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PWR Blowdown Heat Transfer Separate-Effects Program— Thermal-Hydraulic Test Facility Experimental Data Report for Test 100

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PWR BLOWDOWN HEAT TRANSFER SEPARATE-EFFECTS PROGRAM — THERMAL-HYDRAULIC TEST FACILITY EXPERIMENTAL DATA REPORT FOR TEST 100

M. D. White R. A. Hedrick

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NOTICE: This document contains information of a preliminary nature. It is subject to revision or correction and therefore does not represent a final report.

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M. D. White R. A. Hedrick

ABSTRACT

Reduced instrument responses are presented for Thermal-Hydraulic Test Facility (THTF) test 100, 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 100 was conducted to investigate the response of heater rod bundle 1 and instrumented spool pieces with flow homogenizing screens to a double-ended rupture with equal break areas at the test section inlet and outlet.

The primary purpose of this report is to make the reduced instrument responses during test 100 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, 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 100 (conducted Apr. 23, 1976) was the first test conducted in the facility with bundle 1 in place. This test was performed to investigate the response of bundle 1 and instrumented spool pieces with flow homogenizing screens to a double-ended rupture with equal break areas at the test section inlet and outlet. This was an isothermal test to provide baseline information on the experimental facility response.

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

II. SYSTEM, PROCEDURES, CONDITIONS, AND EVENTS FOR TEST 100

1. System Configuration and Test Procedures

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 100 a total break area of 12.54 cm^2 (0.0135 ft^2) was divided equally between the test section inlet and outlet rupture assemblies. The THTF experimental system is described further in Ref. 1.

Since test 100 was an isothermal test, no power was applied to the electric core. The main heat exchangers were drained, and the drains and vents were left open.

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 two rupture assemblies containing the orifice

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

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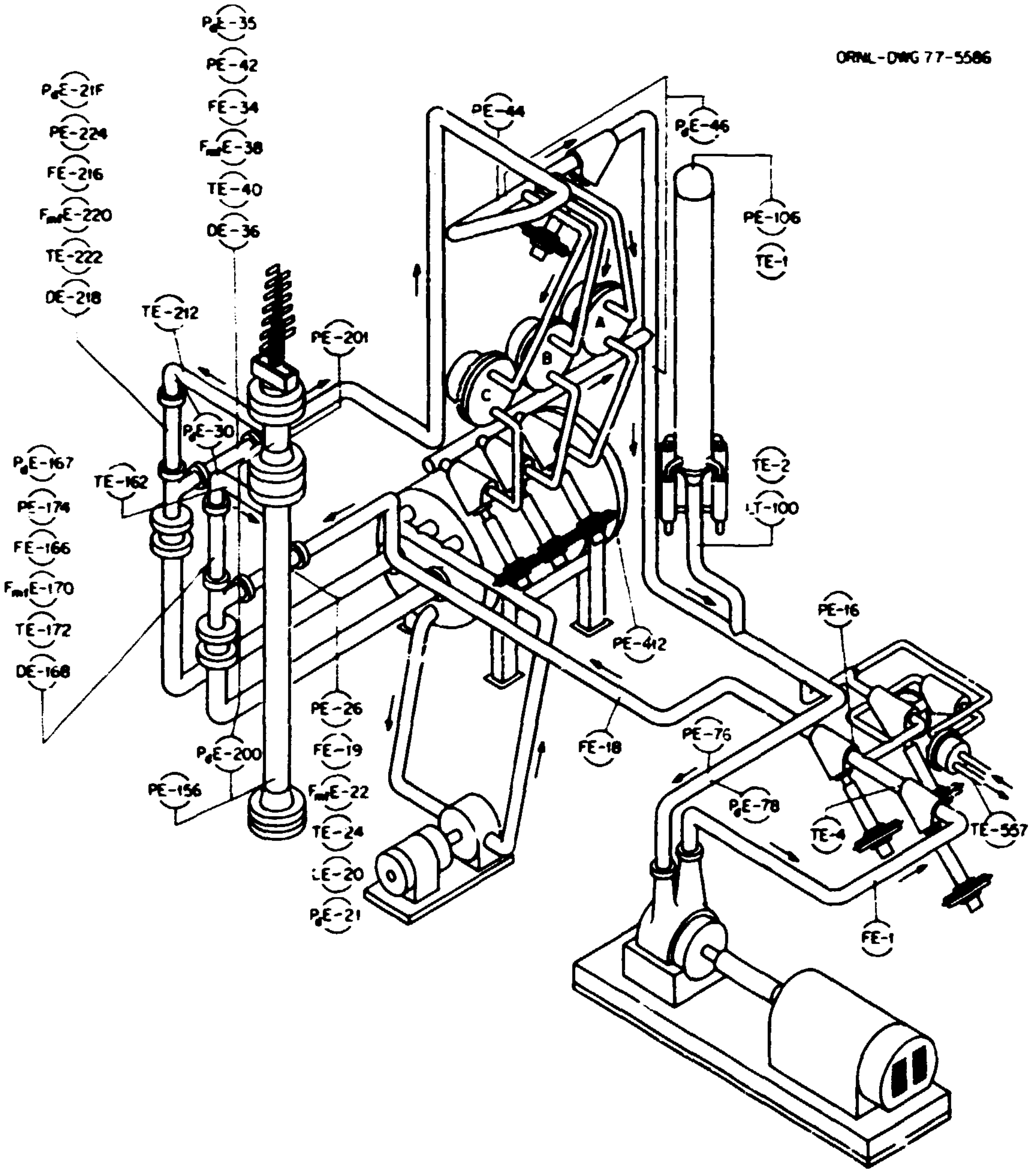

Fig. 1. Thermal-Hydraulic Test Facility (THTF).

plates. 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	PE-201		
MN/m^2		15.513	15.603
psig		2250	2263
Core power	EIE-9, EIE-10, EIE-11, EIE-12 EEE-9, EEE-10, EEE-11, EEE-12	Zero	Zero
Core volumetric flow rate	FE-19		
m^3/s		0.0265	0.0268
gpm		420	425
Test section inlet temperature	TE-162		
°K		559.3	560.9
°F		547	550
Test section outlet temperature	TE-212		
°K		559.3	559.8
°F		547	548
Pressurizer			
Presssure	PE-106		
MN/m^2		14.720	14.851
psig		2135	2154
Mass liquid water			
Kg		51.26	76.88
lb_a		113	169.5
Coolant pump			
Speed	SE-72		
rps		59.67	60.38
rpm		3580	3623
Pressure differential	P_dE-78		
MN/m^2		4.447	4.509
psid		645	654
Pressure between HCV-2 and FCV-18	PE-16		
MN/m^2		16.547	17.361
psig		2400	2518

[a] Desired prerupture conditions are based on programmatic requirements.

