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**PWR Blowdown Heat Transfer
Separate-Effects Program—
Thermal-Hydraulic Test Facility
Experimental Data Report for Test 155**

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Prepared for the U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
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OAK RIDGE NATIONAL LABORATORY
OPERATED BY UNION CARBIDE CORPORATION · FOR THE DEPARTMENT OF ENERGY

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PROGRAM -- THERMAL-HYDRAULIC TEST FACILITY
EXPERIMENTAL DATA REPORT FOR TEST 155

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 155

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

ABSTRACT

Reduced instrument responses are presented for Thermal-Hydraulic Test Facility (THTF) test 155, 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 155 was conducted to obtain thermal-hydraulic and CHF information in the THTF bundle 1 operating at a low power containing four unpowered rods with low outlet subcooling.

The primary purpose of this report is to make the reduced instrument responses during test 155 available. The responses are presented in graphical form in engineering units and have been analyzed only to the extent necessary to assure 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 a 7×7 geometry.

THTF test 155 (conducted February 10, 1977) was the twelfth test conducted in the facility with bundle 1 in place. This test was performed to obtain thermal-hydraulic and CHF information in a bundle operating at low power containing four unpowered rods with low outlet subcooling.

The purpose of this report is to provide the reduced instrument responses during test 155 in a readily usable form to the nuclear community 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 155

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 155 the break configuration was a 40% inlet-60% outlet break 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 (80 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. The power was then decayed with a time constant of ~ 0.45 sec. Rods 19, 24, 39, and 47 were unpowered. Closure of the secondary side heat exchanger valves was initiated at the trip from 80 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.

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

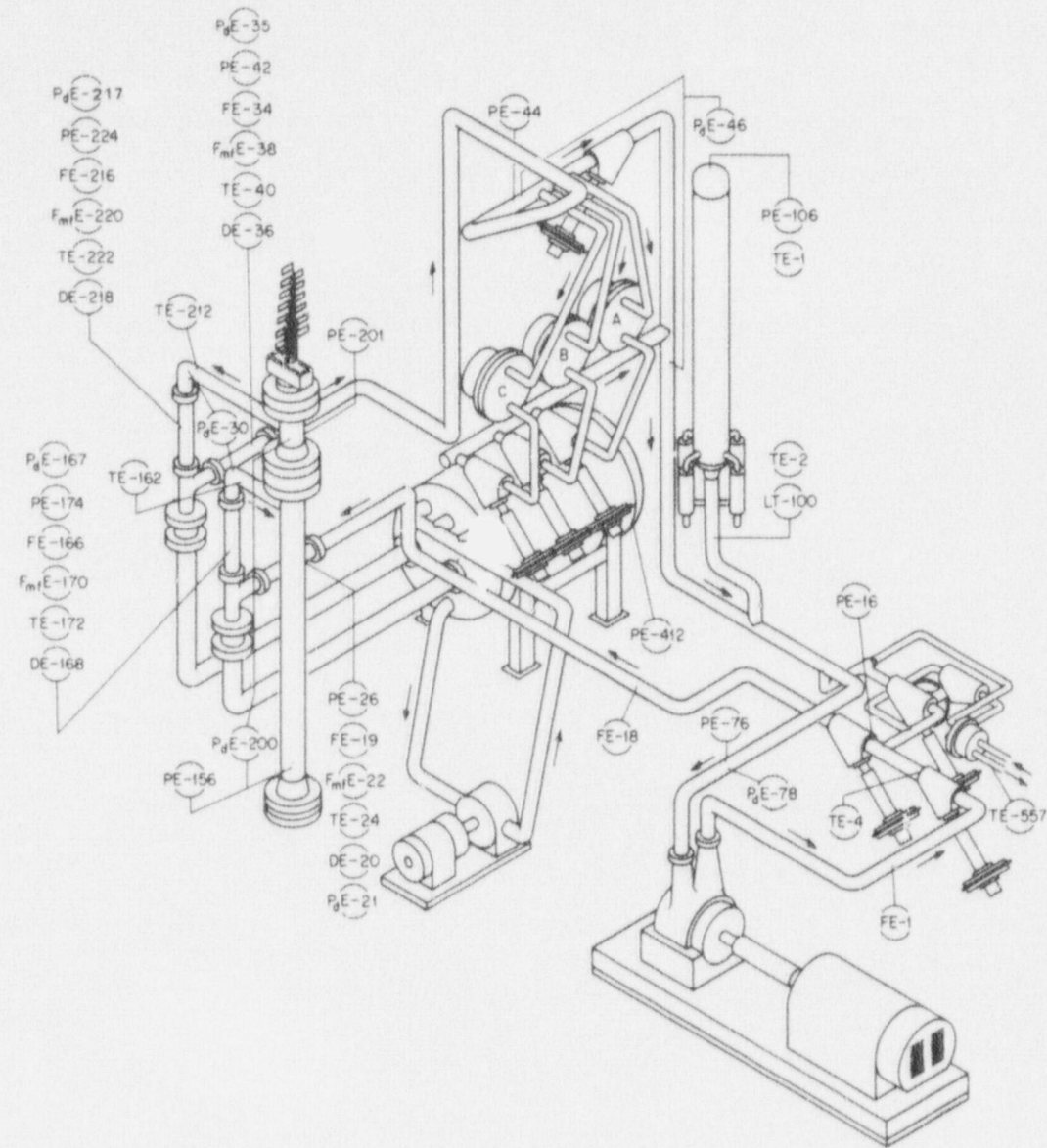


Fig. 1. Thermal-Hydraulic Test Facility (THTF).

During the test, the THTF was successfully subjected to a double-ended pipe break through the rupture assemblies containing the orifice plates. 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 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	PE-201		
MN/m ²		15.513	15.509
psig		2250	2249
Core power	EIE-9, EIE-10, EIE-11, EIE-12		
MW	EEE-9, EEE-10, EEE-11, EEE-12	3.6000	3.591
Number of unpowered rods		4	4
Core volumetric flow rate	FE-19		
m ³ /s		0.0160	0.0174
gpm		254	276
Test section inlet temperature	TE-162		
K		558.2	561.1
°F		545	550
Test section outlet temperature	TE-212		
K		607.0	606.2
°F		633	632
Pressurizer pressure	PE-106		
MN/m ²		15.031	15.197
psig		2180	2204
Mass liquid water			
kg		54.88	77.15
lb _m		121	170
Coolant pump speed	SE-72		
rps		60.52	59.86
rpm		3631	3592
Pressure differential	P _d E-78		
MN/m ²		4.662	4.684
psid		676	679
Pressure between HCV-2 and FCV-18	PE-16		
MN/m ²		17.706	17.582
psig		2568	2550
Pressure differential across main heat exchangers	P _d E-46		
MN/m ²		0.320	0.321
psid		46.4	46.6

^aDesired prerupture conditions are based on programmatic requirements.

