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**PWR Blowdown Heat Transfer Separate-Effects
Program—Thermal-Hydraulic Test Facility
Experimental Data Report for Test 167R**

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PWR BLOWDOWN HEAT TRANSFER SEPARATE-EFFECTS
PROGRAM — THERMAL-HYDRAULIC TEST FACILITY
EXPERIMENTAL DATA REPORT FOR TEST 167R

V. D. Clemons R. A. Hedrick M. D. White

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PWR BLOWDOWN HEAT TRANSFER SEPARATE-EFFECTS
PROGRAM -- THERMAL-HYDRAULIC TEST FACILITY
EXPERIMENTAL DATA REPORT FOR TEST 167R

V. D. Clemons R. A. Hedrick M. D. White

ABSTRACT

Reduced instrument responses are presented for Thermal-Hydraulic Test Facility (THTF) test 167R, 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 167R was conducted to obtain thermal-hydraulic and CHF information in THTF bundle 1 with an intact cold leg.

The primary purpose of this report is to make the reduced instrument responses during test 167R 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 167R (conducted March 9, 1978) was the 28th test conducted in the facility with bundle 1 in place. This test was performed to obtain thermal-hydraulic and CHF information in the bundle with an intact cold leg.

The purpose of this report is to provide the reduced instrument response during test 167R 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 the test series. The program and the experimental facilities are described in Ref. 1.

II. SYSTEM, PROCEDURES, CONDITIONS, AND EVENTS FOR TEST 167R

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 167R was 100% inlet with a total break area of 12.54 cm² (0.0135 ft²). The THTF experimental system is described further in Ref. 1.

The electric core was taken to the preblowdown power (100 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 26 sec into the transient. Rods 19, 24, 39, and 47 were unpowered. Closure of the secondary-side main heat exchanger valves was initiated at the trip from 100 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 single-ended pipe break through the outlet rupture assembly containing the orifice plates.

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

ORNL-DWG 77-5585

Fig. 1. Thermal-Hydraulic Test Facility, MOD-1 — ORNL PWR Blowdown Heat Transfer Separate-Effects Program.

The effluent from the primary system was injected 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 prerupture loop energy balance and steady-state primary and secondary energy balances are shown in Figs. 2 through 4. 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	15.555 2256
Core power MW	EIE-9, EIE-10, EIE-11, EIE-12 EEE-9, EEE-10, EEE-11, EEE-12	4.500	4.501
Number of unpowered rods		4	4
Core volumetric flow rate m ³ /sec gpm	FE-19	0.0252 400	0.0253 401
Test section inlet temperature K °F	TE-162	559.5 547	556.7 546
Test section outlet temperature K °F	TE-212	598.2 617	597.6 616
Pressurizer pressure MN/m ² psig	PE-106	15.237 2210	15.506 2249
Mass liquid water kg lb _m		63.50 140.0	61.10 134.7
Coolant pump speed rps rpm	SE-72	60.35 3623	59.77 3586
Pressure differential MN/m ² psid	P _d E-78	4.599 667	4.561 676
Pressure between HCV-2 and FCV-18 MN/m ² psig	PE-16	18.574 2694	17.899 2596
Pressure differential across main heat exchangers MN/m ² psid	P _d E-46	0.248 36.0	0.254 35.4

^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 for test 167R

Location	Instrument	Temperature [K (°F)]	Pressure [MN/m ² (psig)]
Vertical inlet spool piece	TE-172	559.3 (547)	
Test section inlet	TE-162	558.7 (546)	
Lower plenum	TE-150	560.9 (550)	
Lower plenum	PE-156		15.741 (2283)
Upper plenum	PE-201		15.555 (2256)
Test section outlet	TE-212	597.6 (616)	
Vertical outlet spool piece	TE-222	597.6 (616)	
Pressure differential between vertical spool pieces	P _d E-204		0.333 (48.3)
Heat exchanger inlet header	PE-44		15.375 (2230)
Downstream heat exchangers (mixed mean temperature)	TE-288	564.3 (555)	
Pressurizer surge line	TE-2	617.6 (652)	
Pressurizer	PE-106		15.506 (2249)
Primary pump suction	PE-76		15.175 (2201)
Between main control valves HCV-2 and FCV-18	TE-48	559.8 (548)	
Between main control valves HCV-2 and FCV-18	PE-16		17.899 (2596)

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

Table 3. Sequence of events during test 167R

Event	Time relative to rupture (sec)
Core power level established	-2055
Core temperature rise established	-2055
Analog tapes and CCDAS fast scan started	-15
Blowdown initiated	0
Pump power tripped	0
Heat exchanger secondary valves closure initiated	+6
Core power tripped	+6

PRE-BLONCKA, NO. 167B STAGN-STATE POLICE 3/8/78

PRE-BLOWDOWN NO. 167R STEADY-STATE POINTS 3/9/76

REF ID: A66581

Fig. 4. Prerupture secondary side heat exchanger summary.