[b] Actual 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]

Location	Instrument	Temperature [°K (°F)]	Pressure [MN/m² (psig)]
Vertical inlet spool piece	TE-172	560.4 (549)	
Vertical inlet spool piece	PE-174		15.802 (2292)
Test section inlet	TE-162	560.9 (550)	
Lower plenum	TE-150	559.3 (547)	
Lower plenum	PE-156		15.741 (2283)
Upper plenum	PE-201		15.603 (2263)
Test section outlet	TE-212	559.8 (548)	
Vertical outlet spool piece	TE-222	559.8 (548)	
Vertical outlet spool piece	PE-224		15.534 (2253)
Heat exchanger inlet header	PE-44		15.430 (2235)
Mixed mean temperature			
Downstream heat exchangers	TE-28B	561.5 (551)	
Pressurizer surge line	TE-2	612.0 (642)	
Pressurizer	PE-106		14.851 (2154)
Primary pump suction	PE-76		14.920 (2164)
Between main control valves HCV-2 and FCV-18	TE-4B	557.6 (544)	
Between main control valves HCV-2 and FCV-18	PE-16		17.361 (2518)

[a]Prerupture distribution is based on instrument signals recorded within 10 sec of primary system rupture.

Table 3. Sequence of events during test 100[a]

Event	Time relative to rupture (sec)
Core power level established	N.A.
Core temperature rise established	N.A.
Analog tapes and CCDAS fast scan started	−15
Blowdown initiated	0
Pump power tripped	0
Heat exchanger secondary valves closed	N.A.
Core power tripped	N.A.

[a]N.A. = not applicable.

III. DATA PRESENTATION

The recorded instrument responses for THTF test 100 have been processed only to the extent necessary to obtain appropriate engineering units and to assure reasonableness and consistency. In converting instrument responses to engineering units, a homogeneous fluid has been assumed. Therefore, interpretation or analysis of the data must consider 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 (DAS). Further information on this system may be found in Ref. 1.

Figures 2 through 4 provide supportive information for the instrument responses (on microfiche) 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.

Table 4. Precision of experimental measurements for test 100

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)
Flow measurement, m^3/sec (gpm)	
FE-19	
Forward	+0.0009 −0.0012 (+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 −174.87)
Momentum flux measurement, kg/m-sec^2 (lb_m/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 100

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE	Chromel-Alumel thermocouples	+32 to +1897°F (All)	−0.0[illegible] to +0.0400 V (All)		
Heater Rod Sheath					
	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	
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-333AD	Rod 33			19	Instrument failed before test
TE-338AD	Rod 38			20	
TE-339AD	Rod 39			21	Spurious spike late in transient
TE-341AD	Rod 41			22	
TE-349AD	Rod 49			23	
	LEVEL E				
TE-301AE	Rod 1			24	
TE-304AE	Rod 4			25	Noisy
TE-309AE	Rod 9			26	
TE-310AE	Rod 10			27	Instrument failed before test
TE-312AE	Rod 12			28	Noisy
TE-313AE	Rod 13			29	Noisy
TE-317AE	Rod 17			30	
TE-318AE	Rod 18			31	Noisy
TE-320AE	Rod 20			32	Noisy
TE-322AE	Rod 22			33	
TE-323AE	Rod 23			34	
TE-324AE	Rod 24			35	
TE-325AE	Rod 25			36	
TE-326AE	Rod 26			37	Noisy
TE-331AE	Rod 31			38	
TE-333AE	Rod 33			39	
TE-338AE	Rod 38			40	
TE-339AE	Rod 39			41	
TE-341AE	Rod 41			42	
TE-349AE	Rod 49			43	

CO

Table 5 (continued)

Measurement	Location and comments	Range: Detector	Range: Data acquisition system	Figure	Measurement comments
BUNDLE TEMPERATURE (continued)					
	LEVEL F				
TE-301BF	Rod 1			44	
TE-304BF	Rod 4			45	Noisy
TE-309BF	Rod 9			46	
TE-310BF	Rod 10			47	
TE-312BF	Rod 12			48	Noisy
TE-313BF	Rod 13			49	Noisy
TE-317BF	Rod 17			50	
TE-318BF	Rod 18			51	Instrument failed before test
TE-320BF	Rod 20			52	Noisy
TE-322BF	Rod 22			53	
TE-323BF	Rod 23			54	
TE-324BF	Rod 24			55	
TE-325BF	Rod 25			56	
TE-326BF	Rod 26			57	Noisy
TE-331BF	Rod 31			58	
TE-333BF	Rod 33			59	
TE-338BF	Rod 38			60	
TE-339BF	Rod 39			61	Instrument failed before test
TE-341BF	Rod 41			62	
TE-349BF	Rod 49			63	
	LEVEL G				
TE-301BG	Rod 1			64	
TE-304BG	Rod 4			65	Noisy
TE-309BG	Rod 9			66	
TE-310BG	Rod 10			67	
TE-312BG	Rod 12			68	Noisy
TE-313BG	Rod 13			69	Noisy
TE-317BG	Rod 17			70	
TE-318BG	Rod 18			71	Noisy
TE-320BG	Rod 20			72	Noisy
TE-322BG	Rod 22			73	
TE-323BG	Rod 23			74	
TE-324BG	Rod 24			75	Instrument failed before test
TE-325BG	Rod 25			76	
TE-326BG	Rod 26			77	Noisy
TE-331BG	Rod 31			78	
TE-333BG	Rod 33			79	
TE-338BG	Rod 38			80	Spurious spike late in transient
TE-339BG	Rod 39			81	Spurious spike late in transient
TE-341BG	Rod 41			82	
TE-349BG	Rod 49			83	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
	LEVEL H				
TE-301CH	Rod 1			84	
TE-302AH	Rod 2			85	
TE-303AH	Rod 3			86	
TE-304CH	Rod 4			87	Noisy
TE-305AH	Rod 5			88	Noisy
TE-306AH	Rod 6			89	Noisy
TE-307AH	Rod 7			90	Noisy
TE-308AH	Rod 8			91	
TE-309CH	Rod 9			92	
TE-310CH	Rod 10			93	
TE-311AH	Rod 11			94	Noisy
TE-312CH	Rod 12			95	Noisy
TE-313CH	Rod 13			96	Noisy
TE-314AH	Rod [illegible]			97	Noisy
TE-315AH	Rod 15			98	
TE-316AH	Rod 16			99	
TE-317CH	Rod 17			100	
TE-318CH	Rod 18			101	Noisy
TE-320CH	Rod 20			102	Noisy
TE-321AH	Rod 21			103	Noisy
TE-322CH	Rod 22			104	
TE-323CH	Rod 23			105	
TE-324CH	Rod 24			106	
TE-325CH	Rod 25			107	
TE-326CH	Rod 26			108	Noisy
TE-327AH	Rod 27			109	Noisy
TE-328AH	Rod 28			110	Noisy
TE-331CH	Rod 31			111	
TE-333CH	Rod 33			112	
TE-336AH	Rod 36			113	
TE-337AH	Rod 37			114	
TE-338CH	Rod 38			115	
TE-339CH	Rod 39			116	
TE-340AH	Rod 40			117	Noisy
TE-341CH	Rod 41			118	
TE-342AH	Rod 42			119	
TE-343AH	Rod 43			[illegible]	
TE-344AH	Rod 44			[illegible]	
TE-345AH	Rod 45			[illegible]	
TE-346AH	Rod 46			123	
TE-348AH	Rod 48			124	
TE-349CH	Rod 49			125	

Table 5 (continued)