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

Table 2. Prerupture primary-coolant temperature and pressure distribution^a test 155

Location	Instrument	Temperature [K (°F)]	Pressure [MN/m ² (psig)]
Vertical inlet spool piece	TE-172	561.1 (550)	
Vertical inlet spool piece	PE-174		15.568 (2258)
Test section inlet	TE-162	561.1 (550)	
Lower plenum	TE-150	563.5 (555)	
Lower plenum	PE-156		15.581 (2260)
Upper plenum	PE-201		15.509 (2249)
Test section outlet	TE-212	606.2 (632)	
Vertical outlet spool piece	TE-222	605.8 (631)	
Vertical outlet spool piece	PE-224		15.422 (2237)
Heat exchanger inlet header	PE-44		15.420 (2236)
Mixed mean temperature downstream heat exchangers	TE-28B	574.4 (574)	
Pressurizer surge line	TE-2	615.6 (648)	
Pressurizer	PE-106		15.197 (2204)
Primary pump suction	PE-76		15.100 (2190)
Between main control valves HCV-2, FCV-18	TE-4B	559.3 (547)	
Between main control valves HCV-2, FCV-18	PE-16		17.582 (2550)

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

Table 3. Sequence of events during test 155

Event	Time relative to rupture (sec)
Core power level established	-7995
Core temperature rise established	-735
Analog tapes and CCDAS fast scan started	-15
Blowdown initiated	0
Pump power tripped	0
Heat exchanger secondary valves closure initiated	+2
Core power tripped to decay	+2
Core power tripped	+3.4

PRE-BLOWDOWN NO. 155 STEADY-STATE POINTS 2/10/77

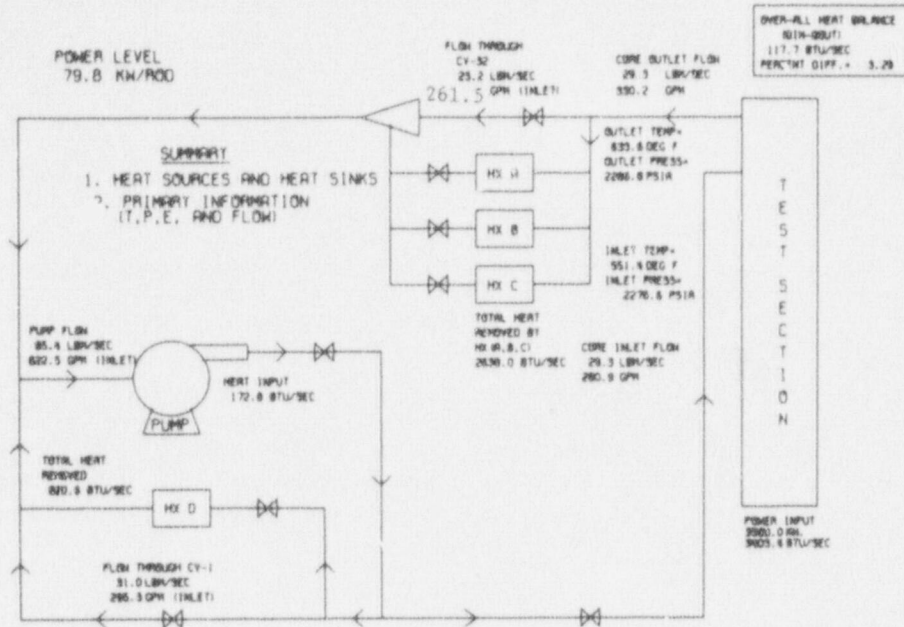


Fig. 2. Prerupture loop energy balance.

PRE-BLOWDOWN NO. 155 STEADY-STATE POINTS 2/10/77

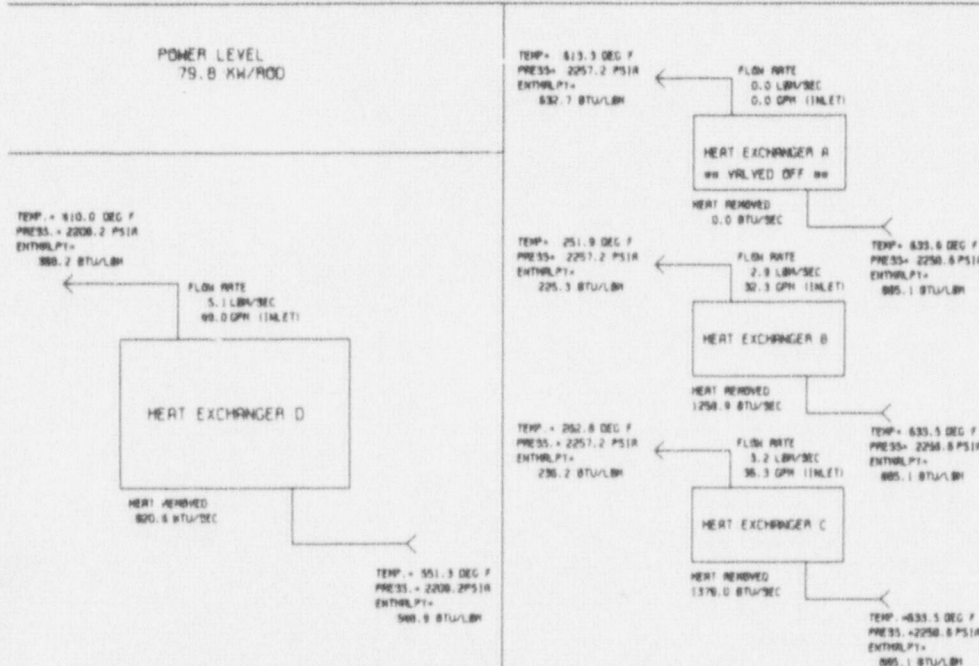


Fig. 3. Prerupture primary side heat exchanger summary.

