**PWR Blowdown Heat Transfer Separate-Effects
Program—Thermal-Hydraulic Test Facility
Experimental Data Report for Test 151**

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Prepared for the U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
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PROGRAM — THERMAL-HYDRAULIC TEST FACILITY
EXPERIMENTAL DATA REPORT FOR TEST 151**

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**PWR BLOWDOWN HEAT TRANSFER SEPARATE-EFFECTS
PROGRAM — THERMAL-HYDRAULIC TEST FACILITY
EXPERIMENTAL DATA REPORT FOR TEST 151**

**D. M. Leon M. D. White
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ABSTRACT

Reduced instrument responses are presented for Thermal-Hydraulic Test Facility (THTF) test 151, which is part of the ORNL Pressurized-Water Reactor (PWR) Blowdown Heat Transfer Separate-Effects Program. The objective of the program is to investigate the thermal-hydraulic phenomenon governing the energy transfer and transport processes that occur during a loss-of-coolant accident in a PWR system.

Test 151 was conducted to obtain CHF information in the THTF bundle 1 containing four unpowered rods.

The primary purpose of this report is to make the reduced instrument responses during test 151 available. These are presented in graphical form in engineering units and have been analyzed only to the extent necessary to ensure reasonableness and consistency.

I. INTRODUCTION

The Oak Ridge National Laboratory Pressurized-Water Reactor (ORNL-PWR) Blowdown Heat Transfer Program is a separate-effects study of the relations among the principal variables that can alter the rate of blowdown, the presence of flow reversal and rereversal, time delay to critical heat flux (CHF), the rate at which dryout progresses, and similar time- and space-related functions that are important in loss-of-coolant accident (LOCA) analyses. Primary test results are obtained from the Thermal-Hydraulic Test Facility (THTF), a large nonnuclear pressurized-water loop incorporating a 49-rod electrically heated bundle in 7×7 geometry.

THTF test 151 (conducted November 5, 1976) was the seventh test conducted in the facility with bundle 1 in place. This test was performed to obtain CHF information in the bundle with four rods unpowered, to investigate the rod failures, and to evaluate the status of the bundle.

The purpose of this report is to provide the reduced instrument responses during test 151 in a readily useable form to the nuclear community

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in advance of detailed analyses and interpretations. (These data are presented on microfiche attached to the back cover of the report.) Final analyses and interpretations are scheduled for publication six months after the completion of the test series. The program and the experimental facilities are described in Ref. 1.

II. SYSTEM, PROCEDURES, CONDITIONS, AND EVENTS FOR TEST 151

1. System Configuration and Test Procedure

The Thermal-Hydraulic Test Facility (THTF), shown in Fig. 1, consists of a test section with a 49-rod, 3.66-m-long (12-ft) electrically heated core; a circulation loop comprised of three parallel heat exchangers with bypass, a pressurizer, a pump with bypass, and associated control valves; two rupture assemblies; and a pressure-suppression system. The break configuration for test 151 was 40% inlet-60% outlet with a total break area of 12.54 cm^2 (0.0135 ft^2). The THTF experimental system is described further in Ref. 1.

The electric core was taken to the preblowdown power (122 kW/rod) in ~20-kW/rod steps to provide steady-state calibration information. The main heat exchangers were operated to match the core power input. The primary coolant pump was tripped coincident with break initiation, but the electric core was operated at the preblowdown power for ~2 sec into the transient and then the power was decayed with a time constant of 0.45 sec. Rod Nos. 19, 24, 39, and 47 were unpowered. Closure of the secondary-side main heat exchanger valves was initiated at the trip from 122 kW/rod.

In preparation for the test, the loop was filled with demineralized water and the system pressure checked. Instrumentation and data acquisition checks were performed. During the warmup, data were taken for use in flow and pressure calibrations.

During the test, the THTF was successfully subjected to a double-ended pipe break through the rupture assemblies containing the orifice plates.

1. *Project Description: ORNL-PWR Blowdown Heat Transfer Separate-Effects Program - Thermal-Hydraulic Test Facility (THTF), ORNL/NUREG/TM-2 (February 1976).*

Fig. 1. Thermal-Hydraulic Test Facility (THTF).

The effluent from the primary system was ejected into the pressure-suppression system, which was maintained at atmospheric pressure.

2. Initial Test Conditions and Sequence of Events

The THTF conditions immediately preceding rupture are given in Tables 1 and 2. The sequence of events relative to the rupture is given in Table 3.

