdown loop accumulator injection flow was 10 gpm average; subsequent ECC blowdown pump injection flow was ~ 6.5 gpm average.

Test 1010

- (1) Initial isothermal conditions were 2260 psig and 577°F at the outlet of the pressure vessel.
- (2) The downcomer gap was 1.0 inch.
- (3) The standard (long) lower plenum configuration ($L/D = 2.8:1$) was used with the thermal shield installed.
- (4) The 100% 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, initial test conditions, and events and conditions following initiation of blowdown that are applicable to Tests 1008 and 1010. 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 TESTS 1008 AND 1010

The system configuration, initial test conditions, and events and conditions following blowdown initiation that are specific to Tests 1008 and 1010 are presented.

1. SYSTEM CONFIGURATION

The 1-1/2-loop isothermal semiscale system used for Tests 1008 and 1010 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.

For Tests 1008 and 1010, 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. For both tests, the lower plenum was thermally insulated with the thermal shield, which consists of the thermal sleeve and the bottom thermal liner plate. A vessel downcomer filler piece was used to provide a 1.0-inch downcomer gap for both tests. The system was subjected to a double-ended offset cold leg break by means of two rupture disc assemblies each employing 100% break area nozzles.

The simulated ECC injection system was used for Test 1008. This system consisted of an accumulator subsystem and a pump injection subsystem in both the operating loop and the blowdown loop. Both accumulators and pumps were required to supply ECC to the cold leg of the operating and blowdown loops.

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

Conditions	Test 1008	Test 1010
Core outlet temperature (°F)	576	577
System flow rate (gpm)	174	171
System pressure at vessel outlet (psig)	2258	2260
Pump differential pressure (psid)	40	40
Suppression tank water level (in.)	47.5	47.5
Suppression tank water temperature (°F)	198	190
Suppression tank pressure (psig)	13.2	19.7
Pressurizer water volume (ft ³)	0.59	0.51
Operating loop accumulator pressure (psig)	~1120	
Blowdown loop accumulator pressure (psig)	~ 600	

TABLE II
WATER CHEMISTRY PRIOR TO BLOWDOWN

Conditions	Test 1008	Test 1010
pH	8.6	9.1
Chlorides (ppm)	0.23	0.03
Conductivity (μmhos)	22.9	32
Suspended solids (ppm)	3.8	2.0
H ₂ (cc/l)	0.01	< 0.01
O ₂ (cc/l)	42.4	45.2
N ₂ (cc/l)	167.1	179.2
CO ₂ (cc/l)	0	< 0.1
Total gas (cc/l)	213.4	229.5

3. EVENTS AND CONDITIONS FOLLOWING BLOWDOWN INITIATION

The sequence of events following blowdown initiation is presented in Table III. After coolant injection was terminated and blowdown was over, the lower plenum was found to contain 2.0 gal of water after Test 1008. The water level in the lower plenum was not measured following Test 1010.

TABLE III

SEQUENCE OF EVENTS FOLLOWING BLOWDOWN INITIATION

<u>Event</u>	<u>Time After Rupture (sec)</u>
	<u>Test 1008</u>
Blowdown loop ECC injection from blowdown loop ECC accumulator starts	~13
Operating loop ECC injection from operating loop ECC accumulator starts	~16
Operating loop ECC injection from operating loop ECC accumulator stops	~28
Blowdown loop ECC injection from blowdown loop ECC accumulator stops	~28
Operating loop ECC injection pump flow starts	~28
Blowdown loop ECC injection pump flow starts	~28
Blowdown loop ECC injection pump flow stops	~59
Operating loop ECC injection pump flow stops	~59

III. DATA PRESENTATION

The data from semiscale isothermal Tests 1008 and 1010 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 IV provide supporting information for interpretation of the data graphs shown in Figures 5 through 117. Figures 1 through 4 show the locations of all measurements in the isothermal system. Table IV groups the measurements taken during Tests 1008 and 1010 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 the form of composite graphs to facilitate comparison of a given variable at several locations during a single test or a given variable during both tests. Zero seconds on all graphs is the time of blow-down 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.