III. DATA PRESENTATION

The recorded instrument responses for THTF test 167R 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 5 through 7 provide supportive information for the instrument responses and indicate the relative locations of the detectors in the THTF.

Fig. 5. Identification of THTF heater rod and subchannel locations in bundles 1 and 2.

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. 6. Location of thermocouples in THTF bundle 1.

Fig. 7. THTF instrument identification and location.

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Fig. 7. THTF instrument identification and location.

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Table 4. Precision of experimental measurements for test 167R

System	Standard deviation
Pressure measurement, MN/m^2 (psig)	
CCDAS	3.185 (26.8)
Analog tape system	0.197 (28.5)
Pressure difference measurement, MN/m^2 (psid)	
CCDAS	
0.89 MN/m^2 (1300 psid) span	0.025 (5.6)
1.38 MN/m^2 (200 psid) span	0.005 (8.7)
0.14 MN/m^2 (50 psid) span	0.002 (6.18)
Analog tape system	
0.89 MN/m^2 (1300 psid) span	0.007 (8.4)
1.38 MN/m^2 (200 psid) span	0.002 (8.7)
0.14 MN/m^2 (50 psid) span	0.002 (6.18)
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	+0.0011 -0.0004 (+17.49) (-6.43)
Reverse	+0.0009 -0.0002 (+14.14) (-3.07)
FE-216	
Forward	+0.0018 -0.0004 (+28.64) (-6.51)
Reverse	+0.0017 -0.0003 (+27.44) (-5.31)
FE-34	
Forward	+0.0019 -0.0005 (+30.71) (-8.58)
Reverse	+0.0019 -0.0005 (+29.54) (-7.41)
Momentum flux measurement, kg/m-sec^2 ($\text{lb}_m/\text{ft-sec}^2$)	
CCDAS	2264 (1522)
Analog tape system	2554 (1716)
Density measurement 0.961 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 167R