Measurement	Location and comments	Range: Detector	Range: Data acquisition system	Figure	Measurement comments
BUNDLE TEMPERATURE (continued)					
	LEVEL I				
TE-301CI	Rod 1			126	
TE-302AI	Rod 2			127	
TE-303AI	Rod 3			128	
TE-304CI	Rod 4			129	Noisy
TE-305AI	Rod 5			130	Noisy
TE-306AI	Rod 6			131	Noisy
TE-307AI	Rod 7			132	Noisy
TE-308AI	Rod 8			133	
TE-309CI	Rod 9			134	
TE-310CI	Rod 10			135	
TE-311AI	Rod 11			136	Noisy
TE-312CI	Rod 12			137	Noisy
TE-313CI	Rod 13			138	Noisy
TE-314AI	Rod 14			139	Noisy
TE-315AI	Rod 15			140	
TE-316AI	Rod 16			141	
TE-317CI	Rod 17			142	
TE-318CI	Rod 18			143	Noisy
TE-320CI	Rod 20			144	Noisy
TE-321AI	Rod 21			145	Noisy
TE-322CI	Rod 22			146	
TE-323CI	Rod 23			147	
TE-324CI	Rod 24			148	
TE-325CI	Rod 25			149	
TE-326CI	Rod 26			150	Noisy
TE-327AI	Rod 27			151	Noisy
TE-328AI	Rod 28			152	Noisy
TE-331CI	Rod 31			153	
TE-333CI	Rod 33			154	
TE-336AI	Rod 36			155	
TE-337AI	Rod 37			156	
TE-338CI	Rod 38			157	Spurious spikes
TE-339CI	Rod 39			158	
TE-340AI	Rod 40			159	Noisy
TE-341CI	Rod 41			160	
TE-342AI	Rod 42			161	
TE-343AI	Rod 43			162	
TE-344AI	Rod 44			163	
TE-345AI	Rod 45			164	Spurious spike late in transient
TE-346AI	Rod 46			165	Spurious spike late in transient
TE-348AI	Rod 48			166	
TE-349CI	Rod 49			167	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
	LEVEL J				
TE-301DJ	Rod 1			168	
TE-302CJ	Rod 2			169	
TE-303CJ	Rod 3			170	
TE-304DJ	Rod 4			171	Noisy
TE-305CJ	Rod 5			172	Noisy
TE-306CJ	Rod 6			173	Noisy
TE-307CJ	Rod 7			174	Noisy
TE-308CJ	Rod 8			175	
TE-309DJ	Rod 9			176	
TE-310DJ	Rod 10			177	
TE-311CJ	Rod 11			178	Noisy
TE-312DJ	Rod 12			179	Noisy
TE-313DJ	Rod 13			180	Noisy
TE-314CJ	Rod 14			181	Noisy
TE-315CJ	Rod 15			182	
TE-316CJ	Rod 16			183	
TE-317DJ	Rod 17			184	
TE-318DJ	Rod 18			185	Noisy
TE-320DJ	Rod 20			186	Noisy
TE-321CJ	Rod 21			187	Noisy
TE-322DJ	Rod 22			188	
TE-323DJ	Rod 23			189	
TE-324DJ	Rod 24			190	
TE-325DJ	Rod 25			191	
TE-326DJ	Rod 26			192	Noisy
TE-327CJ	Rod 27			193	Noisy
TE-328CJ	Rod 28			194	Noisy
TE-331DJ	Rod 31			195	
TE-333DJ	Rod 33			196	
TE-336CJ	Rod 36			197	
TE-337CJ	Rod 37			198	
TE-338DJ	Rod 38			199	Spurious spikes
TE-339DJ	Rod 39			200	
TE-340CJ	Rod 40			201	
TE-341DJ	Rod 41			202	
TE-342CJ	Rod 42			203	
TE-343CJ	Rod 43			204	
TE-344CJ	Rod 44			205	
TE-345CJ	Rod 45			206	
TE-346CJ	Rod 46			207	
TE-347CJ	Rod 47			208	
TE-348CJ	Rod 48			209	Instrument failed before test
TE-349DJ	Rod 49			210	Spurious spikes

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
	LEVEL K				
TE-301DK	Rod 1			211	Spurious spikes
TE-304DK	Rod 4			212	Noisy
TE-309DK	Rod 9			213	
TE-310DK	Rod 10			214	
TE-312DK	Rod 12			215	Noisy
TE-313DK	Rod 13			216	Noisy
TE-317DK	Rod 17			217	
TE-318DK	Rod 18			218	Noisy
TE-320DK	Rod 20			219	Noisy
TE-322DK	Rod 22			220	
TE-323DK	Rod 23			221	
TE-324DK	Rod 24			222	
TE-325DK	Rod 25			223	
TE-326DK	Rod 26			224	Noisy
TE-331DK	Rod 31			225	
TE-333DK	Rod 33			226	
TE-338DK	Rod 38			227	
TE-339DK	Rod 39			228	
TE-341DK	Rod 41			229	
TE-349DK	Rod 49			230	
	LEVEL L				
TE-301EL	Rod 1			231	
TE-302CL	Rod 2			232	
TE-303CL	Rod 3			233	
TE-304EL	Rod 4			234	Noisy
TE-305CL	Rod 5			235	Noisy
TE-306CL	Rod 6			236	Noisy
TE-307CL	Rod 7			237	Noisy
TE-308CL	Rod 8			238	
TE-309EL	Rod 9			239	
TE-310EL	Rod 10			240	
TE-311CL	Rod 11			241	Noisy
TE-312EL	Rod 12			242	Noisy
TE-313EL	Rod 13			243	Noisy
TE-314CL	Rod 14			244	Instrument failed before test
TE-315CL	Rod 15			245	
TE-316CL	Rod 16			246	
TE-317EL	Rod 17			247	
TE-318EL	Rod 18			248	Noisy
TE-320EL	Rod 20			249	Noisy
TE-321CL	Rod 21			250	Noisy
TE-322EL	Rod 22			251	
TE-323EL	Rod 23			252	
TE-324EL	Rod 24			253	
TE-325EL	Rod 25			254	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
BUNDLE TEMPERATURE (continued)					
	LEVEL L (continued)				
TE-326EL	Rod 26			255	Noisy
TE-327CL	Rod 27			256	Noisy
TE-328CL	Rod 28			257	Noisy
TE-331EL	Rod 31			258	
TE-333EL	Rod 33			259	
TE-336CL	Rod 36			260	
TE-337CL	Rod 37			261	
TE-338EL	Rod 38			262	Spurious spike late in transient
TE-339EL	Rod 39			263	
TE-340CL	Rod 40			264	
TE-341EL	Rod 41			265	
TE-342CL	Rod 42			266	
TE-343CL	Rod 43			267	
TE-344CL	Rod 44			268	Spurious spike late in transient
TE-345CL	Rod 45			269	Spurious spike late in transient
TE-346CL	Rod 46			270	
TE-347CL	Rod 47			271	
TE-348CL	Rod 48			272	
TE-349EL	Rod 49			273	
	LEVEL M				
TE-301EM	Rod 1			274	
TE-304EM	Rod 4			275	Noisy
TE-309EM	Rod 9			276	
TE-325EM	Rod 25			277	
	LEVEL N				
TE-301FN	Rod 1			278	
TE-304FN	Rod 4			279	Noisy
TE-325FN	Rod 25			280	
	LEVEL O				
TE-301FO	Rod 1			281	
TE-304FO	Rod 4			282	Noisy
TE-309FO	Rod 9			283	
TE-310EO	Rod 10			284	
TE-312EO	Rod 12			285	Noisy
TE-313EO	Rod 13			286	Instrument failed before test