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

Item	Description
1	Vessel
2	Main Core Barrel Assembly
3	Downcomer Filler, 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 Filler Extension
13	4-in. Top Head
14	Heater Element Lock Nut
15	Turbine Meter Cover
16	Thermal Shield
17	Inner Barrel Spacer Rings (1-1/2")
18	Standard Head
19	Set Screw (core centering pin) (typ)
20	Heater Grounding Strap
21	Downcomer Filler, 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

Type of Measurement
 45° — Rotational Location
 — Location
 — Distance from Upper Flange Face

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

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TABLE IV
DATA PRESENTATION FOR ISOTHERMAL TESTS 1008 AND 1010

Measurement (a)	Location (b)	Range (c,d)	Figure (d)	Comment (d)
FLUID TEMPERATURE				
<u>Operating Loop</u>		33-650°F	5, 6	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 is a shielded thermocouple. TS-20 failed during both tests
<u>Blowdown Loop</u>		33-650°F	7, 8	
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>				
TF-83	Header near downcomer entrance (1 inch from ID of header on bottom)	33-650°F	10	TF-83 failed during Test 1008
TF-86-3	Suppression vessel, Station 86-3	33-300°F	9, 10	
TF-86-4	Suppression vessel, Station 86-4	33-300°F		TF-86-4 data were not taken during Test 1008 and TF-86-4 failed during Test 1010
TF-88	Suppression vessel vapor chamber, 2 inches from tank wall	33-650°F	9, 10	
RB-86-6	Suppression vessel water, Station 86-6	0-1000°F	9, 10	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		11, 12	
TF-260-4	4-inch level from inside bottom of lower head		11, 12	
TF-260-6	6-inch level from inside bottom of lower head		11, 12	
TF-260-8	8-inch level from inside bottom of lower head		11, 12,	
TF-260-10	10-inch level from inside bottom of lower head		11, 12,	
TF-260-12	12-inch level from inside bottom of lower head		11,	TF-260-12 failed during Test 1010
TF-260-14	14-inch level from inside bottom of lower head		11, 12,	
TF-260-16	16-inch level from inside bottom of lower head		11, 12,	
TF-260-18	18-inch level from inside bottom of lower head			TF-260-18 failed during both tests.
TF-263	In lower plenum head, Station 263			Data from TF-263 were questionable and therefore are not presented for either test
<u>Downcomer Gap</u>		33-650°F		
TF-47D-180	~48 inches, 180°, extending 1/8 inch into fluid from vessel wall side		13, 14, 15	
TF-48C-180	~48 inches, 180°, extending 1/8 inch into fluid from core barrel		13, 14, 15	
TF-48D-0	~48 inches, 0°, extending 1/8 inch into fluid from vessel wall side		13, 14, 16	
TF-78D-0	~78 inches, 0°		13, 14, 16	
TF-78D-180	~78 inches, 180°		13, 14, 15	
TF-95D-45	~95 inches, 45°		13, 14, 16	
TF-95D-225	~95 inches, 225°		13, 14, 16	
<u>Outlet Plenum</u>		33-650°F		
TF-211	32.4 inches, 45°		13, 15	TF-211 failed during Test 1010
<u>ECC System</u>		33-300°F		
TF-ECC-BIA	In line from blowdown loop ECC injection accumulator		17	TF-ECC-BIA data were not taken during Test 1010 because ECC injection was not used
TF-ECC-OLA	In line from operating loop ECC injection accumulator		17	TF-ECC-OLA data were not taken during Test 1010 because ECC injection was not used
METAL TEMPERATURE				
<u>Core Barrel</u>		33-650°F	18, 19	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-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			

TABLE IV (contd.)