Table 1. Desired vs actual prerupture conditions

Parameters	Instrument	Desired ^a	Actual ^b
System pressure MM/m ² psig	PE-201	15.513 2250	15.665 2272
Core power MW	EIE-9, EIE-10, EIE-11, EIE-12 EEE-9, EEE-10, EEE-11, EEE-12	5.490	5.493
Number of unpowered rods		4	4
Core volumetric flow rate m ³ /sec gpm	FE-19	0.0242 383	0.0247 392
Test section inlet temperature K °F	TE-162	558.2 545	558.2 545
Test section outlet temperature K °F	TE-212	606.5 632	606.5 632
Pressurizer pressure MM/m ² psig	PE-106	15.162 2199	15.272 2215
Mass liquid water kg lb _m		57.15 126	54.88 121
Coolant pump speed rps rpm	SE-72	59.65 3579	60.52 3631
Pressure differential MM/m ² psid	P _d E-78	4.402 639	4.668 677
Pressure between HCV-2 and PCV-18 MM/m ² psig	PE-16	16.582 2405	17.644 2559
Pressure differential across main heat exchangers MM/m ² psid	P _d E-46	0.141 20.4	0.321 46.6

^aDesired prerupture conditions are based on programmatic requirements.

^bActual prerupture conditions are based on instrument signals recorded within 10 sec of primary system rupture.

Table 2. Prerupture primary-coolant temperature and pressure distribution^a test 151

Location	Instrument	Temperature [K (°F)]	Pressure [MN/m ² (psig)]
Vertical inlet spool piece	TE-172	559.3 (547)	15.823 (2295)
Vertical inlet spool piece	PE-174		
Test section inlet	TE-162	558.2 (545)	
Lower plenum	TE-150	560.9 (550)	
Lower plenum	PE-156		15.803 (2292)
Upper plenum	PE-201		15.665 (2272)
Test section outlet	TE-212	606.5 (632)	
Vertical outlet spool piece	TE-222	606.5 (632)	
Vertical outlet spool piece	PE-224		15.541 (2254)
Heat exchanger inlet header	PE-44		15.486 (2246)
Mixed mean temperature downstream heat exchangers	TE-28B	562.0 (552)	
Pressurizer surge line	TE-2	616.5 (650)	
Pressurizer	PE-106		15.272 (2215)
Primary pump suction	PE-76		15.155 (2198)
Between main control valves HCV-2, FCV-18	TE-4B	558.2 (545)	
Between main control valves HCV-2, FCV-18	PE-16		17.644 (2559)

^aPrerupture distribution is based on instrument signals recorded within 10 sec of primary system rupture.

Table 3. Sequence of events during test 151

Event	Time relative to rupture (sec)
Core power level established	-80
Core temperature rise established	-80
Analog tapes and CCDAS fast scan started	-15
Blowdown initiated	0
Pump power tripped	0
Heat exchanger secondary valves closure initiated	+2
Core power tripped to decay	+2
Core power tripped	+3.30

III. DATA PRESENTATION

The recorded instrument responses for THTF test 151 have been processed only to the extent necessary to obtain appropriate engineering units and to ensure reasonableness and consistency. In converting the instrument responses to engineering units, a homogeneous fluid has been assumed. Therefore, interpretation or analysis of the data must account for the fact that the instruments may have been subjected to nonhomogeneous fluid conditions during the transient.

The reduced instrument responses presented in this report were recorded by a computer-controlled digital data acquisition system (CCDAS). Further information on this system may be found in Ref. 1.

Figures 2 through 4 provide supportive information for the instrument responses and indicate the relative locations of the detectors in the THTF. Table 4 gives the precision of the recorded instrument responses, and Table 5 groups the measurements by location and provides brief comments regarding the detectors and the recorded responses. Time zero on all graphs is the time of break initiation.

Fig. 2. Identification of THTF heater rod and subchannel locations in bundles 1 and 2.

Table 4. Precision of experimental measurements for test 151

System	Standard deviation
Pressure measurement, MN/m² (psig)	
CCDAS	0.185 (26.8)
Analog tape system	0.197 (28.5)
Pressure difference measurement, MN/m² (psid)	
CCDAS	
6.89-MN/m ² (1000-psid) span	0.025 (3.6)
1.38-MN/m ² (200-psid) span	0.005 (0.72)
0.34-MN/m ² (50-psid) span	0.001 (0.18)
Analog tape system	
6.89-MN/m ² (1000-psid) span	0.033 (4.8)
1.38-MN/m ² (200-psid) span	0.007 (0.95)
0.34-MN/m ² (50-psid) span	0.002 (0.24)
Temperature measurement, K (°F)	2.4 (4.3)
Electric core power measurement	
Rod current, A	0.877
Rod voltage, V	0.304
Flow measurement, m³/sec (gpm)	
FE-19	
Forward	+0.0009 -0.0002 (+13.97) (-2.90)
Reverse	+0.0011 -0.0004 (+16.77) (-5.70)
FE-166	
Forward	+0.0012 -0.0005 (+18.74) (-7.68)
Reverse	+0.0010 -0.0003 (+16.15) (-5.09)
FE-216	
Forward	+0.0048 -0.0041 (+75.59) (-64.52)
Reverse	+0.0020 -0.0013 (+31.79) (-20.72)
FE-34	
Forward	+0.0021 -0.0007 (+33.39) (-11.26)
Reverse	+0.0124 -0.0110 (+197.11) (-174.97)
Momentum flux measurement, kg/m-sec² (lb_m/ft-sec²)	
CCDAS	2264 (1522)
Analog tape system	2554 (1716)
Density measurement @ 961 kg/m ³ (60 lb _m /ft ³), kg/m ³ (lb _m /ft ³)	12.9 (0.81)

Fig. 3. Location of thermocouples in THTF bundle 1.