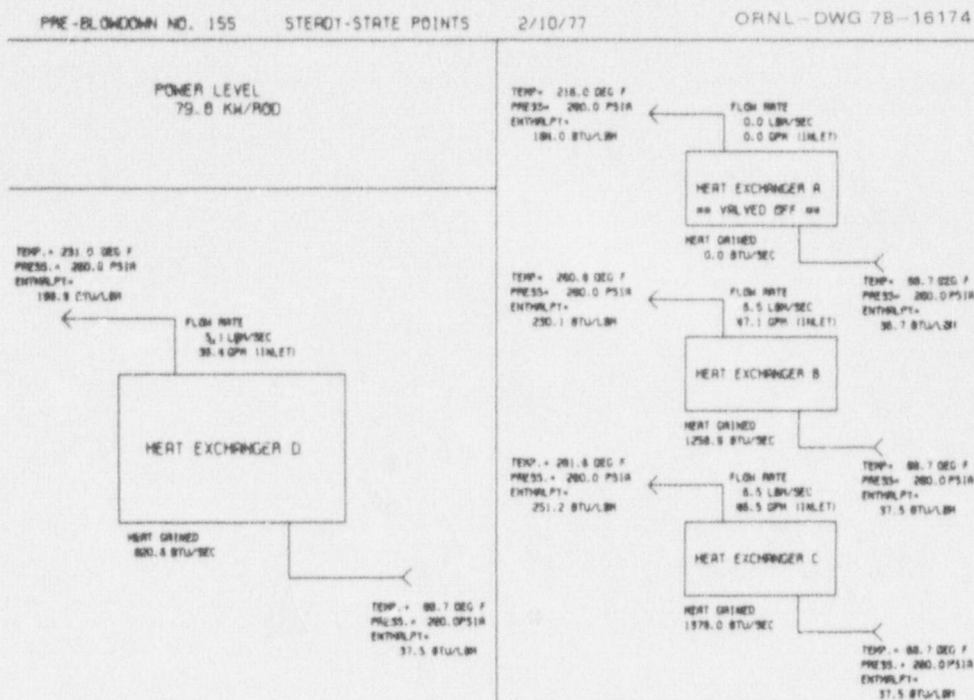


Fig. 4. Prerupture secondary side heat exchanger summary.

III. DATA PRESENTATION

The recorded instrument responses for THTF test 155 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. 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.

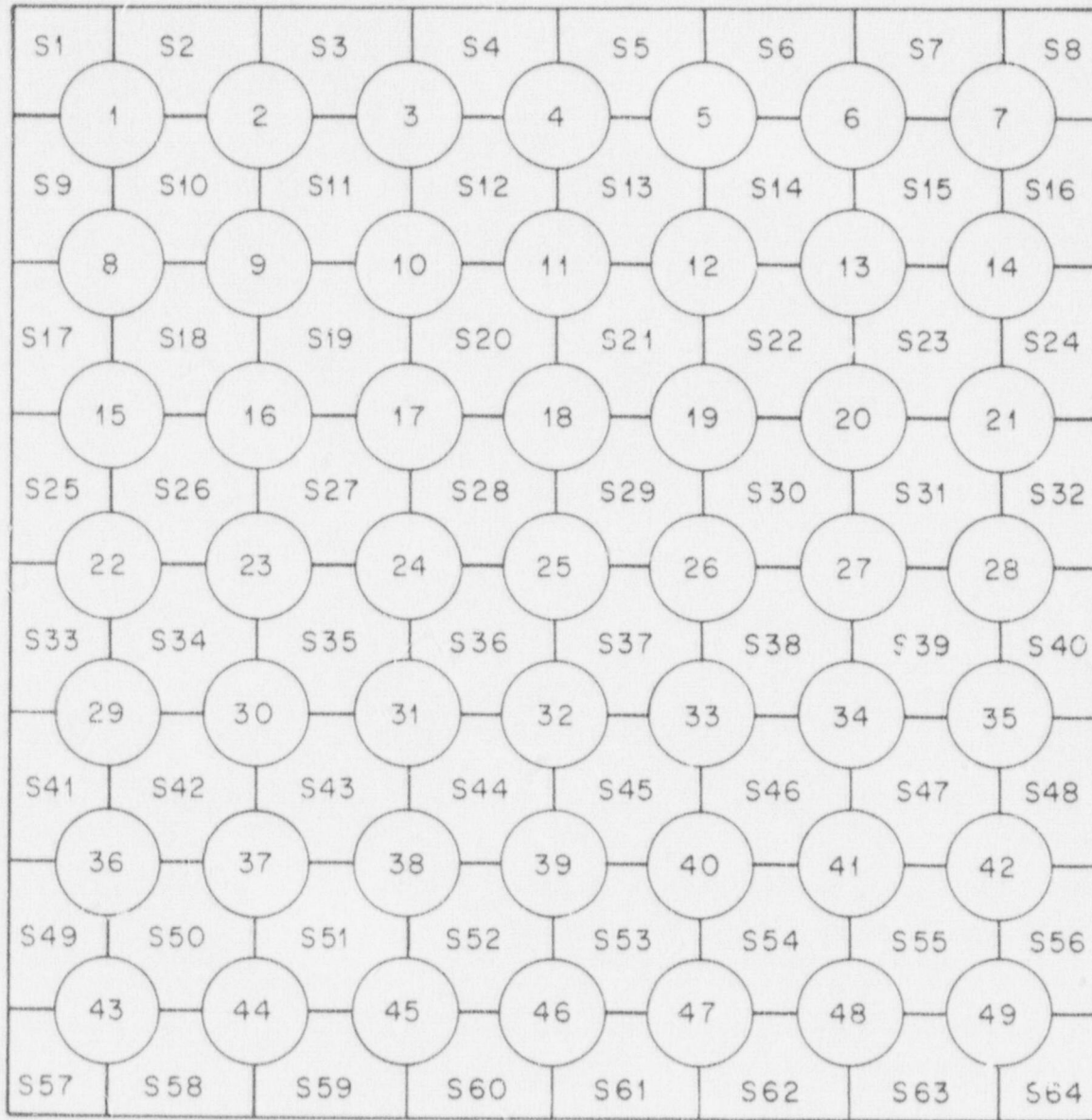


Fig. 5. Identification of THTF heater rod and subchannel locations in bundles 1 and 2.

