The compiled reports contained herein represent the total data accumulated in the testing of the LMS components in a simulated lunar environment.

Prepared By: A. S. Tente
A. S. Tente

Approved By: C. V. Kern
C. V. Kern

CONTENTS

LMS HEAT DISTRIBUTION TESTS

I INTRODUCTION

The Lunar Mass Spectrometer (LMS) electronics assembly is comprised of seven (7) multilayer printed circuit boards assembled to the LMS radiator plate. These PC boards are mounted directly to the radiator plate either by means of posts integral with the radiator plate or by spacers which mechanically tie the boards to the radiator plate. These attachments, in addition to providing a mechanical connection, also provide a thermal path to conduct the heat from the individual boards to the radiator plate, which in turn radiates the heat to space.

Each circuit has been designed to provide the maximum efficiency at a given operating temperature, and it is desirable to establish the operating temperature for each board under expected operating conditions. In order to provide information concerning the operating characteristics of the circuits, and to determine the thermal properties of the multilayer printed circuit boards themselves, a thermal vacuum test has been conducted on the individual circuit boards.

These tests were conducted on test equipment set-up in the LMS laboratory. A description of this equipment is given in Section IV - Test Equipment.

II PURPOSE

Briefly stated, the purpose of this test is to verify the thermal resistance profile and the thermal conductivity of each complete multilayer printed circuit board under various levels of operation simulating both lunar noon and lunar night operating conditions.

III CONCLUSIONS

There were no conclusions drawn from the tests as conducted. The accumulated data were forwarded to Thermal Engineering for analysis and correlation with computer program output.

IV TEST EQUIPMENT

The thermal/vacuum test program was conducted in the LMS mechanical laboratory utilizing equipment that was set-up specifically for these tests. Figure 1 shows the test equipment set up in the laboratory.

The test equipment can be divided into four (4) basic units: vacuum system, temperature conditioner, electrical input, and temperature measurement systems.

A. Vacuum System

The vacuum system consisted of two components: the chamber and the vacuum pump. The vacuum chamber included a 14" diameter bell jar and a phenolic baseplate, which contained all the electrical and fluid feed-throughs as well as mounting provisions for the circuit board under test. This is shown in Figure 2.

The vacuum pump used was a Welch Duo-Seal model 1402 system. This unit is capable of vacuum levels of 0.1 microns, or 1×10^{-4} Torr, and a displacement of 5.6 cubic feet per minute.

B. Temperature Conditioning System

This system established the temperature of the baseplate to simulate the two extreme lunar conditions, lunar noon and lunar night. To accomplish this a liquid solution of ethelyne-glycol and water was circulated through coils to which a sub-baseplate was attached. The baseplate was in turn bolted to the sub-baseplate. The ethelyne-glycol-water solution was heated by means of a controlled electric heater to provide a baseplate temperature of 125°F, and cooled by means of liquid nitrogen to provide a baseplate temperature of 40°F or lower. The heated or cooled liquid was circulated by means of a Simen Model M40K "Mini-Vac" pump capable of circulating 350 gallons of water per hour at standard pressure and temperature.