DATA PRESENTATION FOR ISOTHERMAL TESTS 1008 AND 1010

Measurement [a]	Location [b]	Range [c,d]	Figure [d]	Comment [d]	
Downcomer Filler					
TM-48D-0	~48 inches, 0°, 1/16 inch from ID	33-650°F	20, 21		
TM-48D-180	~48 inches, 180°, 1/16 inch from ID			TM-48D-180 failed during both tests	
TM-63D-45	~63 inches, 45°, 1/16 inch from ID		20, 21		
TM-63D-225	~63 inches, 225°, 1/8 inch from OD			TM-63D-225 failed during both tests	
TM-78D-0	~78 inches, 0°, 1/16 inch from ID		20, 21		
TM-78D-180	~78 inches, 180°, 1/16 inch from ID		20, 21		
TM-95D-45	~95 inches, 45°, 1/16 inch from ID		22, 23		
TM-95D-225	~95 inches, 225°, 1/16 inch from ID		20, 21	No explanation for spike in TM-95D-225 data occurring about 15 sec after blow-down	
TM-116D-45	~116 inches, 45°, 1/16 inch from ID		20, 21	No explanation for spike in TM-116D-45 data occurring about 15 sec after blow-down	
TM-116D-225	~116 inches, 225°, 1/16 inch from ID		20, 21		
TM-116D-0	~116 inches, 0°, 1/16 inch from ID		20, 21		
Vessel Wall					
TM-95V-45	~95 inches, 45°, 1/2 inch from OD	33-650°F	22, 23		
TM-95D-45	~95 inches, 45°, 1/16 inch from ID				
TM-95D-18-45	~95 inches, 45°, 0.176 inch from OD				
Lower Plenum Vessel Wall					
TM-LH-276	In lower plenum head	33-650°F	24, 25		
TM-LP-1DL	4.9 inches below lower plenum upper Grayloc flange face, 270° from cold leg centerline, 1/16 inch from ID of filler piece		24, 25		
TM-LP-1DU	5.0 inches above lower plenum upper Grayloc flange face, 270° from cold leg centerline, 1/16 inch from ID of filler piece		24	TM-LP-1DU failed during Test 1010	
TM-LP-VOD	On vessel OD 5.0 inches above lower plenum upper Grayloc flange face, 270° from cold leg centerline		24, 25		
Operating Loop					
TM-1B	Hot leg, Spool 1, 1/8 inch from ID (bottom)	33-650°F	27	TM-1B data for Test 1010 appear low at the start of the test and should be considered questionable. TM-1B failed during Test 1008	
TM-1I	Hot leg, Spool 1, 1/8 inch from ID (top)		26, 27		
TM-19I	Cold leg, Spool 19, 1/8 inch ID (top)		28, 29		
TM-19M	Cold leg, Spool 19, 1/4 inch from ID (top)		29	TM-19M data were not taken during Test 1008	
TM-19S	Cold leg, Spool 19, outside surface (top)		28, 29		
TM-19B	Cold leg, Spool 19, 1/8 inch from ID (bottom)			TM-19B failed during both tests	
TM-19H	Cold leg, Spool 19, 1/8 inch from ID (middle)		28, 29		
TM-22I	Cold leg, Spool 22, 1/8 inch from ID (top)		30, 31		
TM-22B	Cold leg, Spool 22, 1/8 inch from ID (bottom)		30, 31		
TM-22H	Cold leg, Spool 22, 1/8 inch from ID (middle)		30, 31		
TM-22I	Cold leg, Spool 22, 1/8 inch from ID (top)		30, 31		
TM-22M	Cold leg, Spool 22, 1/4 inch from ID (top)		31	TM-22M data were not taken during Test 1008	
TM-22S	Cold leg, Spool 22, outside surface (top)		30, 31		
Blowdown Loop					
TM-96	Simulated pump suction, Spool 96, 1/16 inch from ID	33-650°F	32		
MOMENTUM FLUX					
Operating Loop					
FD-1	Hot leg, Spool 1	±100 to ±2.0 × 10 ⁴ lb/ft-sec ²	33, 34		
FD-5	Hot leg, Spool 5		33, 34		
FD-15	Pump suction, Spool 15		35, 36		
FD-19	Pump discharge, Spool 19		35, 36		
FD-22	Cold leg, Spool 22		35, 36		
Blowdown Loop					
FD-50	Cold leg, Spool 50	±430 to ±5.0 × 10 ⁴ lb/ft-sec ²	37, 38		
FD-70	Hot leg, Spool 70		±500 to ±6.0 × 10 ⁴ lb/ft-sec ²	37, 38	
FD-76	Cold leg, Spool 76		±500 to ±6.0 × 10 ⁴ lb/ft-sec ²	38	
Pressure Suppression System					
FD-83	Header near downcomer			FD-83 data not reported; system was not calibrated.	
Core Barrel Inlet					
FD-224	110 inches, 315° (target centered in gap)	±140 to ±3.0 × 10 ⁴ lb/ft-sec ²	39, 40		

TABLE IV (contd.)