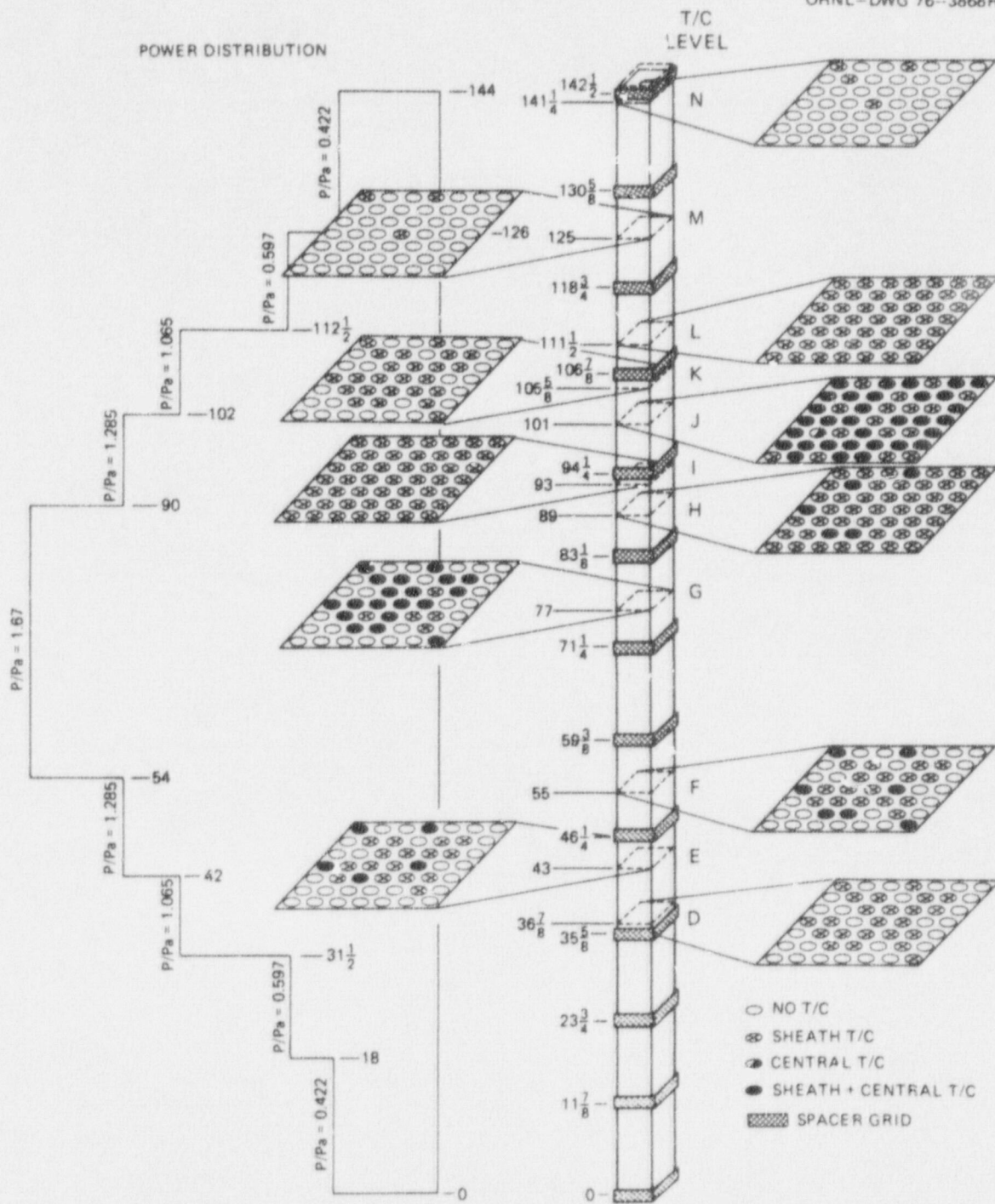


Fig. 6. Location of thermocouples in THTF bundle 1.

