MASTER

**PWR Blowdown Heat Transfer Separate-Effects
Program—Thermal-Hydraulic Test Facility
Experimental Data Report for Test 102**

V. D. Clemons
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Prepared for the U.S. Nuclear Regulatory Commission
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EXPERIMENTAL DATA REPORT FOR TEST 102**

V. D. Clemons P. A. Moore
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UNION CARBIDE CORPORATION
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PWR BLOWDOWN HEAT TRANSFER SEPARATE-EFFECTS
PROGRAM - THERMAL-HYDRAULIC TEST FACILITY
EXPERIMENTAL DATA REPORT FOR TEST 102

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ABSTRACT

Reduced instrument responses are presented for Thermal-Hydraulic Test Facility (THTF) test 102, 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 102 was conducted to investigate the thermal-hydraulic response of bundle 1 under full-power steady-state and blowdown conditions.

The primary purpose of this report is to make the reduced instrument responses during test 102 available. The responses 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 102 (conducted June 18, 1976) was the third test conducted in the facility with bundle 1 in place. This test was performed to investigate the thermal-hydraulic response of bundle 1 and to provide operational verification of the mechanical and electrical systems used to control the THTF under the full range of powered conditions.

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The purpose of this report is to provide the reduced instrument responses during test 102 in a readily usable form to the nuclear community in advance of detailed analyses and interpretations. [These data are on microfiche attached to the back cover of the report. These microfiche (due to an error by the microfiche vendor) have the proper report number, but the test number should be 102; the data presented are indeed for test 102.] Final analyses and interpretations are scheduled for publication six months after the completion of test series 100. The program and the experimental facilities are described in Ref. 1.

II. SYSTEM, PROCEDURES, CONDITIONS, AND EVENTS FOR TEST 102

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. For test 102 the break configuration was 50% inlet-50% outlet with a total break area of 12.54 cm^2 (0.0135 ft^2).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, and the electric core and primary coolant pump were tripped coincident with break initiation. 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, and 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 MN/m ² psig	PE-201	15.513 2250	15.513 2250
Core power MW	EIE-9, EIE-10, EIE-11, EIE-12 EEE-9, EEE-10, EEE-11, EEE-12	5.978	5.972
Core volumetric flow rate m ³ /sec gpm	FE-19	0.0265 420	0.027 424
Test section inlet temperature K °F	TE-162	559.3 547	558.2 545
Test section outlet temperature K °F	TE-212	610.4 639	607.0 633
Pressurizer pressure MN/m ² psig	PE-106	14.996 2175	14.989 2174
Mass liquid water kg lb _m		51.26 113	63.83 140.72
Coolant pump speed rps rpm	SE-72	59.67 3580	• •
Pressure differential MN/m ² psid	P _d E-78	4.413 640	4.440 644
Pressure between HCV-2 and FCV-18 MN/m ² psig	PE-16	16.996 2465	16.692 2421
Pressure differential across main heat exchangers MN/m ² psid	P _d E-46	0.159 23.0	0.407 59

^aDesired prerupture conditions are based on programmatic requirements.

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

^cInstrument failed during test.

Table 2. Prerupture primary-coolant temperature and pressure distribution^a for test 102

Location	Instrument	Temperature [K (°F)]	Pressure [MN/m ² (psig)]
Vertical inlet spool piece	TE-172	559.8 (548)	
Vertical inlet spool piece	PE-174		15.720 (2280)
Test section inlet	TE-162	558.2 (545)	
Lower plenum	TE-150	560.9 (550)	
Lower plenum	PE-156		15.679 (2274)
Upper plenum	PE-201		15.513 (2250)
Test section outlet	TE-212	607.0 (633)	
Vertical outlet spool piece	TE-222	606.5 (632)	
Vertical outlet spool piece	PE-224		15.417 (2236)
Heat exchanger inlet header	PE-44		15.203 (2205)
Downstream heat exchangers (mixed mean temperature)	TE-288	562.0 (552)	
Pressurizer surge line	TE-2	615.3 (648)	
Pressurizer	PE-106		14.989 (2174)
Primary pump suction	PE-76		14.906 (2162)
Between main control valves HCV-2 and FCV-18	TE-48	556.5 (542)	
Between main control valves HCV-2 and FCV-18	PE-16		16.692 (2421)

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

Table 3. Sequence of events during test 102

Event	Time relative to rupture (sec)
Core power level established	-2107
Core temperature rise established	-2107
Analog tapes and CCDAS fast scan started	-15
Blowdown initiated	0
Pump power tripped	0
Heat exchanger secondary valves closure initiated	0
Core power tripped	0

III. DATA PRESENTATION

The recorded instrument responses for THTF test 102 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.