DATA PRESENTATION FOR ISOTHERMAL TESTS 1008 AND 1010

Measurement [a]	Location [b]	Range [c,d]	Figure [d]	Comment [d]
VOLUMETRIC FLOW RATE				
<u>Operating Loop</u>		± 40 to ± 800 gpm	41, 42	Obtained by turbine flowmeters
FT-1	Hot leg, Spool 1			
FT-19	Pump discharge, Spool 19			
FT-22	Cold leg, Spool 22			
<u>Blowdown Loop</u>				
FT-70	Hot leg, Spool 70	± 20 to ± 500 gpm	43	
<u>Core Barrel Inlet</u>				
FT-C-1	110 inches from upper vessel flange face	± 40 to ± 300 gpm	44, 45	FT-C-1 detector capability exceeded during Test 1008 at 300 gpm above which data are considered invalid
<u>Pressurizer</u>				
FT-41	Outlet, Spool 41	± 8 to ± 200 gpm	46	
<u>ECC System</u>			47	No ECC injection during Test 1010.
FT-ECC-OLA	In ECC line from operating loop ECC injection accumulator	± 4.0 to ± 50 gpm		Nonzero reading for FT-ECC-OLA prior to and after ECC injection during Test 1008 is due to electronic noise
FT-ECC-OLP	In ECC line from operating loop ECC injection pump	± 4.0 to ± 100 gpm		
FT-ECC-BLP	In line from blowdown loop ECC injection pump	± 4.0 to ± 70 gpm		
FT-ECC-BLA	In line from blowdown loop ECC injection accumulator	± 4.0 to ± 50 gpm		
FLUID VELOCITY				
<u>Vessel Downcomer Gap</u>		± 1 to ± 10 ft/sec		Obtained by turbine flowmeters
FT-212	49.88 inches, 135°			FT-212 data were not taken during either test
FT-239	47.88 inches, 225°		48, 49	
FT-253	119.23 inches, 225°		48, 49	
FT-270	94.43 inches, 180°		48, 49	
MASS FLOW RATE				
<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		Mass flow rate obtained by combining density (gamma attenuation technique) with volumetric flow rate (turbine flowmeters) or with momentum flux (drag disc)
FD-1 D-1V			50, 51	
FT-1 D-1V	Hot leg, Spool 1		50, 51	
FD-19 D-19V			52, 53	
FT-19 D-19V	Pump discharge, Spool 19		52, 53	FT-19 data spikes above 35 lb/sec are questionable
FD-22 D-22V			54, 55	
FT-22 D-22V	Cold leg, Spool 22		54, 55	
FD-5 D-5V	Hot leg, Spool 5		56, 57	
FD-15 D-15V	Pump suction, Spool 15		56, 57	
<u>Blowdown Loop</u>		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			58, 59, 60	
FT-70 D-70V	Hot leg, Spool 70		58, 59	
FD-50 D-50V	Cold leg, Spool 50		60, 61	
FD-76 D-76V	Cold leg, Spool 76		61	FD-76 failed during Test 1008
<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: 0.05 to 62.4 lbm/ft ³		
FD-224 D-225H	D-225H: 110.0 inches, 0° FD-224: 110.0 inches, 115°		62, 63	
FT-C-1 D-225H	FT-C-1: 110.0 inches		62, 63	
DENSITY, FLUID				
<u>Operating Loop</u>		0.05 to 62.4 lbm/ft ³		Obtained by gamma attenuation technique (densitometer).
D-1V	Hot leg, Spool 1		64, 64	
D-5V	Hot leg, Spool 5		64, 65	
D-15V	Pump suction, Spool 15		66, 67	
D-19V	Pump discharge, Spool 19		66, 67	
D-22H				
D-22V	Cold leg, Spool 22		68, 69	

TABLE IV (contd.)