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE	Chromel-Alumel thermocouples	+12 to +1897°F (all)	-0.0027 to +0.0400 V (all)		
<u>Reactor Rod Sheath</u>					
	LEVEL D				
TE-101AD	Rod 1			8	Instrument erroneous prior to power trip
TE-102AD	Rod 4			9	
TE-109AD	Rod 9			10	
TE-110AD	Rod 10			11	
TE-112AD	Rod 12			12	
TE-113AD	Rod 13			13	
TE-117AD	Rod 17			14	
TE-118AD	Rod 18			15	
TE-120AD	Rod 20			16	
TE-122AD	Rod 22			17	
TE-123AD	Rod 23			18	
TE-125AD	Rod 25			19	Instrument failed
TE-126AD	Rod 26			20	
TE-131AD	Rod 31			21	
TE-138AD	Rod 38			22	
TE-139AD	Rod 39			23	Unpowered rod
TE-141AD	Rod 41			24	
TE-149AD	Rod 49			25	
	LEVEL E				
TE-101AE	Rod 1			26	Instrument failed
TE-105AE	Rod 5			27	Instrument erroneous prior to power trip
TE-109AE	Rod 9			28	
TE-112AE	Rod 12			29	
TE-113AE	Rod 13			30	
TE-117AE	Rod 17			31	
TE-118AE	Rod 18			32	
TE-120AE	Rod 20			33	
TE-122AE	Rod 22			34	
TE-123AE	Rod 23			35	
TE-124AE	Rod 24			36	Unpowered rod
TE-125AE	Rod 25			37	
TE-126AE	Rod 26			38	
TE-131AE	Rod 31			39	
TE-133AE	Rod 33			40	
TE-138AE	Rod 38			41	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL E (continued)					
TE-339AE	Rod 39			42	Unpowered rod
TE-341AE	Rod 41			43	
TE-349AE	Rod 49			44	
LEVEL F					
TE-301BF	Rod 1			45	
TE-304BF	Rod 4			46	
TE-309BF	Rod 9			47	
TE-310BF	Rod 10			48	
TE-312BF	Rod 12			49	
TE-313BF	Rod 13			50	
TE-317BF	Rod 17			51	
TE-320BF	Rod 20			52	
TE-322BF	Rod 22			53	
TE-323BF	Rod 23			54	
TE-324BF	Rod 24			55	Unpowered rod
TE-325BF	Rod 25			56	
TE-326BF	Rod 26			57	
TE-331BF	Rod 31			58	Instrument failed
TE-333BF	Rod 33			59	Spurious spikes
TE-335BF	Rod 38			60	
TE-341BF	Rod 41			61	
TE-349BF	Rod 49			62	
LEVEL G					
TE-301BG	Rod 1			63	Instrument failed
TE-304BG	Rod 4			64	
TE-309BG	Rod 9			65	
TE-310BG	Rod 10			66	
TE-312BG	Rod 12			67	
TE-313BG	Rod 13			68	
TE-317BG	Rod 17			69	
TE-318BG	Rod 18			70	
TE-320BG	Rod 20			71	
TE-322BG	Rod 22			72	
TE-323BG	Rod 23			73	
TE-325BG	Rod 25			74	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL G (continued)					
TE-326BG	Rod 26			75	
TE-331BG	Rod 31			76	
TE-333BG	Rod 33			77	
TE-338BG	Rod 38			78	
TE-339BG	Rod 39			79	Unpowered rod
TE-341BG	Rod 41			80	Instrument erroneous
TE-349BG	Rod 49			81	prior to power trip
LEVEL H					
TE-301CH	Rod 1			82	
TE-302AH	Rod 2			83	
TE-303AH	Rod 3			84	
TE-304CH	Rod 4			85	
TE-305AH	Rod 5			86	
TE-306AH	Rod 6			87	
TE-307AH	Rod 7			88	
TE-308AH	Rod 8			89	
TE-309CH	Rod 9			90	
TE-310CH	Rod 10			91	Instrument failed
TE-311AH	Rod 11			92	
TE-312CH	Rod 12			93	
TE-313CH	Rod 13			94	Spurious spike
TE-314AH	Rod 14			95	Spurious spike
TE-315AH	Rod 15			96	Spurious spike
TE-316AH	Rod 16			97	Small spurious spike
TE-317CH	Rod 17			98	Spurious spike
TE-318CH	Rod 18			99	
TE-320CH	Rod 20			100	Small spurious spike
TE-321AH	Rod 21			101	Small spurious spike
TE-322CH	Rod 22			102	
TE-323CH	Rod 23			103	
TE-324CH	Rod 24			104	Unpowered rod
TE-325CH	Rod 25			105	
TE-326CH	Rod 26			106	
TE-327AH	Rod 27			107	
TE-331CH	Rod 31			108	
TE-333CH	Rod 33			109	Spurious spikes
TE-336AH	Rod 36			110	
TE-337AH	Rod 37			111	
TE-338CH	Rod 38			112	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL N (continued)					
TE-339CH	Rod 39			113	Unpowered rod
TE-341CH	Rod 41			114	
TE-342AH	Rod 42			115	Spurious spike
TE-343AH	Rod 43			116	
TE-344AH	Rod 44			117	
TE-345AH	Rod 45			118	
TE-346AH	Rod 46			119	
TE-348AH	Rod 48			120	
TE-349CH	Rod 49			121	
LEVEL I					
TE-301CI	Rod 1			122	Spurious spikes
TE-302AI	Rod 2			123	Spurious spike
TE-303AI	Rod 3			124	Spurious spikes
TE-304CI	Rod 4			125	Spurious spikes
TE-305AI	Rod 5			126	Spurious spikes
TE-306AI	Rod 6			127	
TE-307AI	Rod 7			128	
TE-308AI	Rod 8			129	
TE-309CI	Rod 9			130	Spurious spike
TE-310CI	Rod 10			131	
TE-311AI	Rod 11			132	
TE-312CI	Rod 12			133	
TE-313CI	Rod 13			134	
TE-314AI	Rod 14			135	
TE-315AI	Rod 15			136	
TE-316AI	Rod 16			137	
TE-317CI	Rod 17			138	
TE-318CI	Rod 18			139	
TE-320CI	Rod 20			140	
TE-321AI	Rod 21			141	
TE-322CI	Rod 22			142	
TE-323CI	Rod 23			143	Instrument failed
TE-324CI	Rod 24			144	
TE-325CI	Rod 25			145	
TE-326CI	Rod 26			146	Instrument failed
TE-327AI	Rod 27			147	
TE-328AI	Rod 28			148	Instrument failed
TE-331CI	Rod 31			149	
TE-333CI	Rod 33			150	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL 1 (continued)					
TE-336A1	Rod 36			151	
TE-337A1	Rod 37			152	
TE-338C1	Rod 38			153	
TE-339C1	Rod 39			154	
TE-341C1	Rod 41			155	
TE-342A1	Rod 42			156	
TE-343A1	Rod 43			157	Spurious spike
TE-344A1	Rod 44			158	
TE-345A1	Rod 45			159	
TE-346A1	Rod 46			160	
TE-348A1	Rod 48			161	
TE-349C1	Rod 49			162	Spurious spike
LEVEL J					
TE-301DJ	Rod 1			163	
TE-302CJ	Rod 2			164	
TE-304DJ	Rod 4			165	
TE-305CJ	Rod 5			166	
TE-306CJ	Rod 6			167	
TE-307CJ	Rod 7			168	
TE-308CJ	Rod 8			169	
TE-309DJ	Rod 9			170	
TE-310DJ	Rod 10			171	
TE-312DJ	Rod 12			172	
TE-313DJ	Rod 13			173	
TE-314CJ	Rod 14			174	
TE-316CJ	Rod 16			175	
TE-317DJ	Rod 17			176	
TE-318DJ	Rod 18			177	
TE-320DJ	Rod 20			178	
TE-321CJ	Rod 21			179	
TE-322DJ	Rod 22			180	
TE-323DJ	Rod 23			181	
TE-324DJ	Rod 24			182	Unpowered rod
TE-325DJ	Rod 25			183	
TE-326DJ	Rod 26			184	
TE-327CJ	Rod 27			185	
TE-328CJ	Rod 28			186	
TE-331DJ	Rod 31			187	
TE-333DJ	Rod 33			188	Spurious spikes

