PWR Blowdown Heat Transfer Separate-Effects Program—Thermal-Hydraulic Test Facility Experimental Data Report for Test 103

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PWR BLOWDOWN HEAT TRANSFER SEPARATE-EFFECTS
PROGRAM — THERMAL-HYDRAULIC TEST FACILITY
EXPERIMENTAL DATA REPORT FOR TEST 103

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**PWR BLOWDOWN HEAT TRANSFER SEPARATE-EFFECTS
PROGRAM - THERMAL-HYDRAULIC TEST FACILITY
EXPERIMENTAL DATA REPORT FOR TEST 103**

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ABSTRACT

Reduced instrument responses are presented for Thermal-Hydraulic Test Facility (THTF) test 103, 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 103 was conducted to obtain design information for THTF test 105.

The primary purpose of this report is to make the reduced instrument responses during test 103 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 103 (conducted August 5, 1976) was the fifth test conducted in the facility with bundle 1 in place. This test was performed to provide experimental verification of the RELAP4 prediction of spool piece flows with a 40% inlet-60% outlet break.

The purpose of this report is to provide the reduced instrument responses during test 103 in a readily usable 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 test series 100. The program and the experimental facilities are described in Ref. 1.

II. SYSTEM, PROCEDURES, CONDITIONS, AND EVENTS FOR TEST 103

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 103 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. 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. The primary-coolant pump was tripped coincident with break initiation.

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	15.561 2257
Core power MW	EIE-9, EIE-10, EIE-11, EIE-12 EEE-9, EEE-10, EEE-11, EEE-12	5.978	5.975
Core volumetric flow rate m ³ /sec gpm	FE-19	0.0265 420	0.027 427
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	606.5 632
Pressurizer pressure MM/m ² psig	PE-106	15.031 2180	15.306 2220
Mass liquid water kg lb _m		63.50 140	58.94 129.94
Coolant pump speed rps rpm	SE-72	59.67 3580	60.12 3607
Pressure differential MM/m ² psid	P _d E-78	4.413 640	4.475 649
Pressure between HCV-2 and FCV-18 MM/m ² psig	PE-16	16.996 2465	16.927 2455
Pressure differential across main heat exchangers MM/m ² psid	P _d E-46	0.172 25	0.165 24

^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 103

Location	Instrument	Temperature [K (°F)]	Pressure [MN/m ² (psig)]
Vertical inlet spool piece	TE-172	558.7 (546)	15.796 (2291)
Vertical inlet spool piece	PE-174		
Test section inlet	TE-162	558.2 (545)	
Lower plenum	TE-150	560.9 (550)	15.755 (2285)
Lower plenum	PE-156		
Upper plenum	PE-201		15.561 (2247)
Test section outlet	TE-212	606.5 (632)	
Vertical outlet spool piece	TE-222	606.5 (632)	15.458 (2242)
Vertical outlet spool piece	PE-224		
Heat exchanger inlet header	PE-44		15.396 (2233)
Mixed mean temperature downstream heat exchangers	TE-28B	564.8 (557)	
Pressurizer surge line	TE-2	544.8 (521)	15.306 (2220)
Pressurizer	PE-106		
Primary pump suction	PE-76		15.279 (2216)
Between main control valves HCV-2, FCV-18	TE-4B	556.5 (542)	
Between main control valves HCV-2, FCV-18	PE-16		16.927 (2455)

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

Table 3. Sequence of events during test 103

Event	Time relative to rupture (sec)
Core power level established	-4920
Core temperature rise established	-4920
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	+2

III. DATA PRESENTATION

The recorded instrument responses for THTF test 103 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 103

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)

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

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1. Location of thermocouples in THTF bundle 1.

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Fig. 4. THTF instrument identification and location.