DATA PRESENTATION FOR ISOTHERMAL TESTS 1008 AND 1010

Measurement ^[a]	Location ^[b]	Range ^[c,d]	Figure ^[d]	Comment ^[d]
Blowdown Loop				
D-50V	Cold leg, Spool 50		70, 71	
D-70V	Hot Leg, Spool 70			
D-76V	Cold leg, Spool 76			
Vessel				
D-225H	Core barrel inlet 110.0 inches, 0°		72, 73	
D-220H	Lower plenum 122.4 inches, 0°			
D-275H	Lower plenum 114.5 inches, 315°			Caused beam diagonally across lower plenum. D-275V was not calibrated for Tests 1008 and 1010
Pressure Suppression Header				
D-83V	Near suppression tank downcomer		74	D-83V data were not taken during Test 1008
PRESSURE				
Operating Loop				
P-1	Hot leg, Spool 1	0-3000 psig	75	P-1 data were not taken during Test 1010
P-15	Pump suction, Spool 15		75, 76	
P-19	Pump discharge, Spool 19		75, 76	
P-40	Pressurizer outlet, Spool 40		75	P-40 data were not taken during Test 1010
Blowdown Loop				
P6-HN2	Simulated pump side, nozzle throat; Port 2	60-3000 psig	77, 78	
P-50	Cold leg, Spool 50		77, 78	
P-51	Cold leg, downstream of vessel-side nozzle, Station 51		77, 78	
P-52	Cold leg, vessel side, rupture assembly inner disc cavity, Spool 52		79	P-52 data were not taken during Test 1008
P-61	Downstream of hot leg nozzle, Station 61		77, 78	
P-62	Pump side, rupture assembly inner disc cavity, Spool 62		77, 78	
P-70	Hot leg, Spool 70		77, 78	
P-76	Cold leg, Spool 76		77, 78	
Vessel				
P-207	Outlet plenum, 28.4 inches, 30°	60-3000 psig	80, 81	
P-255	Lower plenum, 121.3 inches, 240°			
Pressure Suppression System				
P-53	Blowdown loop cold leg, Spool 53	0-1000 psig	82, 83	
P-89	Vapor chamber of pressure suppression vessel	0-200 psig		
ECC Accumulator				
P-ECC-BLA	Blowdown loop ECC accumulator	0-3000 psig	84	No ECC injection during Test 1010
P-ECC-OLA	Operating loop ECC accumulator			
Outlet Plenum				
P-LFF-HL (LOFT Pressure Transducer)	Hot leg stub in outlet plenum		85	
DIFFERENTIAL PRESSURE				
Operating Loop				
DP-22-1	Across pressure vessel, operating loop cold leg to hot leg, Spool 22 to Spool 1	±28.9 psid	86	
DP-1-5	Hot leg, Spool 1 to Spool 5	±0.72 psig	87	
DP-5-13	Across steam generator, Spool 5 to Spool 13	±28.9 psid	88	Elevation difference between DP-5-13 taps is 30.62 inches
DP-8-13	Pump suction orifice, Spool 8 to Spool 13	±10.8 psid	89	Elevation difference between DP-8-13 taps is 20.25 inches
DP-13-15	Spool 13 to Spool 15	±3.6 psid	90	
DP-19-15	Across pump, Spool 19 to Spool 15	±50.0 psid	91	Elevation difference between DP-19-15 taps is 9.75 inches
DP-19-15L	Across pump, Spool 19 to Spool 15	±3.6 psid	92	Elevation difference between DP-19-15L taps is 9.75. DP-19-15L transducer capability was exceeded for first 6 seconds of both tests
DP-19-22	Spool 19 to Spool 22	±10.8 psid	93	
DP-22-255	Cold leg to lower plenum, Spool 22 to Station 255	±10.8 psid	94	Elevation difference between DP-22-255 taps is 82 inches
Vessel				
DP-255-207	Vessel lower plenum to vessel upper plenum, Station 255 to Station 207	±18.0 psid	95	
Downcomer				
DP-216-246	Station 216 to Station 246	±1.8 psid	96	
DP-246-249	Station 246 to Station 249	±1.8 psid	97	Elevation difference between DP-246-249 taps is 24 inches

TABLE IV (contd.)