Table 5 (continued)

Measurement	Location and comments	Range: Detector	Range: Data acquisition system	Figure	Measurement comments
BUNDLE TEMPERATURE (continued)					
	LEVEL O (continued)				
TE-317EO	Rod 17			287	
TE-318EO	Rod 18			288	Noisy
TE-320EO	Rod 20			289	Noisy
TE-322EO	Rod 22			290	
TE-323EO	Rod 23			291	
TE-324EO	Rod 24			292	
TE-325EO	Rod 25			293	
TE-326EO	Rod 26			294	Noisy
TE-331EO	Rod 31			295	Noisy
TE-333EO	Rod 33			296	
TE-338EO	Rod 38			297	
TE-339EO	Rod 39			298	
TE-341EO	Rod 41			299	
TE-349EO	Rod 49			300	
Heater Rod Center					
	LEVEL E				
TE-301HE	Rod 1			301	Spurious spikes early in transient
TE-318HE	Rod 18			302	
TE-322HE	Rod 22			303	
	LEVEL F				
TE-301HF	Rod 1			304	
TE-318HF	Rod 18			305	
TE-322HF	Rod 22			306	
	LEVEL G				
TE-301HG	Rod 1			307	
TE-318HG	Rod 18			308	
TE-322HG	Rod 22			309	
TE-325HG	Rod 25			310	
	LEVEL H				
TE-318HH	Rod 18			311	
TE-322HH	Rod 22			312	
	LEVEL J				
TE-301HJ	Rod 1			313	
TE-322HJ	Rod 22			314	

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		
Bundle Shroud					
TE-175	0.142L/LMAX			324	
TE-176	0.142L/LMAX			325	
TE-177	0.142L/LMAX			326	
TE-178	0.142L/LMAX			327	
TE-179	0.388L/LMAX			328	
TE-180	C.388L/LMAX			329	Questionable
TE-181	0.388L/LMAX			330	Questionable
TE-182	0.388L/LMAX			331	Questionable
TE-183	0.633L/LMAX			332	
TE-184	0.633L/LMAX			333	
TE-185	0.633L/LMAX			334	
TE-186	0.633L/LMAX			335	Questionable
TE-187	0.875L/LMAX			336	Questionable
TE-188	0.875L/LMAX			337	
TE-189	0.875L/LMAX			338	Noisy
TE-190	0.875L/LMAX			339	
Bundle Subchannel					
TE-S1	Subchannel 1			473	
TE-S2	Subchannel 2			474	
TE-S3	Subchannel 3			475	
TE-S4	Subchannel 4			476	
TE-S5	Subchannel 5			477	
TR-S6	Subchannel 6			478	
TE-S7	Subchannel 7			479	
TE-S8	Subchannel 8			480	Instrument failed before transient
TE-S9	Subchannel 9			481	
TE-S10	Subchannel 10			482	
TE-S11	Subchannel 11			483	
TE-S13	Subchannel 13			484	Instrument failed before transient
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	

Table 5 (continued)

Measurement	Location and comments	Range: Detector	Range: Data acquisition system	Figure	Measurement comments
TEST SECTION TEMPERATURE (continued)					
<u>**Bundle Subchannel**</u> **(continued)**					
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	
TE-S37	Subchannel 37			501	
TE-S46	Subchannel 46			502	
TE-S55	Subchannel 55			503	
TE-S64	Subchannel 64			504	
<u>**Test Section**</u>					
TE-162	Inlet line T/C			319	
TE-150	Bottom flange T/C			320	
TE-151	Bottom flange T/C			321	
TE-152	Bottom flange T/C			322	
TE-153	Bottom flange T/C			323	
TE-212	Outlet line T/C			340	
TE-210A	Outlet line RTD (steady state)	+32 to +800°F	+0.2 to +0.52V	402	
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	394	
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	384	Instrument indicated zero shift
TEST SECTION PRESSURE DROP					
PDT-199	Shroud box steady-state differential pressure	0 to +50 psid	+1.0 to +5.0 V	372	Instrument indicated zero shift
PDE-200	Bundle transient differential pressure	−50 to +50 psid	-5.0 to +5.0 V	373	Instrument indicated zero shift
PDT-30	Test section steady-state differential pressure	0 to +50 psid	+1.0 to +5.0 V	393	Instrument indicated zero shift

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			315	
TE-172	Vertical inlet			316	
TE-222	Vertical outlet			317	
TE-40	Horizontal outlet			318	
<u>Pressure</u>		0 to + 3000 psig	0.0 to + 5.0 V		
PE-26	Horizontal inlet			359	
PE-174	Vertical inlet			360	
PE-224	Vertical outlet			363	
PE-42	Horizontal outlet			364	
<u>Pressure Drop</u>		-200 to +200 psid	-5.0 to +5.0 V		
PDE-21	Horizontal inlet			369	
PDE-167	Vertical inlet			370	
PDE-217	Vertical outlet			375	
PDE-35	Horizontal outlet			374	
<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 $lb_m/ft\text{-}sec^2$	-5.0 to +5.0 V		
FMFE-22	Horizontal inlet			384	
FMFE-170	Vertical inlet			385	Instrument indicated zero shift
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	Unreliable
DE-168	Vertical inlet			462	Unreliable
DE-218	Vertical outlet			463	
DE-36	Horizontal outlet			464	

Table 5 (continued)

Measurement	Location and comments	Range: Detector	Range: Data acquisition system	Figure	Measurement comments
PRESSURIZER INSTRUMENTS					
<u>Temperature</u>					
TE-1	Tank top T/C	+32 to +1497°F	0.0027 to +0.0400 V	146	
TE-2	Tank exit T/C	+32 to +1897°F	0.0027 to +0.0400 V	147	
<u>Pressure</u>					
PT-102	Steady-state pressure	+500 to +2500 psig	+1.0 to +5.0 V	167	Instrument indicated zero shift
PE-106	Vapor transient pressure	0 to +3000 psig	0 to +5.0 V	168	
<u>Level</u>					
LT-100	Steady-state liquid level	0 to +130 in.	+1.0 to +5.0 V	198	
HEATER ROD POWER					
<u>Heat·c Current</u>		0 to +800 A	0.0 to +5.0 V		
EIE-11S6	Rod 1			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	

Table 5 (continued)

Measurement	Location and comments	Range: Detector	Range: Data acquisition system	Figure	Measurement comments
HEATER ROD POWER (continued)					
<u>Heater Current</u> (continued)					
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-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	
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					
<u>Generator Current</u>		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	
<u>Generator Voltage</u>		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	

Table 5 (continued)

Measurement	Location and comments	Range		Figure	Measurement comments
		Detector	Data acquisition system		
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-5B	Heat exchanger D			345	
TE-28B	Main HX 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	
TE-627	Heat exchanger B			376	
TE-727	Heat exchanger C			381	Noisy
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	Noisy
FE-620	Heat exchanger B	0 to +150 gpm	+0.. 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	
Heat Exchanger Pressure					
PE-44	Upstream main HX transient pressure	0 to +3000 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	
Pressure Drop					
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	Instrument saturated at ~1.0 sec
PRIMARY PUMP INSTRUMENTS					
FE-1A	Primary side pump flow	0 to +200 gpm	+1.0 to +5.0 V	354	Instrument saturated at ~1.0 sec
PE-76	Pump suction transient pressure	0 to +3000 psig	0 to +5.0 V	366	
PDE-76	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	