Table 5. Data presentation for test 103

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

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	Noisy and spurious spike
TE-309BF	Rod 9			44	
TE-310BF	Rod 10			45	
TE-312BF	Rod 12			46	Noisy
TE-313BF	Rod 13			47	Noisy and spurious spike
TE-317BF	Rod 17			48	
TE-320BF	Rod 20			49	Noisy
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	
TE-341BF	Rod 41			58	
TE-349BF	Rod 49			59	
LEVEL G					
TE-301BG	Rod 1			60	
TE-304BG	Rod 4			61	Noisy
TE-309BG	Rod 9			62	
TE-310BG	Rod 10			63	
TE-312BG	Rod 12			64	Noisy and spurious spike
TE-313BG	Rod 13			65	Noisy and spurious spike
TE-317BG	Rod 17			66	
TE-318BG	Rod 18			67	Noisy
TE-320BG	Rod 20			68	Noisy
TE-322BG	Rod 22			69	
TE-323BG	Rod 23			70	
TE-325BG	Rod 25			71	
TE-326BG	Rod 26			72	Noisy and spurious spike
TE-331BG	Rod 31			73	
TE-333BG	Rod 33			74	
TE-338BG	Rod 38			75	Spurious spikes
TE-339BG	Rod 39			76	Spurious spike late in transient
TE-341BG	Rod 41			77	
TE-349BG	Rod 49			78	

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	Noisy
TE-305AN	Rod 5			83	Noisy
TE-306AN	Rod 6			84	Noisy
TE-307AN	Rod 7			85	Noisy
TE-308AN	Rod 8			86	
TE-309CN	Rod 9			87	
TE-310CN	Rod 10			88	
TE-311AN	Rod 11			89	Noisy
TE-312CN	Rod 12			90	Noisy
TE-313CN	Rod 13			91	Noisy
TE-314AN	Rod 14			92	Noisy
TE-315AN	Rod 15			93	
TE-316AN	Rod 16			94	
TE-317CN	Rod 17			95	
TE-318CN	Rod 18			96	Noisy
TE-320CN	Rod 20			97	Noisy
TE-321AN	Rod 21			98	Noisy
TE-322CN	Rod 22			99	
TE-323CN	Rod 23			100	
TE-324CN	Rod 24			101	
TE-325CN	Rod 25			102	
TE-326CN	Rod 26			103	Noisy
TE-327AN	Rod 27			104	Noisy
TE-328AN	Rod 28			105	Instrument failed
TE-331CN	Rod 31			106	
TE-333CN	Rod 33			107	
TE-336AN	Rod 36			108	
TE-337AN	Rod 37			109	Spurious spike
TE-338CN	Rod 38			110	
TE-339CN	Rod 39			111	Noisy
TE-340AN	Rod 40			112	
TE-341CN	Rod 41			113	
TE-342AN	Rod 42			114	
TE-343AN	Rod 43			115	
TE-344AN	Rod 44			116	
TE-345AN	Rod 45			117	Small spurious spike
TE-346AN	Rod 46			118	Spurious spikes
TE-348AN	Rod 48			119	
TE-349CN	Rod 49			120	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL 1					
TE-301CI	Rod 1			121	
TE-302AI	Rod 2			122	
TE-303AI	Rod 3			123	
TE-304CI	Rod 4			124	Noisy
TE-305AI	Rod 5			125	Noisy
TE-306AI	Rod 6			126	Noisy
TE-307AI	Rod 7			127	Noisy
TE-308AI	Rod 8			128	
TE-309CI	Rod 9			129	
TE-310CI	Rod 10			130	
TE-311AI	Rod 11			131	Noisy
TE-312CI	Rod 12			132	Noisy
TE-313CI	Rod 13			133	Noisy
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
TE-321AI	Rod 21			140	Noisy and spurious spikes
TE-322CI	Rod 22			141	
TE-323CI	Rod 23			142	
TE-324CI	Rod 24			143	
TE-325CI	Rod 25			144	
TE-326CI	Rod 26			145	Noisy
TE-327AI	Rod 27			146	Noisy
TE-328AI	Rod 28			147	Noisy
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	Small spurious spikes
TE-339CI	Rod 39			153	Small spurious spike late in transient
TE-340AI	Rod 40			154	Noisy
TE-341CI	Rod 41			155	Spurious spike
TE-342AI	Rod 42			156	
TE-343AI	Rod 43			157	Large spurious spike early in transient