DATA PRESENTATION FOR ISOTHERMAL TESTS 1008 AND 1010

Measurement ^[a]	Location ^[b]	Range ^[c,d]	Figure ^[d]	Comment ^[d]
DP-249-255	Station 249 to Station 255	+0.72 psid	98	Elevation difference between DP-249-255 taps is 15.44 inches
<u>Lower Plenum</u>				
DP-261-255	Station 261 to Station 255	+0.72	99	Elevation difference between DP-261-255 taps is 15.7 inches
<u>Core</u>				
DP-LOFT	Lower plenum to upper plenum of vessel	+50.0	100	
<u>Blowdown Loop</u>				
DP-207-70	Vessel upper plenum to blowdown loop hot leg, Station 207 to Spool 70	+3.6 psid	101	
DP-264-50	Vessel inlet annulus to blowdown loop cold leg, Station 264 to Spool 50	+18.0 psid	102	DP-264-50 was pressure sensitive which may explain the difference in differential pressure during Tests 1008 and 1010
DP-52-62	Across rupture discs, Spool 52 to Spool 62	+500.0 psid	103	
DP-76-61	Across hot leg nozzle, Spool 76 to Station 61	+1000.0 psid	104	
DP-76-HN2	Spool 76 to hot leg nozzle downstream throat (Port 2)	+500.0 psid	105	
DP-96-76	Across simulated pump, Spool 96 to Spool 76	+100.0 psid	106	
DP-70-96	Across simulated steam generator, Spool 70 to Spool 96	+100.0 psid	107	
DP5-HN2-HN4	Vessel side, downstream nozzle throat (Port 2) to downstream nozzle expansion section (Port 4)	+1000.0 psid	108	
DP6-HN2-HN4	Simulated pump side, downstream nozzle throat (Port 2) to downstream nozzle expansion section (Port 4)	+1000.0 psid	109	
DP-HN4-61	Across hot leg nozzle outlet, downstream nozzle expansion section (Port 4) to Station 61	+18.0 psid for Test 1008 +200.0 psid for Test 1010	110	DP-HN4-61 transducer capability was exceeded for first 4 sec of Test 1008 and for first 16.5 sec of Test 1010.
<u>Pressure Suppression System</u>				
DP-207-89	Vessel upper plenum to vapor chamber of pressure suppression tank	+500.0 psid	111	DP-207-89 transducer capability was exceeded for first 15.5 sec of Tests 1008 and 1010
DP-81-89	Header to tank vapor chamber	+50.0 psid	112	
DP-81-85	Header to downcomer entrance	+10.8 psid	113	
<u>LIQUID LEVEL</u>				
<u>Lower Plenum</u>				
LL-LFTA-259	Port 259			Liquid level in lower plenum is indicated by density measurements D-228H and D-275V and by differential pressure measurement DP-261-255
<u>Pressure Suppression System</u>				
LL-PSS	Suppression tank	3.64 psid	114	System not calibrated, data not digitized.
<u>PUMP CHARACTERISTICS</u>				
<u>Operating loop pump</u>				
<u>Pump Speed</u>				
PS-RPM		--	115	
<u>Pump Power</u>				
PM-PMP		--	116	
<u>Pump Torque^b</u>				
T-PMP		--	117	T-PMP data for Test 1010 could not be digitized
<u>TIME OF BREAK</u>				
				Data not presented; measurement established time of rupture as indicated by t=0 sec on all data plots
<u>Blowdown Loop</u>				
BW-52	Cold leg, vessel side			
BW-62	Cold leg, simulated pump side			
<u>FLOW DIRECTION</u>				
<u>Downcomer Gap</u>				
S-271	65.6 inches, 0°, Station 271			Data of no value for Tests 1008 and 1010
<u>DISPLACEMENT</u>				
<u>Pressure Suppression System</u>				
LDT-PSH	Header first elbow (horizontal deflection)			
LDT-PSV	Beneath suppression vessel (vessel vertical deflection)			

[a] Measurement nomenclature is defined in Reference 1.

[b] Measurement locations are shown in Figures 1 through 4.

[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. In general, where two figures are indicated the first applies to Test 1008 and the second to Test 1010.

Fig. 5 Fluid temperatures in operating loop -- Test 1008.

Fig. 6 Fluid temperatures in operating loop -- Test 1010.

Fig. 7 Fluid temperatures in blowdown loop -- Test 1008.

Fig. 8 Fluid temperatures in blowdown loop -- Test 1010.

Fig. 9 Fluid temperatures in pressure suppression system -- Test 1008.

Fig. 10 Fluid temperatures in pressure suppression system -- Test 1010.

Fig. 11 Fluid temperatures in lower plenum at thermocouple rack -- Test 1008.

Fig. 12 Fluid temperatures in lower plenum at thermocouple rack -- Test 1010.

Fig. 13 Fluid temperatures in downcomer gap and outlet plenum -- Test 1008.

Fig. 14 Fluid temperatures in downcomer gap -- Test 1010.

Fig. 15 Fluid temperatures in downcomer gap and outlet plenum -- Test 1008 (expansion of Figure 13 for TF-47D-180, TF-48C-180, TF-78D-180, and TF-211).

Fig. 16 Fluid temperatures in downcomer gap -- Test 1008 (expansion of Figure 13 for TF-48D-0, TF-78D-0, TF-95D-45, and TF-95D-225).

Fig. 17 Fluid temperatures in ECC lines from blowdown loop accumulator tank and operating loop accumulator tank -- Test 1008.

Fig. 18 Metal temperatures in core barrel -- Test 1008.

Fig. 19 Metal temperatures in core barrel -- Test 1010.

Fig. 20 Metal temperatures in downcomer filler -- Test 1008.

Fig. 21 Metal temperatures in downcomer filler -- Test 1010.

Fig. 22 Metal temperatures in vessel wall 95 inches from vessel upper flange face -- Test 1008.

Fig. 23 Metal temperatures in vessel wall 95 inches from vessel upper flange face -- Test 1010.

Fig. 24 Metal temperatures in lower plenum vessel wall -- Test 1008.

Fig. 25 Metal temperatures in lower plenum vessel wall -- Test 1010.

