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APPLIED PHYSICS LABORATORY
SILVER SPRING, MARYLAND

S4S-72-094

THERMAL-VACUUM TEST REPORT
FOR THE
ULTRAVIOLET SPECTROMETER THERMAL MODEL

July 25, 1972

By

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Thermal System Design Project
S4S-2

CONTENTS

Objective

Early design studies showed that the UVS thermal design margins were very small so that an experimental confirmation of the analytical model would be desirable. At that time the prototype unit was scheduled too far downstream to be of value, so a separate thermal model was built for use in verifying the analytical model.

Description of the Thermal Model

The thermal model was constructed from basic flight parts except where impractical or unnecessary. In these cases, capacity and/or thermal resistance simulations were used.

The baffle was identical to a flight baffle including thermal control coatings and all hardware pieces. Several views of the baffle are seen in Figures 1 through 4.

The main body consists of three pieces: the housing, the mirror cell assembly, and the front plate assembly. The housing is identical to flight hardware including weight relieving and thermal control coatings. The mirror cell assembly consists of a flight-type cell with a simulated ebert mirror installed. Using transient conduction scaling rules, the proper thickness of plate glass was used to give the correct thermal lag, and the first surface was aluminized to simulate the correct optical properties.

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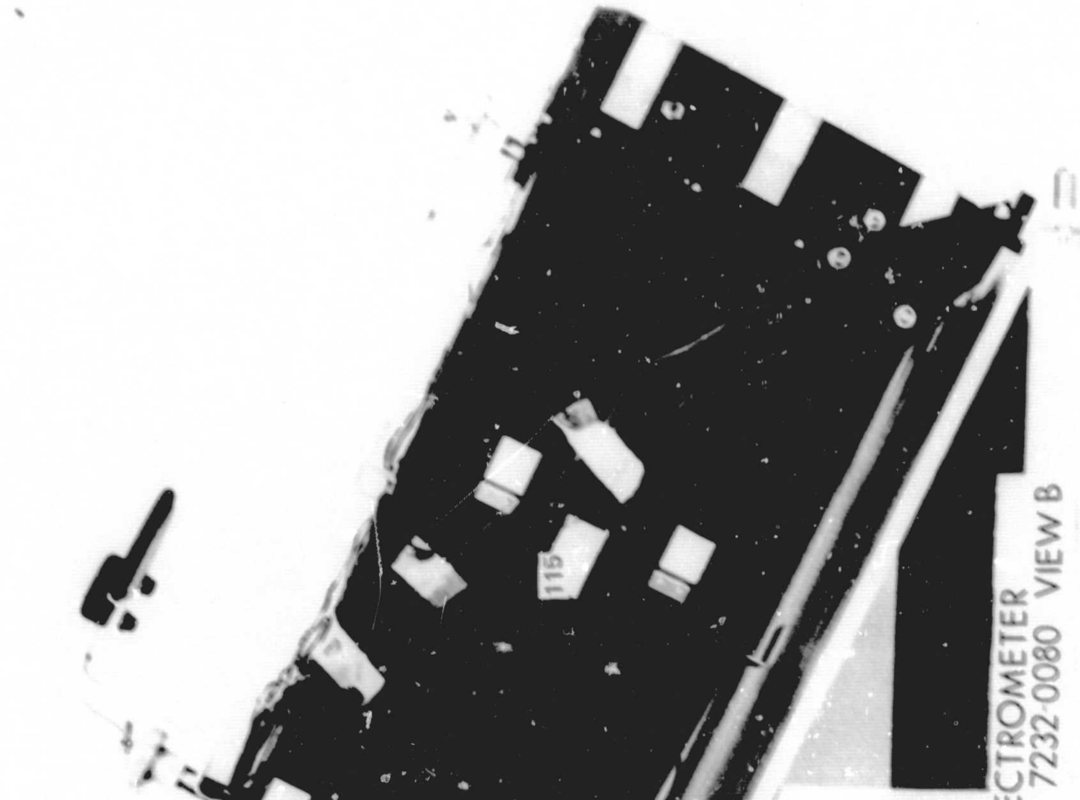

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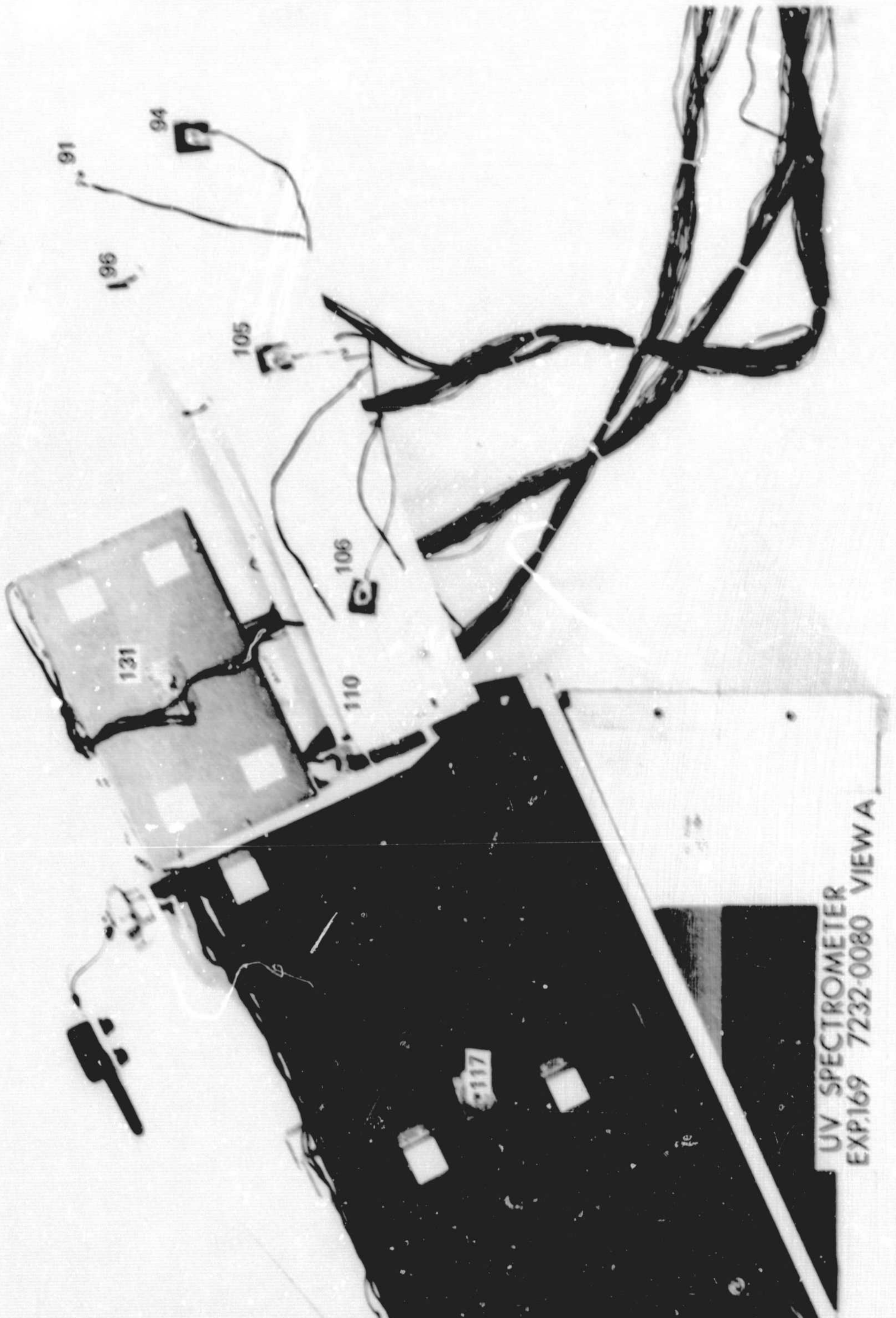


Fig. 2

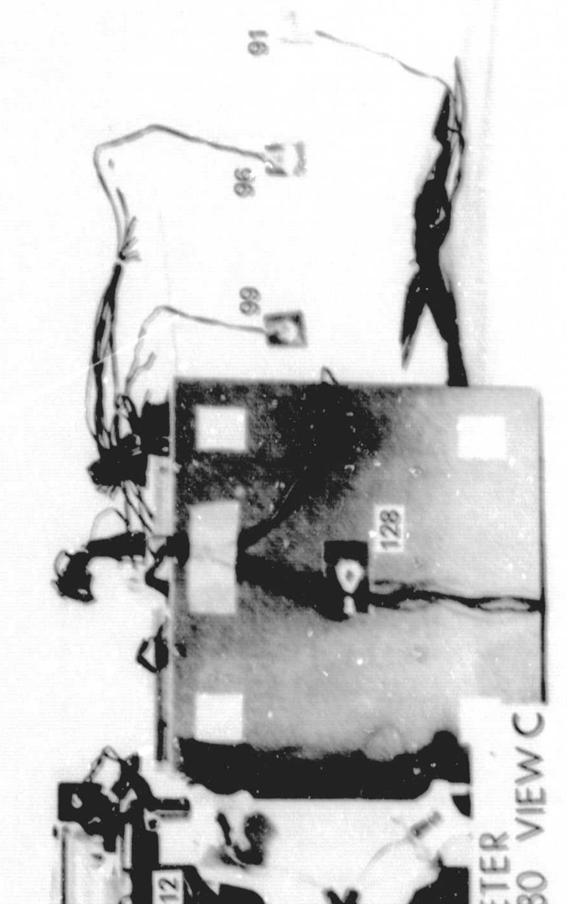

UV SPECTROMETER
EXP.169 7232·0080 VIEW C
91
96
99
128
112
114
113

Fig. 3

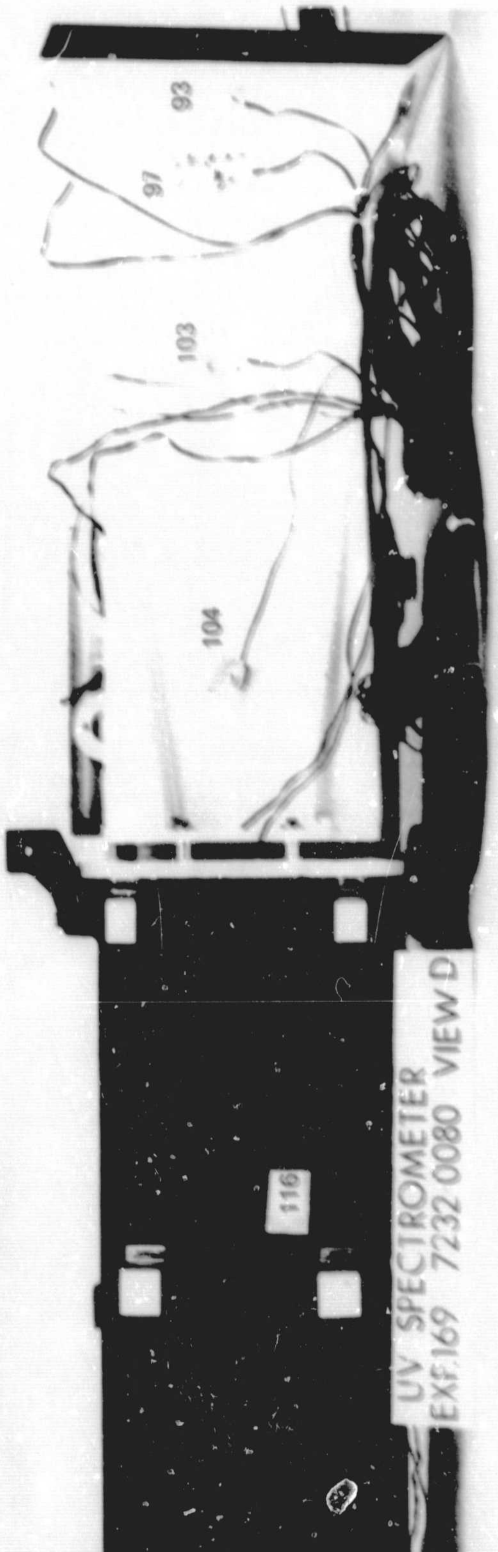
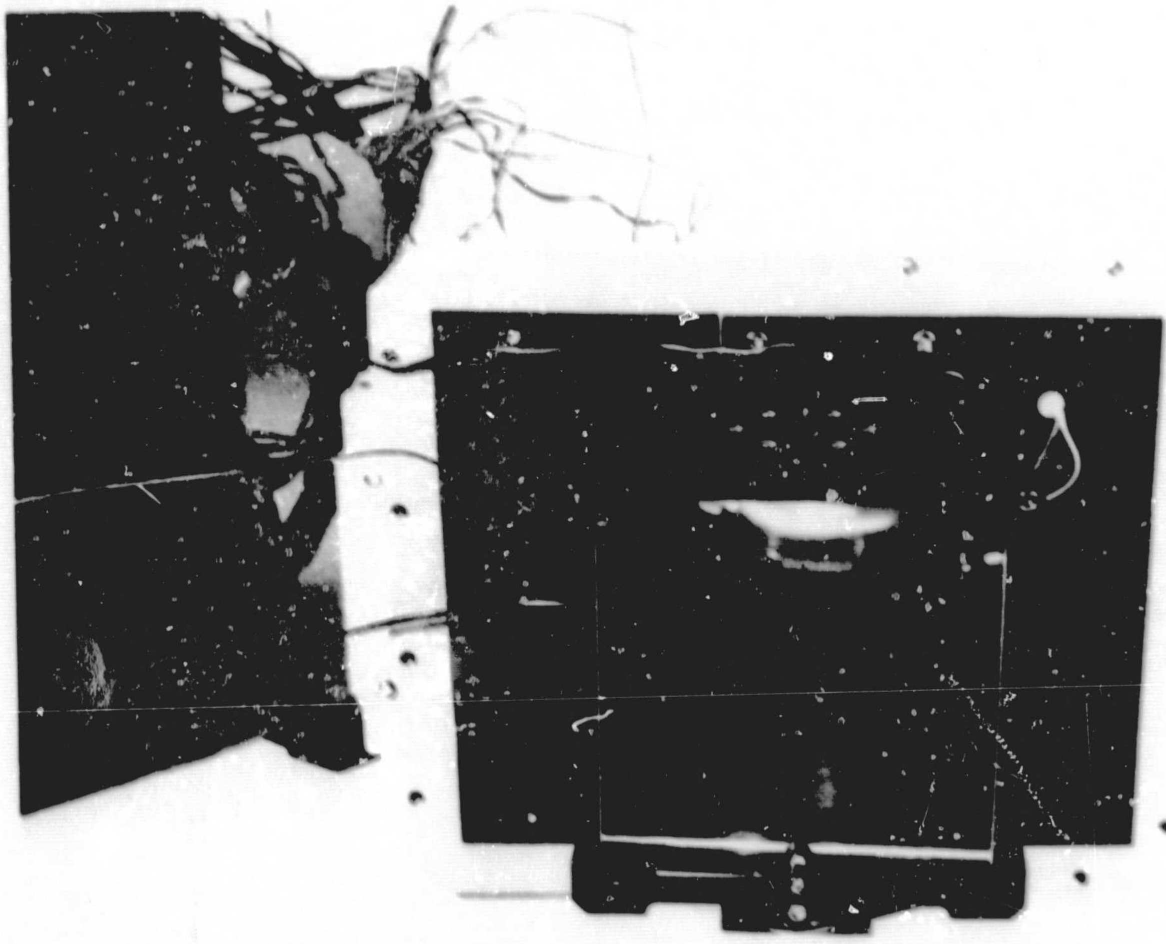