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL I (continued)					
TE-344AI	Rod 44			158	
TE-345AI	Rod 45			159	Spurious spike
TE-346AI	Rod 46			160	Spurious spike
TE-348AI	Rod 48			161	
TE-349CI	Rod 49			162	
LEVEL J					
TE-301DJ	Rod 1			163	
TE-302CJ	Rod 2			164	Spurious spike
TE-303CJ	Rod 3			165	Instrument failed
TE-304DJ	Rod 4			166	Noisy and spurious spike
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 spike
TE-314CJ	Rod 14			176	Noisy and spurious spike
TE-316CJ	Rod 16			177	
TE-317DJ	Rod 17			178	
TE-318CJ	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	Spurious spikes
TE-325DJ	Rod 25			185	
TE-326DJ	Rod 26			186	Noisy
TE-327CJ	Rod 27			187	Noisy
TE-328CJ	Rod 28			188	Noisy and spurious spike
TE-331DJ	Rod 31			189	
TE-333DJ	Rod 33			190	
TE-336CJ	Rod 36			191	Spurious spike
TE-337CJ	Rod 37			192	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL J (continued)					
TE-338DJ	Rod 38			193	Spurious spike
TE-339DJ	Rod 39			194	
TE-340CJ	Rod 40			195	
TE-341DJ	Rod 41			196	
TE-342CJ	Rod 42			197	
TE-343CJ	Rod 43			198	
TE-344CJ	Rod 44			199	Spurious spikes
TE-345CJ	Rod 45			200	Spurious spike late in transient
TE-346CJ	Rod 46			201	
TE-347CJ	Rod 47			202	Small spurious spikes early in transient
TE-349DJ	Rod 49			203	
LEVEL K					
TE-301DK	Rod 1			204	
TE-304DK	Rod 4			205	Noisy
TE-309DK	Rod 9			206	Small spike early in transient
TE-310DK	Rod 10			207	
TE-312DK	Rod 12			208	Noisy
TE-313DK	Rod 13			209	Noisy
TE-317DK	Rod 17			210	
TE-318DK	Rod 18			211	Noisy
TE-320DK	Rod 20			212	Noisy
TE-322DK	Rod 22			213	
TE-323DK	Rod 23			214	
TE-324DK	Rod 24			215	
TE-325DK	Rod 25			216	
TE-326DK	Rod 26			217	Noisy
TE-331DK	Rod 31			218	
TE-333DK	Rod 33			219	
TE-338DK	Rod 38			220	Spurious spike
TE-339DK	Rod 39			221	
TE-341DK	Rod 41			222	
TE-349DK	Rod 49			223	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL L					
TE-301EL	Rod 1			224	Spurious spikes early in transient
TE-302CL	Rod 2			225	Spurious spike early in transient
TE-303CL	Rod 3			226	Noisy and spurious spike
TE-304EL	Rod 4			227	Noisy
TE-305CL	Rod 5			228	Extremely noisy
TE-306CL	Rod 6			229	Spurious spike early in transient
TE-307CL	Rod 7			230	Noisy
TE-308CL	Rod 8			231	Noisy
TE-309EL	Rod 9			232	Noisy
TE-310EL	Rod 10			233	Noisy
TE-311CL	Rod 11			234	Noisy and spurious spike
TE-312EL	Rod 12			235	Noisy
TE-313EL	Rod 13			236	Noisy and spurious spike
TE-315CL	Rod 15			237	Instrument failed
TE-316CL	Rod 16			238	Spurious spike
TE-317EL	Rod 17			239	Noisy
TE-318EL	Rod 18			240	Noisy
TE-320EL	Rod 20			241	Noisy
TE-321CL	Rod 21			242	Noisy
TE-322EL	Rod 22			243	Noisy
TE-323EL	Rod 23			244	Noisy
TE-324EL	Rod 24			245	Noisy
TE-325EL	Rod 25			246	Noisy
TE-326EL	Rod 26			247	Noisy
TE-327CL	Rod 27			248	Noisy and spurious spike
TE-328CL	Rod 28			249	Noisy
TE-331EL	Rod 31			250	Noisy
TE-333EL	Rod 33			251	Noisy
TE-336CL	Rod 36			252	Noisy
TE-337CL	Rod 37			253	Noisy
TE-338EL	Rod 38			254	Noisy
TE-339EL	Rod 39			255	Noisy
TE-340CL	Rod 40			256	Noisy
TE-341EL	Rod 41			257	Noisy
TE-342CL	Rod 42			258	Noisy