Fig. 26 Metal temperatures in operating loop hot leg Spool 1 -- Test 1008.

Fig. 27 Metal temperatures in operating loop hot leg Spool 1 -- Test 1010.

Fig. 28 Metal temperatures in operating loop cold leg Spool 19 -- Test 1008.

Fig. 29 Metal temperatures in operating loop cold leg Spool 19 -- Test 1010.

Fig. 30 Metal temperatures in operating loop cold leg Spool 22 -- Test 1008.

Fig. 31 Metal temperatures in operating loop cold leg Spool 22 -- Test 1010.

Fig. 32 Metal temperatures in blowdown loop -- Tests 1008 and 1010.

Fig. 33 Momentum flux from drag discs in operating loop hot leg -- Test 1008.

Fig. 34 Momentum flux from drag discs in operating loop hot leg -- Test 1010.

Fig. 35 Momentum flux from drag discs in operating loop cold leg -- Test 1008.

Fig. 36 Momentum flux from drag discs in operating loop cold leg -- Test 1010.

Fig. 37 Momentum flux from drag discs in blowdown loop -- Test 1008.

Fig. 38 Momentum flux from drag discs in blowdown loop -- Test 1010.

Fig. 39 Momentum flux from drag discs at core barrel inlet -- Test 1008.

Fig. 40 Momentum flux from drag discs at core barrel inlet -- Test 1010.

Fig. 41 Volumetric flow rate from turbine meters in operating loop -- Test 1008.

Fig. 42 Volumetric flow rate from turbine meters in operating loop -- Test 1010.

Fig. 43 Volumetric flow rate from turbine meter in blowdown loop hot leg -- Tests 1008 and 1010.

Fig. 44 Volumetric flow rate from turbine meter at core barrel inlet -- Test 1008.

Fig. 45 Volumetric flow rate from turbine meter at core barrel inlet -- Test 1010.

Fig 46. Volumetric flow rate from turbine meter at pressurizer outlet -- Tests 1008 and 1010.

Fig. 47 Volumetric flow rate from ECC accumulator tanks and ECC injection pumps in operating and blowdown loops (turbine meters) -- Test 1008.

Fig. 48 Fluid velocity from turbine meters in downcomer gap -- Test 1008.

Fig. 49 Fluid velocity from turbine meters in downcomer gap -- Test 1010.

Fig. 50 Mass flow rate in operating loop hot leg Spool 1 -- Test 1008.

Fig. 51 Mass flow rate in operating loop hot leg Spool 1 -- Test 1010.

Fig. 52 Mass flow rate in operating loop at pump discharge (Spool 19) -- Test 1008.

Fig. 53 Mass flow rate in operating loop at pump discharge (Spool 19) -- Test 1010.

Fig. 54 Mass flow rate in operating loop cold leg Spool 22 -- Test 1008.

Fig. 55 Mass flow rate in operating loop cold leg Spool 22 -- Test 1010.

Fig. 56 Mass flow rate in operating loop Spools 5 and 15 -- Test 1008.

Fig. 57 Mass flow rate in operating loop Spools 5 and 15 -- Test 1010.

Fig. 58 Mass flow rate in blowdown loop Spool 70 -- Test 1008.

Fig. 59 Mass flow rate in blowdown loop Spool 70 -- Test 1010.

Fig. 60 Mass flow rate in blowdown loop Spools 50 and 70 -- Test 1008.

Fig. 61 Mass flow rate in blowdown loop Spools 50 and 76 -- Test 1010.

Fig. 62 Mass flow rate at core barrel inlet -- Test 1008.

Fig. 63 Mass flow rate at core barrel inlet -- Test 1010.

Fig. 64 Fluid density in operating loop hot leg -- Test 1008.

Fig. 65 Fluid density in operating loop hot leg -- Test 1010.

Fig. 66 Fluid density at operating loop pump inlet and outlet -- Test 1008.

Fig. 67 Fluid density at operating loop pump inlet and outlet -- Test 1010.

Fig. 68 Fluid density in operating loop cold leg -- Test 1008.

Fig. 69 Fluid density in operating loop cold leg -- Test 1010.

Fig. 70 Fluid density in blowdown loop -- Test 1008.

Fig. 71 Fluid density in blowdown loop -- Test 1010.

Fig. 72 Fluid density in vessel -- Test 1008.

Fig. 73 Fluid density in vessel -- Test 1010.

Fig. 74 Fluid density in pressure suppression header -- Test 1010.

Fig. 75 Pressure in operating loop -- Test 1008.