Fig. 4



UV SPECTROMETER
EXP.169 7232-0090 VIEW H

Fig. 5

Fig. 6

In a similar manner, the grating was simulated and installed in a flight grating holder, as shown in Figure 5.

Because the front plate is an extremely complicated machining, only the capacity and the conductance were simulated in the form of a flat plate. Included on the front plate are a motor mount and grating mount. The grating mount was suspended with ball bearings to simulate the actual conductance path, and an aluminum slug of the proper weight was used for the motor. Figure 6 shows the motor and the back of the grating holder.

A complete flight-type electronics housing was used. It was fitted with boards, aluminum slugs, and resistors to simulate the electronics. A typical simulated electronics board consists of an epoglas board on which are mounted aluminum slugs to simulate the capacity of bulk parts and a resistor to provide a heat source simulating the total board electrical dissipation. These details are illustrated in Figures 7 through 11.

The IPS was simulated with a slug of aluminum of the proper weight.

Since in most cases the actual capacity of the flight parts was not known, it was assumed that an average specific heat of .23 was applicable. The aluminum slugs were then sized accordingly.

Flight-type multilayer blankets were used; the electronics housing blanket and part of the main housing blanket installed, can be seen in Figure 12.

To avoid excess thermal leaks, the internal heater lead wires were brought out through a plug as seen in Figures 9 and 12. The UVS was mounted on the NR supplied bracket and installed in the SIM simulation as shown in Figure 12.

Description of the Test Setup

A mockup of the lower shelf area of the SIM was made so that the proper view factors to the UVS could be maintained. It was constructed of .040-in. sheet aluminum with channel stiffeners where needed. Since mission simulation under some conditions requires steep heat input transients, a door over the front was fitted to tracks so that it could be raised or lowered by remote control while under vacuum. The exterior of the SIM is covered with multilayer insulation. Although the thermal capacity of the SIM is near the actual flight SIM, heaters in the form of constantan wire are fixed to the surface with aluminum tape. This allows more accurate control of the SIM temperature profiles during mission simulation. One heater is used for each side of the SIM. The door is uninsulated and has 12 heaters attached. All heaters are capable of approximately 150 to 200 W dissipation. Figure 13 shows the SIM simulator with the door open.

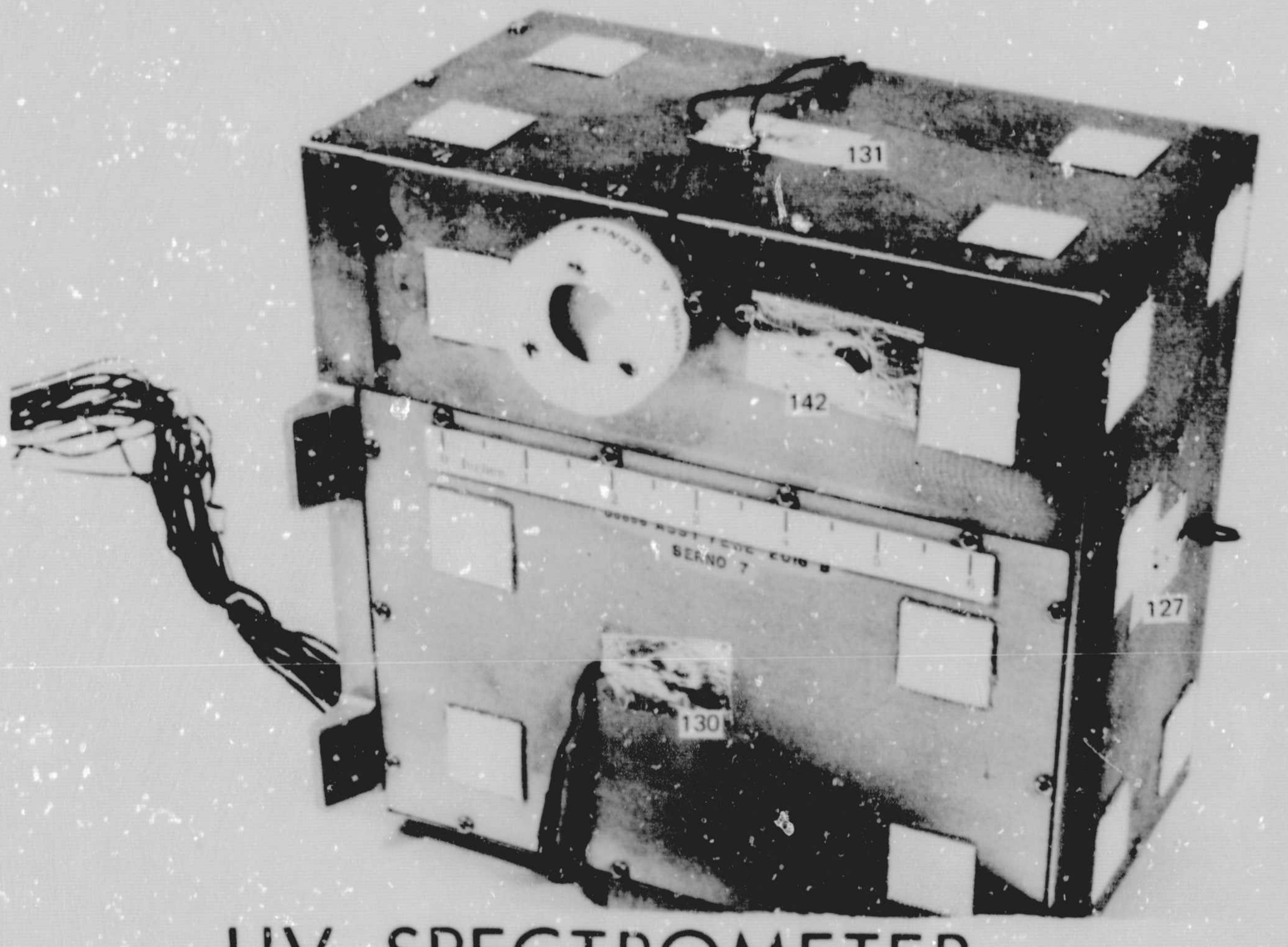
The mechanism for opening and closing the door consists of a reversible induction motor, a gear box, a drum, and cables. The cables are attached to the door, and winding them onto or unwinding them from the drum raises or lowers the door. Half a cycle operation (either up or down) requires about 29 sec.

Instrumentation for the test consisted of thermocouples, thermocouple DVM, scanners, and DVMs for power measurement.

No. 22 AWG Copper-Constantan Thermocouples were soldered to 3/8 in. copper disks. These were attached at the locations specified in Appendix A using 3M No. 425 Aluminum Foil Tape. Figures 1 through 11 show the thermocouple installations with the channel number indicated beside each one.

Thermocouple readout was multiplexed through a scanner and read on a DORIC thermocouple DVM. Continuous calibration of the DVM was maintained using two channels with stable voltages corresponding to +100°F and to -100°F.

Input power to the heater resistors was measured using a scanner for multiplexing to a VIDAR DVM. The voltage across the heater times the voltage across the current sensing resistor (.1 ohm nominal) times a calibration factor gives the desired result.