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL L (continued)					
TE-343CL	Rod 43			259	
TE-344CL	Rod 44			260	Spurious spike
TE-345CL	Rod 45			261	Spurious spikes
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	
TE-304EM	Rod 4			267	Noisy
TE-309EM	Rod 9			268	Spurious spike
TE-325EM	Rod 25			269	
LEVEL N					
TE-301FN	Rod 1			270	
TE-304FN	Rod 4			271	Noisy
TE-325VN	Rod 25			272	
LEVEL O					
TE-301FO	Rod 1			273	
TE-304FO	Rod 4			274	Noisy
TE-309FO	Rod 9			275	Spurious spike
TE-310EO	Rod 10			276	
TE-312EO	Rod 12			277	Noisy
TE-317EO	Rod 17			278	
TE-318EO	Rod 18			279	Noisy
TE-320EO	Rod 20			280	Noisy and spurious spikes
TE-322EO	Rod 22			281	
TE-323EO	Rod 23			282	
TE-324EO	Rod 24			283	Slightly noisy
TE-325FO	Rod 25			284	
TE-326EO	Rod 26			285	Noisy
TE-331EO	Rod 31			286	Slightly noisy
TE-333EO	Rod 33			287	
TE-338EO	Rod 38			288	
TE-339EO	Rod 39			289	Slightly noisy
TE-341EO	Rod 41			290	
TE-349EO	Rod 49			291	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
<u>Heater Rod Center</u>					
	LEVEL E				
TE-301ME	Rod 1			292	
TE-318ME	Rod 18			293	
TE-322ME	Rod 22			294	
	LEVEL F				
TE-301MF	Rod 1			295	Spurious spike early in transient
TE-322MF	Rod 22			296	
	LEVEL G				
TE-301MG	Rod 1			297	Small spurious spike
TE-310MG	Rod 10			298	
TE-317MG	Rod 17			299	
TE-318MG	Rod 18			300	
TE-322MG	Rod 22			301	Small spurious spike
TE-323MG	Rod 23			302	Noisy
TE-325MG	Rod 25			303	
	LEVEL H				
TE-304MH	Rod 4			304	
TE-309MH	Rod 9			305	
TE-318MH	Rod 18			306	
TE-322MH	Rod 22			307	
	LEVEL J				
TE-301MJ	Rod 1			308	Spurious spike
TE-303MJ	Rod 3			309	Noisy
TE-308MJ	Rod 8			310	Noisy
TE-310MJ	Rod 10			311	
TE-317MJ	Rod 17			312	
TE-322MJ	Rod 22			313	Instrument failed
TE-323MJ	Rod 23			314	Spurious spike
TE-324MJ	Rod 24			315	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
SPOOL PIECE INSTRUMENTS					
<u>Temperature</u>	Chromel-Alumel thermocouples	+32 to +1897°F	-0.0027 to +0.0400 V		
TE-24	Horizontal inlet			316	
TE-172	Vertical inlet			317	
TE-222	Vertical outlet			318	
TE-40	Horizontal outlet			319	
<u>Pressure</u>		0 to +3000 psig	0.0 to +5.0 V		
PE-26	Horizontal inlet			359	Spurious spikes
PE-174	Vertical inlet			360	
PE-224	Vertical outlet			363	
PE-42	Horizontal outlet			364	Spurious spikes
<u>Pressure Drop</u>		-200 to +200 psid	-5.0 to +5.0 V		
PDE-21	Horizontal inlet			389	
PDE-167	Vertical inlet			370	
PDE-217	Vertical outlet			375	Instrument failed
PDE-35	Horizontal outlet			374	Instrument saturates at blowdown initiation
<u>Flow</u>					
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	
<u>Momentum Flux</u>		-250,000 to +250,000 lb _m /ft-sec ²	-5.0 to +5.0 V		
FMFE-22	Horizontal inlet			384	
FMFE-170	Vertical inlet			385	Zero shifted
FMFE-220	Vertical outlet			386	
FMFE-38	Horizontal outlet			387	
<u>Fluid Density</u>		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	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
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			325	Instrument failed
TE-176	0.142L/LMAX			326	
TE-177	0.142L/LMAX			327	Instrument failed
TE-178	0.142L/LMAX			328	Spurious spike at power trip
TE-179	0.388L/LMAX			329	Large spike at power trip
TE-180	0.388L/LMAX			330	Large spike at power trip
TE-181	0.388L/LMAX			331	Large spike at power trip
TE-182	0.388L/LMAX			332	Large spike at power trip
TE-183	0.633L/LMAX			333	Large spike at power trip
TE-184	0.633L/LMAX			334	Large spike at power trip
TE-185	0.633L/LMAX			335	Large spike at power trip
TE-186	0.633L/LMAX			336	Large spike at power trip
TE-187	0.875L/LMAX			337	Large spike at power trip
TE-189	0.875L/LMAX			338	Large spike at power trip
TE-190	0.875L/LMAX			339	Large spike at power trip
<u>Bundle Subchannel</u>					
TE-S1	Subchannel 1			473	
TE-S2	Subchannel 2			474	
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	Instrument failed
TE-S8	Subchannel 8			480	Instrument failed
TE-S9	Subchannel 9			481	
TE-S10	Subchannel 10			482	
TE-S11	Subchannel 11			483	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
TEST SECTION TEMPERATURE (continued)					
Bundle Subchannel (continued)					
TE-S13	Subchannel 13			484	Instrument failed
TE-S17	Subchannel 17			485	Instrument failed
TE-S18	Subchannel 18			486	
TE-S19	Subchannel 19			487	Spurious spike
TE-S20	Subchannel 20			488	Instrument failed
TE-S25	Subchannel 25			489	Instrument failed
TE-S26	Subchannel 26			490	Instrument failed
TE-S27	Subchannel 27			491	
TE-S28	Subchannel 28			492	
TE-S29	Subchannel 29			493	Instrument failed
TE-S30	Subchannel 30			494	
TE-S31	Subchannel 31			495	
TE-S32	Subchannel 32			496	Instrument failed
TE-S33	Subchannel 33			497	
TE-S34	Subchannel 34			498	
TE-S35	Subchannel 35			499	
TE-S36	Subchannel 36			500	
TE-S37	Subchannel 37			501	Instrument failed
TE-S46	Subchannel 46			502	
TE-S55	Subchannel 55			503	
TE-S64	Subchannel 64			504	
Test Section					
TE-162	Inlet line T/C			320	
TE-150	Bottom flange T/C			321	
TE-151	Bottom flange T/C			322	
TE-152	Bottom flange T/C			323	
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 +3000 psig	0.0 to +5.0 V	361	
PE-201	Outlet plenum	0 to +3000 psig	0.0 to +5.0 V	362	
PE-27	Inlet plenum bottom	0 to +3000 psig	0.0 to +5.0 V	391	
PE-43	Outlet plenum bottom	0 to +3000 psig	0.0 to +5.0 V	392	
PT-32	Outlet steady state	+500 to +2500 psig	+1.0 to +5.0 V	394	