Fig. 3. Tentative location of thermocouples in THTF bundle 1 (1 in. = 2.54 cm).

Fig. 4. THTF loop section details.

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Table 4. Precision of experimental measurements for test 102

System	Standard deviation
Pressure measurement, MN/m^2 (psig)	
CCDAS	0.185 (26.8)
Analog tape system	0.197 (28.5)
Pressure difference measurement, MN/m^2 (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 ($^{\circ}\text{F}$)	2.4 (4.3)
Electric core power measurement	
Rod current, A	0.877
Rod voltage, V	0.304
Flow measurement, m^3/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-sec^2 ($\text{lb}_m/\text{ft-sec}^2$)	
CCDAS	6793 (4565)
Analog tape system	7661 (5148)
Density measurement @ 961 kg/m^3 (60 lb_m/ft^3), kg/m^3 (lb_m/ft^3)	12.9 (0.81)

Table 5. Data presentation for test 102

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE	Chromel Alumel thermocouples	+32 to +1897°F (all)	0.0027 to +0.0400 V (all)		
<u>Heater Rod Sheath</u>					
	LEVEL D				
TE-301AD	Rod 1			5	
TE-304AD	Rod 4			6	Noisy
TE-309AD	Rod 9			7	
TE-310AD	Rod 10			8	
TE-312AD	Rod 12			9	Noisy
TE-313AD	Rod 13			10	Noisy
TE-317AD	Rod 17			11	Spurious spikes
TE-318AD	Rod 18			12	Noisy
TE-320AD	Rod 20			13	Noisy
TE-322AD	Rod 22			14	
TE-323AD	Rod 23			15	
TE-325AD	Rod 25			16	
TE-326AD	Rod 26			17	Noisy
TE-331AD	Rod 31			18	
TE-338AD	Rod 38			19	
TE-339AD	Rod 39			20	
TE-341AD	Rod 41			21	
TE-349AD	Rod 49			22	
	LEVEL E				
TE-301AE	Rod 1			23	
TE-304AE	Rod 4			24	Noisy
TE-309AE	Rod 9			25	
TE-312AE	Rod 12			26	Noisy
TE-313AE	Rod 13			27	Noisy
TE-317AE	Rod 17			28	
TE-318AE	Rod 18			29	Noisy
TE-320AE	Rod 20			30	Noisy
TE-322AE	Rod 22			31	
TE-323AE	Rod 23			32	
TE-324AE	Rod 24			33	
TE-325AE	Rod 25			34	
TE-326AE	Rod 26			35	Noisy
TE-331AE	Rod 31			36	
TE-333AE	Rod 33			37	
TE-338AE	Rod 38			38	
TE-339AE	Rod 39			39	Spurious spikes
TE-342AE	Rod 41			40	
TE-349AE	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	Spurious spike
TE-304BF	Rod 4			43	Noisy and spurious spikes
TE-309BF	Rod 9			44	Spurious spike
TE-310BF	Rod 10			45	Spurious spike
TE-312BF	Rod 12			46	Noisy and spurious spike
TE-313BF	Rod 13			47	Noisy and spurious spike
TE-317BF	Rod 17			48	
TE-320BF	Rod 20			49	Noisy and spurious spike
TE-322BF	Rod 22			50	
TE-323BF	Rod 23			51	
TE-324BF	Rod 24			52	
TE-325BF	Rod 25			53	
TE-326BF	Rod 26			54	Noisy
TE-331BF	Rod 31			55	
TE-333BF	Rod 33			56	
TE-338BF	Rod 38			57	Spurious spikes
TE-341BF	Rod 41			58	Spurious spike
TE-349BF	Rod 49			59	
LEVEL G					
TE-301BG	Rod 1			60	Spurious spike
TE-304BG	Rod 4			61	Noisy
TE-309BG	Rod 9			62	
TE-310BG	Rod 10			63	
TE-312BG	Rod 12			64	Noisy
TE-313BG	Rod 13			65	Noisy
TE-317BG	Rod 17			66	
TE-318BG	Rod 18			67	Noisy
TE-320BG	Rod 20			68	Spurious spike and noisy
TE-322BG	Rod 22			69	
TE-323BG	Rod 23			70	
TE-325BG	Rod 25			71	
TE-326BG	Rod 26			72	Noisy
TE-331BG	Rod 31			73	
TE-333BG	Rod 33			74	
TE-338BG	Rod 38			75	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
	Level G (continued)				
TE-339BC	Rod 39			76	
TE-341BC	Rod 41			77	
TE-349BC	Rod 49			78	
	LEVEL H				
TE-301CH	Rod 1			79	Spurious spike
TE-302AH	Rod 2			80	Spurious spike
TE-303AH	Rod 3			81	Spurious spike
TE-304CH	Rod 4			82	Spurious spike and noisy
TE-305AH	Rod 5			83	Noisy
TE-306AH	Rod 6			84	Spurious spike and noisy
TE-307AH	Rod 7			85	Spurious spike and noisy
TE-308AH	Rod 8			86	
TE-309CH	Rod 9			87	Spurious spike
TE-310CH	Rod 10			88	
TE-311AH	Rod 11			89	Noisy
TE-312CH	Rod 12			90	Noisy
TE-313CH	Rod 13			91	Noisy
TE-314AH	Rod 14			92	Noisy
TE-315AH	Rod 15			93	
TE-316AH	Rod 16			94	
TE-317CH	Rod 17			95	
TE-318CH	Rod 18			96	Noisy
TE-320CH	Rod 20			97	Noisy
TE-321AH	Rod 21			98	Spurious spike and noisy
TE-322CH	Rod 22			99	Spurious spike
TE-323CH	Rod 23			100	
TE-324CH	Rod 24			101	
TE-325CH	Rod 25			102	
TE-326CH	Rod 26			103	Noisy
TE-327AH	Rod 27			104	Noisy
TE-328AH	Rod 28			105	Noisy
TE-331CH	Rod 31			106	
TE-333CH	Rod 33			107	
TE-336AH	Rod 36			108	
TE-337AH	Rod 37			109	
TE-338CH	Rod 38			110	Spurious spike late in transient