UV SPECTROMETER
EXP.169 7232-0080 VIEW E

Fig. 7

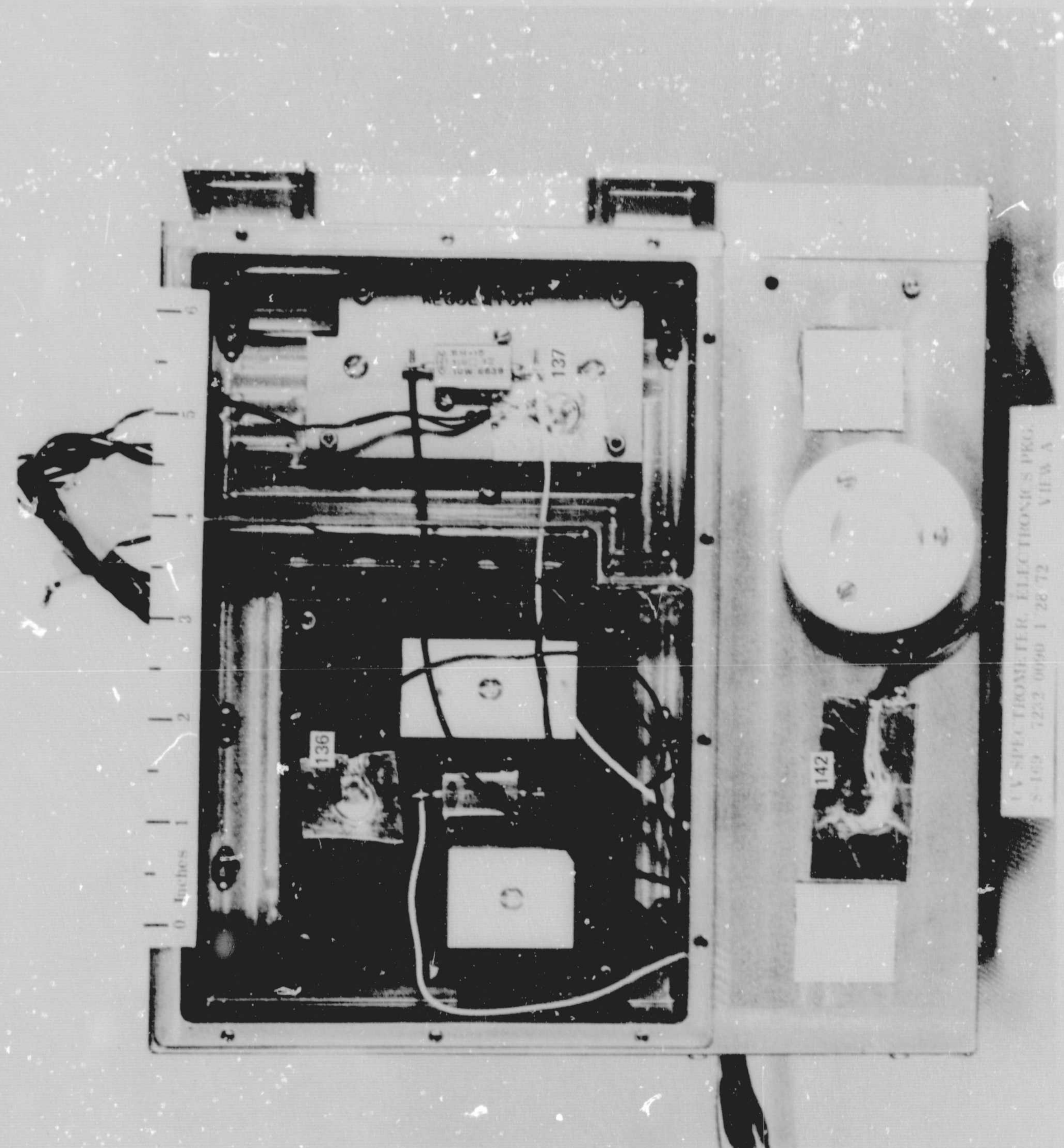


Fig. 8

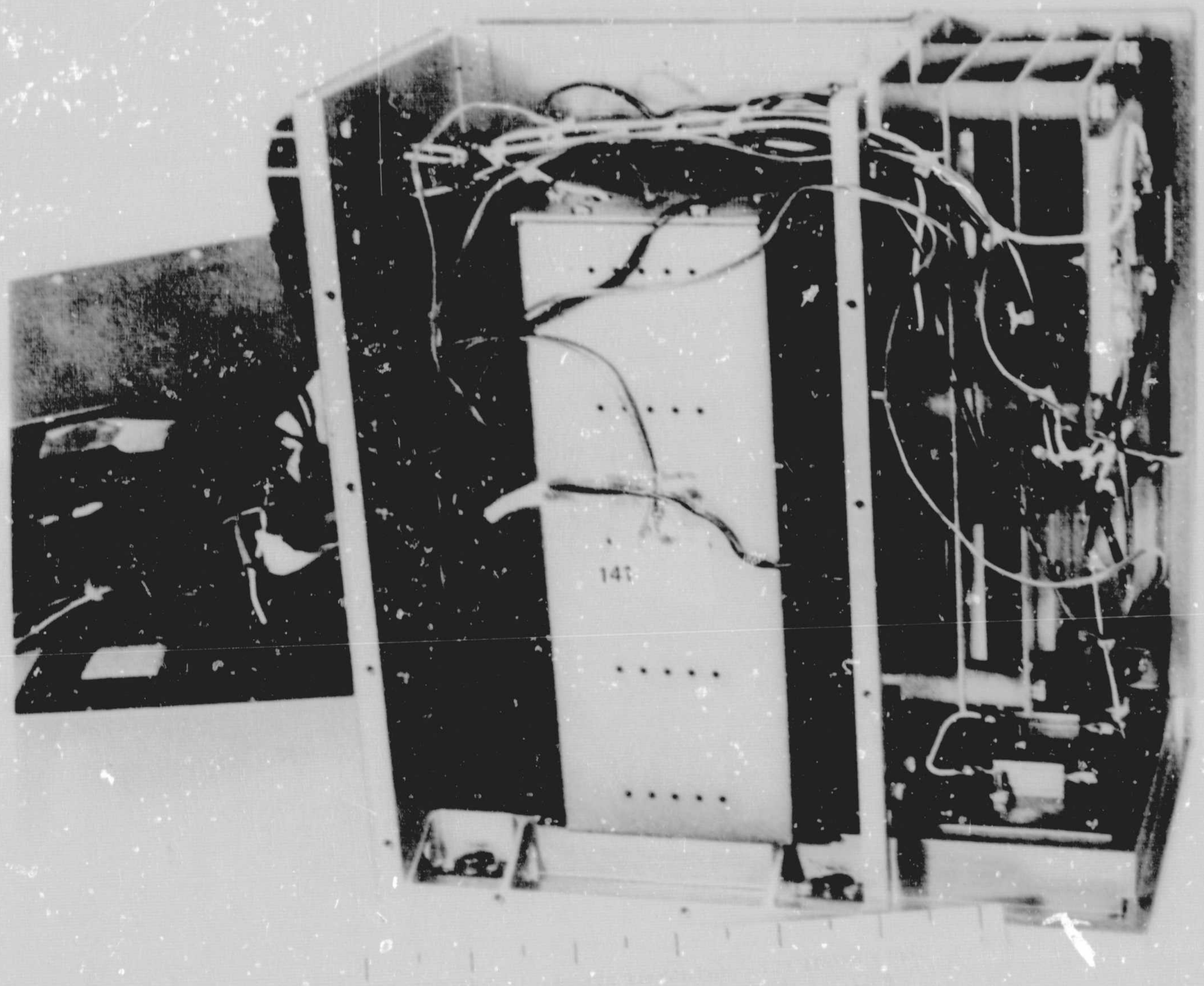


Fig. 9

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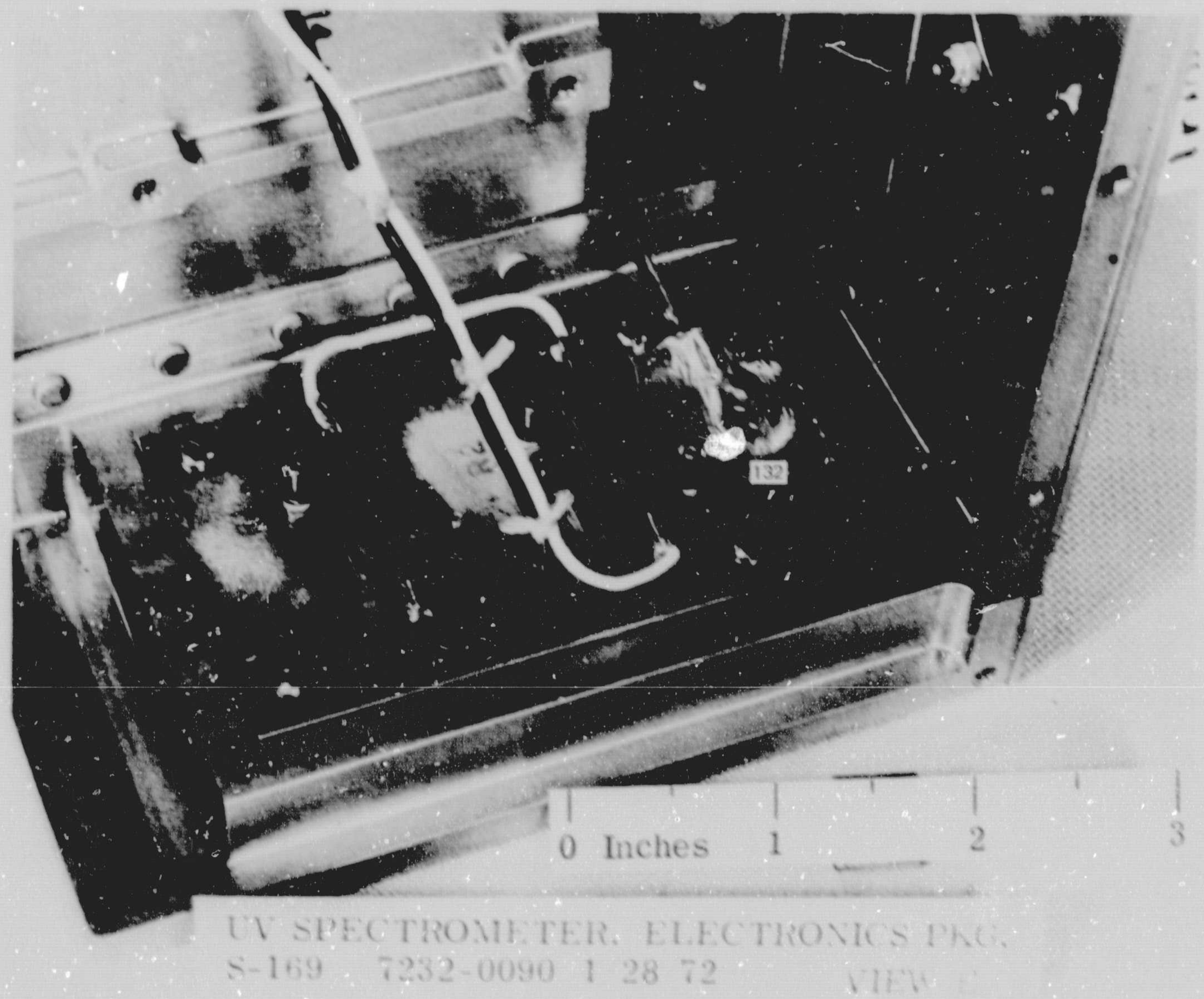