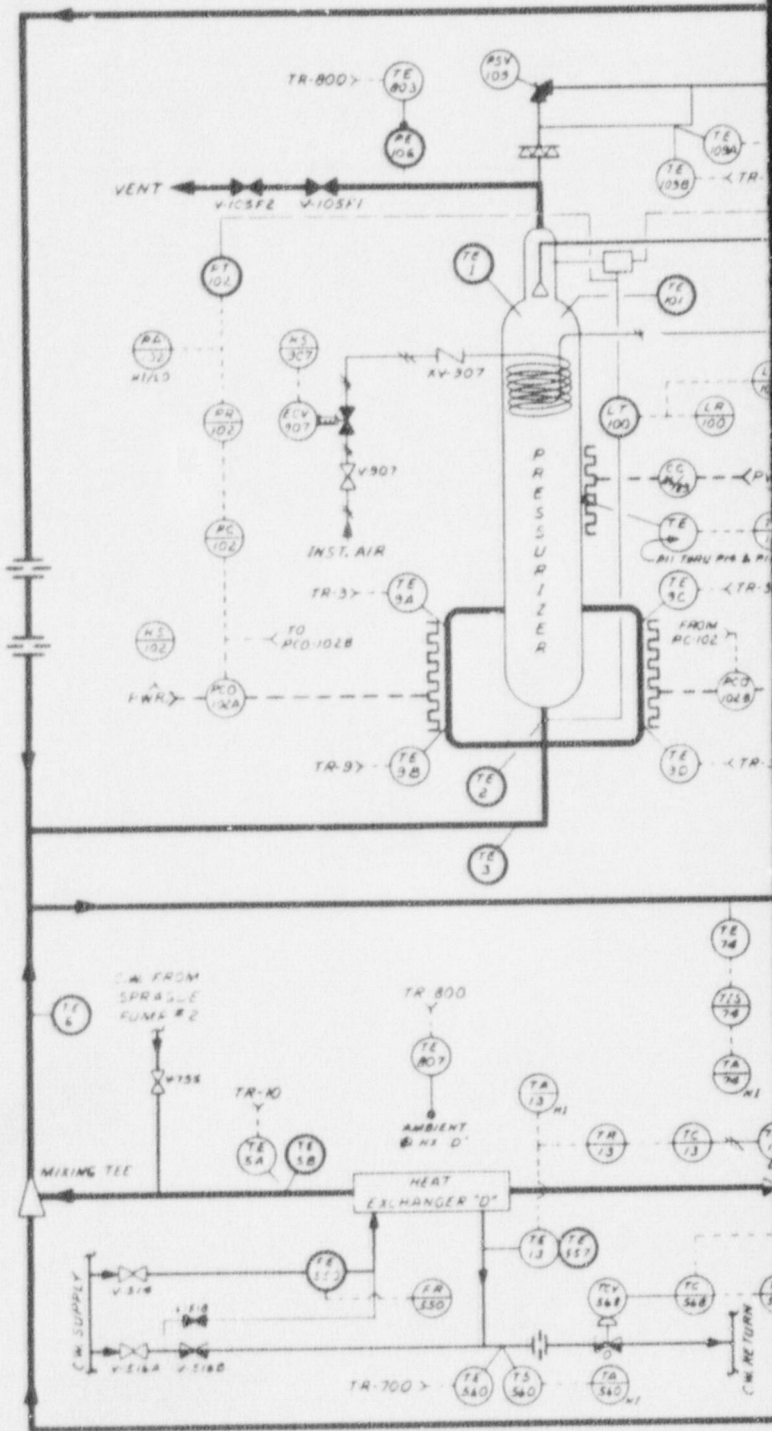
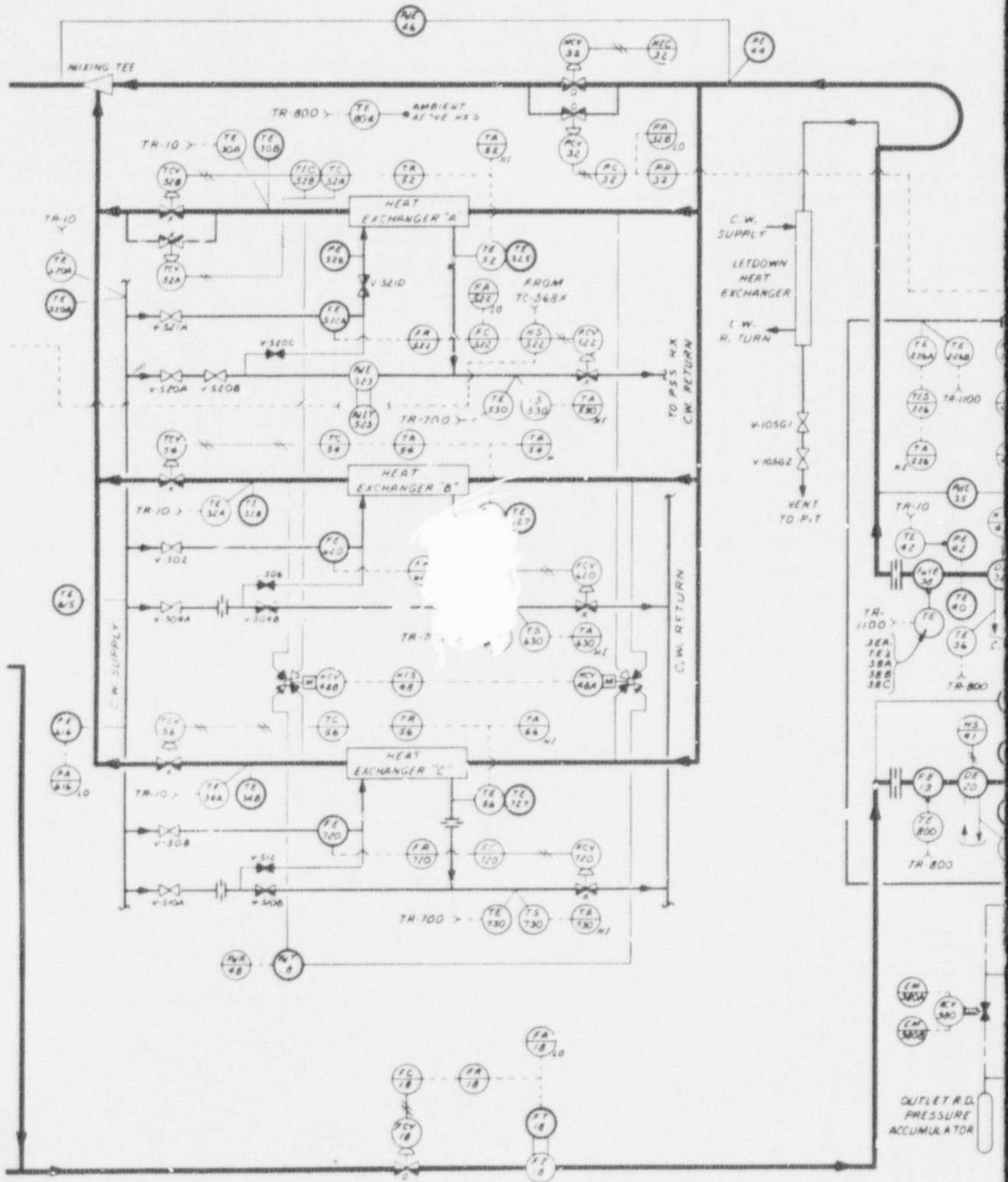