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Fig. 3. Location of thermocouples in THTF bundle 1.

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Fig. 3 (continued)

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Fig. 4. THTF instrument identification and location.

Table 5. Data presentation for test 151

Measurement	Location and comments	Detector	Range	Data acquisition system	Figure	Measurement comments
BUNDLE TEMPERATURE						
Heater Rod Sheath						
	Chromel-Alumel thermocouples	+12 to +1897°F (all)	-0.0027 to +0.0400 V (all)			
LEVEL D						
TE-101AD	Rod 1				5	
TE-104AD	Rod 4				6	
TE-109AD	Rod 9				7	Spike
TE-110AD	Rod 10				8	
TE-112AD	Rod 12				9	
TE-113AD	Rod 13				10	
TE-117AD	Rod 17				11	
TE-118AD	Rod 18				12	
TE-120AD	Rod 20				13	
TE-122AD	Rod 22				14	
TE-123AD	Rod 23				15	
TE-125AD	Rod 25				16	
TE-126AD	Rod 26				17	
TE-131AD	Rod 31				18	
TE-138AD	Rod 38				19	
TE-139AD	Rod 39				20	Unpowered rod
TE-141AD	Rod 41				21	Spike
TE-149AD	Rod 49				22	Spike
LEVEL E						
TE-101AE	Rod 1				23	Instrument failed
TE-104AE	Rod 4				24	
TE-109AE	Rod 9				25	
TE-112AE	Rod 12				26	
TE-113AE	Rod 13				27	
TE-117AE	Rod 17				28	
TE-118AE	Rod 18				29	
TE-120AE	Rod 20				30	
TE-122AE	Rod 22				31	Low reading
TE-123AE	Rod 23				32	
TE-124AE	Rod 24				33	Unpowered rod
TE-125AE	Rod 25				34	
TE-126AE	Rod 26				35	
TE-131AE	Rod 31				36	
TE-133AE	Rod 33				37	
TE-138AE	Rod 38				38	
TE-139AE	Rod 39				39	Small spikes, un-powered rod
TE-141AE	Rod 41				40	Spike
TE-149AE	Rod 49				41	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL F					
TE-301BF	Rod 1			42	
TE-304BF	Rod 4			43	Spike
TE-309BF	Rod 9			44	Small spike
TE-310BF	Rod 10			45	Spike
TE-312BF	Rod 12			46	Spike
TE-313BF	Rod 13			47	Spike
TE-317BF	Rod 17			48	
TE-320BF	Rod 20			49	
TE-322BF	Rod 22			50	Spike
TE-323BF	Rod 23			51	
TE-324BF	Rod 24			52	Unpowered rod
TE-325BF	Rod 25			53	
TE-326BF	Rod 26			54	
TE-331BF	Rod 31			55	
TE-333BF	Rod 33			56	
TE-338BF	Rod 38			57	
TE-341BF	Rod 41			58	Spike
TE-349BF	Rod 49			59	Small spike
LEVEL G					
TE-301BG	Rod 1			60	Small spike
TE-304BG	Rod 4			61	
TE-309BG	Rod 9			62	Small spike
TE-310BG	Rod 10			63	
TE-312BG	Rod 12			64	
TE-313BG	Rod 13			65	
TE-317BG	Rod 17			66	
TE-318BG	Rod 18			67	
TE-320BG	Rod 20			68	
TE-322BG	Rod 22			69	Noisy
TE-323BG	Rod 23			70	
TE-325BG	Rod 25			71	
TE-326BG	Rod 26			72	
TE-331BG	Rod 31			73	
TE-333BG	Rod 33			74	
TE-338BG	Rod 38			75	
TE-339BG	Rod 39			76	Unpowered rod
TE-341BG	Rod 41			77	
TE-349BG	Rod 49			78	Instrument reading bad in early part of transient