FIGURE 1

LMS Thermal/Vacuum Test Set-up

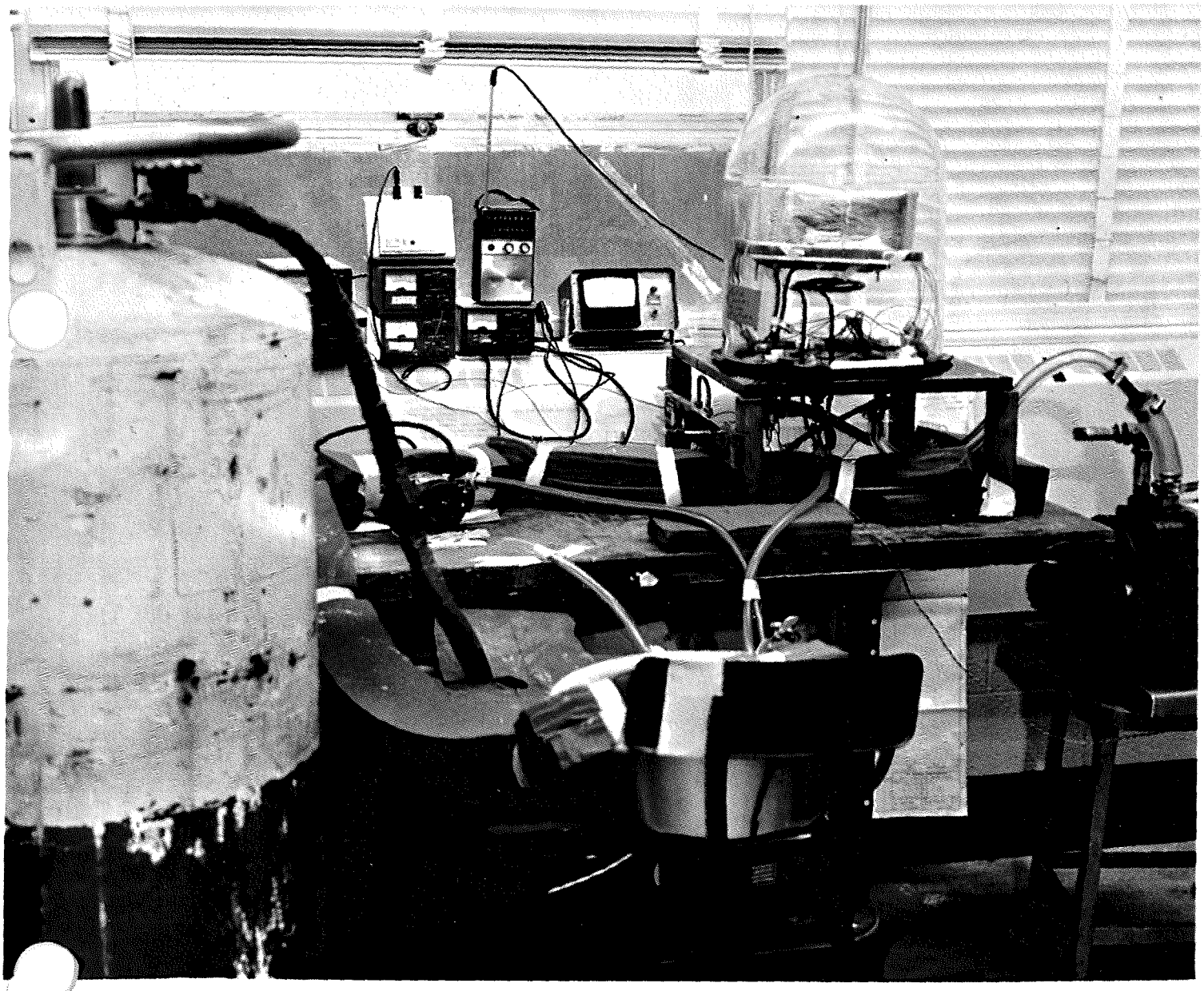
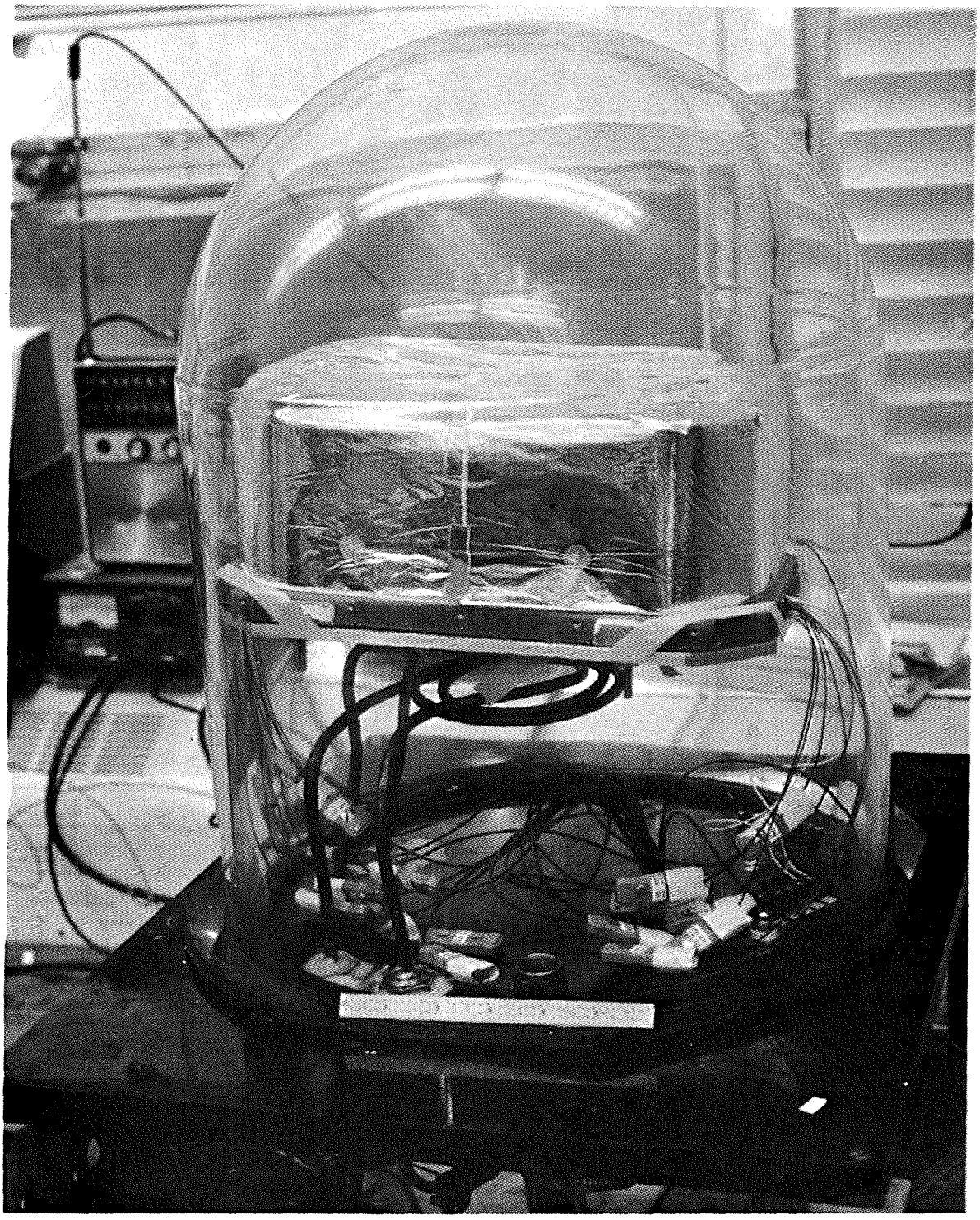