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL J (continued)					
TE-336CJ	Rod 36			189	
TE-337CJ	Rod 37			190	
TE-338DJ	Rod 38			191	Small spurious spikes
TE-339DJ	Rod 39			192	Unpowered rod
TE-340CJ	Rod 40			193	Spurious spike
TE-341DJ	Rod 41			194	Spurious spikes
TE-342CJ	Rod 42			195	Spurious spike
TE-343CJ	Rod 43			196	
TE-344CJ	Rod 44			197	Spurious spikes
TE-345CJ	Rod 45			198	Spurious spike
TE-346CJ	Rod 46			199	
TE-349DJ	Rod 49			200	
LEVEL K					
TE-301DK	Rod 1			201	Spurious spike
TE-304DK	Rod 4			202	
TE-309DK	Rod 9			203	Small spurious spike
TE-310DK	Rod 10			204	
TE-312DK	Rod 12			205	
TE-313DK	Rod 13			206	
TE-317DK	Rod 17			207	
TE-318DK	Rod 18			208	
TE-320DK	Rod 20			209	
TE-324DK	Rod 22			210	
TE-323DK	Rod 23			211	
TE-324DK	Rod 24			212	Unpowered rod
TE-325DK	Rod 25			213	
TE-326DK	Rod 26			214	
TE-331DK	Rod 31			215	
TE-333DK	Rod 33			216	
TE-338DK	Rod 38			217	
TE-339DK	Rod 39			218	Instrument failed
TE-341DK	Rod 41			219	Small spurious spike
TE-349DK	Rod 49			220	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
LEVEL L					
TE-301EL	Rod 1			221	Spurious spike
TE-302CL	Rod 2			222	
TE-303CL	Rod 3			223	
TE-304EL	Rod 4			224	
TE-305CL	Rod 5			225	
TE-306CL	Rod 6			226	
TE-307CL	Rod 7			227	Instrument failed
TE-308CL	Rod 8			228	
TE-309EL	Rod 9			229	
TE-310EL	Rod 10			230	
TE-311CL	Rod 11			231	
TE-312EL	Rod 12			232	
TE-313EL	Rod 13			233	
TE-316CL	Rod 16			234	
TE-317EL	Rod 17			235	
TE-318EL	Rod 18			236	
TE-320EL	Rod 20			237	
TE-321CL	Rod 21			238	
TE-322EL	Rod 22			239	
TE-323EL	Rod 23			240	
TE-324EL	Rod 24			241	Unpowered rod
TE-325EL	Rod 25			242	
TE-326EL	Rod 26			243	
TE-327CL	Rod 27			244	
TE-328EL	Rod 28			245	Spurious spike
TE-331EL	Rod 31			246	
TE-333EL	Rod 33			247	
TE-336CL	Rod 36			248	
TE-337CL	Rod 37			249	
TE-338EL	Rod 38			250	Questionable
TE-339EL	Rod 39			251	Unpowered rod
TE-341EL	Rod 41			252	
TE-342CL	Rod 42			253	
TE-343CL	Rod 43			254	
TE-344CL	Rod 44			255	
TE-345CL	Rod 45			256	
TE-346CL	Rod 46			257	
TE-348CL	Rod 48			258	
TE-349EL	Rod 49			259	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
	LEVEL M				
TE-301EM	Rod 1			260	
TE-304EM	Rod 4			261	
TE-309EM	Rod 9			262	
TE-325EM	Rod 25			263	
	LEVEL N				
TE-301FN	Rod 1			264	
TE-304FN	Rod 4			265	
TE-325FN	Rod 25			266	
	LEVEL O				
TE-301FO	Rod 1			267	Small spurious spike
TE-304FO	Rod 4			268	Small spurious spike
TE-309FO	Rod 9			269	Spurious spike
TE-310EO	Rod 10			270	Small spurious spike
TE-312EO	Rod 12			271	Small spurious spike
TE-317EO	Rod 17			272	
TE-318EO	Rod 18			273	
TE-320EO	Rod 20			274	Spurious spike
TE-322EO	Rod 22			275	
TE-323EO	Rod 23			276	
TE-324EO	Rod 24			277	Unpowered rod
TE-325FO	Rod 25			278	
TE-326EO	Rod 26			279	
TE-331EO	Rod 31			280	
TE-333EO	Rod 33			281	
TE-338EO	Rod 38			282	
TE-339EO	Rod 39			283	Unpowered rod
TE-341EO	Rod 41			284	Spurious spike
TE-349EO	Rod 49			285	Spurious spikes
Heater Rod Center					
	LEVEL E				
TE-301ME	Rod 1			286	
TE-304ME	Rod 4			287	Spurious spike
TE-318ME	Rod 18			288	
TE-322ME	Rod 22			289	
TE-326ME	Rod 26			290	