Fig. 10

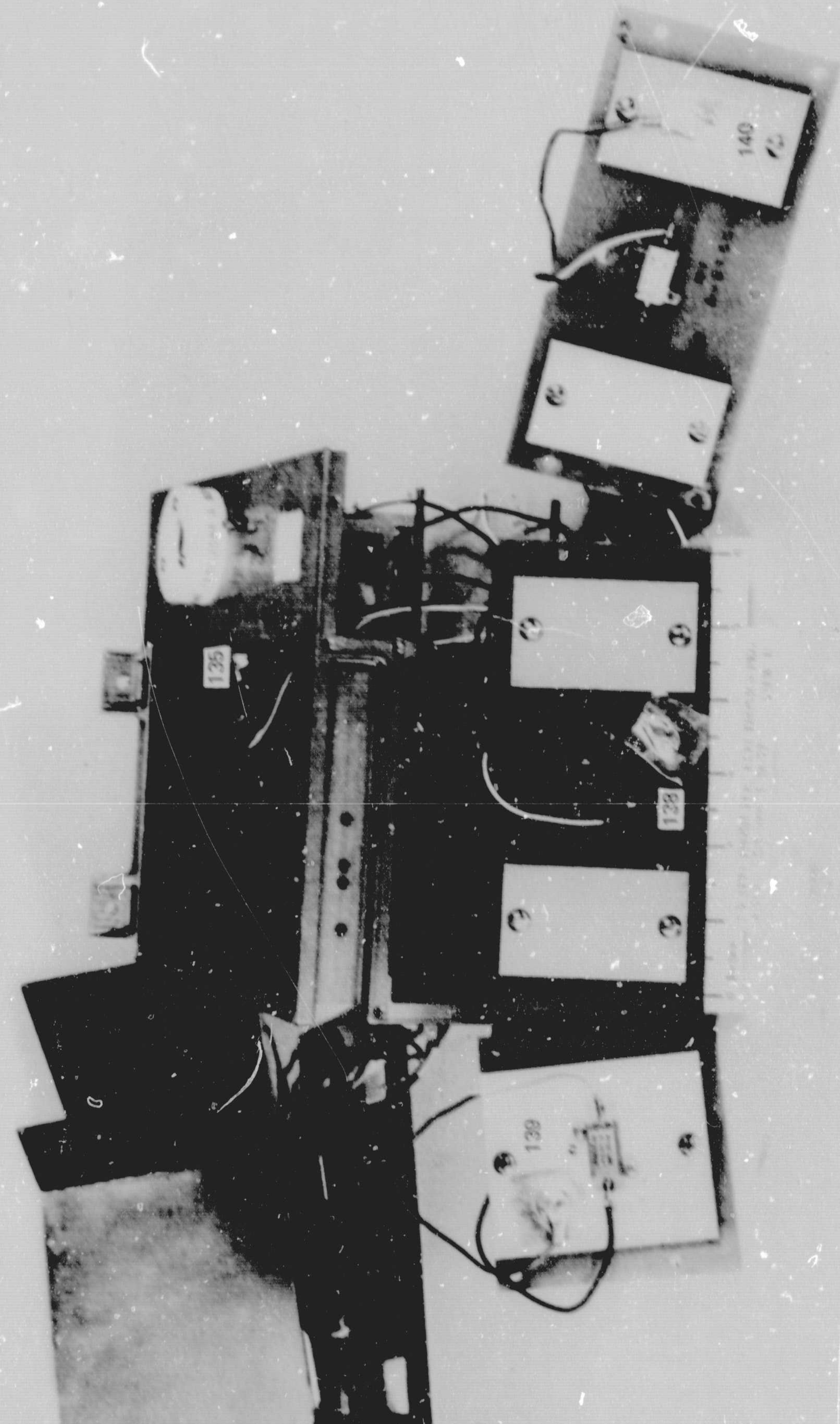


Fig. 11

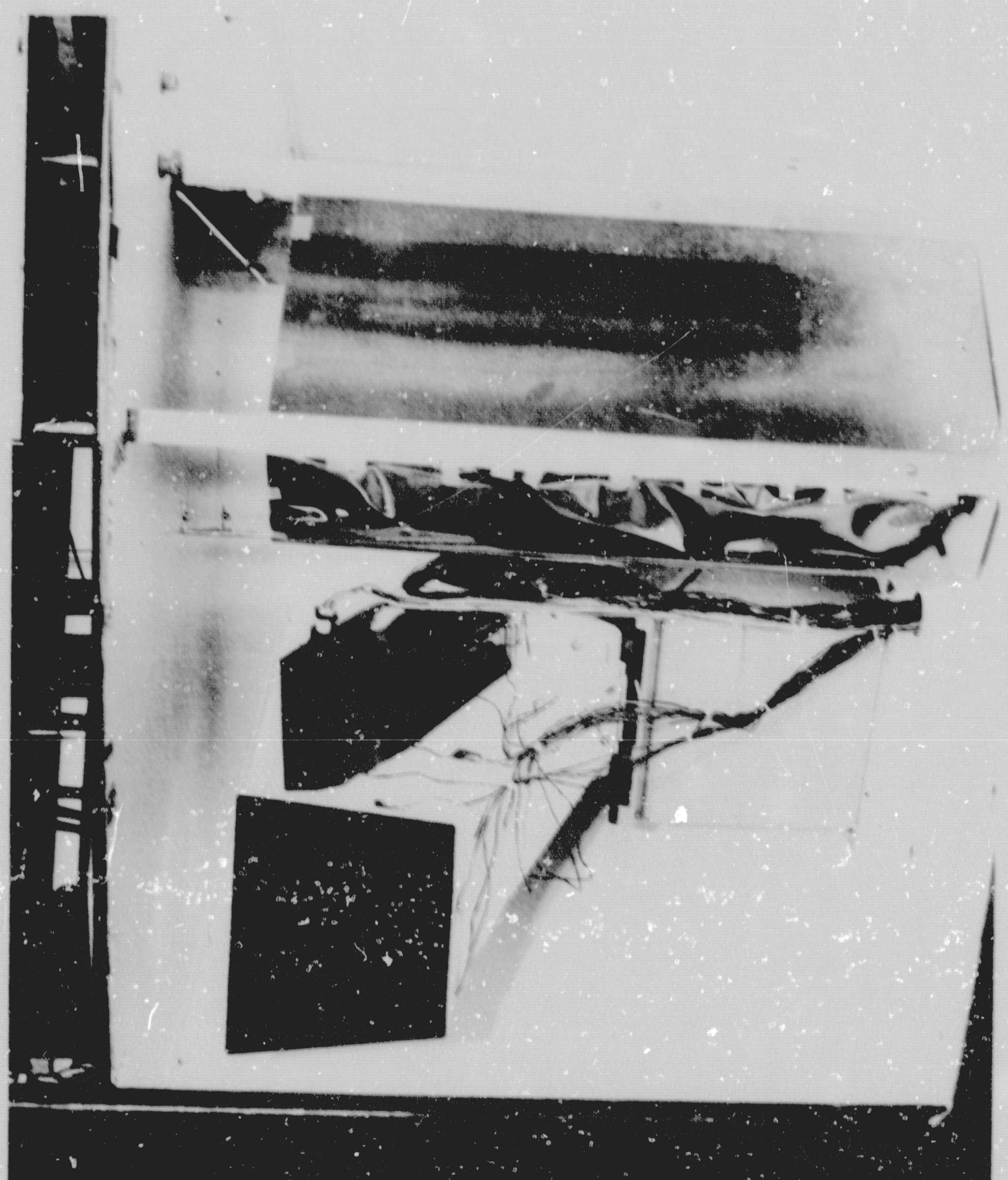


Fig. 12

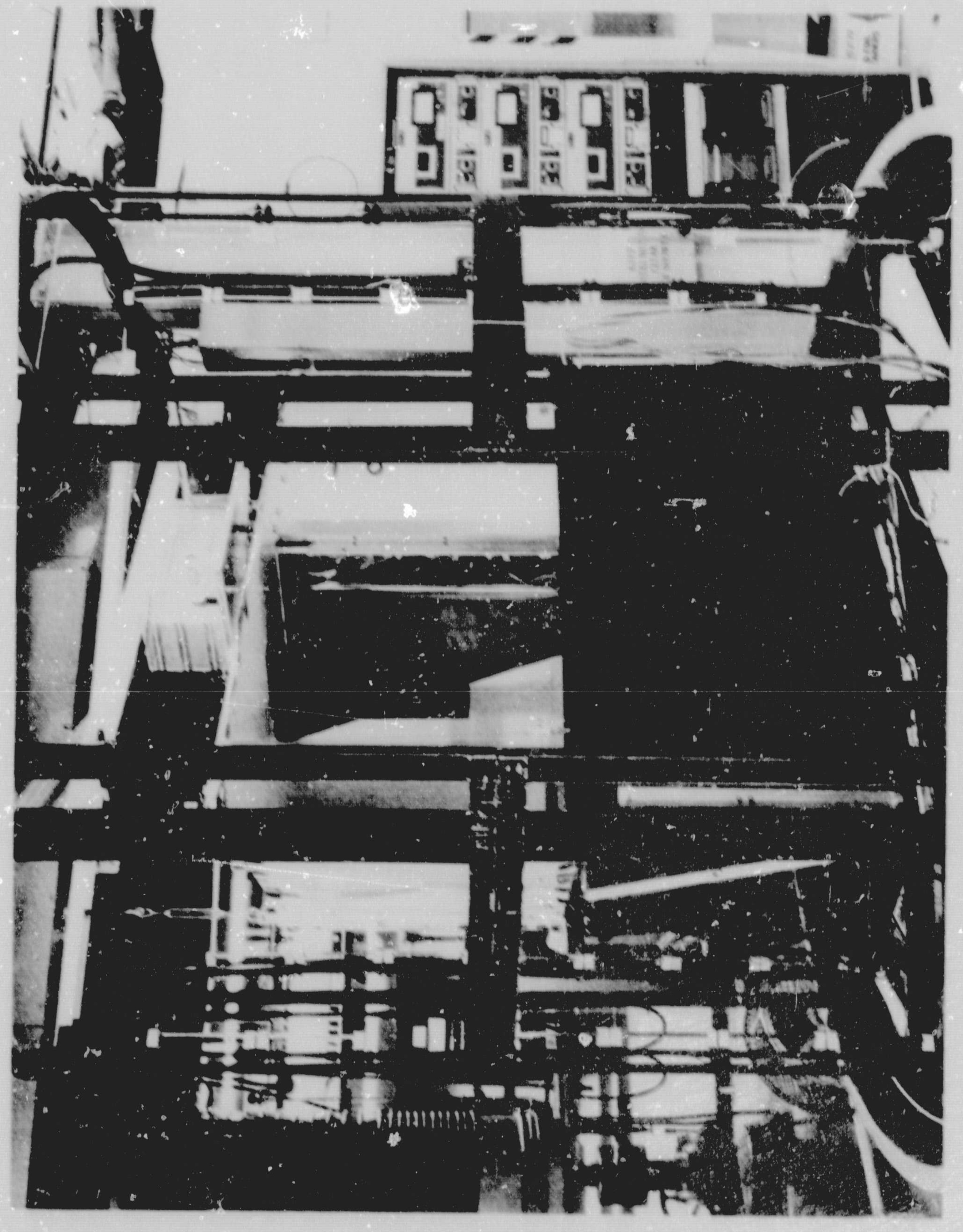


Fig. 13

Test Program

The test program was divided into two parts: analytical model verification and mission simulation.

For comparison with the analytical model, three runs were made: a hot soak at 100°F, a cold soak at 0°F, and a transient between these two limits.

A complete mission simulation was out of the scope of these tests so that only the most critical phases were to be simulated. These were: hot bias SIM door jettison, hot bias lunar orbit, and cold bias trans-earth.

In all cases, the SIM simulator was used, and temperatures were manually controlled by varying the voltage and consequently the power, input to the heaters.

Results

The first series of tests was completed successfully, and these results are presented in Tables 1 and 2 and Figure 14.

SIM door jettison was the first mission simulation attempted, and it became immediately apparent that manual control of the temperatures would not be sufficiently accurate, so the remaining mission simulation tests were abandoned. A comparison of the actual achieved time-temperature profiles with the desired is shown on Figure 15.

TABLE 1

EXHIBIT A: UVS THERMAL TEST DATA SHEET

TEST: RESISTANCE TEST WITH 0°F SINK

1	2	4	1	2	4	1	2	4	1	2	4
CH.#	NODE #	TEST TEMP. (°F)	CH.#	NODE #	TEST TEMP. (°F)	CH.#	NODE #	TEST TEMP. (°F)	CH.#	NODE #	TEST TEMP. (°F)
41	3'	.2	66	4'	-0.1	93	11'	6.1	118	34	17.6
42	"	1.0	67	9'	0.8	94	"	5.7	119	45	22.1
43	"	-3.4	68	"	1.7	95	"	5.8	120	35	19.8
44	8'	2.8	69	4+9	0.43	96	12'	5.7	121	46	18.0
45	"	2.4	70	1,3-6, 8-10	0.04	97	"	6.3	122	41	22.0
46	"	-4.0	71	7'	-0.2	98	12	6.0	123	42	24.7
47	3+8	- .17	72	"	-0.2	99	13	8.4	124	43	17.0
48	10'	-3.6	73	"	-0.2	100	14	12.9	125	44	27.6
49	"	-0.3	74	"	-0.5	101	15	7.7	126	25	31.5
50	"	-1.2	75	"	-0.1	102	16	12.4	127	26	34.9
51	"	-0.4	76	"	0.3	103	17	7.0	128	27	33.2
52	10	-1.38	77	2'	0.5	104	18	12.3	129	28	31.9
53	6'	--	78	"	0.9	105	19	5.6	130	29	35.3
54	"	2.6	79	"	0.4	106	20	10.5	131	30	35.4
55	"	3.5	80	2'+7	0.1	107	21	6.5	132	47	38.4
56	1'	0.9	81	2'	-0.5	108	22	11.0	133	48	34.8
57	"	1.6	82	"	1.0	109	23	11.8	134	50	36.0
58	"	1.1	83	"	0.25	110	24	11.9	135	51	36.2
59	1+6	1.94	84		--	111	39	15.1	136	52	96.5
60	5'	-1.9	85	2'	-0.2	112	31	19.9	137	53	76.9
61	"	1.1	86	"	0.0	113	"	17.4	138	54	86.5
62	"	0.1	87	"	-0.1	114	"	18.3	139	55	95.2
63	"	-1.8	88	2+7	0.08	115	32	18.6	140	56	65.7
64	5	-0.63	91	11'	5.7	116	40	17.7	141	57	35.1
65	4'	-0.7	92	"	5.9	117	33	19.0	142	29	92.5

TABLE 2

EXHIBIT A: UVS THERMAL TEST DATA SHEET

TEST: RESISTANCE TEST WITH 100°F SINK

1	2	4	1	2	4	1	2	4	1	2	4
CH.#	NODE	TEST TEMP. (°F)	CH.#	NODE	TEST TEMP. (°F)	CH.#	NODE	TEST TEMP. (°F)	CH.#	NODE	TEST TEMP. (°F)
41	3'	101.3	66	4'	99.6	93	11'	104.9	118	34	113.7
42	"	103.8	67	9'	100.4	94	"	104.8	119	45	117.6
43	"	101.4	68	"	100.9	95	"	104.8	120	35	114.9
44	8'	95.9	69	4+9	100.0	96	12'	105.3	121	46	113.1
45	"	98.4	70	1,3-6, 8-10	100.4	97	"	106.0	122	41	116.9
46	"	98.9	71	7'	99.0	98	12	105.6	123	42	113.9
47	3+8	99.9	72	"	98.4	99	13	107.2	124	43	113.0
48	10'	95.2	73	"	98.5	100	14	110.6	125	44	120.9
49	"	101.6	74	"	98.6	101	15	105.6	126	25	124.6
50	"	101.0	75	"	99.2	102	16	109.0	127	26	127.5
51	"	101.3	76	"	97.8	103	17	104.5	128	27	126.5
52	10	99.8	77	2'	100.0	104	18	108.9	129	28	124.7
53	6'	--	78	"	100.1	105	19	103.6	130	29	128.5
54	"	100.6	79	"	99.6	106	20	107.5	131	30	128.5
55	"	102.9	80	2'+7	99.0	107	21	106.5	132	47	130.3
56	1'	98.6	81	2'	98.8	108	22	107.6	133	48	127.0
57	"	100.7	82	"	99.5	109	23	108.7	134	50	128.5
58	"	100.8	83	"	99.1	110	24	108.9	135	51	128.3
59	1+6	100.7	84	--	--	111	39	110.7	136	52	168.4
60	5'	100.1	85	2'	100.3	112	31	115.7	137	53	160.2
61	"	103.8	86	"	101.0	113	"	113.2	138	54	163.4
62	"	102.6	87	2	100.6	114	"	113.9	139	55	171.8
63	"	99.8	88	2+7	99.6	115	32	114.5	140	56	149.0
64	5	101.6	91	11'	104.7	116	40	113.2	141	57	128.5
65	4'	99.3	92	"	104.7	117	33	114.9	142	29	175.3