Table 5 (continued)

Measurement	Location and comments	Range: Detector	Range: Data acquisition system	Figure	Measurement comments
PRIMARY PUMP INSTRUMENTS (continued)					
TE-48	Base primary steady-state temp., RTD	+32 to +800°F	+0.2 to +0.52 V	350	
PE-16	Downs... a MCV-2 transient pressure	0.0 to +3000 psig	0.0 to +5.0 V	390	
PRESSURE SUPPRESSION SYSTEM INSTRUMENTS					
PE-412	Pressure suppression receiver transient pressure	0 to +200 psig	0 to +5.0 V	369	Instrument indicated slight zero shift
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	
DEMINERALIZED WATER SYSTEM					
TE-520B	RBT 4 in. demineralized water header T/C	+32 to +1897°F	−0.0027 to +0.0400 V	344	
TE-615	Demineralized water 6-in. header steady-state temp., RTD	+32°F to +500°F	+0.2 to +0.4 V	371	Noisy
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	433	
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	
Full-scale cal. input	Channels 128–255	35.00 mV	35.00 mV	470	
Full-scale cal. input	Channels 256–383	35.00 mV	35.00 mV	471	
Full-scale Cal. input	Channels 384–511	35.00 mV	35.00 mV	472	

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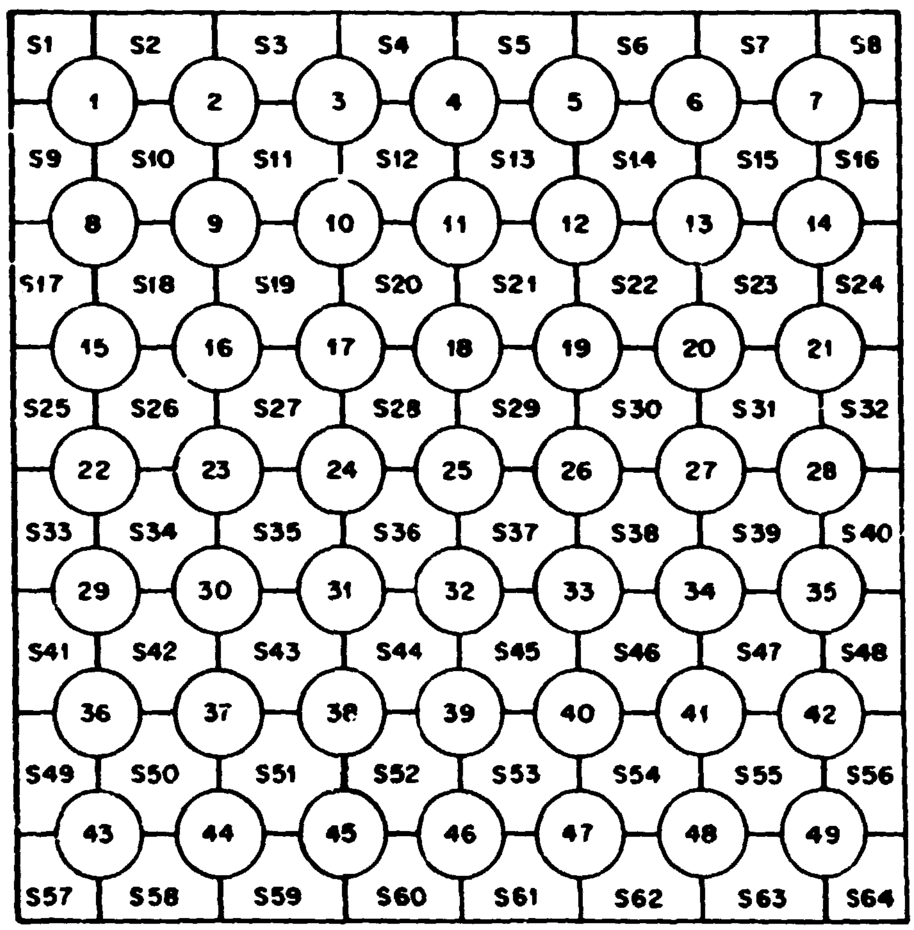

Fig. 2. Identification of THTF heater rod and subchannel locations in bundles 1 and 2.

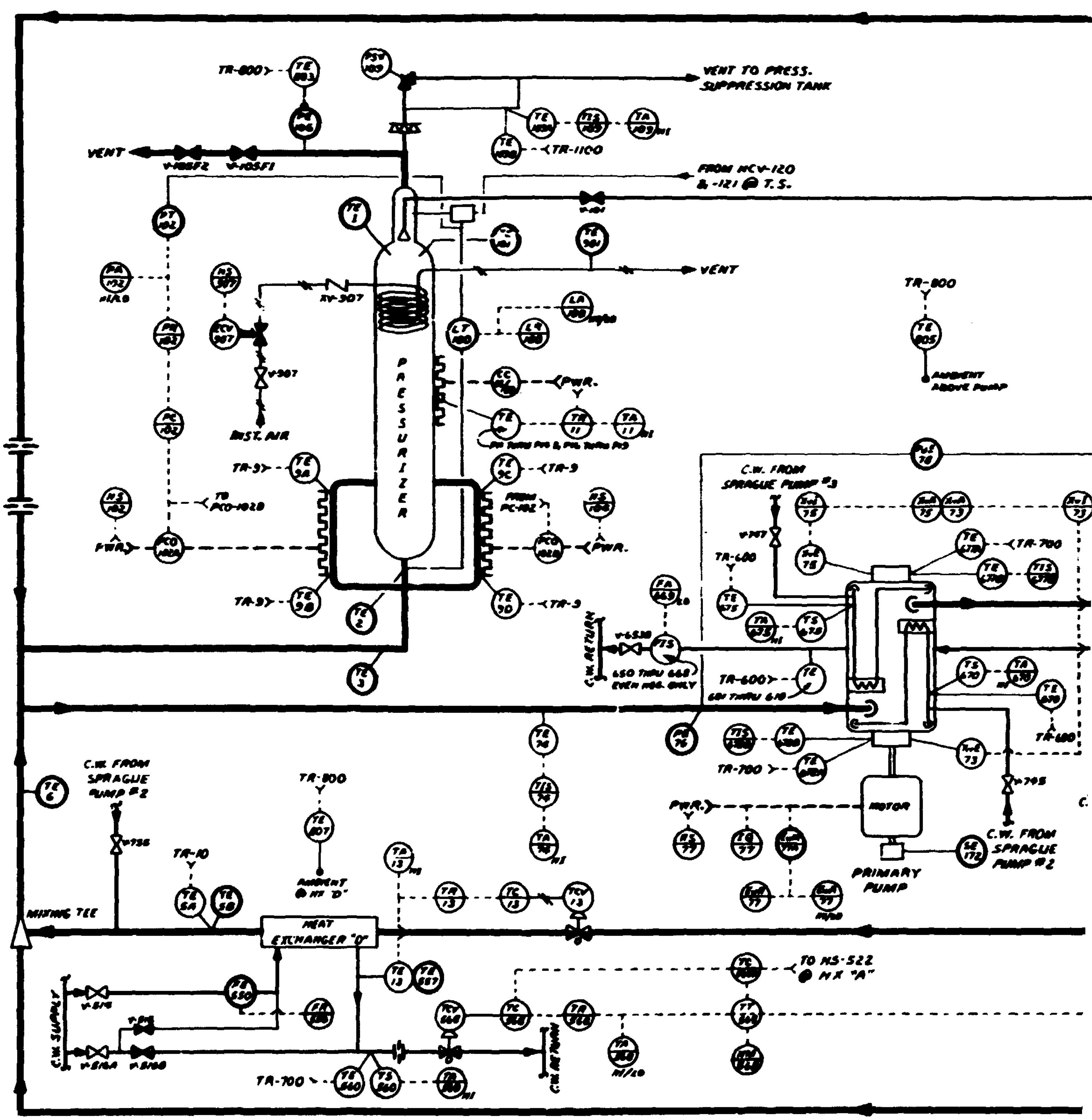

Fig. 3. THTF loop test section details.