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
	LEVEL N				
TE-301CN	Rod 1			79	
TE-302AN	Rod 2			80	
TE-303AN	Rod 3			81	
TE-304CN	Rod 4			82	
TE-305AN	Rod 5			83	
TE-306AN	Rod 6			84	
TE-307AN	Rod 7			85	
TE-308AN	Rod 8			86	
TE-309CN	Rod 9			87	
TE-310CN	Rod 10			88	
TE-311AN	Rod 11			89	
TE-312CN	Rod 12			90	
TE-313CN	Rod 13			91	
TE-314AN	Rod 14			92	
TE-315AN	Rod 15			93	
TE-316AN	Rod 16			94	
TE-317CN	Rod 17			95	
TE-318CN	Rod 18			96	
TE-320CN	Rod 20			97	
TE-321AN	Rod 21			98	
TE-322CN	Rod 22			99	
TE-323CN	Rod 23			100	
TE-324CN	Rod 24			101	Unpowered rod
TE-325CN	Rod 25			102	
TE-326CN	Rod 26			103	
TE-327AN	Rod 27			104	
TE-331CN	Rod 31			105	
TE-333CN	Rod 33			106	
TE-336AN	Rod 36			107	
TE-337AN	Rod 37			108	
TE-338CN	Rod 38			109	
TE-339CN	Rod 39			110	Unpowered rod
TE-341CN	Rod 41			111	
TE-342AN	Rod 42			112	
TE-343AN	Rod 43			113	
TE-344AN	Rod 44			114	
TE-345AN	Rod 45			115	
TE-346AN	Rod 46			116	Spurious spike
TE-348AN	Rod 48			117	Spike
TE-349CN	Rod 49			118	Spike

Table 3 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL 1					
TE-301C1	Rod 1			119	Spike
TE-302A1	Rod 2			120	
TE-303A1	Rod 3			121	Spike
TE-304C1	Rod 4			122	
TE-305A1	Rod 5			123	
TE-306A1	Rod 6			124	
TE-307A1	Rod 7			125	
TE-308A1	Rod 8			126	
TE-309C1	Rod 9			127	
TE-310C1	Rod 10			128	
TE-311A1	Rod 11			129	
TE-312C1	Rod 12			130	
TE-313C1	Rod 13			131	
TE-314A1	Rod 14			132	
TE-315A1	Rod 15			133	
TE-316A1	Rod 16			134	
TE-317C1	Rod 17			135	
TE-318C1	Rod 18			136	
TE-320C1	Rod 20			137	
TE-321A1	Rod 21			138	
TE-322C1	Rod 22			139	
TE-323C1	Rod 23			140	
TE-324C1	Rod 24			141	Unpowered rod
TE-325C1	Rod 25			142	
TE-326C1	Rod 26			143	
TE-327A1	Rod 27			144	
TE-328A1	Rod 28			145	
TE-331C1	Rod 31			146	
TE-333C1	Rod 33			147	
TE-334A1	Rod 36			148	
TE-337A1	Rod 37			149	
TE-338C1	Rod 38			150	Unpowered rod
TE-339C1	Rod 39			151	
TE-341C1	Rod 41			152	
TE-342A1	Rod 42			153	
TE-343A1	Rod 43			154	Spike
TE-344A1	Rod 44			155	
TE-345A1	Rod 45			156	
TE-346A1	Rod 46			157	
TE-348A1	Rod 48			158	
TE-349C1	Rod 49			159	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
	LEVEL J				
TE-301DJ	Rod 1			160	
TE-302CJ	Rod 2			161	
TE-304DJ	Rod 4			162	
TE-305CJ	Rod 5			163	
TE-306CJ	Rod 6			164	
TE-307CJ	Rod 7			165	
TE-308CJ	Rod 8			166	
TE-309DJ	Rod 9			167	
TE-310DJ	Rod 10			168	
TE-312DJ	Rod 12			169	
TE-313DJ	Rod 13			170	
TE-314CJ	Rod 14			171	
TE-316CJ	Rod 16			172	
TE-317DJ	Rod 17			173	
TE-318DJ	Rod 18			174	
TE-320DJ	Rod 20			175	
TE-321CJ	Rod 21			176	
TE-322DJ	Rod 22			177	
TE-323DJ	Rod 23			178	
TE-324DJ	Rod 24			179	Unpowered rod
TE-325DJ	Rod 25			180	
TE-326DJ	Rod 26			181	
TE-327CJ	Rod 27			182	
TE-328CJ	Rod 28			183	
TE-331DJ	Rod 31			184	
TE-333DJ	Rod 33			185	
TE-336CJ	Rod 36			186	
TE-337CJ	Rod 37			187	
TE-338DJ	Rod 38			188	
TE-339DJ	Rod 39			189	Unpowered rod
TE-340CJ	Rod 40			190	
TE-341DJ	Rod 41			191	
TE-342CJ	Rod 42			192	
TE-343CJ	Rod 43			193	
TE-344CJ	Rod 44			194	Spike
TE-345CJ	Rod 45			195	Spike
TE-346CJ	Rod 46			196	
TE-349DJ	Rod 49			197	Small spike