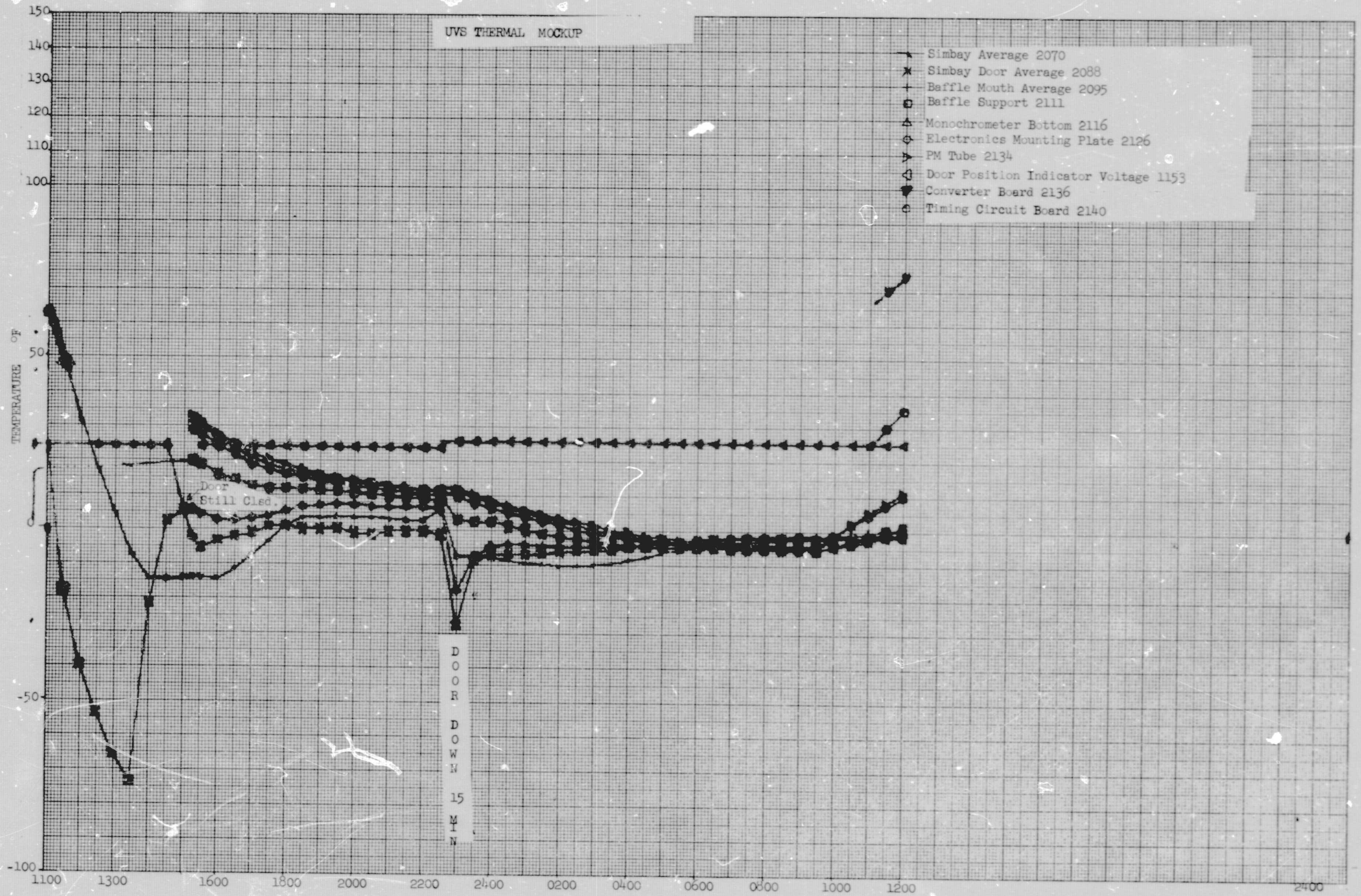
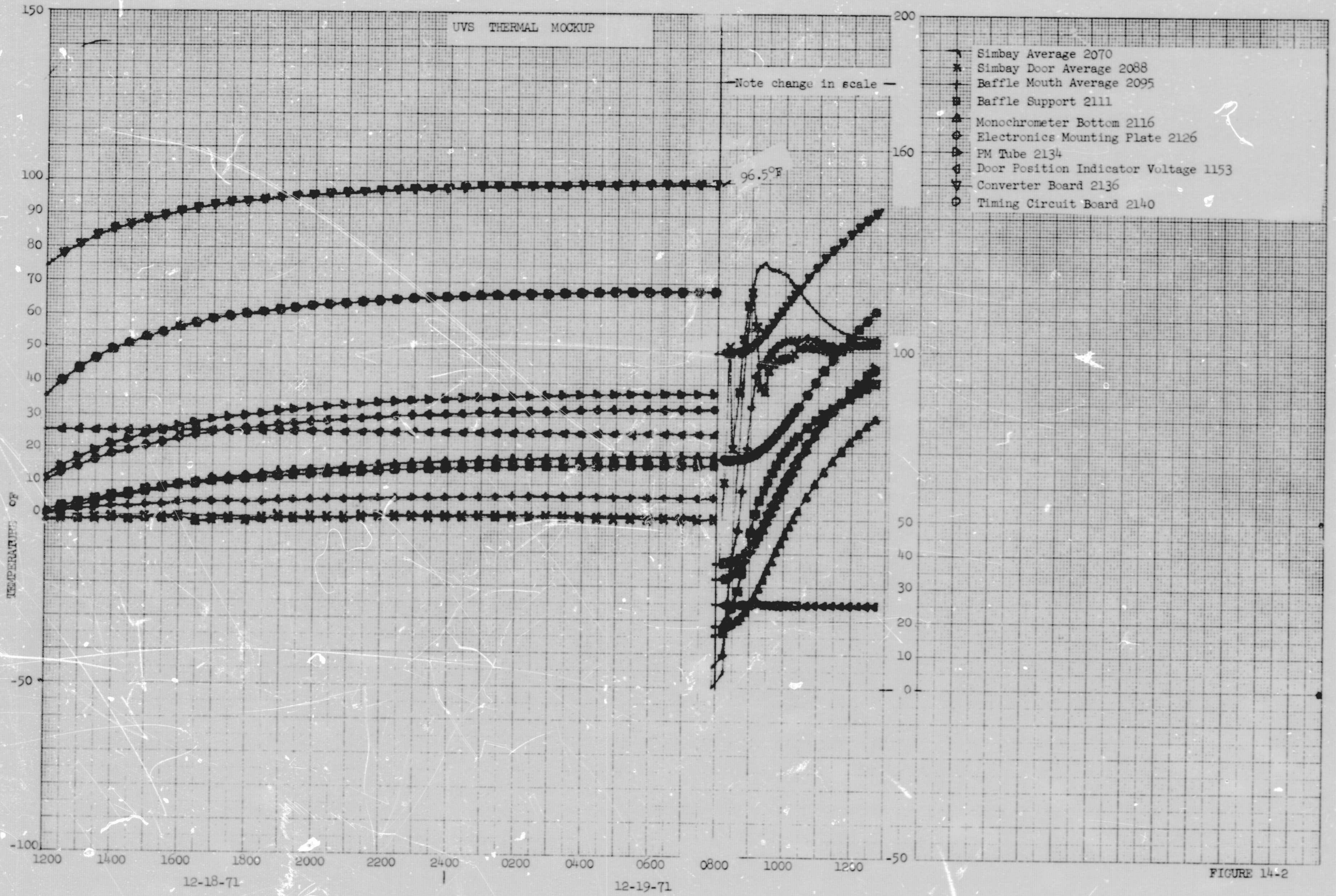

UVS THERMAL MOCKUP
Simbay Average 2070
Simbay Door Average 2088
Baffle Mouth Average 2095
Baffle Support 2111
Monochrometer Bottom 2116
Electronics Mounting Plate 2126
PM Tube 2134
Door Position Indicator Voltage 1153
Converter Board 2136
Timing Circuit Board 2140
TEMPERATURE °F
150
140
130
120
110
100
50
0
-50
-100
1100
1300
1600
1800
2000
2200
2400
0200
0400
0600
0800
1000
1200
2400
Door Still Clsd.
DOOR DOWN 15 MIN

FIGURE 14-1



UVS THERMAL MOCKUP
Note change in scale
96.5°F
Simbay Average 2070
Simbay Door Average 2088
Baffle Mouth Average 2095
Baffle Support 2111
Monochrometer Bottom 2116
Electronics Mounting Plate 2126
PM Tube 2134
Door Position Indicator Voltage 1153
Converter Board 2136
Timing Circuit Board 2140
TEMPERATURE °F
12-18-71
12-19-71

FIGURE 14-2

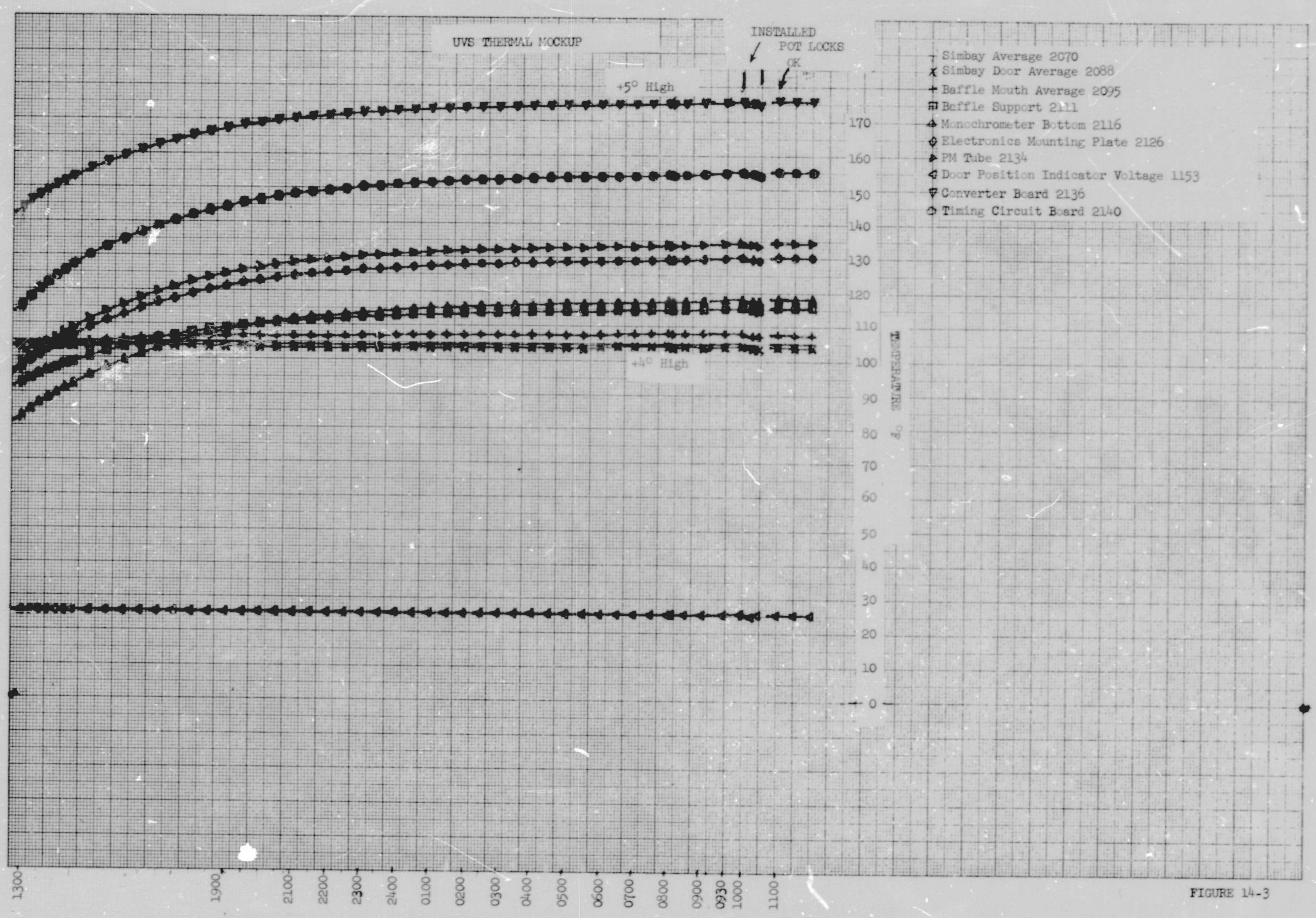

UVS THERMAL MOCKUP
INSTALLED
POT LOCKS OK
+5° High
+4° High
TEMPERATURE °F
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Simbay Average 2070
Simbay Door Average 2088
Baffle Mouth Average 2095
Baffle Support 2111
Monochrometer Bottom 2116
Electronics Mounting Plate 2126
PM Tube 2134
Door Position Indicator Voltage 1153
Converter Board 2136
Timing Circuit Board 2140
1300
1900
2100
2200
2300
2400
0100
0200
0300
0400
0500
0600
0700
0800
0900
0930
1000
1100