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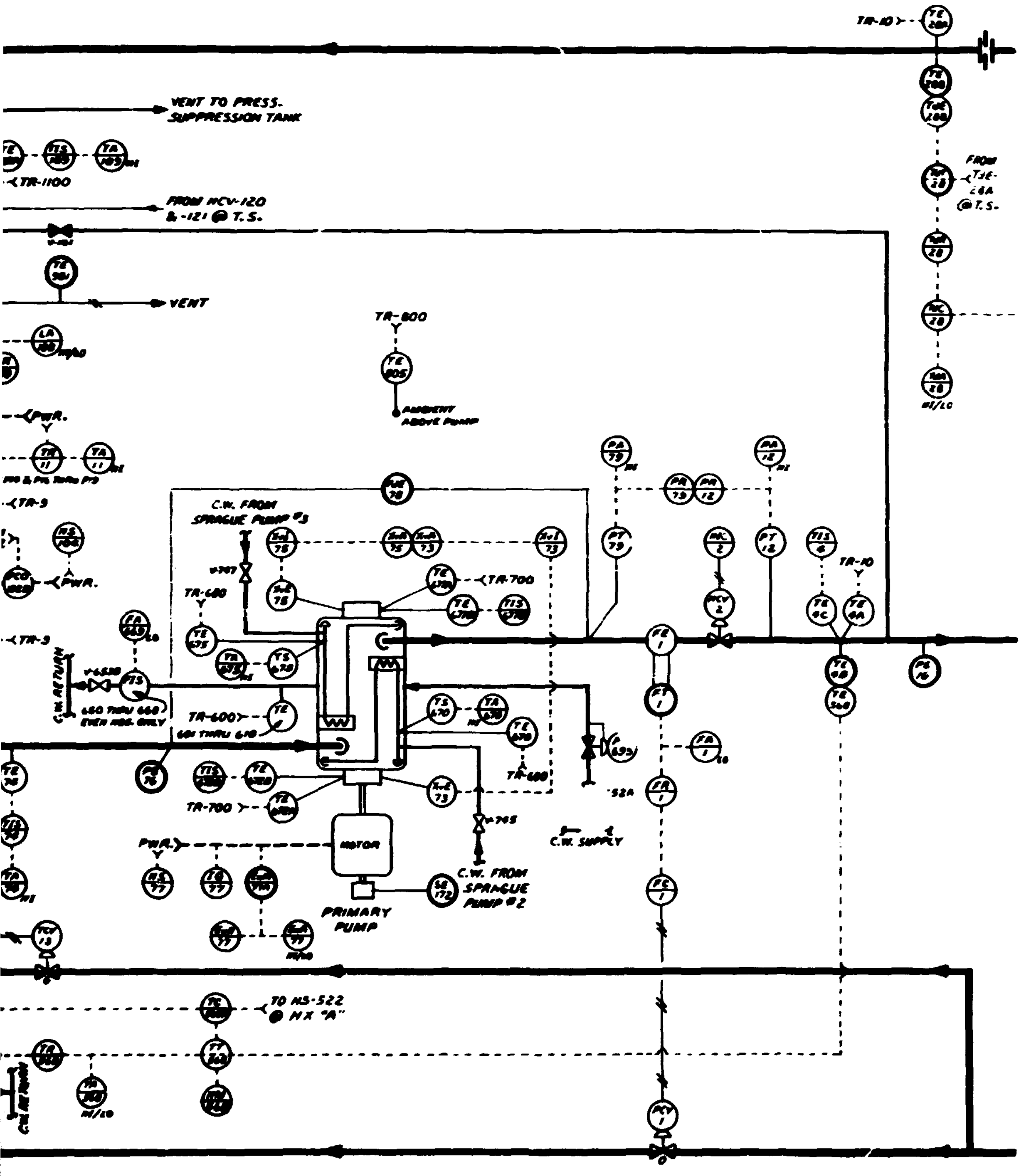
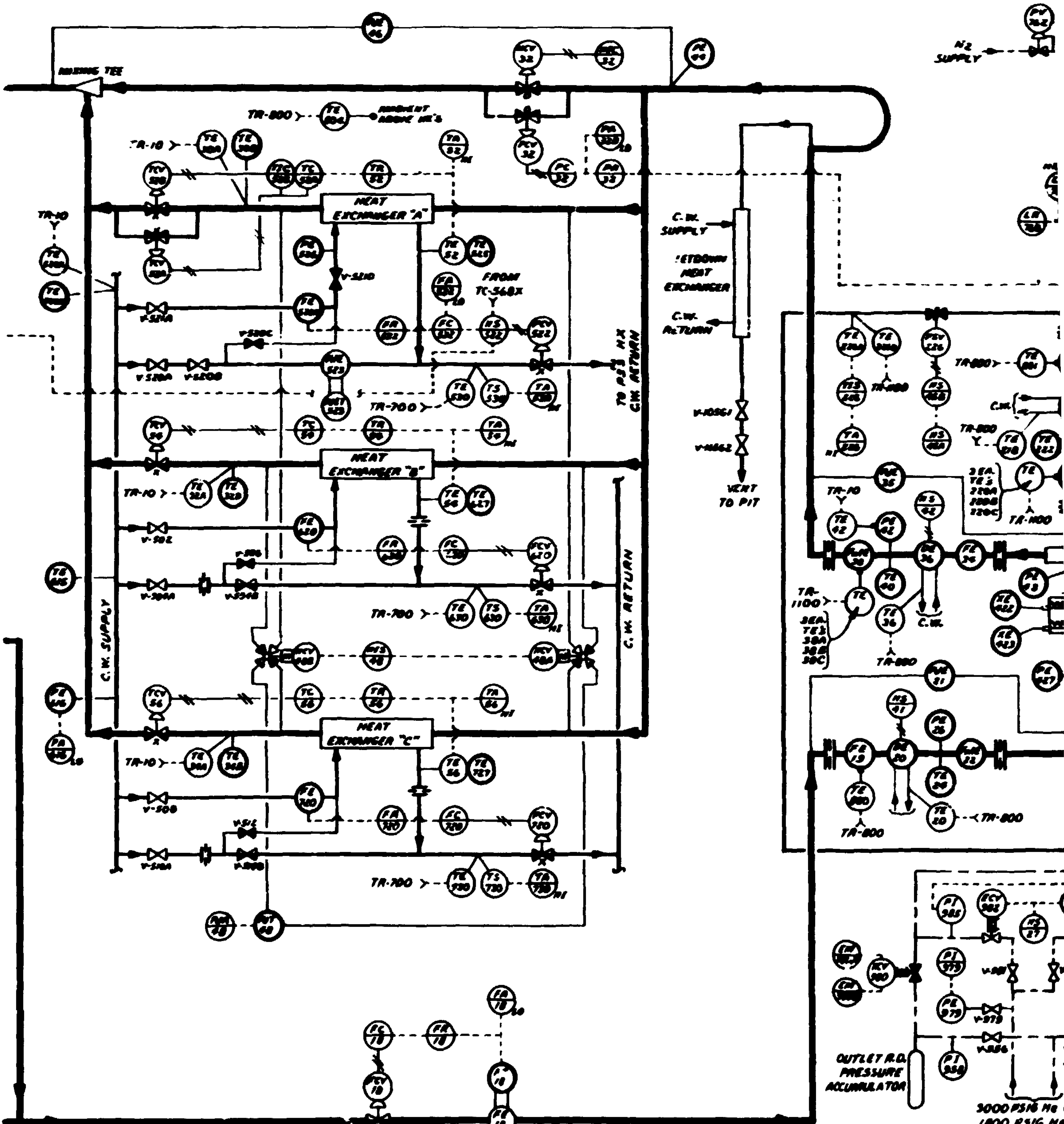