Table 5 (cont inued)

Measurement	Location and comments	Detector	Range	Figure	Measurement comments
BUNDLE TEMPERATURE (cont inued)					
Boiler Rod Center (cont inued)					
LEVEL E (cont inued)					
TE-11ME	Rod 11			291	
TE-11NE	Rod 18			292	
TE-11WE	Rod 44			293	
LEVEL F					
TE-101MF	Rod 1			294	Spurious spike
TE-102MF	Rod 4			295	Spurious spike
TE-122MF	Rod 22			296	
TE-126MF	Rod 26			297	
TE-118MF	Rod 38			298	Spurious spike
TE-119MF	Rod 49			299	Spurious spike
LEVEL G					
TE-101NG	Rod 1			300	
TE-110NG	Rod 10			301	
TE-112NG	Rod 13			302	
TE-117NG	Rod 17			303	
TE-118NG	Rod 18			304	
TE-122NG	Rod 22			305	
TE-123NG	Rod 23			306	
TE-125NG	Rod 25			307	
TE-126NG	Rod 26			308	
TE-118NG	Rod 38			309	Spurious spike
TE-142NG	Rod 49			310	Spurious spikes
LEVEL H					
TE-104NH	Rod 4			311	Spurious spikes
TE-105NH	Rod 9			312	Spurious spikes
TE-118NH	Rod 18			313	Spurious spikes
TE-122NH	Rod 22			314	Spurious spikes
TE-138NH	Rod 38			315	Spurious spikes
Instrument failed					