Fig. 7. T



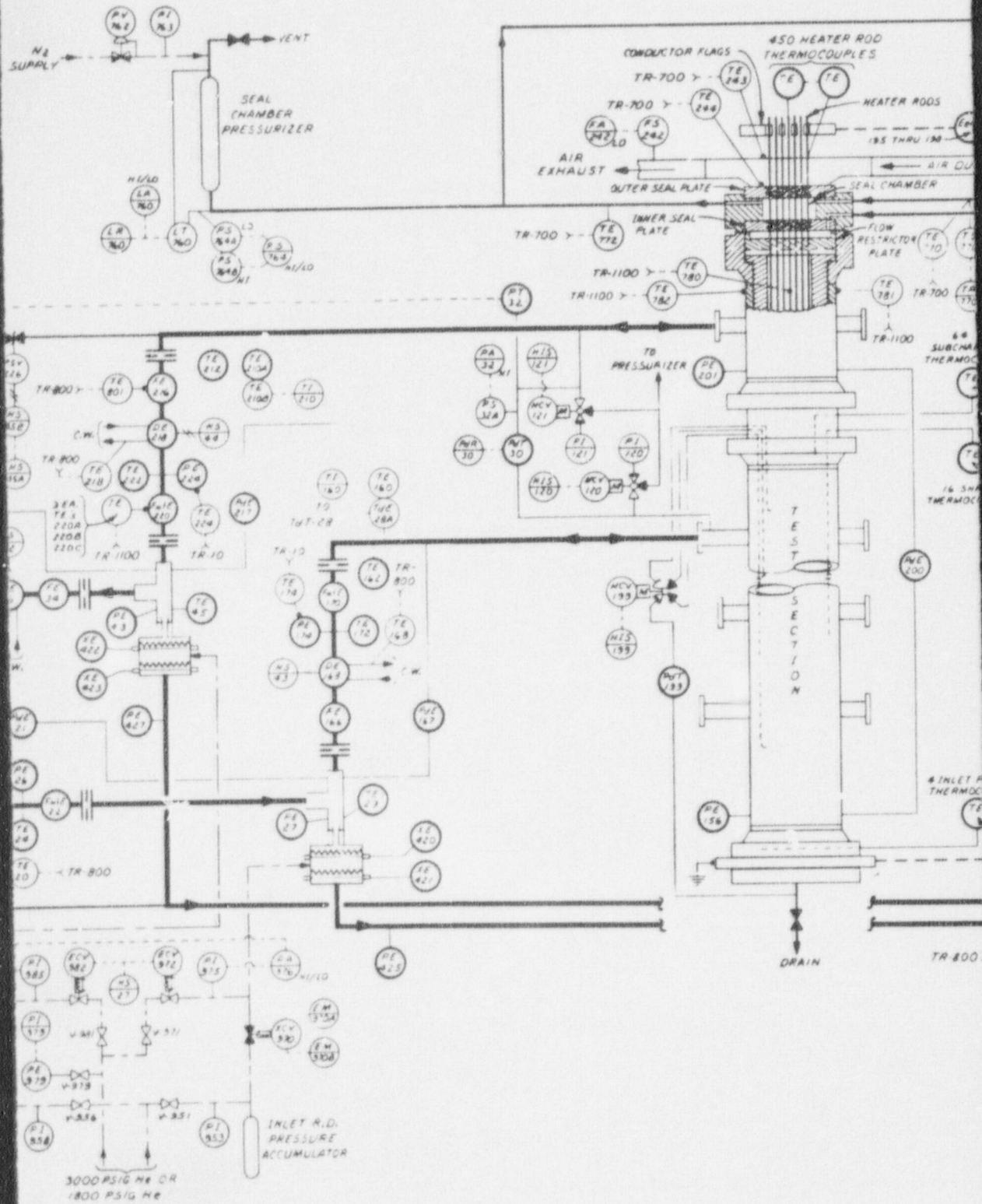


Fig. 7 (continued)

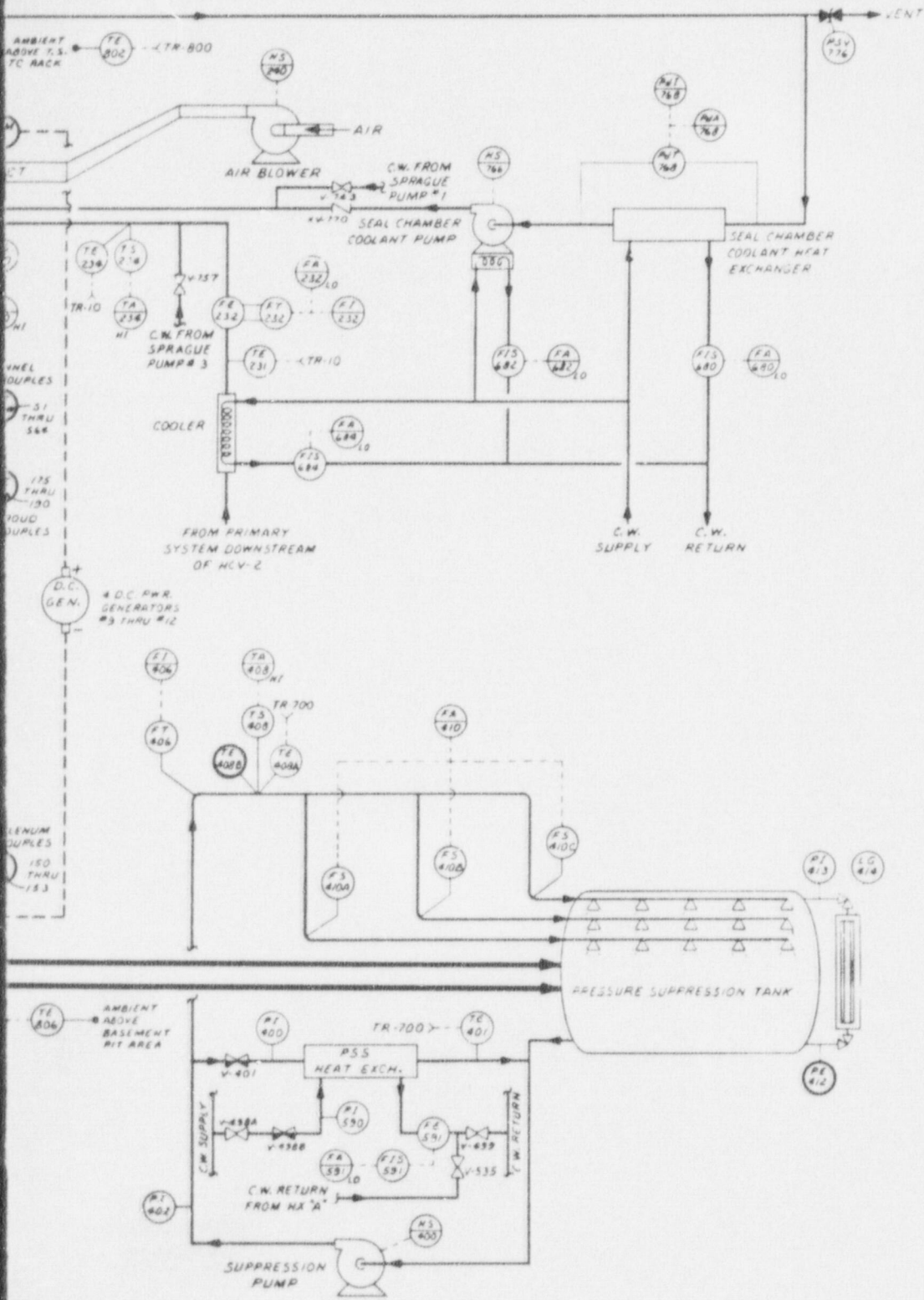


Table 4. Precision of experimental measurements for test 155

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 (°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	+0.0011 -0.0004 (+17.49) (-6.43)
Reverse	+0.0009 -0.0002 (+14.14) (-3.07)
FE-216	
Forward	+0.0008 -0.0001 (+12.88) (-1.81)
Reverse	+0.0009 -0.0002 (+14.46) (-3.39)
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 (lb _m /ft-sec ²)	
CCDAS	2264 (1522)
Analog tape system	2554 (1716)
Density measurement @ 961 kg/m ³ (60 lb _m /ft ³), kg/m ³ (lb _m /ft ³)	12.9 (0.81)