Table 5 (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	172	
PDE-200	Bundle transient differential pressure	-200 to +200 psid	-5.0 to +5.0 V	171	
PDT-30	Test section steady-state differential pressure	0 to +50 psid	+1.0 to +5.0 V	191	
PRESSURIZER INSTRUMENTS					
Temperature					
TE-1	Tank top T/C	+32 to +189°F	-0.0027 to +0.0400 V	146	Small spurious spikes
TE-2	Tank exit T/C	+32 to +139°F	-0.0027 to +0.0400 V	147	
Pressure					
PT-102	Steady-state pressure	+500 to +2500 psig	+1.0 to +5.0 V	167	Spurious spikes
PE-106	Vapor transient pressure	0 to +1000 psig	0 to +5.0 V	168	
Level					
LT-100	Steady-state liquid level	0 to +150 in.	+1.0 to +5.0 V	178	
HEATER ROD POWER					
Heater Current					
EIE-1156	Rod 1	0 to +800 A	0.0 to +5.0 V	404	
EIE-1256	Rod 2			405	
EIE-1157	Rod 3			406	
EIE-1257	Rod 4			407	
EIE-956	Rod 5			408	
EIE-958	Rod 6			409	
EIE-955	Rod 7			410	
EIE-1155	Rod 8			411	
EIE-1158	Rod 9			412	
EIE-1258	Rod 10			413	
EIE-957	Rod 11			414	
EIE-954	Rod 12			415	
EIE-953	Rod 13			416	
EIE-9511	Rod 14			417	
EIE-1154	Rod 15			418	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
HEATER ROD POWER (continued)					
Heater Current (continued)					
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-10S5	Rod 34			437	
EIE-10J8	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	
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	