Fig. 3. THTF loop test section details.

2


HEAT EXCHANGER "A"
HEAT EXCHANGER "B"
HEAT EXCHANGER "C"
C.W. SUPPLY
C.W. RETURN
C.W. SUPPLY
C.W. RETURN
VENT TO PIT
N2 SUPPLY
OUTLET R.D. PRESSURE ACCUMULATOR
TR-800
TR-10
TR-700
FROM TC-568X

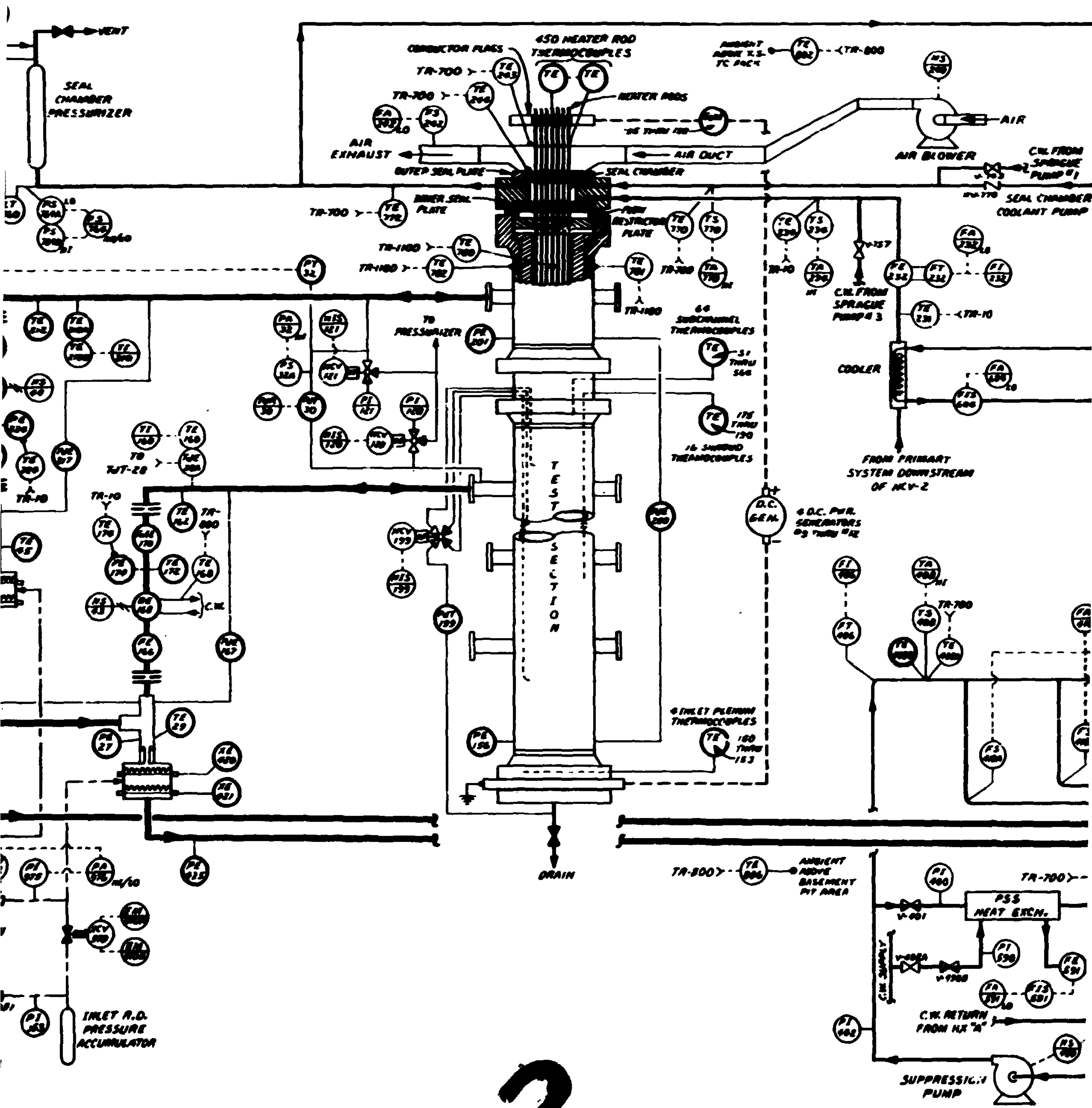


Fig. 3. (continued).