FIGURE 14-3

12-20-71

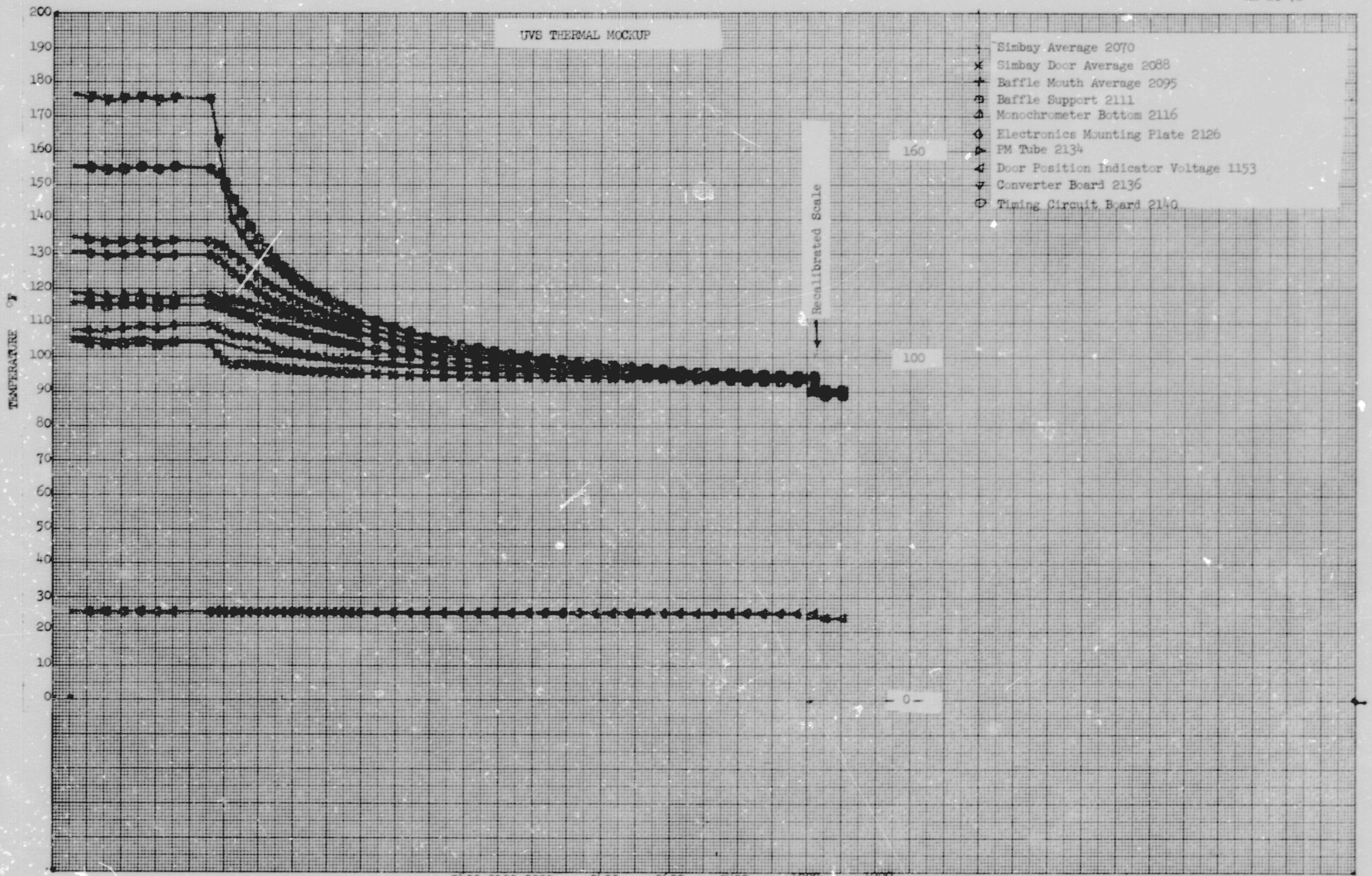
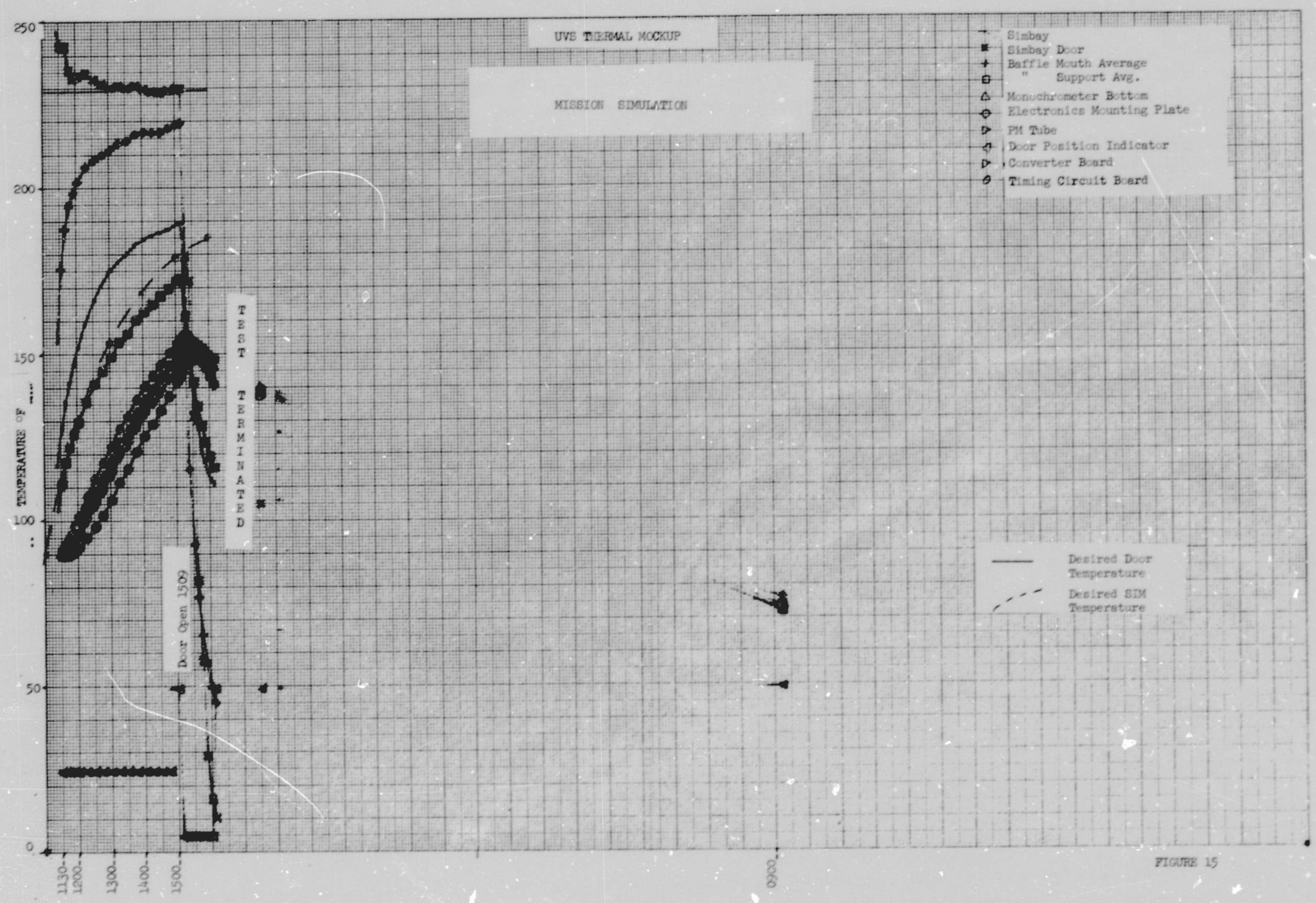


FIGURE 14-4



UVS THERMAL MOCKUP
MISSION SIMULATION
Simbay
Simbay Door
Baffle Mouth Average
" Support Avg.
Monochrometer Bottom
Electronics Mounting Plate
PM Tube
Door Position Indicator
Converter Board
Timing Circuit Board
TEST TERMINATED
Door Open 1509
Desired Door Temperature
Desired SIM Temperature
TEMPERATURE °F
250
200
150
100
50
0
1130
1200
1300
1400
1500
0900

FIGURE 15

Discussion of Data and Results

It is convenient to divide this discussion into comments on the test setup and comments on the results.

Manual control of the hot and cold soak portions of the test is a routine operation for ETL and no problems were evident. However, the attempt to simulate the SIM door jettison phase showed that it was essentially impossible to follow the required temperature profile by manual control. The computer control system was not yet checked out so the remaining mission simulation tests were abandoned. The principal reason for our inability to follow a changing temperature profile manually is the time required to set the power levels. A predetermined profile of heater power versus time can be derived from the temperature profile but to follow this profile adequately adjustment of the power levels must be done more often than the five to ten minute frequency that one is able to achieve manually. During checkout of the computer control program it was found that a control period of 60 seconds or less is needed to follow typical UVS temperature profiles.

During the execution of these tests the SIM door was required to move several times and it did so with no apparent problems.

Computer simulations of the hot and cold soaks were made for comparison with the experimental data. This comparison is shown in Tables 3 and 4. Node 29 (Channel #142) is an erroneous reading due to an open circuit in the thermocouple. It is seen that the agreement is in general within 10°F at both the 100° soak and the 0° soak. The notable exceptions are the simulated electronic boards which differ by as much as 30°F. This difference cannot be accounted for by experimental error, since a simple change in the environmental temperature over a small range would produce a corresponding change in the UVS temperatures. The standard environmental test laboratory instrumentation allows ±1°F accuracy over the range of +100°F to -100°F and this is well within the 5° to 10°F differences noted. One must attribute the differences to modeling error.

Several adjustments were made, in the analytical model, in the baffle and front plate conductance and in the electronics box radiation factors to reduce the difference between analysis and test results. This comparison is shown in Table 5 for 100°F. Most of the differences are reduced to less than 5°F and many are less than 2°F. Substantial difference still exists for nodes 53, 54, and 55 which are the regulator, the housekeeping and the timing circuit boards respectively. This difference is attributed to inadequacy in the physical simulation of the electronic components and boards in the thermal model, as well as errors in analysis.

TABLE 3

COMPARISON OF ANALYTICAL AND EXPERIMENTAL
RESULTS AT 0° F

NODE #	TEMPERATURE °F		T-A	NODE #	TEMPERATURE °F		T-A
	ANALYSIS	TEST			ANALYSIS	TEST	
11'	3.93	6.1	2.2	34	23.38	17.6	-5.8
"	3.93	5.7	1.8	45	35.58	22.1	-13.5
"	3.93	5.8	1.9	35	33.40	19.8	-13.6
12'	4.55	5.7	1.1	46	28.83	18.0	-10.8
12'	4.55	6.3	1.7	41	31.31	22.0	-9.3
12	4.55	6.0	1.4	42	32.42	24.7	-7.7
13	6.56	8.4	1.8	43	23.66	17.0	-6.7
14	13.33	12.9	-0.4	44	35.65	27.6	-8.0
15	6.53	7.7	1.2	25	41.04	31.5	-9.5
16	14.09	12.4	-1.7	26	44.82	34.9	-9.9
17	6.35	7.0	0.6	27	43.40	33.2	-10.2
18	12.56	12.3	-0.3	28	41.93	31.9	-10.0
19	6.45	5.6	-0.8	29	44.77	35.3	- 9.5
20	14.06	10.5	-3.6	30	50.99	35.4	-15.6
21	15.97	6.5	-9.5	47	36.42	38.4	2.0
22	15.56	11.0	-4.6	48	46.68	34.8	-11.9
23	15.52	11.8	-3.7	50	42.99	36.0	- 7.0
24	15.93	11.9	-4.0	51	53.63	36.2	-17.4
39	27.38	15.1	-12.3	52	97.77	96.5	- 1.3
31	23.88	19.9	- 4.0	53	103.73	76.9	-26.8
31	23.88	17.4	- 6.5	54	76.66	86.5	9.8
31	23.88	18.3	- 5.6	55	69.47	95.2	25.7
32	23.49	18.6	- 4.9	56	85.17	65.7	-19.5
40	23.54	17.7	- 5.8	57	--	35.1	--
33	23.48	19.0	- 4.5	29	44.77	92.5	47.7

TABLE 4

COMPARISON OF ANALYTICAL AND EXPERIMENTAL
RESULTS AT 100° F

NODE #	TEMPERATURE °F		T-A	NODE #	TEMPERATURE °F		T-A
	ANALYSIS	TEST			ANALYSIS	TEST	
11'	102.1	104.9	2.8	34	118.6	113.7	-4.9
"	102.1	104.8	2.7	45	128.8	117.6	-11.2
"	102.1	104.8	2.7	35	126.7	114.9	-11.8
12'	102.5	105.3	2.8	46	122.6	113.1	-9.5
"	102.5	106.0	3.5	41	124.5	116.9	-7.6
12	102.5	105.6	3.1	42	125.9	113.9	-12.0
13	104.0	107.2	3.2	43	119.0	113.0	- 6.0
14	108.8	110.6	1.7	44	128.8	120.9	- 7.9
15	103.7	105.6	1.9	25	133.9	124.6	- 9.3
16	109.2	109.0	-0.2	26	137.6	127.5	-10.1
17	103.5	104.5	1.0	27	136.3	126.5	- 9.8
18	107.8	108.9	1.1	28	134.9	124.7	-10.2
19	103.8	103.6	-0.2	29	138.1	128.5	- 9.6
20	109.3	107.5	-1.8	30	143.2	128.5	-14.7
21	110.8	106.5	-4.3	47	129.7	130.3	0.6
22	110.2	107.6	-2.6	48	139.2	127.0	-12.2
23	110.3	108.7	-1.6	50	136.0	128.5	- 7.5
24	110.9	108.9	-2.0	51	145.6	128.3	-17.3
39	121.2	110.7	-10.5	52	174.8	168.4	- 6.4
31	124.5	115.7	-8.8	53	183.3	160.2	-23.1
"	124.5	113.2	-11.3	54	158.9	163.4	4.5
"	124.55	113.9	-10.6	55	154.9	171.8	16.9
32	118.8	114.5	-4.3	56	164.5	149.0	-15.5
40	119.0	113.2	-5.8	57	--	128.5	
33	118.8	114.9	-3.9	29	138.1	175.3	37.2

TABLE 5

COMPARISON OF ANALYTICAL AND TEST RESULTS OF
REVISED THERMAL MODEL

NODE #	TEMPERATURE, °F		T-A	NODE #	TEMPERATURE, °F		T-A
	Anal.	Test			Anal.	Test	
11'	100.3	104.9	4.6	34	111.3	113.7	2.4
"	100.3	104.8	4.5	45	118.3	117.6	-0.7
"	100.3	104.8	4.5	35	116.9	114.9	-2.0
12'	100.5	105.3	4.8	46	114.9	113.1	-1.8
"	100.5	106.0	5.5	41	115.7	116.9	1.2
12	100.5	105.6	5.1	42	116.6	113.9	-2.7
13	101.6	107.2	5.6	43	111.6	113.0	1.4
14	105.9	110.6	4.7	44	119.2	120.9	1.7
15	100.9	105.6	4.7	25	124.1	124.6	0.5
16	105.5	109.0	3.5	26	127.7	127.5	-0.2
17	101.0	104.5	3.5	27	126.2	126.5	0.3
8	104.7	108.9	4.2	28	125.0	124.7	-0.3
19	101.5	103.6	2.1	29	128.3	128.5	-0.2
20	106.1	107.5	1.4	30	133.3	128.5	-4.8
21	106.3	106.5	0.2	47	119.5	130.3	10.8
22	106.0	107.6	1.6	48	129.4	127.0	-2.4
23	106.6	108.7	2.1	50	126.2	128.5	2.3
24	106.8	108.9	2.1	51	135.8	128.3	-7.5
39	113.6	110.7	-2.9	52	166.4	168.4	2.0
31	111.7	115.7	4.0	53	174.8	160.2	-14.6
"	111.7	113.2	1.5	54	149.9	163.4	13.5
"	111.7	113.9	2.2	55	145.7	171.8	26.1
32	111.4	114.5	3.1	56	155.8	149.0	-6.8
40	111.5	113.2	1.7	57	---	128.5	--
33	111.5	114.9	3.4	29	128.3	175.3	47.0

The changes made in the external radiation factors of the electronics box reflect our inability to predict an exact value of effective emittance for multilayer insulation.