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL K					
TE-301DK	Rod 1			198	Small spike early in transient
TE-304DK	Rod 4			199	Small spike
TE-309DK	Rod 9			200	
TE-310DK	Rod 10			201	
TE-312DK	Rod 12			202	
TE-313DK	Rod 13			203	
TE-317DK	Rod 17			204	
TE-318DK	Rod 18			205	
TE-320DK	Rod 20			206	
TE-322DK	Rod 22			207	
TE-323DK	Rod 23			208	
TE-324DK	Rod 24			209	Unpowered rod
TE-325DK	Rod 25			210	
TE-326DK	Rod 26			211	
TE-331DK	Rod 31			212	
TE-333DK	Rod 33			213	
TE-338DK	Rod 38			214	
TE-339DK	Rod 39			215	Unpowered rod
TE-341DK	Rod 41			216	
TE-349DK	Rod 49			217	
LEVEL L					
TE-301EL	Rod 1			218	
TE-302CL	Rod 2			219	
TE-303CL	Rod 3			220	
TE-304EL	Rod 4			221	
TE-305CL	Rod 5			222	
TE-306CL	Rod 6			223	
TE-307CL	Rod 7			224	
TE-308CL	Rod 8			225	
TE-309EL	Rod 9			226	
TE-310EL	Rod 10			227	
TE-311CL	Rod 11			228	
TE-312EL	Rod 12			229	
TE-313EL	Rod 13			230	
TE-316CL	Rod 16			231	
TE-317EL	Rod 17			232	
TE-318EL	Rod 18			233	
TE-320EL	Rod 20			234	
TE-321CL	Rod 21			235	

Table 5 (continued)

Measurement	Location and comments	Range			Figure	Measurement comments
		Detector	Data acquisition system			
BUNDLE TEMPERATURE (continued)						
LEVEL L (continued)						
TE-322EL	Rod 22				236	Unpowered rod
TE-323EL	Rod 23				237	
TE-324EL	Rod 24				238	
TE-325EL	Rod 25				239	
TE-326EL	Rod 26				240	
TE-327CL	Rod 27				241	
TE-328CL	Rod 28				242	
TE-331EL	Rod 31				243	
TE-333EL	Rod 33				244	
TE-336CL	Rod 36				245	
TE-337CL	Rod 37				246	
TE-338EL	Rod 38				247	Unpowered rod
TE-339EL	Rod 39				248	
TE-341EL	Rod 41				249	
TE-342CL	Rod 42				250	
TE-343CL	Rod 43				251	
TE-344CL	Rod 44				252	
TE-345CL	Rod 45				253	
TE-346CL	Rod 46				254	
TE-348CL	Rod 48				255	
TE-349EL	Rod 49				256	
LEVEL N						
TE-301EN	Rod 1				257	
TE-304EN	Rod 4				258	
TE-309EN	Rod 9				259	
TE-325EN	Rod 25				260	
LEVEL N						
TE-301FN	Rod 1				261	
TE-304FN	Rod 4				262	
TE-323FN	Rod 25				263	
LEVEL O						
TE-301FO	Rod 1				264	
TE-304FO	Rod 4				265	
TE-309FO	Rod 9				266	
TE-310FO	Rod 10				267	
TE-312FO	Rod 12				268	

Table 3 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL O (continued)					
TE-317RO	Rod 17			269	Moisy
TE-318RO	Rod 18			270	
TE-320RO	Rod 20			271	
TE-322RO	Rod 22			272	Unpowered rod
TE-323RO	Rod 23			273	
TE-324RO	Rod 24			274	
TE-325RO	Rod 25			275	Moisy
TE-326RO	Rod 26			276	
TE-331RO	Rod 31			277	
TE-333RO	Rod 33			278	Unpowered rod
TE-338RO	Rod 38			279	
TE-339RO	Rod 39			280	
TE-341RO	Rod 41			281	
TE-349RO	Rod 49			282	
Heater Rod Center					
LEVEL E					
TE-301NE	Rod 1			283	
TE-304NE	Rod 4			284	
TE-318NE	Rod 18			285	
TE-322NE	Rod 22			286	
TE-326NE	Rod 26			287	
TE-331NE	Rod 31			288	
TE-338NE	Rod 38			289	Small spike
TE-349NE	Rod 49			290	
LEVEL F					
TE-301NF	Rod 1			291	
TE-304NF	Rod 4			292	
TE-322NF	Rod 22			293	
TE-326NF	Rod 26			294	Small spike
TE-338NF	Rod 38			295	
TE-349NF	Rod 49			296	
LEVEL G					
TE-301MG	Rod 1			297	
TE-310MG	Rod 10			298	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Date acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL G (continued)					
TE-313MC	Rod 13			299	
TE-317MC	Rod 17			300	
TE-318MC	Rod 18			301	
TE-322MC	Rod 22			302	
TE-323MC	Rod 23			303	
TE-325MC	Rod 25			304	
TE-326MC	Rod 26			305	
TE-328MC	Rod 28			306	
TE-349MC	Rod 49			307	
LEVEL H					
TE-304NH	Rod 4			308	
TE-309NH	Rod 9			309	
TE-318NH	Rod 18			310	
TE-322NH	Rod 22			311	
TE-338NH	Rod 38			312	
LEVEL J					
TE-301MJ	Rod 1			313	
TE-310MJ	Rod 10			314	
TE-317MJ	Rod 17			315	
TE-323MJ	Rod 23			316	
TE-324MJ	Rod 24			317	Unpowered rod
TE-326MJ	Rod 26			318	
TE-338MJ	Rod 38			319	
SPOOL PIECE INSTRUMENTS					
Temperature	Chromel-Alumel thermocouples	+32 to +1897°F	-0.0027 to +0.0400 V		
TE-24	Horizontal inlet			320	Slightly noisy
TE-172	Vertical inlet			321	
TE-222	Vertical outlet			322	
TE-40	Horizontal outlet			323	