Table 5. Data presentation for test 155

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>Heater Rod Sheath</u>					
	LEVEL D				
TE-301AD	Rod 1			8	
TE-304AD	Rod 4			9	
TE-309AD	Rod 9			10	Small spurious spike
TE-310AD	Rod 10			11	
TE-312AD	Rod 12			12	
TE-313AD	Rod 13			13	
TE-317AD	Rod 17			14	
TE-318AD	Rod 18			15	
TE-320AD	Rod 20			16	
TE-322AD	Rod 22			17	
TE-323AD	Rod 23			18	
TE-325AD	Rod 25			19	
TE-326AD	Rod 26			20	
TE-331AD	Rod 31			21	
TE-338AD	Rod 38			22	
TE-339AD	Rod 39			23	Unpowered rod
TE-341AD	Rod 41			24	
TE-349AD	Rod 49			25	
	LEVEL E				
TE-301AE	Rod 1			26	
TE-304AE	Rod 4			27	
TE-309AE	Rod 9			28	Instrument failed
TE-312AE	Rod 12			29	
TE-313AE	Rod 13			30	
TE-317AE	Rod 17			31	
TE-310AE	Rod 18			32	
TE-320AE	Rod 20			33	
TE-322AE	Rod 22			34	
TE-323AE	Rod 23			35	
TE-324AE	Rod 24			36	
TE-325AE	Rod 25			37	Unpowered rod
TE-326AE	Rod 26			38	
TE-331AE	Rod 31			39	
TE-333AE	Rod 33			40	
TE-338AE	Rod 38			41	

Table 5 (cont. Inuse)

Measurement	Location and comments	Detector	Range	Figure	Measurement comments
BUNDLE TEMPERATURE (continued)					
LEVEL G (continued)					
TE-3268G	Rod 26			75	
TE-3318G	Rod 31			76	
TE-3338G	Rod 33			77	Small spurious spike
TE-3388G	Rod 38			78	Small spurious spikes
TE-3398G	Rod 39			79	Unpowered rod
TE-3418G	Rod 41			80	
TE-3498G	Rod 49			81	Erroneous prior to power trip
LEVEL H					
TE-301CH	Rod 1			82	
TE-303CH	Rod 3			83	
TE-303AB	Rod 3			84	
TE-304CH	Rod 4			85	
TE-305AB	Rod 5			86	
TE-306AB	Rod 6			87	
TE-307AH	Rod 7			88	
TE-308AH	Rod 8			89	
TE-309CH	Rod 9			90	
TE-310CH	Rod 10			91	
TE-311AB	Rod 11			92	
TE-312CH	Rod 12			93	
TE-313CH	Rod 13			94	
TE-314AB	Rod 14			95	
TE-315AB	Rod 15			96	Instrument failed
TE-316AB	Rod 16			97	
TE-317CH	Rod 17			98	
TE-318CH	Rod 18			99	
TE-319CH	Rod 20			100	
TE-321AB	Rod 21			101	
TE-322AB	Rod 22			102	Slightly noisy
TE-323CH	Rod 23			103	Empowered rod
TE-324CH	Rod 24			104	
TE-325CH	Rod 25			105	
TE-326CH	Rod 26			106	
TE-327AB	Rod 27			107	
TE-331CH	Rod 31			108	Slightly noisy
TE-333CH	Rod 33			109	Spurious spike
TE-336AB	Rod 36			110	
TE-337AB	Rod 37			111	
TE-338CH	Rod 38			112	Spurious spike

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	
TE-339DJ	Rod 39			192	Unpowered rod
TE-340CJ	Rod 40			193	
TE-341DJ	Rod 41			194	
TE-342CJ	Rod 42			195	
TE-343CJ	Rod 43			196	
TE-344CJ	Rod 44			197	Small spurious spike
TE-345CJ	Rod 45			198	Small spurious spike
TE-346CJ	Rod 46			199	
TE-349DJ	Rod 49			200	
LEVEL K					
TE-301DK	Rod 1			201	
TE-304DK	Rod 4			202	
TE-309DK	Rod 9			203	
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-322DK	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	Unpowered rod
TE-341DK	Rod 41			219	
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	
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	
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 "			243	
TE-327CL	Rod "			244	
TE-328CL	"			245	
TE-331EL	"			246	
TE-333EL	Rod 33			247	
TE-336CL	Rod 36			248	
TE-337CL	Rod 37			249	
TE-338EL	Rod 38			250	
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	Small spurious spike
TE-346CL	Rod 46			257	
TE-348CL	Rod 48			258	
TE-349EL	Rod 49			259	

Table 5 (continued)

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

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
Heater Rod Center (continued)					
LEVEL E (continued)					
TE-326ME	Rod 26			290	
TE-331ME	Rod 31			291	Instrument failed
TE-338ME	Rod 38			292	
TE-349ME	Rod 49			293	Spurious spike
LEVEL F					
TE-301MF	Rod 1			294	
TE-304MF	Rod 4			295	
TE-322MF	Rod 22			296	
TE-326MF	Rod 26			297	
TE-338MF	Rod 38			298	Spurious spike
TE-349MF	Rod 49			299	Spurious spike
LEVEL G					
TE-301MG	Rod 1			300	
TE-310MG	Rod 10			301	
TE-313MG	Rod 13			302	
TE-317MG	Rod 17			303	
TE-318MG	Rod 18			304	
TE-322MG	Rod 22			305	
TE-323MG	Rod 23			306	
TE-325MG	Rod 25			307	
TE-326MG	Rod 26			308	
TE-338MG	Rod 38			309	
TE-349MG	Rod 49			310	
LEVEL H					
TE-304HH	Rod 4			311	
TE-309HH	Rod 9			312	
TE-318HH	Rod 18			313	
TE-322HH	Rod 22			314	
TE-338HH	Rod 38			315	

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 $\text{lb}_m/\text{ft-sec}^2$	-5.0 to +5.0 V		
FMFE-22	Horizontal inlet			361	Erratic
FMFE-170	Vertical inlet			367	Erratic, zero shifted
FMFE-220	Vertical outlet			373	Erratic
FMFE-38	Horizontal outlet			379	Erratic
<u>Fluid Density</u>					
		0 to +62.4 lb_m/ft^3	0.0 to +10.0 V		
DE-20	Horizontal inlet			359	Large spurious spikes
DE-168	Vertical inlet			365	
DE-218	Vertical outlet			371	
DE-36	Horizontal outlet			377	
<u>TEST SECTION TEMPERATURE</u>					
	Chrome'-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	
TE-179	0.388L/LMAX			332	
TE-180	0.388L/LMAX			333	Erroneous prior to BD
TE-181	0.388L/LMAX			334	Erroneous prior to BD
TE-182	0.388L/LMAX			335	Erroneous prior to BD
TE-183	0.633L/LMAX			336	Erroneous prior to BD
TE-184	0.633L/LMAX			337	Questionable
TE-185	0.633L/LMAX			338	Large spurious spike
TE-186	0.633L/LMAX			339	Erroneous prior to BD
TE-187	0.875L/LMAX			340	Large spurious spike
TE-189	0.875L/LMAX			1	Spurious spikes
TE-190	0.875L/LMAX			342	Spurious spikes