A comparison run was made of the 0°F to 100°F transient using the revised model. These results are shown in Figures 16-1 through 16-4. The data points are taken directly from Figure 14-2 and 14-3 and therefore are 4 to 5°F too high. The agreement is quite good for the main body, indicating that both the capacity and resistance are accurately modeled. The baffle support agreement is good toward the end at steady state conditions but the analytical value of capacitance appears to be too small. The same comment applies to the electronics box back but in both cases the error is not large and no changes in capacity have been made. Further changes in the analytical model would be in the area of the electronics boards and here the physical simulation is not accurate enough to warrant matching. Therefore, no additional changes will be made in the analytical model until the qualification thermal vacuum tests are completed.

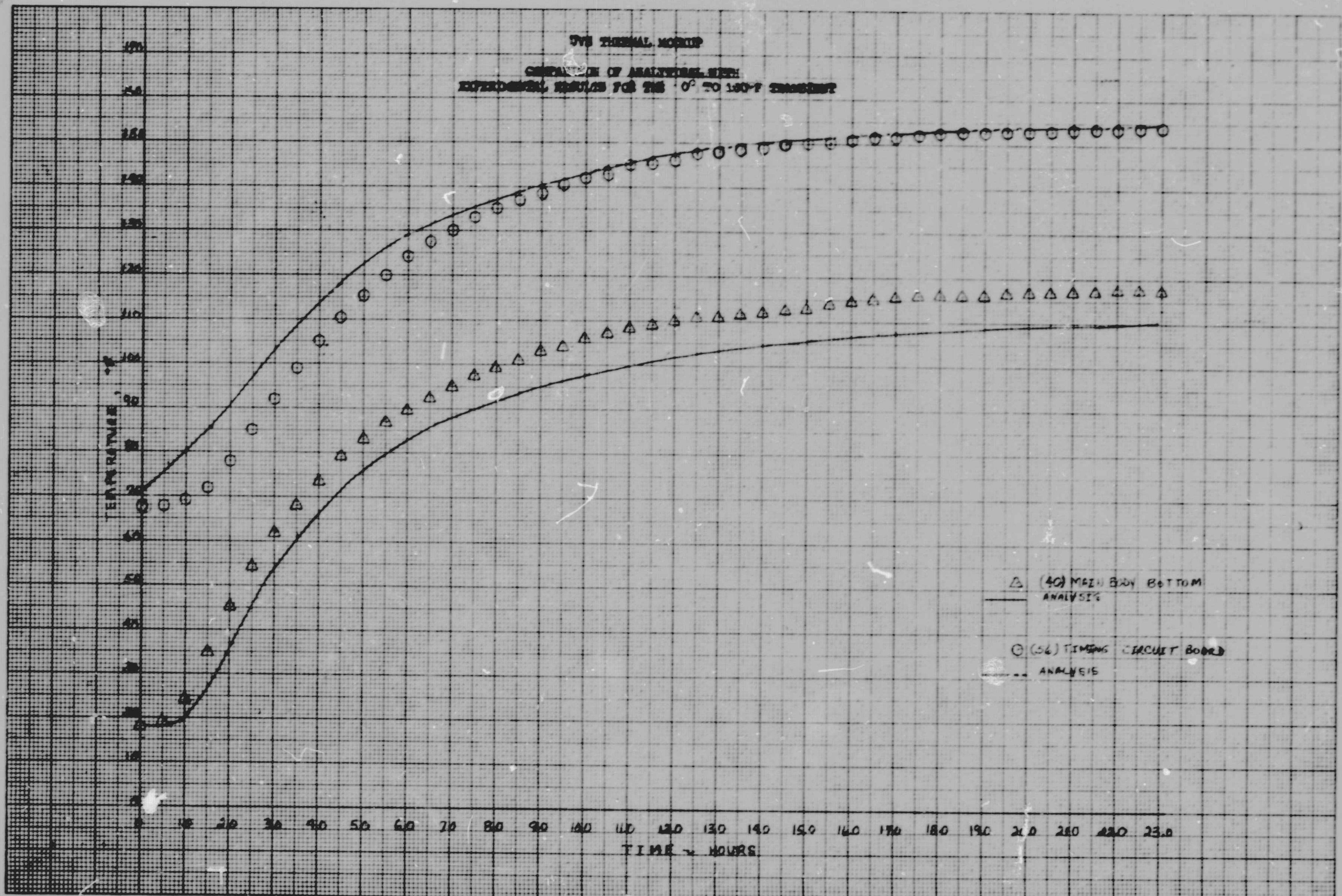

TEMPERATURE, °F
TIME ~ HOURS
(40) MAIN BODY BOTTOM
ANALYSIS
(56) TIMING CIRCUIT BOARD
ANALYSIS

FIGURE 16-1

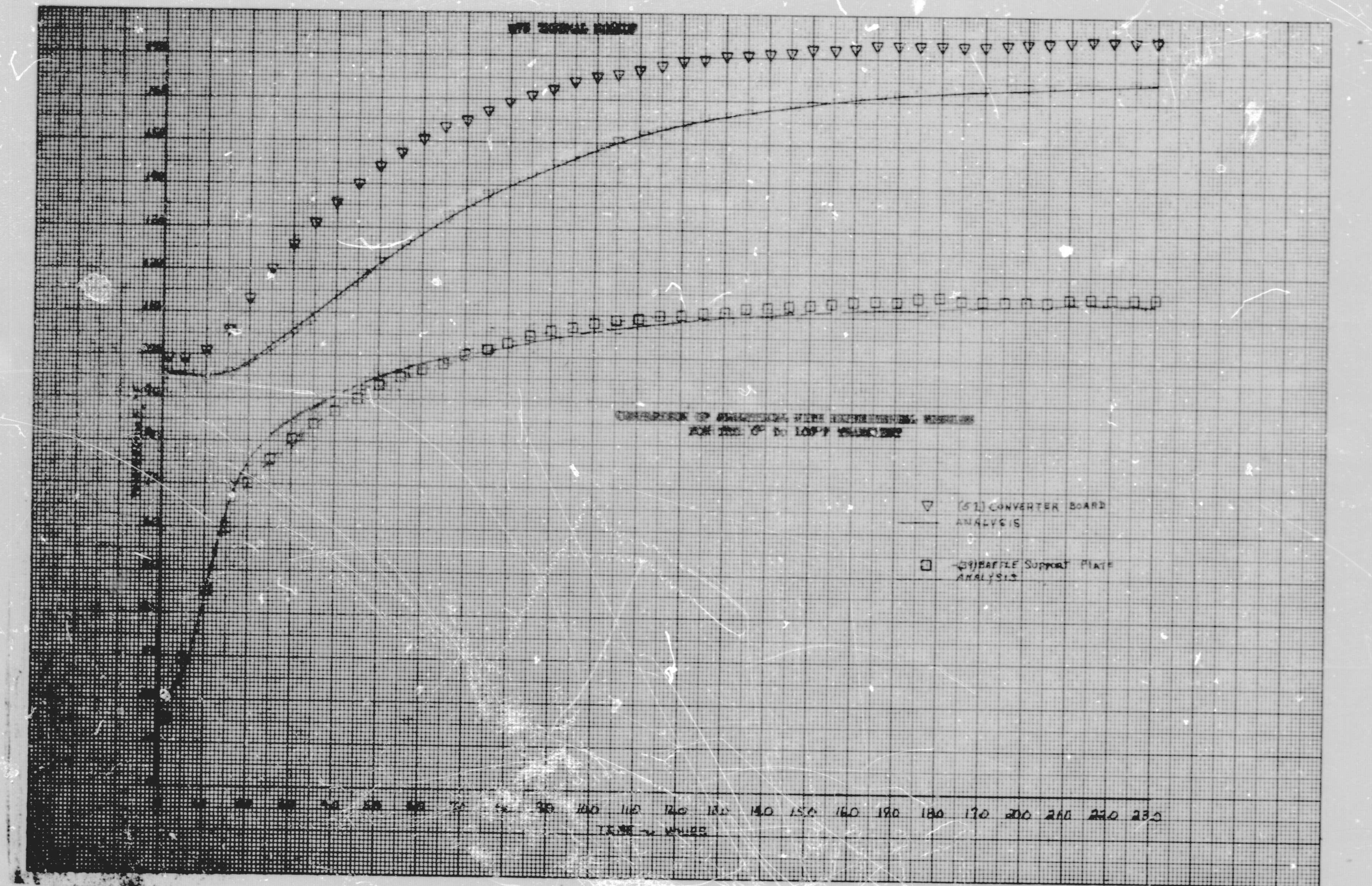
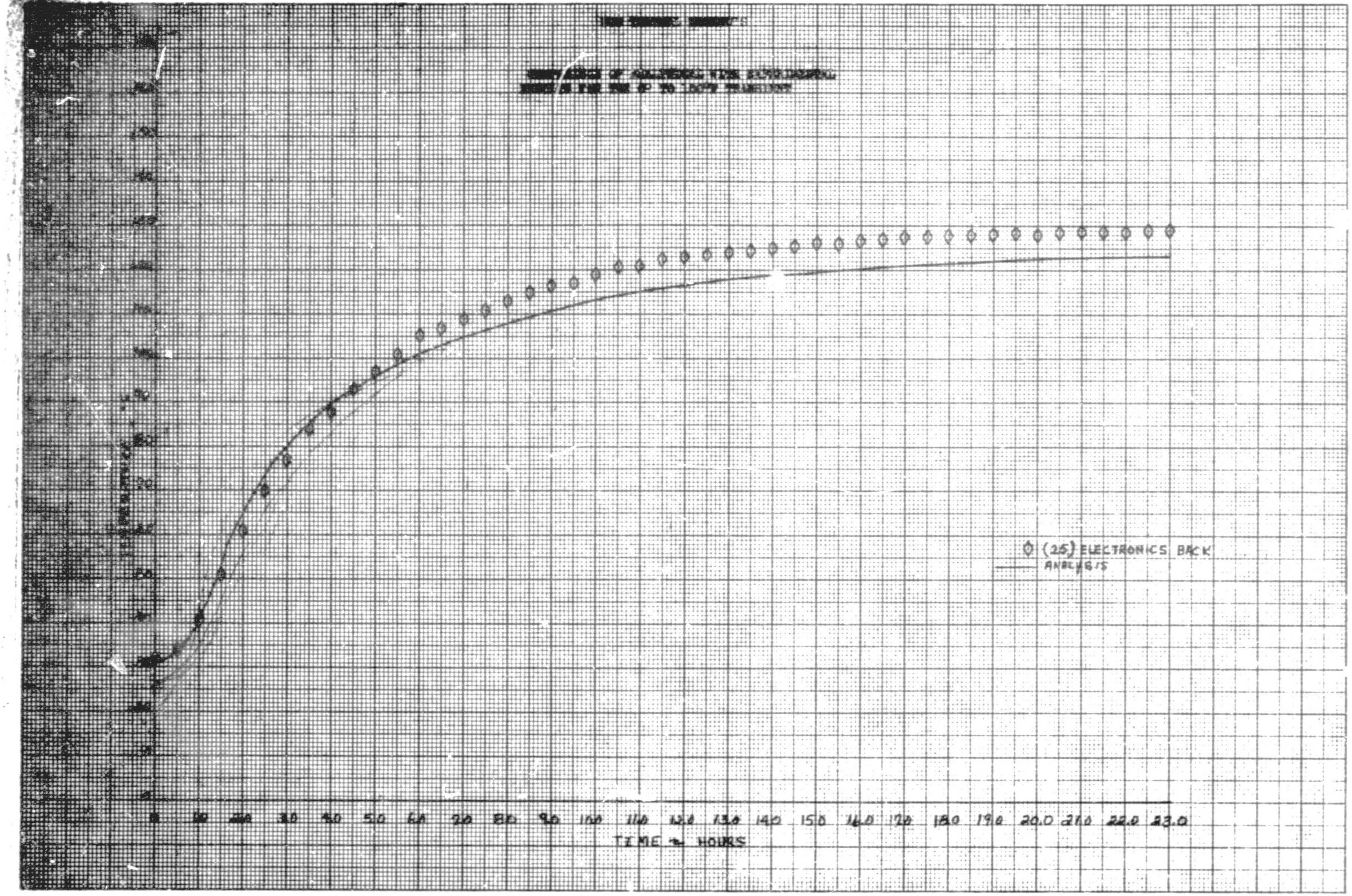