2

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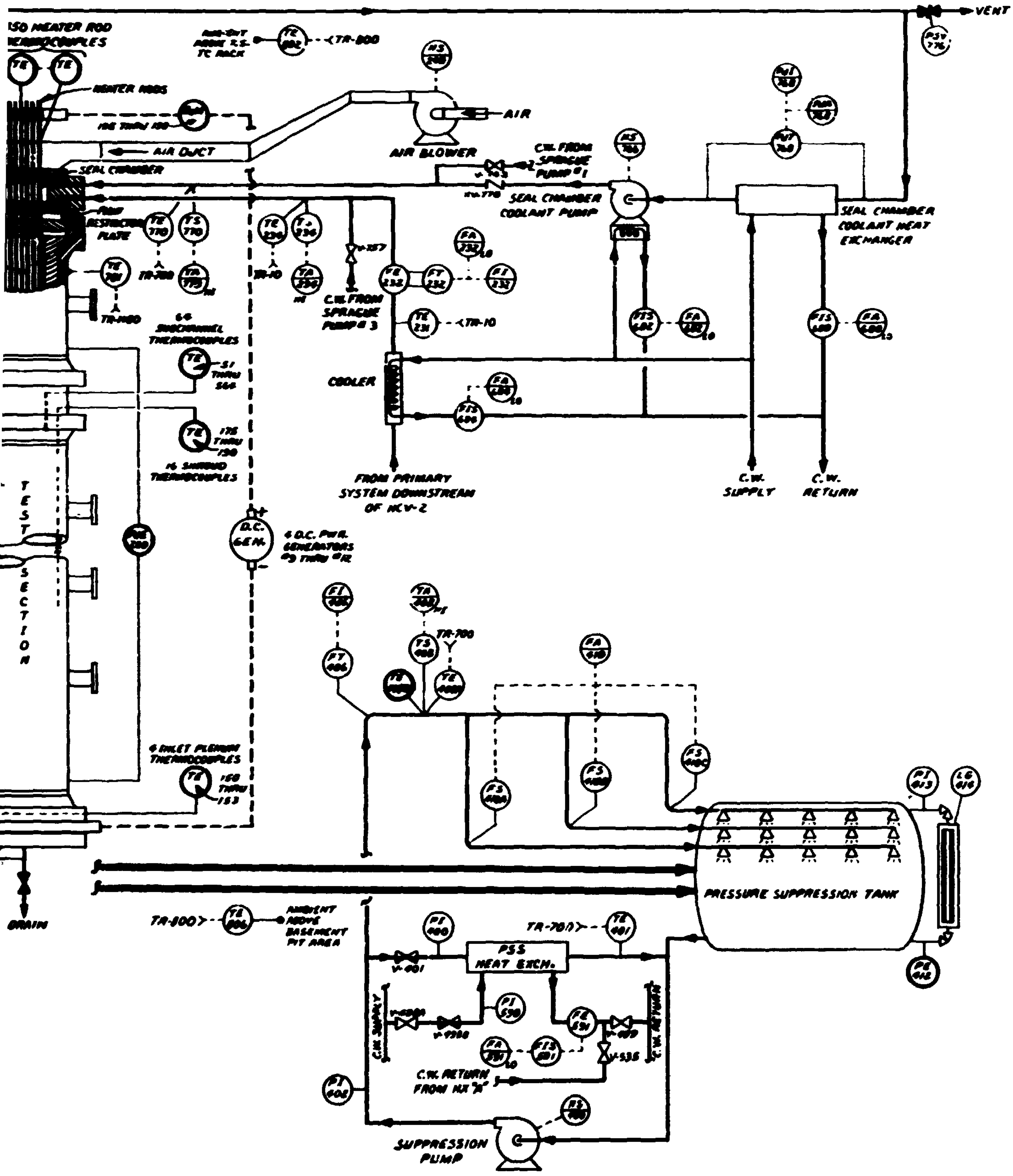

VENT
PSV 776
150 HEATER ROD THERMOCOUPLES
HEATER RODS
AIR DUCT
SEAL CHAMBER
RESTRICTOR PLATE
AIR BLOWER
AIR
C.W. FROM SPRAGUE PUMP #1
SEAL CHAMBER COOLANT PUMP
SEAL CHAMBER COOLANT HEAT EXCHANGER
C.W. FROM SPRAGUE PUMP # 3
COOLER
FROM PRIMARY SYSTEM DOWNSTREAM OF HCV-2
C.W. SUPPLY
C.W. RETURN
64 SUBCHANNEL THERMOCOUPLES
16 SHROUD THERMOCOUPLES
TEST SECTION
D.C. GEN.
4 D.C. PWR. GENERATORS #9 THRU #12
4 INLET PLENUM THERMOCOUPLES
DRAIN
TR-800
TR-700
TR-10
AMBIENT ABOVE BASEMENT PIT AREA
PRESSURE SUPPRESSION TANK
PSS HEAT EXCH.
V-401
C.W. SUPPLY
C.W. RETURN
C.W. RETURN FROM HX "A"
SUPPRESSION PUMP

3

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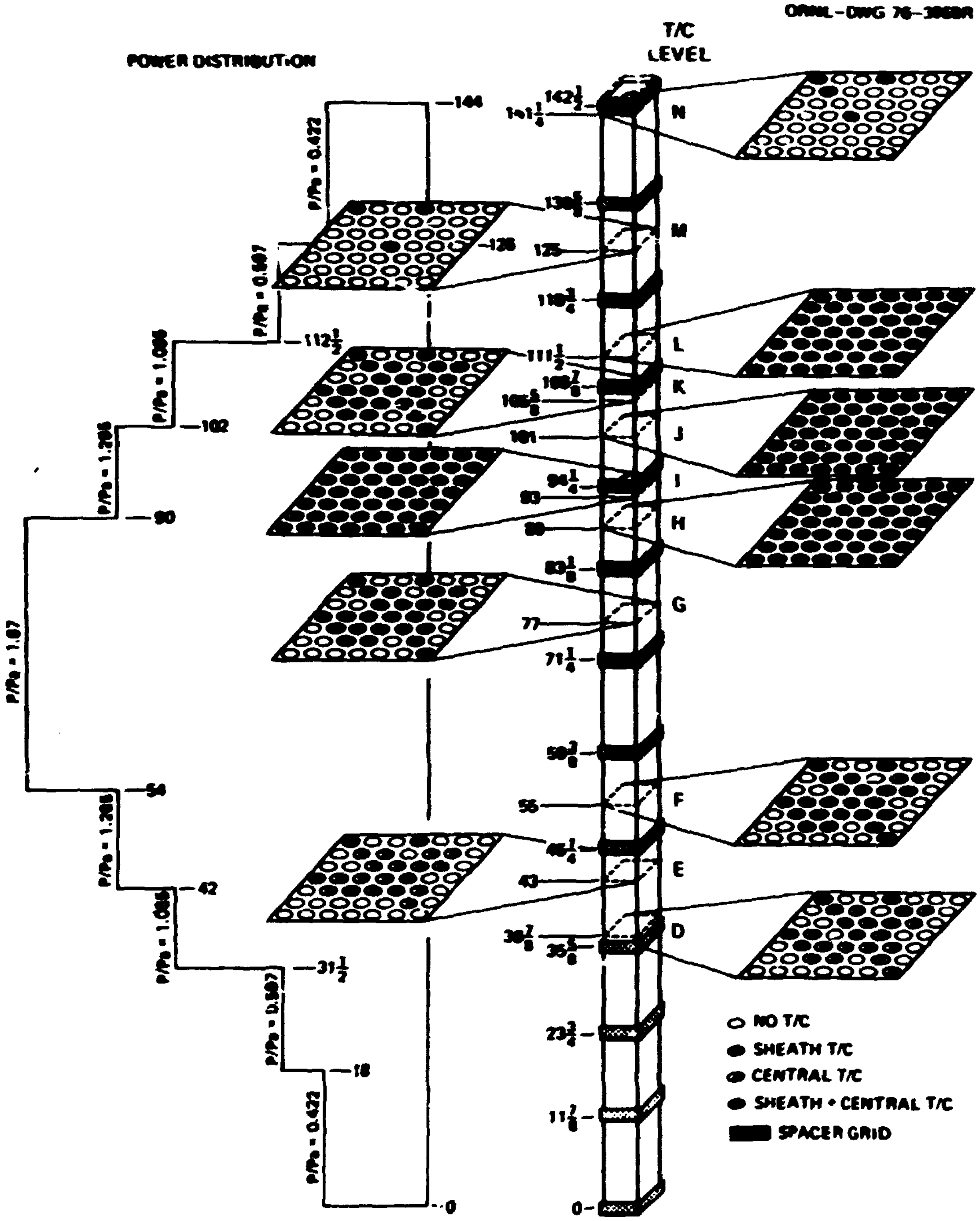

Fig. 4. Tentative location of thermocouples in THTF bundle 1 (1 in. = 2.54 cm).