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
Heater Rod Center (continued)					
	LEVEL J				
TE-301NJ	Rod 1			316	Spurious spikes
TE-310NJ	Rod 10			317	Spurious spikes
TE-317NJ	Rod 17			318	Spurious spikes
TE-323NJ	Rod 23			319	
TE-324NJ	Rod 24			320	Spurious spike, unpowered rod
TE-326NJ	Rod 26			321	Spurious spikes
TE-338NJ	Rod 38			322	Spurious spikes
SPOOL PIECE INSTRUMENTS					
Temperature	Chromel-Alumel thermocouples	+32 to +1897°F	-0.0027 to +0.0400 V		
TE-24	Horizontal inlet			363	
TE-172	Vertical inlet			369	
TE-222	Vertical outlet			375	
TE-40	Horizontal outlet			381	
Pressure		0 to +3000 psig	0.0 to +5.0 V		
PE-26	Horizontal inlet			360	Spurious spikes
PE-spare				481	
PE-42	Horizontal outlet			378	Spurious spike
Pressure Drop		-200 to +200 psid	-5.0 to +5.0 V		
PDF-1	Horizontal inlet			362	
PDI-167	Vertical inlet			368	
PDE-117	Vertical outlet			374	
PDE-35	Horizontal outlet			380	
Flow					
FE-19	Horizontal inlet	-2000 to +2000 gpm	-5.0 to +5.0 V	358	
FE-166	Vertical inlet	-2000 to +2000 gpm	-5.0 to +5.0 V	364	
FE-216	Vertical outlet	-4000 to +4000 gpm	-5.0 to +5.0 V	370	
FE-34	Horizontal outlet	-4000 to +4000 gpm	-5.0 to +5.0 V	376	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
SPOOL PIECE INSTRUMENTS (continued)					
<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			361	Zero shifted
FMFE-170	Vertical inlet			367	Erratic
FMFE-220	Vertical outlet			373	Erratic
FMFE-38	Horizontal outlet			379	Zero shifted
<u>Fluid Density</u>		0 to +62.4 lb _m /ft ³	0.0 to +10.0 V		
DE-20	Horizontal inlet			359	Spike
DE-168	Vertical inlet			365	Spike
DE-218	Vertical outlet			371	
DE-36	Horizontal outlet			377	Spike
<u>TEST SECTION TEMPERATURE</u>		Chromel-Alumel thermocouples	+32 to +1897°F	-0.0027 to +0.0400 V	
<u>Bundle Shroud</u>					
TE-175	0.142L/LMAX			328	Instrument failed
TE-176	0.142L/LMAX			329	Instrument failed
TE-177	0.142L/LMAX			330	Instrument failed
TE-178	0.142L/LMAX			331	Instrument failed
TE-179	0.388L/LMAX			332	Spurious spikes, power effects
TE-180	0.388L/LMAX			333	Erratic
TE-181	0.388L/LMAX			334	Erratic
TE-182	0.388L/LMAX			335	Spurious spikes, power effects
TE-183	0.633L/LMAX			336	Erratic
TE-184	0.633L/LMAX			337	Instrument failed
TE-185	0.633L/LMAX			338	Erratic
TE-186	0.633L/LMAX			339	Erratic
TE-187	0.875L/LMAX			340	Instrument failed
TE-189	0.875L/LMAX			341	Reads high
TE-190	0.875L/LMAX			342	Erratic
<u>Bundle Subchannel</u>					
TE-S3	Subchannel 3			482	Instrument failed
TE-S5	Subchannel 5			483	Instrument failed
TE-S9	Subchannel 9			484	Instrument failed

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
TEST SECTION TEMPERATURE (continued)					
Bundle Subchannel (continued)					
TE-S10	Subchannel 10			485	Instrument failed
TE-S11	Subchannel 11			486	Instrument failed
TE-S14	Subchannel 14			487	Instrument failed
TE-S16	Subchannel 16			488	
TE-S33	Subchannel 33			489	Instrument failed
TE-S34	Subchannel 34			490	Instrument failed
TE-S36	Subchannel 36			491	Instrument failed
TE-S38	Subchannel 38			492	Instrument failed
TE-S39	Subchannel 39			493	Spurious spike
TE-S40	Subchannel 40			494	
TE-S41	Subchannel 41			495	Instrument failed
TE-S42	Subchannel 42			496	Instrument failed
TE-S44	Subchannel 44			497	Instrument failed
TE-S45	Subchannel 45			498	
TE-S49	Subchannel 49			499	
TE-S50	Subchannel 50			500	
TE-S51	Subchannel 51			501	
TE-S54	Subchannel 54			502	Instrument failed
TE-S55	Subchannel 55			503	Instrument failed
TE-S57	Subchannel 57			504	
TE-S59	Subchannel 59			505	
TE-S63	Subchannel 63			506	Instrument failed
TE-S64	Subchannel 64			507	Instrument failed
Test Section					
TE-162	Inlet line T/C			323	Spurious spike
TE-150	Bottom flange T/C			324	Spurious spike
TE-151	Bottom flange T/C			325	Spurious spike
TE-152	Bottom flange T/C			326	
TE-153	Bottom flange T/C			327	Instrument failed
TE-212	Outlet line T/C			343	
TE-210A	Outlet line RTD (steady state)	+32 to +800°F	+0.2 to +0.32V	414	Spurious spikes
TEST SECTION PRESSURE					
PE-156	Inlet plenum	0 to +3000 psig	0.0 to +5.0 V	382	
PE-201	Outlet plenum	0 to +3000 psig	0.0 to +5.0 V	383	
PE-27	Inlet plenum bottom	0 to +3000 psig	0.0 to +5.0 V	403	
PE-43	Outlet plenum bottom	0 to +3000 psig	0.0 to +5.0 V	404	
PT-32	Outlet steady state	+500 to +2500 psig	+1.0 to +5.0 V	406	