Fig. 76 Pressure in operating loop -- Test 1010.

Fig. 77 Pressure in blowdown loop -- Test 1008.

Fig. 78 Pressure in blowdown loop -- Test 1010.

Fig. 79 Pressure in blowdown loop Spool 52 (rupture assembly inner disc cavity) -- Test 1010.

Fig. 80 Pressure in vessel -- Test 1008.

Fig. 81 Pressure in vessel -- Test 1010.

Fig. 82 Pressure in pressure suppression system -- Test 1008.

Fig. 83 Pressure in pressure suppression system -- Test 1010.

Fig. 84 Pressure of ECC in accumulators -- Test 1008.

Fig. 85 Pressure at hot leg stub in upper plenum (LOFT free field pressure transducer) -- Tests 1008 and 1010.

Fig. 86 Differential pressure across operating loop (DP-22-1) -- Tests 1008 and 1010.

Fig. 87 Differential pressure, operating loop hot leg (DP-1-5) -- Tests 1008 and 1010.

Fig. 88 Differential pressure across steam generator (DP-5-13) -- Tests 1008 and 1010.

Fig. 89 Differential pressure across pump suction orifice (DP-8-13) -- Tests 1008 and 1010.

Fig. 90 Differential pressure across operating loop pump inlet (DP-13-15) -- Tests 1008 and 1010.

Fig. 91 Differential pressure across operating loop pump (DP-19-15) -- Tests 1008 and 1010.

Fig. 92 Differential pressure across operating loop pump, low range (DP-19-15L) -- Tests 1008 and 1010.

Fig. 93 Differential pressure across operating loop cold leg (DP-19-22) -- Tests 1008 and 1010.

Fig. 94 Differential pressure between cold leg and lower plenum (DP-22-255) -- Tests 1008 and 1010.

Fig. 95 Differential pressure across core (DP-255-207) -- Tests 1008 and 1010.

Fig. 96 Differential pressure across upper portion of downcomer (DP-216-246)
-- Tests 1008 and 1010.

Fig. 97 Differential pressure across middle portion of downcomer (DP-246-249)
-- Tests 1008 and 1010.

Fig. 98 Differential pressure across lower portion of downcomer (DP-249-255) -- Tests 1008 and 1010.

Fig. 99 Differential pressure across lower plenum (DP-261-255) -- Tests 1008 and 1010.

Fig. 100 Differential pressure across vessel (DP-LOFT) -- Tests 1008 and 1010.

Fig. 101 Differential pressure between vessel upper plenum and blowdown loop hot leg (DP-207-70) -- Tests 1008 and 1010.

Fig. 102 Differential pressure between vessel inlet annulus and blowdown loop cold leg (DP-264-50) -- Tests 1008 and 1010.

Fig. 103 Differential pressure between inner disc cavities (DP-52-62) -- Tests 1008 and 1010.

Fig. 104 Differential pressure across blowdown loop hot leg nozzle (DP-76-61) -- Tests 1008 and 1010.

Fig. 105 Differential pressure between simulated pump and throat of blowdown loop hot leg nozzle (DP-76-HN2) -- Tests 1008 and 1010.

Fig. 106 Differential pressure across simulated pump (DP-96-76) -- Tests 1008 and 1010.

Fig. 107 Differential pressure across simulated steam generator (DP-70-96) -- Tests 1008 and 1010.

Fig. 108 Differential pressure across blowdown loop cold leg nozzle diverging section (DP5-HN2-HN4) -- Tests 1008 and 1010.

Fig. 109 Differential pressure across blowdown loop hot leg nozzle diverging section (DP6-HN2-HN4) -- Tests 1008 and 1010.

Fig. 110 Differential pressure across blowdown loop hot leg nozzle, Station 61 (DP-HN4-61) -- Tests 1008 and 1010.

Fig. 111 Differential pressure between vessel upper plenum and pressure suppression tank vapor chamber (DP-207-89) -- Tests 1008 and 1010.

Fig. 112 Differential pressure between pressure suppression header and pressure suppression tank vapor chamber (DP-81-89) -- Tests 1008 and 1010.

Fig. 113 Differential pressure between pressure suppression header and pressure suppression tank downcomer entrance (DP-81-85) -- Tests 1008 and 1010.

Fig. 114 Liquid level in pressure suppression tank -- Tests 1008 and 1010.

Fig. 115 Pump speed -- Tests 1008 and 1010.

Fig. 116 Pump power -- Tests 1008 and 1010.

Fig. 117 Pump torque -- Test 1008.

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).