Table 3 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
SPOOL PIECE INSTRUMENTS (continued)					
<u>Pressure</u>		0 to +3000 psig	0.0 to +5.0 V		
PE-26	Horizontal inlet			363	
PE-174	Vertical inlet			364	
PE-224	Vertical outlet			367	
PE-42	Horizontal outlet			368	
<u>Pressure Drop</u>		-200 to +200 psid	-5.0 to +5.0 V		
PDE-21	Horizontal inlet			393	
PDE-167	Vertical inlet			374	
PDE-217	Vertical outlet			379	
PDE-35	Horizontal outlet			378	
<u>Flow</u>					
FE-19	Horizontal inlet	-2000 to +2000 gpm	-5.0 to +5.0 V	359	
FE-166	Vertical inlet	-2000 to +2000 gpm	-5.0 to +5.0 V	360	
FE-216	Vertical outlet	-2000 to +2000 gpm	-5.0 to +5.0 V	361	
FE-34	Horizontal outlet	-4000 to +4000 gpm	-5.0 to +5.0 V	362	
<u>Momentum Flux</u>		-250,000 to +250,000 lb _m /ft ² -sec ²	-5.0 to +5.0 V		
FMFE-22	Horizontal inlet			388	
FMFE-170	Vertical inlet			389	Zero shifted
FMFE-220	Vertical outlet			390	
FMFE-38	Horizontal outlet			391	
<u>Fluid Density</u>		0 to +62.4 lb _m /ft ³	0.0 to +10.0 V		
DE-20	Horizontal inlet			465	No signal
DE-168	Vertical inlet			466	
DE-218	Vertical outlet			467	
DE-36	Horizontal outlet			468	
TEST SECTION TEMPERATURE	Chromel-Alumel thermocouples	+32 to +1897°F	-0.0027 to +0.0400 V		
<u>Bundle Shroud</u>					
TE-175	0.142L/LMAX			329	Instrument failed
TE-176	0.142L/LMAX			330	Instrument failed

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
TEST SECTION TEMPERA- TURE (continued)					
<u>Bundle Shroud (continued)</u>					
TE-177	0.142L/LMAX			331	Instrument failed
TE-178	0.142L/LMAX			332	Spike
TE-179	0.388L/LMAX			333	Large spike at power trip
TE-180	0.388L/LMAX			334	Large spike at power trip
TE-181	0.388L/LMAX			335	Large spike at power trip
TE-182	0.388L/LMAX			336	Large spike at power trip
TE-183	0.633L/LMAX			337	Large spike at power trip
TE-184	0.633L/LMAX			338	Large spike at power trip
TE-185	0.633L/LMAX			339	Large spike at power trip
TE-186	0.633L/LMAX			340	Noisy before power trip
TE-187	0.875L/LMAX			341	Large spike at power trip
TE-189	0.875L/LMAX			342	Large spike at power trip
TE-190	0.875L/LMAX			343	Large spike at power trip
<u>Bundle Subchannel</u>					
TE-S1	Subchannel 1			477	Spike
TE-S2	Subchannel 2			478	
TE-S3	Subchannel 3			479	
TE-S5	Subchannel 5			480	
TE-S9	Subchannel 9			481	Instrument failed
TE-S10	Subchannel 10			482	Small spike
TE-S11	Subchannel 11			483	
TE-S14	Subchannel 14			484	
TE-S16	Subchannel 16			485	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
TEST SECTION TEMPERATURE (continued)					
Bundle Subchannel (continued)					
TE-933	Subchannel 33			486	
TE-934	Subchannel 34			487	Instrument failed
TE-936	Subchannel 36			488	
TE-938	Subchannel 38			489	Instrument failed
TE-939	Subchannel 39			490	
TE-940	Subchannel 40			491	
TE-941	Subchannel 41			492	
TE-942	Subchannel 42			493	
TE-944	Subchannel 44			494	
TE-945	Subchannel 45			495	
TE-949	Subchannel 49			496	
TE-950	Subchannel 50			497	
TE-951	Subchannel 51			498	
TE-954	Subchannel 54			499	
TE-955	Subchannel 55			500	
TE-957	Subchannel 57			501	
TE-959	Subchannel 59			502	
TE-963	Subchannel 63			503	
TE-964	Subchannel 64			504	
Test Section					
TE-162	Inlet line T/C			324	
TE-150	Bottom flange T/C			325	
TE-151	Bottom flange T/C			326	
TE-152	Bottom flange T/C			327	
TE-153	Bottom flange T/C			328	
TE-212	Outlet line T/C			344	
TE-210A	Outlet line RTD (steady state)	+32 to +800°F	+0.2 to +0.52V	406	
TEST SECTION PRESSURE					
PE-156	Inlet plenum	0 to +3000 psig	0.0 to +5.0 V	365	
PE-201	Outlet plenum	0 to +3000 psig	0.0 to +5.0 V	366	
PE-27	Inlet plenum bottom	0 to +3000 psig	0.0 to +5.0 V	395	
PE-43	Outlet plenum bottom	0 to +3000 psig	0.0 to +5.0 V	396	
PT-32	Outlet steady state	+500 to +1500 psig	+1.0 to +5.0 V	398	Zero shifted