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	190	
PDE-200	Bundle transient differential pressure	-200 to +200 psid	-5.0 to +5.0 V	191	Instrument failed
PDT-30	Test section steady-state differential pressure	0 to +50 psid	+1.0 to +5.0 V	405	
PDE-204	Transient pressure between vertical spool pieces	-200 to +200 psid	-5.0 to +5.0 V	166	
PRESSURIZER					
INSTRUMENTS					
Temperature					
TE-1	Tank top T/C	+32 to +1897°F	-0.0027 to +0.0400 V	349	
TE-2	Tank exit T/C	+32 to +1897°F	-0.0027 to +0.0400 V	350	
Pressure					
PT-102	Steady-state pressure	+500 to +2500 psig	+1.0 to +5.0 V	386	
PE-106	Vapor transient pressure	0 to +3000 psig	0 to +5.0 V	387	Spurious spike
Level					
LT-100	Steady-state liquid level	0 to +150 in.	+1.0 to +5.0 V	410	
HEATER ROD POWER					
Heater Current		0 to +800 A	0.0 to +5.0 V		
EIE-11S6	Rod 1			416	
EIE-12S6	Rod 2			417	
EIE-11S7	Rod 3			418	
EIE-12S7	Rod 4			419	
EIE-9S6	Rod 5			420	
EIE-9S8	Rod 6			421	
EIE-9S5	Rod 7			422	Spurious spike
EIE-11S5	Rod 8			423	
EIE-11S8	Rod 9			424	
EIE-12S8	Rod 10			425	
EIE-9S7	Rod 11			426	
EIE-9S4	Rod 12			427	
EIE-9S3	Rod 13			428	
EIE-9S11	Rod 14			429	Spurious spike
EIE-11S4	Rod 15			430	

Table 5 (continued)

Measurement	Location and comments	Range	Detector	Data acquisition system	Figure	Measurement comments
HEATER ROD POWER (continued)						
Heater Current (continued)						
EIE-11S9	Rod 16				431	
EIE-12S5	Rod 17				432	
EIE-9S9	Rod 18				433	Unpowered rod
EIE-9S10	Rod 19				434	
EIE-9S2	Rod 20				435	
EIE-9S12	Rod 21				436	
EIE-11S11	Rod 22				437	
EIE-11S10	Rod 23				438	
EIE-11S3	Rod 24				439	Unpowered rod
EIE-9S13	Rod 25				440	
EIE-10S6	Rod 26				441	
EIE-9S1	Rod 27				442	
EIE-10S7	Rod 28				443	
EIE-11S2	Rod 29				444	
EIE-11S12	Rod 30				445	
EIE-12S2	Rod 31				446	
EIE-12S1	Rod 32				447	
EIE-10S12	Rod 33				448	
EIE-10S5	Rod 34				449	
EIE-10S8	Rod 35				450	
EIE-11S1	Rod 36				451	
EIE-12S4	Rod 37				452	
EIE-12S3	Rod 38				453	
EIE-12S12	Rod 39				454	Unpowered rod
EIE-10S11	Rod 40				455	
EIE-10S10	Rod 41				456	
EIE-10S9	Rod 42				457	
EIE-12S9	Rod 43				458	
EIE-12S10	Rod 44				459	
EIE-12S11	Rod 45				460	
EIE-10S1	Rod 46				461	
EIE-10S2	Rod 47				462	Unpowered rod
EIE-10S3	Rod 48				463	
EIE-10S4	Rod 49				464	
GENERATOR POWER						
Generator Current						
EIE-9	Generator 9 current	0 to +10,000 A			465	
EIE-10	Generator 10 current	0.0 to +5.0 V			466	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
GENERATOR POWER (continued)					
Generator Current (continued)					
EIE-11	Generator 11 current			467	
EIE-12	Generator 12 current			468	
Generator Voltage		0 to +285 V	0.0 to +10.0 V		
EEE-9	Generator 9 voltage			469	
EEE-10	Generator 10 voltage			470	
EEE-11	Generator 11 voltage			471	
EEE-12	Generator 12 voltage			472	
HEAT EXCHANGER INSTRUMENTS					
Primary Side					
Outlet Line Thermocouples		+32 to +1897°F	-0.0027 to +0.0400 V		
TE-308	Heat exchanger A			344	
TE-328	Heat exchanger B			345	
TE-348	Heat exchanger C			346	
TE-58	Heat exchanger D			348	Small spurious spikes
TE-288	Main HX mixing tee steady-state temp., RTD	+32 to +800°F	+0.2 to +0.52 V	398	
TE-6	Heat exchanger D mixing tee temperature			399	Reads low
Secondary Side					
Secondary discharge steady-state temp., RTD		+32 to +500°F	+0.2 to +0.4 V		
TE-525	Heat exchanger A			413	Spurious spike
TE-627	Heat exchanger B			392	Spurious spikes
TE-727	Heat exchanger C			397	Spurious spikes
TE-557	Heat exchanger D			412	Spurious spikes
Heat Exchanger					
Secondary Flow					
FE-522	Heat exchanger A	0 to +150 gpm	+0.2 to +1.0 V	411	
FE-620	Heat exchanger B	0 to +150 gpm	+0.2 to +1.0 V	354	
FE-720	Heat exchanger C	0 to +150 gpm	+0.2 to +1.0 V	355	
FE-550	Heat exchanger D	0 to +50 gpm	+0.2 to +1.0 V	356	
Heat Exchanger					
Pressure					
PE-44	Upstream main HX transient pressure	0 to +3000 psig	0.0 to +5.0 V	384	Small spurious spike
PE-526	HX A secondary inlet pressure	0 to +350 psig	0.0 to +5.0 V	401	