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL H (continued)					
TE-339CH	Rod 39			111	Spurious spike late in transient
TE-340AH	Rod 40			112	Spurious spike and noisy
TE-341CH	Rod 41			113	
TE-342AH	Rod 42			114	
TE-343AH	Rod 43			115	
TE-344AH	Rod 44			116	
TE-345AH	Rod 45			117	Spurious spike
TE-346AH	Rod 46			118	Spurious spike
TE-348AH	Rod 48			119	Spurious spike
TE-349CH	Rod 49			120	Spurious spike
LEVEL I					
TE-301CI	Rod 1			121	
TE-302AI	Rod 2			122	
TE-303AI	Rod 3			123	
TE-304CI	Rod 4			124	Spurious spikes and noisy
TE-305AI	Rod 5			125	Noisy
TE-306AI	Rod 6			126	Noisy
TE-307AI	Rod 7			127	Noisy
TE-308AI	Rod 8			128	Spurious spike
TE-309CI	Rod 9			129	
TE-310CI	Rod 10			130	Spurious spike
TE-311AI	Rod 11			131	Spurious spikes and noisy
TE-312CI	Rod 12			132	Noisy and spurious spike
TE-313CI	Rod 13			133	Noisy and spurious spike
TE-314AI	Rod 14			134	Noisy
TE-315AI	Rod 15			135	
TE-316AI	Rod 16			136	
TE-317CI	Rod 17			137	
TE-318CI	Rod 18			138	Noisy
TE-320CI	Rod 20			139	Noisy and spurious spike
TE-321AI	Rod 21			140	Noisy and spurious spikes
TE-322CI	Rod 22			141	Spurious spike