FIGURE 2

LMS Thermal/Vacuum Chamber



C. Electrical Power Supply

Electrical power was supplied by using Hewlett Packard Model 6215A power supplies as required. Power was provided for two (2) purposes: the first was to provide a known heat source at some given location on the board, and the second was to provide current and voltage to certain pins in order to energize selected components.

Heating was accomplished by placing Dale RH-10 wire-wound resistors on the board as selected by Thermal Engineering and providing a given current and voltage level to provide the necessary heating levels.

Voltage and current levels to the selected pins were supplied by Electrical Engineering personnel and verified by them at time of test.

D. Temperature Measurement System

Temperature measurement was provided by using copper-constantan thermocouples cemented to various locations on the boards, as selected by Thermal Engineering, and measuring the voltages by means of a Leeds and Northrup Potentiometer BSD Serial Number #51650.

V TEST PROCEDURE

The following represent an outline of the test as it was conducted for each card. Variations were required from card to card or as circumstances dictated.

1.0 Assemble P.C. board onto heat sink and make all necessary electrical connections.

2.0 Cover assembly with thermal bag and place belljar cover over unit.

3.0 Evacuate belljar to vacuum level.

4.0 Establish heat sink temperature at low temperature level.

4.1 Turn on test item to operating power level (s) to the board components.

4.2 Hold test condition until equilibrium is reached and record data.

4.3 Remove operating power input.

4.4 Input low power to heater element.

4.4.1 Hold test condition until equilibrium is reached and record data.

4.5 Increase power to heater element to intermediate level.

4.5.1 Hold test condition until equilibrium is reached and record data.

4.6 Increase power to heater element to maximum level.

4.6.1 Hold test condition until equilibrium is reached and record data.

4.7 Remove all power.

5.0 Increase heat sink temperature to 125°F.

5.1 Turn on test item to operating level (s) to the board components.

5.2 Hold test condition until equilibrium is reached and record data.

5.3 Remove operating power input.

5.4 Input low power to heater element.

5.4.1 Hold test condition until equilibrium is reached and record data.

5.5 Increase power to heater element to intermediate level.

5.5.1 Hold test condition until equilibrium is reached and record data.

5.6 Increase power to heater element to maximum level.

5.6.1 Hold test condition until equilibrium is reached and record data.

5.7 Remove all power.

6.0 Turn off heat sink power.

7.0 Turn off experiment and pressurized chamber.

8.0 Repeat above steps for all P. C. boards until all circuits have been tested.

VI

Data Sheets

Control and Monitor Card

FIGURE 3

Control and Monitor Card
Front

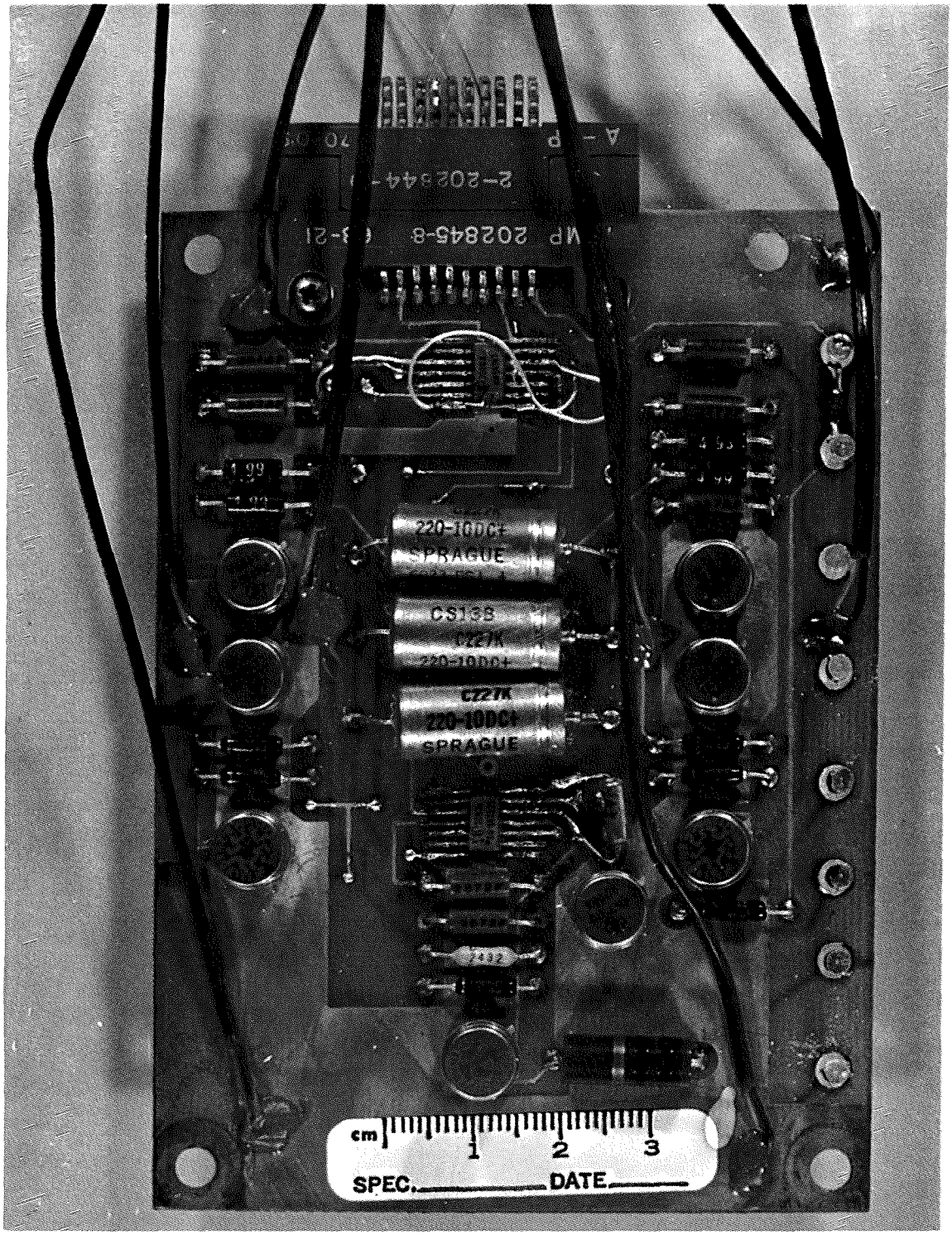
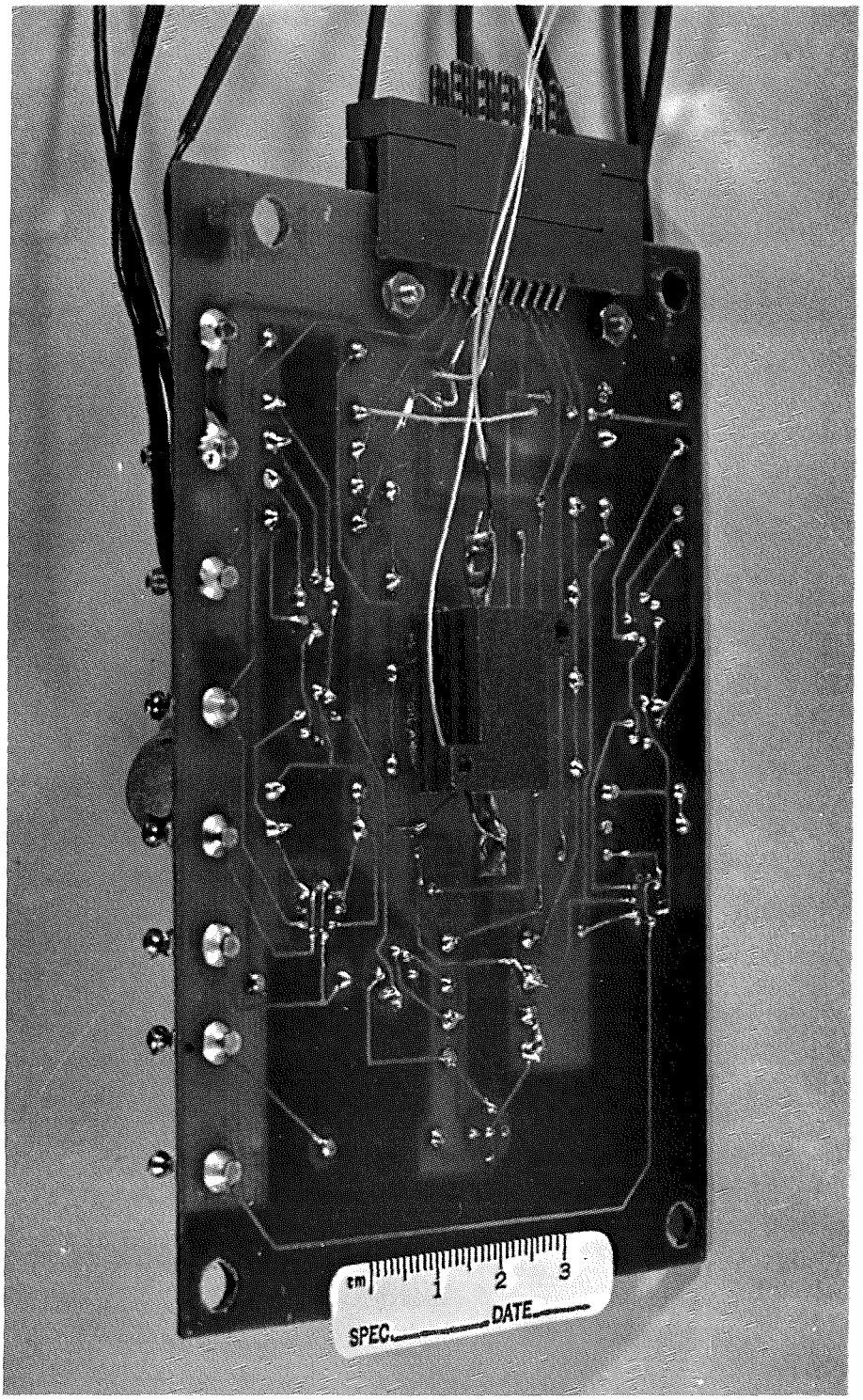