Table 3 (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	393	
PDE-46	Main HX bypass transient pressure drop	-200 to +200 psid	-5.0 to +5.0 V	400	
PRIMARY PUMP INSTRUMENTS					
FE-1A	Primary side pump flow	0 to +800 gpm	+1.0 to +5.0 V	357	
PE-76	Pump suction transient pressure	0 to +3000 psig	0 to +5.0 V	385	Spurious spikes
PDE-78	Primary pump transient pressure drop	-1000 to +1000 psid	-5.0 to +5.0 V	394	Spurious spike
SE-72	Primary pump speed	+100 to +5400 rpm	0 to +5.0 V	407	
TE-4B	Base primary steady-state temp., RTD	+32 to +800°F	+0.2 to +0.52 V	353	
PE-16	Downstream HCV-2 transient pressure	0.0 to +3000 psig	0.0 to +5.0 V	402	
PRESSURE SUPPRESSION SYSTEM INSTRUMENTS					
PE-412	Pressure suppression receiver transient pressure	0 to +200 psig	0 to +5.0 V	388	
PE-425	PSS inlet blowdown line transient pressure	0 to +3000 psig	0 to +5.0 V	393	Outlet break only
PE-427	PSS outlet blowdown line transient pressure	0 to +3000 psig	0 to +5.0 V	396	
TE-29	Inlet blowdown plenum T/C	+32 to +1897°F	-0.0027 to +0.0400 V	351	
TE-45	Outlet blowdown plenum T/C	+32 to +1897°F	-0.0027 to +0.0400 V	352	
DEMINERALIZED WATER SYSTEM					
TE-520B	RBT 4-in. demineralized water header T/C	+32 to +1897°F	-0.0027 to +0.0400 V	347	
TE-615	Demineralized water 6-in. header steady-state temp., RTD	+32°F to +500°F	+0.2 to +0.4 V	389	
GENERAL INSTRUMENTATION (ELECTRICAL)					
Breakwire Detectors					
XN-40001	Inlet break	0.0 to +5.0 V	0.0 to +5.0 V	408	Outlet break only
XN-40000	Outlet break	0.0 to +5.0 V	0.0 to +5.0 V	409	Outlet break only

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
GENERAL INSTRUMENTATION (ELECTRICAL) (continued)					
<u>RTD Power</u>					
EIN-1001B	RTD power supply current	2.0 mA	0.400 V	415	
<u>Data Acquisition Calibration Signals</u>					
Zero cal. input	Channels 0-127, gain 0	5.0 mV	5.0 mV	372	
Zero cal. input	Channels 0-127, gain 8	0.0 mV	0.0 mV	473	
Zero cal. input	Channels 128-255	0.0 mV	0.0 mV	474	
Zero cal. input	Channels 256-383	0.0 mV	0.0 mV	475	
Zero cal. input	Channels 384-511	0.0 mV	0.0 mV	476	
Full-scale cal. input	Channels 0-127	35.00 mV	35.00 mV	477	
Full-scale cal. input	Channels 128-255	35.00 mV	35.00 mV	478	
Full-scale cal. input	Channels 256-383	35.00 mV	35.00 mV	479	
Full-scale cal. input	Channels 384-511	35.00 mV	35.00 mV	480	
Spare				481	Ignore