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL I (continued)					
TE-323CI	Rod 23			142	
TE-324CI	Rod 24			143	
TE-325CI	Rod 25			144	
TE-326CI	Rod 26			145	Noisy and spurious spikes
TE-327AI	Rod 27			146	Noisy and spurious spike
TE-328AI	Rod 28			147	Noisy and spurious spike
TE-331CI	Rod 31			148	
TE-333CI	Rod 33			149	
TE-336AI	Rod 36			150	
TE-337AI	Rod 37			151	
TE-338CI	Rod 38			152	Spurious spike
TE-339CI	Rod 39			153	
TE-340AI	Rod 40			154	Noisy
TE-341CI	Rod 41			155	Spurious spike
TE-342AI	Rod 42			156	
TE-343AI	Rod 43			157	Spurious spike
TE-344AI	Rod 44			158	
TE-345AI	Rod 45			159	
TE-346AI	Rod 46			160	
TE-348AI	Rod 48			161	Spurious spike
TE-349CI	Rod 49			162	
LEVEL J					
TE-301DJ	Rod 1			163	
TE-302CJ	Rod 2			164	
TE-303CJ	Rod 3			165	Instrument failed
TE-304DJ	Rod 4			166	Noisy
TE-305CJ	Rod 5			167	Noisy
TE-306CJ	Rod 6			168	Noisy
TE-307CJ	Rod 7			169	Noisy
TE-308CJ	Rod 8			170	
TE-309DJ	Rod 9			171	
TE-310DJ	Rod 10			172	
TE-311CJ	Rod 11			173	Instrument failed
TE-312DJ	Rod 12			174	Noisy
TE-313DJ	Rod 13			175	Noisy and spurious spikes
TE-314CJ	Rod 14			176	Noisy
TE-316CJ	Rod 16			177	
TE-317DJ	Rod 17			178	

Table 3 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL J (continued)					
TE-318DJ	Rod 18			179	Noisy
TE-320DJ	Rod 20			180	Noisy
TE-321CJ	Rod 21			181	Noisy
TE-322DJ	Rod 22			182	
TE-323DJ	Rod 23			183	
TE-324DJ	Rod 24			184	
TE-325DJ	Rod 25			185	
TE-326DJ	Rod 26			186	Noisy
TE-327CJ	Rod 27			187	Noisy
TE-328CJ	Rod 28			188	Noisy
TE-331DJ	Rod 31			189	
TE-333DJ	Rod 33			190	Spurious spikes
TE-336CJ	Rod 36			191	
TE-337CJ	Rod 37			192	
TE-338DJ	Rod 38			193	Spurious spikes
TE-339FJ	Rod 39			194	Spurious spikes
TE-340CJ	Rod 40			195	Spurious spikes
TE-341DJ	Rod 41			196	Spurious spikes
TE-342CJ	Rod 42			197	Spurious spikes
TE-343CJ	Rod 43			198	Spurious spikes
TE-344CJ	Rod 44			199	Spurious spikes
TE-345CJ	Rod 45			200	Spurious spikes
TE-346CJ	Rod 46			201	Spurious spikes
TE-347CJ	Rod 47			202	Spurious spikes
TE-349DJ	Rod 49			203	Spurious spikes
LEVEL K					
TE-301DK	Rod 1			204	Spurious spike
TE-304DK	Rod 4			205	Noisy and spurious spikes
TE-309DK	Rod 9			206	Spurious spikes
TE-310DK	Rod 10			207	Spurious spike
TE-312DK	Rod 12			208	Noisy and spurious spike
TE-313DK	Rod 13			209	Noisy and spurious spike
TE-317DK	Rod 17			210	
TE-318DK	Rod 18			211	Noisy
TE-320DK	Rod 20			212	Noisy
TE-322DK	Rod 22			213	Spurious spike
TE-323DK	Rod 23			214	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL K (continued)					
TE-324DK	Rod 24			215	
TE-325DK	Rod 25			216	
TE-326DK	Rod 26			217	Noisy and spurious spike
TE-331DK	Rod 31			218	
TE-333DK	Rod 33			219	
TE-338DK	Rod 38			220	Spurious spikes
TE-339DK	Rod 39			221	Spurious spike
TE-341DK	Rod 41			222	
TE-349DK	Rod 49			223	
LEVEL L					
TE-301EL	Rod 1			224	
TE-302CL	Rod 2			225	
TE-303CL	Rod 3			226	Spurious spike
TE-304EL	Rod 4			227	Noisy and spurious spike
TE-305CL	Rod 5			228	Noisy
TE-306CL	Rod 6			229	Noisy and spurious spike
TE-307CL	Rod 7			230	Noisy
TE-308CL	Rod 8			231	
TE-309EL	Rod 9			232	
TE-310EL	Rod 10			233	
TE-311CL	Rod 11			234	Noisy
TE-312EL	Rod 12			235	Noisy
TE-313EL	Rod 13			236	Noisy
TE-315CL	Rod 15			237	
TE-316CL	Rod 16			238	
TE-317EL	Rod 17			239	
TE-318EL	Rod 18			240	Noisy
TE-320EL	Rod 20			241	Noisy
TE-321CL	Rod 21			242	Noisy
TE-322EL	Rod 22			243	Questionable
TE-323EL	Rod 23			244	
TE-324EL	Rod 24			245	
TE-325EL	Rod 25			246	
TE-326EL	Rod 26			247	Noisy
TE-327CL	Rod 27			248	Noisy
TE-328CL	Rod 28			249	Noisy
TE-331EL	Rod 31			250	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL L (continued)					
TE-333EL	Rod 33			251	
TE-336CL	Rod 36			252	
TE-337CL	Rod 37			253	
TE-338EL	Rod 38			254	
TE-339EL	Rod 39			255	
TE-340CL	Rod 40			256	
TE-341EL	Rod 41			257	
TE-342CL	Rod 42			258	
TE-343CL	Rod 43			259	
TE-344CL	Rod 44			260	Spurious spike
TE-345CL	Rod 45			261	
TE-346CL	Rod 46			262	
TE-347CL	Rod 47			263	
TE-348CL	Rod 48			264	
TE-349EL	Rod 49			265	
LEVEL M					
TE-301EM	Rod 1			266	Noisy
TE-304EM	Rod 4			267	
TE-309EM	Rod 9			268	
TE-325EM	Rod 25			269	
LEVEL N					
TE-301FN	Rod 1			270	Questionable Noisy and spurious spikes
TE-304FN	Rod 4			271	
TE-325FN	Rod 25			272	
LEVEL O					
TE-301FO	Rod 1			273	Questionable Noisy and spurious spikes
TE-304FO	Rod 4			274	
TE-309FO	Rod 9			275	Spurious spikes
TE-310EO	Rod 10			276	
TE-312EO	Rod 12			277	Noisy and spurious spikes
TE-317EO	Rod 17			278	
TE-318EO	Rod 18			279	Noisy and spurious spikes