Table 5 (continued)

Measurement	Location and comments	Detector	Range	Figure	Measurement comments
GENERATOR POWER (continued)					
Generator Current (continued)					
EE-11	Generator 11 current			455	
EE-12	Generator 12 current			456	
Generator Voltage					
EE-9	Generator 9 voltage	0 to +285 V	0.0 to +10.0 V	457	
EE-10	Generator 10 voltage			458	
EE-11	Generator 11 voltage			459	
EE-12	Generator 12 voltage			460	
HEAT EXCHANGER INSTRUMENTS					
Primary Side					
Outlet Line Thermocouples		+12 to +189°F	0.0027 to +0.0600 V		
TE-10B	Heat exchanger A			161	Spurious spike
TE-12B	Heat exchanger B			162	Spurious spikes
TE-14B	Heat exchanger C			163	Spurious spikes
TE-5B	Heat exchanger D			165	Spurious spikes
TE-28B	Main MX mixing tee steady-state temp., RTD	+12 to +800°F	+0.2 to +0.52 V	182	
Secondary Side					
Secondary discharge steady-state temp., RTD		+12 to +100°F	+0.2 to +0.4 V		
TE-52S	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	
Heat Exchanger Secondary Flow					
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	Spurious spike
FE-720	Heat exchanger C	0 to +150 gpm	+0.2 to +1.0 V	352	Spurious spikes
FE-550	Heat exchanger D	0 to +50 gpm	+0.2 to +1.0 V	353	
Heat Exchanger Pressure					
PE-64	Upstream main MX transient pressure	0 to +1000 psig	0.0 to +5.0 V	365	
PE-526	MX A secondary inlet pressure	0 to +150 psig	0.0 to +5.0 V	388	Slightly noisy

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	377	Instrument saturates at blowdown initiation
PDE-16	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	Spurious spikes
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-48	Base primary steady-state temp., RTD	+32 to +800°F	+0.2 to +0.52 V	350	Spurious spikes
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	Spurious spikes
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	
DEMINEALIZED WATER SYSTEM					
TE-520B	RBT 4 in. demineralized water header T/C	+32 to +1897°F	-0.0027 to +0.0400 V	344	Large 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					
XN-40001	Inlet break	0.0 to +5.0 V	0.0 to +5.0 V	396	
XN-40000	Outlet break	0.0 to +5.0 V	0.0 to +5.0 V	397	

Table 5 (continued)

Measurement	Location and comments	Detector	Range	Figure	Measurement comments
GENERAL INSTRUMENTATION (ELECTRICAL) (continued)					
RTD Power					
FIN-1001B	RTD power supply current	2.0 mA	0.400 V	401	
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	Reads 40 mV this test
Full-scale cal. input	Channels 128-255	35.00 mV	35.00 mV	470	Reads 40 mV this test
Full-scale cal. input	Channels 256-383	35.00 mV	35.00 mV	471	Reads 40 mV this test
Full-scale cal. input	Channels 384-511	35.00 mV	35.00 mV	472	Reads 40 mV this test