Table 3 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
TEST SECTION					
PRESSURE DROP					
PDT-199	Shroud box steady-state differential pressure	0 to +50 psid	+1.0 to +5.0 V	376	
PDE-200	Bundle transient differential pressure	-200 to +200 psid	-5.0 to +5.0 V	377	
PDT-30	Test section steady-state differential pressure	0 to +50 psid	+1.0 to +5.0 V	397	Erratic at blowdown
PRESSURIZER INSTRUMENTS					
Temperature					
TE-1	Tank top T/C	+12 to +1897°F	-0.0027 to +0.0400 V	350	
TE-2	Tank exit T/C	+12 to +1897°F	-0.0027 to +0.0400 V	351	
Pressure					
PT-102	Steady-state pressure	+500 to +2500 psia	+1.0 to +5.0 V	371	Zero shifted
PE-106	Vapor transient pressure	0 to +1000 psia	0 to +5.0 V	372	
Level					
LT-100	Steady-state liquid level	0 to +150 in.	+1.0 to +5.0 V	402	
HEATER ROD POWER					
Heater Current					
EIE-1156	Rod 1			408	
EIE-1236	Rod 2			409	
EIE-1157	Rod 3			410	
EIE-1257	Rod 4			411	
EIE-956	Rod 5			412	
EIE-958	Rod 6			413	
EIE-955	Rod 7			414	
EIE-1155	Rod 8			415	
EIE-1158	Rod 9			416	
EIE-1258	Rod 10			417	
EIE-957	Rod 11			418	
EIE-954	Rod 12			419	
EIE-953	Rod 13			420	
EIE-9511	Rod 14			421	
EIE-1154	Rod 15			422	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
HEATER ROD POWER (continued)					
Heater Current (continued)					
EIE-1159	Rod 16			423	
EIE-1255	Rod 17			424	
EIE-959	Rod 18			425	
EIE-9510	Rod 19			426	Unpowered rod
EIE-952	Rod 20			427	
EIE-9512	Rod 21			428	
EIE-11511	Rod 22			429	
EIE-11510	Rod 23			430	
EIE-1153	Rod 24			431	Unpowered rod
EIE-9513	Rod 25			432	
EIE-1056	Rod 26			433	
EIE-951	Rod 27			434	
EIE-1057	Rod 28			435	
EIE-1152	Rod 29			436	
EIE-11512	Rod 30			437	
EIE-1252	Rod 31			438	
EIE-1251	Rod 32			439	
EIE-10512	Rod 33			440	
EIE-1055	Rod 34			441	
EIE-1058	Rod 35			442	
EIE-1151	Rod 36			443	
EIE-1254	Rod 37			444	
EIE-1253	Rod 38			445	
EIE-12512	Rod 39			446	Unpowered rod
EIE-10511	Rod 40			447	
EIE-10510	Rod 41			448	
EIE-1059	Rod 42			449	
EIE-1259	Rod 43			450	
EIE-12510	Rod 44			451	
EIE-12511	Rod 45			452	
EIE-1051	Rod 46			453	
EIE-1052	Rod 47			454	Unpowered rod
EIE-1053	Rod 48			455	
EIE-1054	Rod 49			456	
GENERATOR POWER					
Generator Current		0 to +10,000 A	0.0 to +2.5 V		
EIE-9	Generator 9 current			457	
EIE-10	Generator 10 current			458	

Table 5 (continued)