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL O (continued)					
TE-320EO	Rod 20			280	Noisy and spurious spike
TE-322EO	Rod 22			281	Spurious spike
TE-323EO	Rod 23			282	
TE-324EO	Rod 24			283	
TE-325FO	Rod 25			284	
TE-326EO	Rod 26			285	Noisy and spurious spike
TE-331EO	Rod 31			286	Noisy and spurious spike
TE-333EO	Rod 33			287	
TE-338EO	Rod 38			288	Spurious spike late in transient
TE-339EO	Rod 39			289	
TE-341EO	Rod 41			290	
TE-349EO	Rod 49			291	Spurious spike
<u>Heater Rod Center</u>					
LEVEL E					
TE-301ME	Rod 1			292	Spurious spikes
TE-318ME	Rod 18			293	Spurious spikes
TE-322ME	Rod 22			294	Spurious spikes
LEVEL F					
TE-301MF	Rod 1			295	Spurious spikes
TE-322MF	Rod 22			296	Spurious spikes
LEVEL G					
TE-301MG	Rod 1			297	Spurious spikes
TE-310MG	Rod 10			298	
TE-317MG	Rod 17			299	Spurious spikes
TE-318MG	Rod 18			300	Spurious spikes
TE-322MG	Rod 22			301	
TE-323MG	Rod 23			302	Spurious spikes and noisy
TE-325MG	Rod 25			303	