[51] CONVERTER BOARD
ANALYSIS
[31] BAFFLE Support PLATE
ANALYSIS
100
110
120
140
150
160
180
200
240
220
230

FIGURE 16-2



(25) ELECTRONICS BACK
ANALYSIS
0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0 21.0 22.0 23.0
TIME ~ HOURS

FIGURE 16-3

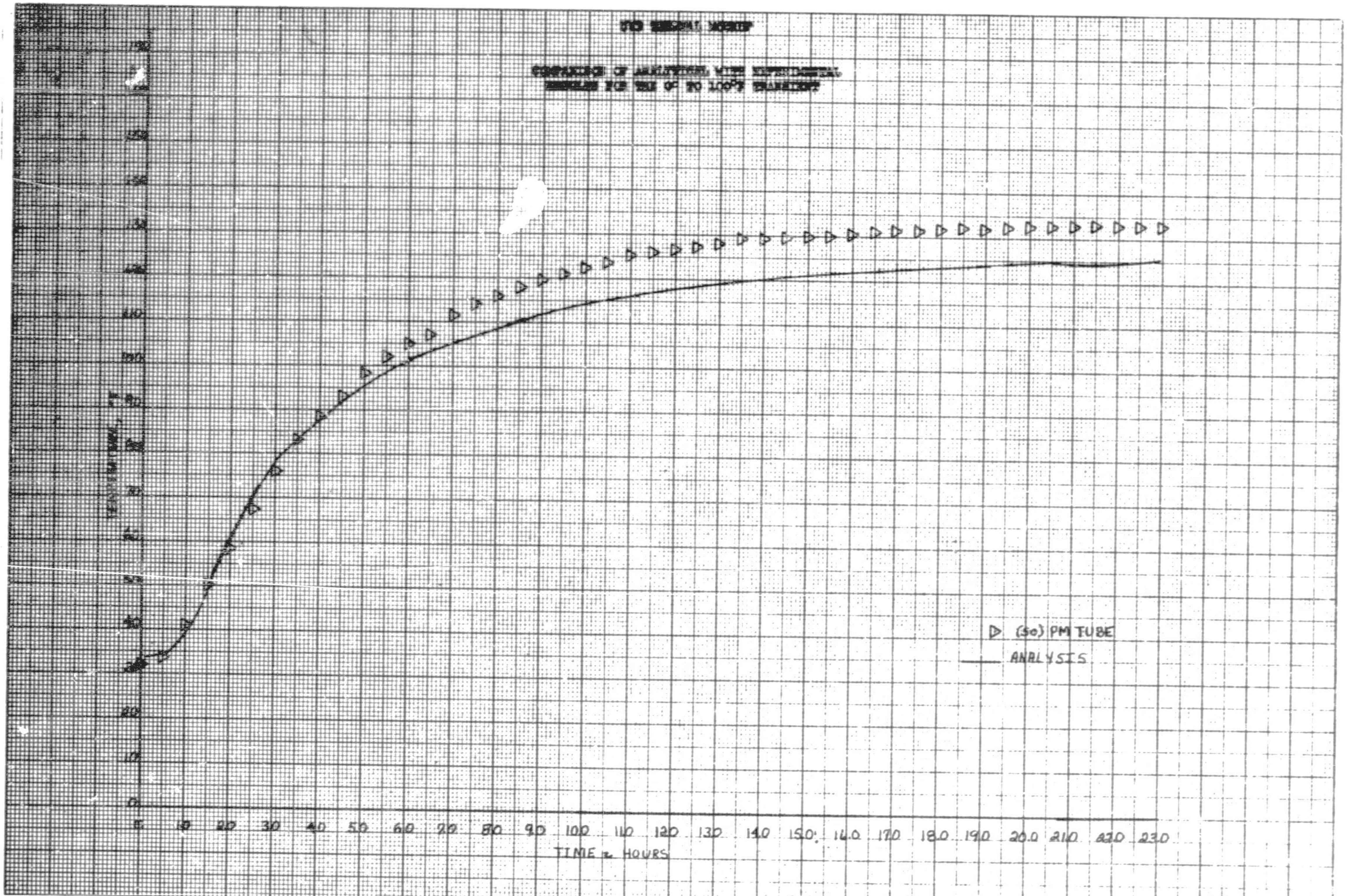

(50) PM TUBE
ANALYSIS
TIME ~ HOURS
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

FIGURE 6-4

Conclusions

Although there were several deficiencies in the thermal model the analytical model is validated by these tests. Additional changes in the electronic board description are needed and the data required will be obtained during the qualification test series.

The model as it stands predicts conservative temperatures for hot cases when turned on. In cold cases with the instrument turned off predictions are close but when the instrument is turned on the electronics temperatures will be inconservative.

The difficulty in performing the mission simulation test by manual control underlines the need to complete and checkout the computer control system for the qualification test series

APPENDIX A

TABLE 1

LIST OF THERMOCOUPLES FOR UVS THERMAL TEST

ETL CHNL. NO.	THERMAL MODEL NO.	MEASUREMENT	LOCATION	SEE DRWG. 7232-
		SIMULATOR[(1)]		
41	3	Top Panel, Left-Half ℄	Outer, 6" from Front Lip	
42	3	Top Panel, Left-Half ℄	Middle, 18" from Front Lip	
43	3	Top Panel, Left-Half ℄	Inner, 37" from Front Lip	
44	8	Top Panel, Right-Half ℄	Outer, 6" from Front Lip	
45	8	" " " " "	Middle, 18" from Front Lip	
46	8	" " " " "	Inner, 37" from Front Lip	
47	3,8	Entire Top Panel	Avg. of 41-46; Controls Heater #1	
48	10	Right Side, Centerline	1st, 6" from Front Lip	
49	10	" " "	2nd 17" from Front Lip	
50	10	" " "	3rd 28" from Front Lip	
51	10	" " "	4th 40" from Front Lip	
52	10	Entire Right Side Panel	Avg. of 48-51; Controls Heater #2	

(1) All Simulator T/C's are located on the "outside" Surface.

TABLE 1 (CONT.)

-A2 -

ETL CHNL. NO.	THERMAL MODEL NO.	MEASUREMENT	LOCATION	SEE DRWG. 7232-
53	6	Bottom Panel, Right-Half ℄	Outer, 6" from Front Lip	
54	6	" " " "	Middle, 18" from Front Lip	
55	6	" " " "	Inner, 37" from Front Lip	
56	1	Bottom Panel Left-Half ℄	Outer, 6" from Front Lip	
57	1	" " " "	Middle, 18" from Front Lip	
58	1	" " " "	Inner, 37" from Front Lip	
59	1,6	Entire Bottom Panel	Avg. of 53-58; Controls Heater #3	
60	5	Left-Side Panel, Centerline	1st, 6" from Front Lip	
61	5	" " " "	2nd, 17" from Front Lip	
62	5	" " " "	3rd, 28" from Front Lip	
63	5	" " " "	4th, 40" from Front Lip	
64	5	Entire Left-Side Panel	Avg. of 60-63; Controls Heater #4	

TABLE 1 (CONT.)

-A3 -

ETL CHNL. NO.	THERMAL MODEL NO.	MEASUREMENTS	LOCATION	SEE DRWG. 7232-
65	4	Back Panel, Left-Half	Center of Left(1st) 1/4	
66	4	Back Panel, Left-Half	Center of 2nd "	
67	9	" " " "	Center of 3rd "	
68	9	" " " "	Center of Right(4th) 1/4	
69	9	Entire Back Panel	Avg. of 65-68; Controls Heater #5	
70	[illegible]	5 Panel Simulator	Avg. of 47, 52, 59, 64, & 69	
71	7	Front Panel, Right-Half	1st 1/4, Bottom, Controls Heater #13	
72	7	" " " "	1st 1/4, Middle, Controls Heater #14	
73	7	" " " "	1st 1/4, Top, Controls Heater #15	
74	7	" " " "	2nd 1/4, Bottom, Controls Heater #16	
75	7	" " " "	2nd 1/4, Middle, Controls Heater #17	
76	7	" " " "	2nd 1/4, Top, Controls Heater #18	

TABLE 1 (CONT.)

ETL CHNL. NO.	THERMAL MODEL NO.	MEASUREMENT	LOCATION	SEE DRWG. 7232-
77	2	Front Panel, Left-Half	3rd 1/4 Bottom; Controls Heater #19	
82	2	" " " "	3rd 1/4 Middle;	
78	2	" " " "	3rd 1/4 Top/ Controls Heater #20	
79	2	" " " "	4th 1/4 Bottom; Controls Heater #21	
81	2	" " " "	4th 1/4 Middle; Controls Heater #	
80	2,7	Front Panel	Avg. 71-79	
85	2	Removable Cover in Front Panel	Right-Half Center, Controls Heater #23	
86	2	" " " " "	Left-Half Center, Controls Heater #24	
87	2	Removable Cover in Front Panel	Avg. of 85-86	
(84)		Omitted		
88	-	Entire Front Panel	Avg. of 80, 83 & 87	
89	-	Entire Simulator	Avg. of 47, 52, 59, 64, 69, & 88	
83	2	Front Panel, Left-Half Center 1/3	Avg. of 81 & 82, Control Heater #22	

TABLE 1 (CONT.)

-A5 -

ETL CHNL. NO.	THERMAL MODEL NO.	MEASUREMENT	LOCATION	SEE DRWG. 7232-
		BAFFLE(2)		
91	11	Outer Section	Centered Top	
92	11	Outer Section	Centered Right-Side	
93	11	Outer Section	Centered Bottom	
94	11	Outer Section	Centered Left-Side	
95	11	Entire Outer Section	Avg. of 91-94	
96	12	Middle Section	Center of Top	
97	12	Middle Section	Center of Bottom	
98		Entire Middle Section	Avg. of 96 & 97	

(2) All Baffle T/C's are located on its Outside Surfaces.

TABLE 1 (CONT.)

-A6 -

ETL CHNL. NO.	THERMAL MODEL NO.	MEASUREMENTS	LOCATION	SEE DRWG. 7232-
99	13	Inner Section, Top	On ℄, 3-3/4" Back	
100	14	" " , "	" " 11-1/4" Back	
101	15	" " , Right-Side	" " 3-3/4" Back	
102	16	" " , " "	" " 11-1/4" Back	
103	17	" " , Bottom	" " 3-3/4" Back	
104	18	" " , "	" " 11-1/4" Back	
105	19	" " , Left-Side	" " 3-3/4" Back	
106	20	" " , " "	" " 11-1/4" Back	
107	21	Gusset, Top-Right	3-5/8" From Back, Top of Hor. Surf.	
108	22	" , Bottom-Right	" " " " " "	
109	23	" , " -Left	" " " " " "	
110	24	" , Top-Left	" " " " " "	
111	39	Baffle Support Plate	Bottom-Center	

TABLE 1 (CONT.)

-A7 -

ETL CHNL. NO.	THERMAL MODEL NO.	MEASUREMENT	LOCATION	SEE DRWG. 7232-
MONOCHROMATOR SECTION				
112	-	Top Front Housing	Right of Center Outside	
113	-	Top Rear "	" " "	
114	31	Top	Center Outside	
115	32	Right-Side "	" "	
116	40	Bottom "	" "	
117	33	Left-Side "	" "	
118	34	Back "	" "	
120	35	Front Plate "	" "	
119	45	" " "	Top "	
121	46	" " "	Bottom (In-Line w/Baffle) Outside	
122	41	Grating	Back Center	
123	42	Grating Box	" " (Offset)	
124	43	Mirror	" "	

TABLE 1 (CONT.)

-A8 -

ETL CHNL. NO.	THERMAL MODEL NO.	MEASUREMENT	LOCATION	SEE DRWG. 7232-
125	44	Motor	Top Center (Off-Set)	
		ELECTRONICS		
126	25	Back (Mounting Plate)	Centered Left of PM Tube (Outside)	
127	26	Front (Dust Cover)	Centered "	
128	27	Top " "	Centered "	
129	23	Right-Side ("Left" Gusset)	" (Beneath J2) "	
130	29	Bottom (DC/DC Conv. Cover)	" "	
131	30	Left-Side (Dust Cover)	" "	
142	-	Bottom Left-Side	Centered "	
132	47	Circuit Breaker (Mount)		
133	48	Internal ("Right") Gusset		
134	50	PM Tube	Top Center (Off-Set)	
135	51	DC/DC Converter Housing		
136	52	" " Board		
137	53	" Regulator "		

TABLE 1 (CONT.)

ETL CHNL. NO.	THERMAL MODEL NO.	MEASUREMENT	LOCATION	SEE DRWG. 7232-
138	54	Housekeeping Board (A1)		
139	55	Motor Drive " (A2)		
140	56	Timing Circuits " (A3)		
141	57	RF Shield		

Distribution:

AABraunstein
LDEckard
WAHenderson
IBIrving
GLiebermann (25)
ELMarshall
CAWingate
TWyatt
Archives (2)
S4S-2 File (5)