Measurement	Location and comments	Detector	Range	Data acquisition system	Figure	Measurement comments
GENERATOR POWER (continued)						
Generator Current (continued)						
EE-11	Generator 11 current				459	
EE-12	Generator 12 current				460	
Generator Voltage						
		0 to ± 25 V	0.0 to ± 10.0 V			
EE-9	Generator 9 voltage				461	
EE-10	Generator 10 voltage				462	
EE-11	Generator 11 voltage				463	
EE-12	Generator 12 voltage				464	
HEAT EXCHANGER INSTRUMENTS						
Primary Side						
	Outlet line thermocouples	± 12 to $\pm 180^\circ\text{F}$		0.0017 to ± 0.0400 V		
TE-108	Heat exchanger A				143	
TE-109	Heat exchanger B				144	
TE-110	Heat exchanger C				145	
TE-111	Heat exchanger D				146	
TE-112	Main HX mixing for steady-state temp., RTD	± 12 to $\pm 400^\circ\text{F}$		± 0.2 to ± 0.52 V	147	Spikes
Secondary Side						
	Secondary discharge steady-state temp., RTD	± 12 to $\pm 100^\circ\text{F}$		± 0.2 to ± 0.4 V		
TE-213	Heat exchanger A				403	Spikes
TE-214	Heat exchanger B				380	Spikes
TE-215	Heat exchanger C				381	Spikes
TE-216	Heat exchanger D				404	Spikes
Heat Exchanger Secondary Flow						
FE-222	Heat exchanger A	0 to ± 150 gpm		± 0.7 to ± 1.0 V	407	
FE-223	Heat exchanger B	0 to ± 150 gpm		± 0.2 to ± 1.0 V	153	
FE-224	Heat exchanger C	0 to ± 150 gpm		± 0.2 to ± 1.0 V	154	
FE-225	Heat exchanger D	0 to ± 150 gpm		± 0.2 to ± 1.0 V	155	
Heat Exchanger Pressure						
PE-226	Upstream main HX transient pressure	0 to ± 1000 psig		0.0 to ± 1.0 V	349	
PE-227	HX A secondary inlet pressure	0 to ± 150 psig		0.0 to ± 1.0 V	392	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
HEAT EXCHANGER INSTRUMENTS (continued)					
Pressure Drop					
PDT-48	Main HX steady-state pressure drop	0 to +24 psid	+1.0 to +5.0 V	381	
PDE-46	Main HX bypass transient pressure drop	-200 to +200 psid	-5.0 to +5.0 V	387	
PRIMARY PUMP INSTRUMENTS					
PE-1A	Primary side pump flow	0 to +800 gpm	+1.0 to +5.0 V	358	
PE-76	Pump suction transient pressure	0 to +3000 psig	0 to +5.0 V	370	
PDE-78	Primary pump transient pressure drop	-1000 to +1000 psid	-5.0 to +5.0 V	382	
SE-72	Primary pump speed	+100 to +5400 rpm	0 to +5.0 V	399	
TE-48	Base primary steady-state temp., RTD	+32 to +800°F	+0.2 to +0.52 V	334	
PE-16	Downstream HCV-2 transient pressure	0.0 to +1000 psig	0.0 to +5.0 V	394	
PRESSURE SUPPRESSION SYSTEM INSTRUMENTS					
PE-412	Pressure suppression receiver transient pressure	0 to +200 psig	0 to +5.0 V	373	
PE-425	PSS inlet blowdown line transient pressure	0 to +1000 psig	0 to +5.0 V	383	Spike
PE-427	PSS outlet blowdown line transient pressure	0 to +3000 psig	0 to +5.0 V	384	
TE-29	Inlet blowdown plenum T/C	+32 to +1897°F	-0.0027 to +0.0400 V	352	
TE-45	Outlet blowdown plenum T/C	+32 to +1897°F	-0.0027 to +0.0400 V	353	
DEMINERALIZED WATER SYSTEM					
TE-5208	RBT 4 in. demineralized water header T/C	+32 to +1897°F	-0.0027 to +0.0400 V	348	
TE-615	Demineralized water 6-in. header steady-state temp., RTD	+32°F to +500°F	+0.2 to +0.4 V	375	
GENERAL INSTRUMENTATION (ELECTRICAL)					
Breakwire Detectors					
XM-40001	Inlet break	0.0 to +5.0 V	0.0 to +5.0 V	400	
XM-40000	Outlet break	0.0 to +5.0 V	0.0 to +5.0 V	401	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
GENERAL INSTRUMENTATION (ELECTRICAL) (continued)					
RTD Power					
EIN-1001B	RTD power supply current	2.0 mA	0.400 V	407	
Data Acquisition Calibration Signals					
Zero cal. input	Channels 0-127	0.0 mV	0.0 mV	469	
Zero cal. input	Channels 128-255	0.0 mV	0.0 mV	470	
Zero cal. input	Channels 256-383	0.0 mV	0.0 mV	471	
Zero cal. input	Channels 384-511	0.0 mV	0.0 mV	472	
Full-scale cal. input	Channels 0-127	15.00 mV	15.00 mV	473	
Full-scale cal. input	Channels 128-255	15.00 mV	15.00 mV	474	Spike
Full-scale cal. input	Channels 256-383	15.00 mV	15.00 mV	475	
Full-scale cal. input	Channels 384-511	15.00 mV	15.00 mV	476	Spike