Table 3 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
Master Rod Center (continued)					
LEVEL H					
TE-304M	Rod 4			304	
TE-305M	Rod 9			305	
TE-318M	Rod 18			306	
TE-320M	Rod 22			307	
LEVEL J					
TE-301M	Rod 1			308	Spurious spike
TE-303M	Rod 3			309	Noisy
TE-308M	Rod 8			310	Noisy and spurious spike
TE-310M	Rod 10			311	Spurious spike
TE-317M	Rod 17			312	Spurious spike
TE-322M	Rod 22			313	Spurious spike
TE-323M	Rod 23			314	Noisy
TE-324M	Rod 24			315	
SPOOL PIECE INSTRUMENTS					
Temperature					
Chromel-Alumel thermocouples					
TE-24	Horizontal inlet	+32 to +1897°F	-0.0027 to +0.0400 V	316	
TE-172	Vertical inlet			317	
TE-222	Vertical outlet			318	
TE-40	Horizontal outlet			319	
Pressure					
PE-26	Horizontal inlet	0 to +1000 psig	0.0 to +3.0 V	359	
PE-174	Vertical inlet			360	
PE-224	Vertical outlet			363	
PE-42	Horizontal outlet			364	
Pressure Drop					
PDE-21	Horizontal inlet	-200 to +200 psid	-3.0 to +1.0 V	369	
PDE-167	Vertical inlet			370	
PDE-217	Vertical outlet			375	
PDE-35	Horizontal outlet			374	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
SPOWL PIECE INSTRUMENTS (continued)					
Flow					
FE-19	Horizontal inlet	-2000 to +2000 gpm	-5.0 to +5.0 V	355	
FE-166	Vertical inlet	-2000 to +2000 gpm	-5.0 to +5.0 V	356	
FE-216	Vertical outlet	-2000 to +2000 gpm	-5.0 to +5.0 V	357	
FE-34	Horizontal outlet	-4000 to +4000 gpm	-5.0 to +5.0 V	358	
Momentum Flux		250,000 to +250,000 $\text{lb}_m/\text{ft}^2\text{-sec}^2$	5.0 to +5.0 V		
FMFE-22	Horizontal inlet			384	Zero shifted
FMFE-170	Vertical inlet			385	
FMFE-220	Vertical outlet			386	
FMFE-38	Horizontal outlet			387	
Fluid Density		0 to +62.4 lb_m/ft^3	0.0 to +10.0 V		
DE-20	Horizontal inlet			461	
DE-168	Vertical inlet			462	
DE-218	Vertical outlet			463	
DE-36	Horizontal outlet			464	
TEST SECTION TEMPERATURE	Chromel-Alumel thermocouples	+32 to +1897°F	0.0027 to +0.0400 V		
Bundle Shroud					
TE-175	0.142L/LMAX			325	Failed
TE-176	0.142L/LMAX			326	
TE-177	0.142L/LMAX			327	
TE-178	0.142L/LMAX			328	
TE-179	0.388L/LMAX			329	Questionable
TE-180	0.388L/LMAX			330	Questionable
TE-181	0.388L/LMAX			331	Questionable
TE-182	0.388L/LMAX			332	Questionable
TE-183	0.633L/LMAX			333	Questionable
TE-184	0.633L/LMAX			334	Questionable
TE-185	0.633L/LMAX			335	Questionable
TE-186	0.633L/LMAX			336	Questionable
TE-187	0.875L/LMAX			337	Questionable
TE-189	0.875L/LMAX			338	Questionable
TE-190	0.875L/LMAX			339	Questionable