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
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	402	
PE-43	Outlet plenum bottom	0 to +3000 psig	0.0 to +5.0 V	403	
PT-32	Outlet steady state	+500 to +2500 psig	+1.0 to +5.0 V	405	
TEST SECTION PRESSURE DROP					
PDT-199	Shroud box steady-state differential pressure	0 to +50 psid	+1.0 to +5.0 V	390	
PDE-200	Bundle transient differential pressure	-200 to +200 psid	-5.0 to +5.0 V	391	Zero shifted
PDT-30	Test section steady-state differential pressure	0 to +50 psid	+1.0 to +5.0 V	404	
PRESSURIZER INSTRUMENTS					
<u>Temperature</u>					
TE-1	Tank top T/C	+32 to +1897°F	-0.0027 to +0.0400 V	3-9	
TE-2	Tank exit T/C	+32 to +1897°F	-0.0027 to +0.0400 V	350	
<u>Pressure</u>					
PT-102	Steady-state pressure	+500 to +2500 psig	+1.0 to +5.0 V	386	
PE-106	Vapor transient pressure	0 to +4000 psig	0 to +5.0 V	387	
<u>Level</u>					
LT-100	Steady-state liquid level	0 to +150 in.	+1.0 to +5.0 V	409	
HEATER ROD POWER					
<u>Heater Current</u>					
EIE-1186	Rod 1			415	
EIE-1286	Rod 2			416	
EIE-1187	Rod 3			417	
EIE-1287	Rod 4			418	
EIE-9S6	Rod 5			419	
EIE-9S8	Rod 6			420	
EIE-9S5	Rod 7			421	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
HEATER ROD POWER (continued)					
Heater Current (continued)					
EIE-1155	Rod 8			422	
EIE-1156	Rod 9			423	
EIE-1256	Rod 10			424	
EIE-957	Rod 11			425	
EIE-984	Rod 12			426	
EIE-983	Rod 13			427	
EIE-9511	Rod 14			428	
EIE-1154	Rod 15			429	
EIE-1159	Rod 16			430	
EIE-1255	Rod 17			431	
EIE-959	Rod 18			432	
EIE-9810	Rod 19			433	Unpowered rod
EIE-982	Rod 20			434	
EIE-9512	Rod 21			435	
EIE-11511	Rod 22			436	
EIE-11510	Rod 23			437	
EIE-1153	Rod 24			438	Unpowered rod
EIE-9513	Rod 25			439	
EIE-1056	Rod 26			440	
EIE-951	Rod 27			441	
EIE-1057	Rod 28			442	
EIE-1152	Rod 29			443	
EIE-11512	Rod 30			444	
EIE-1252	Rod 31			445	
EIE-1251	Rod 32			446	
EIE-10512	Rod 33			447	
EIE-1055	Rod 34			448	
EIE-1056	Rod 35			449	
EIE-1151	Rod 36			450	
EIE-1254	Rod 37			451	
EIE-1253	Rod 38			452	
EIE-12512	Rod 39			453	Unpowered rod
EIE-10511	Rod 40			454	
EIE-10510	Rod 41			455	
EIE-1059	Rod 42			456	
EIE-1259	Rod 43			457	
EIE-12510	Rod 44			458	
EIE-12511	Rod 45			459	
EIE-1051	Rod 46			460	Unpowered rod
EIE-1052	Rod 47			461	
EIE-1053	Rod 48			462	
EIE-1054	Rod 49			463	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
GENERATOR POWER					
<u>Generator Current</u>					
EIE-9	Generator 9 current	0 to +10,000 A	0.0 to +2.5 V	464	
EIE-10	Generator 10 current			465	
EIE-11	Generator 11 current			466	
EIE-12	Generator 12 current			467	
<u>Generator Voltage</u>					
EEE-9	Generator 9 voltage	0 to +285 V	0.0 to +10.0 V	468	
EEE-10	Generator 10 voltage			469	
EEE-11	Generator 11 voltage			470	
EEE-12	Generator 12 voltage			471	
HEAT EXCHANGER INSTRUMENTS					
<u>Primary Side</u>					
Outlet Line Thermocouples					
TE-308	Heat exchanger A	+32 to +189°F	-0.0027 to +0.0400 V	344	Valved off
TE-328	Heat exchanger B			345	
TE-348	Heat exchanger C			346	
TE-58	Heat exchanger D			348	
TE-288	Main HX mixing tee steady-state temp., RTD	+32 to +800°F	+0.2 to +0.52 V	398	Small spurious spikes
<u>Secondary Side</u>					
Secondary discharge steady-state temp., RTD					
TE-525	Heat exchanger A	+32 to +500°F	+0.2 to +0.4 V	412	Small spurious spike
TE-627	Heat exchanger B			392	Small spurious spike
TE-727	Heat exchanger C			397	Small spurious spike
TE-557	Heat exchanger D			411	Small spurious spike
<u>Heat Exchanger Secondary Flow</u>					
FE-522	Heat exchanger A	0 to +150 gpm	+0.2 to +1.0 V	410	Valved off
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	
<u>Heat Exchanger Pressure</u>					
PE-64	Upstream main HX transient pressure	0 to +3000 psig	0.0 to +5.0 V	384	
PE-526	HX A secondary inlet pressure	0 to +350 psig	0.0 to +5.0 V	400	Valved off

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
GENERAL INSTRUMENTATION (ELECTRICAL) (continued)					
<u>RTD Power</u>					
EIM-1001B	RTD power supply current	2.0 mA	0.400 V	414	
<u>Data Acquisition</u>					
<u>Calibration Signals</u>					
Zero cal. input	Channels 0-127	0.0 mV	0.0 mV	472	
Zero cal. input	Channels 128-255	0.0 mV	0.0 mV	473	
Zero cal. input	Channels 256-383	0.0 mV	0.0 mV	474	
Zero cal. input	Channels 384-511	0.0 mV	0.0 mV	475	
Full-scale cal. input	Channels 0-127	35.00 mV	35.00 mV	476	Spurious spike
Full-scale cal. input	Channels 128-255	35.00 mV	35.00 mV	477	Spurious spike
Full-scale cal. input	Channels 256-383	35.00 mV	35.00 mV	478	Spurious spike
Full-scale cal. input	Channels 384-511	35.00 mV	35.00 mV	479	Spurious spike

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