Table 3 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
TEST SECTION TEMPERA- TURE (continued)					
<u>Bundle Subchannel</u>					
TE-S1	Subchannel 1			473	Spurious spikes
TE-S2	Subchannel 2			474	Spurious spikes
TE-S3	Subchannel 3			475	
TE-S4	Subchannel 4			476	instrument failed
TE-S5	Subchannel 5			477	
TE-S6	Subchannel 6			478	
TE-S7	Subchannel 7			479	
TE-S8	Subchannel 8			480	Instrument failed
TE-S9	Subchannel 9			481	
TE-S10	Subchannel 10			482	
TE-S11	Subchannel 11			483	
TE-S13	Subchannel 13			484	Instrument failed
TE-S17	Subchannel 17			485	
TE-S18	Subchannel 18			486	
TE-S19	Subchannel 19			487	
TE-S20	Subchannel 20			488	
TE-S25	Subchannel 25			489	
TE-S26	Subchannel 26			490	
TE-S27	Subchannel 27			491	
TE-S28	Subchannel 28			492	
TE-S29	Subchannel 29			493	
TE-S30	Subchannel 30			494	
TE-S31	Subchannel 31			495	
TE-S32	Subchannel 32			496	
TE-S33	Subchannel 33			497	
TE-S34	Subchannel 34			498	
TE-S35	Subchannel 35			499	
TE-S36	Subchannel 36			500	Spurious spikes
TE-S37	Subchannel 37			501	
TE-S46	Subchannel 46			502	
TE-S55	Subchannel 55			503	
TE-S64	Subchannel 64			504	Spurious spikes
<u>Test Section</u>					
TE-162	Inlet line T/C			120	
TE-150	Bottom flange T/C			121	
TE-151	Bottom flange T/C			122	
TE-152	Bottom flange T/C			123	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
TEST SECTION TEMPERA- TURE (continued)					
Test Section (continued)					
TE-153	Bottom flange T/C			324	
TE-212	Outlet line T/C			340	
TE-210A	Outlet line RTD (steady state)	+32 to +800°F	+0.2 to +0.52V	402	Spurious spikes
TEST SECTION PRESSURE					
PE-156	Inlet plenum	0 to +1000 psig	0.0 to +5.0 V	361	
PE-201	Outlet plenum	0 to +1000 psig	0.0 to +5.0 V	362	
PE-27	Inlet plenum bottom	0 to +1000 psig	0.0 to +5.0 V	391	
PE-43	Outlet plenum bottom	0 to +1000 psig	0.0 to +5.0 V	392	
PT-32	Outlet steady state	+500 to +2500 psig	+1.0 to +5.0 V	394	
TEST SECTION PRESSURE DROP					
PDT-199	Shroud box steady-state differential pressure	0 to +50 psid	+1.0 to +5.0 V	372	
PDE-200	Bundle transient differential pressure	-200 to +200 psid	-5.0 to +5.0 V	373	
PDT-30	Test section steady-state differential pressure	0 to +50 psid	+1.0 to +5.0 V	393	
PRESSURIZER INSTRUMENTS					
Temperature					
TE-1	Tank top T/C	+32 to +1897°F	-0.0027 to +0.0400 V	346	
TE-2	Tank exit T/C	+32 to +1897°F	-0.0027 to +0.0400 V	347	
Pressure					
PT-102	Steady-state pressure	+500 to +2500 psig	+1.0 to +5.0 V	367	
PE-106	Vapor transient pressure	0 to +1000 psig	0 to +5.0 V	368	Spurious spikes
Level					
LT-100	Steady-state liquid level	0 to +150 in.	+1.0 to +5.0 V	398	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
HEATER ROD POWER					
Heater Current					
EIE-11S6	Rod 1	0 to +800 A	0.0 to +5.0 V		404
EIE-12S6	Rod 2			405	
EIE-11S7	Rod 3			406	
EIE-12S7	Rod 4			407	
EIE-9S6	Rod 5			408	
EIE-9S8	Rod 6			409	
EIE-9S5	Rod 7			410	
EIE-11S5	Rod 8			411	
EIE-11S8	Rod 9			412	
EIE-12S8	Rod 10			413	
EIE-9S7	Rod 11			414	
EIE-9S4	Rod 12			415	
EIE-9S3	Rod 13			416	
EIE-9S11	Rod 14			417	
EIE-11S4	Rod 15			418	
EIE-11S9	Rod 16			419	
EIE-12S5	Rod 17			420	
EIE-9S9	Rod 18			421	
EIE-9S10	Rod 19			422	
EIE-9S2	Rod 20			423	
EIE-9S12	Rod 21			424	
EIE-11S11	Rod 22			425	
EIE-11S10	Rod 23			426	
EIE-11S3	Rod 24			427	
EIE-9S13	Rod 25			428	
EIE-10S6	Rod 26			429	
EIE-9S1	Rod 27			430	
EIE-10S7	Rod 28			431	
EIE-11S2	Rod 29			432	
EIE-11S12	Rod 30			433	
EIE-12S2	Rod 31			434	
EIE-12S1	Rod 32			435	
EIE-10S12	Rod 33			436	
EIE-10S3	Rod 34			437	
EIE-10S8	Rod 35			438	
EIE-11S1	Rod 36			439	
EIE-12S4	Rod 37			440	
EIE-12S3	Rod 38			441	
EIE-12S12	Rod 39			442	
EIE-10S11	Rod 40			443	
EIE-10S10	Rod 41			444	

Table 3 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
HEATER ROD POWER					
(continued)					
Heater Current (continued)					
EIE-10S9	Rod 42			445	
EIE-12S9	Rod 43			446	
EIE-12S10	Rod 44			447	
EIE-12S11	Rod 45			448	
EIE-10S1	Rod 46			449	
EIE-10S2	Rod 47			450	
EIE-10S3	Rod 48			451	
EIE-10S4	Rod 49			452	
GENERATOR POWER					
Generator Current					
		0 to +10,000 A	0.0 to +2.5 V		
EIE-9	Generator 9 current			453	
EIE-10	Generator 10 current			454	
EIE-11	Generator 11 current			455	
EIE-12	Generator 12 current			456	
Generator Voltage					
		0 to +285 V	0.0 to +10.0 V		
EEE-9	Generator 9 voltage			457	
EEE-10	Generator 10 voltage			458	
EEE-11	Generator 11 voltage			459	
EEE-12	Generator 12 voltage			460	
HEAT EXCHANGER INSTRUMENTS					
Primary Side					
	Outlet line thermocouples	+32 to +1897°F	-0.0027 to +0.0400 V		
TE-30B	Heat exchanger A			341	
TE-32B	Heat exchanger B			342	
TE-34B	Heat exchanger C			343	
TE-36	Heat exchanger D			345	
TE-25r	Main MX mixing tee steady-state temp., RTD	+32 to +800°F	+0.2 to +0.52 V	382	
Secondary Side					
	Secondary discharge steady-state temp., RTD	+32 to +500°F	+0.2 to +0.4 V		
TE-525	Heat exchanger A			401	Spurious spikes
TE-627	Heat exchanger B			376	Spurious spikes
TE-727	Heat exchanger C			381	Spurious spikes
TE-557	Heat exchanger D			400	Spurious spikes

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
HEAT EXCHANGER INSTRUMENTS (continued)					
<u>Heat Exchanger Secondary Flow</u>					
FE-522	Heat exchanger A	0 to +150 gpm	+0.2 to +1.0 V	399	
FE-620	Heat exchanger B	0 to +150 gpm	+0.2 to +1.0 V	351	
FE-720	Heat exchanger C	0 to +150 gpm	+0.2 to +1.0 V	352	
FE-550	Heat exchanger D	0 to +50 gpm	+0.2 to +1.0 V	353	
<u>Heat Exchanger Pressure</u>					
PE-44	Upstream main HX transient pressure	0 to +1000 psig	0.0 to +5.0 V	365	
PE-526	HX A secondary inlet pressure	0 to +350 psig	0.0 to +5.0 V	388	
<u>Pressure Drop</u>					
PDT-48	Main HX steady-state pressure drop	0 to +24 psid	+1.0 to +5.0 V	377	
PDE-46	Main HX bypass transient pressure drop	-200 to +200 psid	-5.0 to +5.0 V	383	
PRIMARY PUMP INSTRUMENTS					
FE-1A	Primary side pump flow	0 to +800 gpm	+1.0 to +5.0 V	354	
PE-76	Pump suction transient pressure	0 to +3000 psig	0 to +5.0 V	366	
PDE-78	Primary pump transient pressure drop	-1000 to +1000 psid	-5.0 to +5.0 V	378	
SE-72	Primary pump speed	+100 to +5400 rpm	0 to +5.0 V	395	
TE-4B	Base primary steady-state temp., RTD	+32 to +800°F	+0.2 to +0.52 V	350	Instrument failed
PE-16	Downstream HCV-2 transient pressure	0.0 to +3000 psig	0.0 to +5.0 V	390	Spurious spikes
PRESSURE SUPPRESSION SYSTEM INSTRUMENTS					
PE-412	Pressure suppression receiver transient pressure	0 to +200 psig	0 to +5.0 V	369	
PE-425	PSS inlet blowdown line transient pressure	0 to +3000 psig	0 to +5.0 V	379	
PE-427	PSS outlet blowdown line transient pressure	0 to +3000 psig	0 to +5.0 V	380	
TE-29	Inlet blowdown plenum T/C	+32 to +1897°F	-0.0027 to +0.0400 V	348	
TE-45	Outlet blowdown plenum T/C	+32 to +1897°F	-0.0027 to +0.0400 V	349	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
DEMINERALIZED WATER SYSTEM					
TE-5208	RBT 4 in. demineralized water header T/C	+32 to +1897°F	-0.0027 to +0.0400 V	344	Spurious spikes
TE-615	Demineralized water 6-in. header steady-state temp., RTD	+32°F to +500°F	+0.2 to +0.4 V	371	
GENERAL INSTRUMENTATION (ELECTRICAL)					
breakwire Detectors					
XM-40001	Inlet break	0.0 to +5.0 V	0.0 to +5.0 V	396	
XM-40000	Outlet break	0.0 to +5.0 V	0.0 to +5.0 V	397	
RTD Power					
EIM-1001B	RTD power supply current	2.0 mA	0.400 V	403	
Data Acquisition Calibration Signals					
Zero cal. input	Channels 0-127	0.0 mV	0.0 mV	465	
Zero cal. input	Channels 128-255	0.0 mV	0.0 mV	466	
Zero cal. input	Channels 256-383	0.0 mV	0.0 mV	467	
Zero cal. input	Channels 384-511	0.0 mV	0.0 mV	468	
Full-scale cal. input	Channels 0-127	35.00 mV	35.00 mV	469	Spurious spikes
Full-scale cal. input	Channels 128-255	35.00 mV	35.00 mV	470	Spurious spikes
Full-scale cal. input	Channels 256-383	35.00 mV	35.00 mV	471	Spurious spike
Full-scale cal. input	Channels 384-511	35.00 mV	35.00 mV	472	Spurious spikes