FIGURE 4

Control and Monitor
Back



Misc Control & Monitor

Test # 1

Chamber Pressure: 33 microns

Test Conditions:

Power to Heater: 0.2 watts

Voltage to Cord: None

Radiator Plate Temp: 0° F *

Fluid Flow Rate:

Thermocouple Data: Radiator Plate - N° 16

Note: Unable to obtain this temperature, lowest reading was 42° F

Test N° 1

DATA

Time	1600	1630	1645	1700		
T/C N° \ Temp °F						
4	51 °F	52 °F	52 °F	51 °F		
6	42	42	45	46		
7	45	43	45	46		
10	45	43	45	46		
11	51	51	51	49		
12	51	51	—	—		
5	51	51	51	49		
16	42	42	42	42		
18	51	55	55	55		

Misc. Control & Monitor

Test # 2

Chamber Pressure: 37 microns

Test Conditions:

Power to Heater: - None

Voltage to Cord 5 volts

Radiator Plate Temp: 125°F

Fluid Flow Rate:

Thermocouple Data: Fluid Out - N° 5
Fluid In - N° 8
Radiator Plate - N° 16

Test No 2

DATA

Time / TEMP °F / C No	1700	1715	1730	
4	120°F	121°F	121°F	
5	135	135	135	
6	125	126	125	
7	125	125	125	
8	135	135	135	
10	125	124	125	
	124	123	123	
12	122	121	121	
15	122	123	123	
16	125	125	124	
18	122	122	121	

Misc. Control & Monitor

Test N° 3

Chamber Pressure: 37 microns

Test Conditions

Power to Heater: 0.25 watts

Voltage to Cord: None

Radiator Plate Temp: 125° F

Fluid Flow Rate:

Thermocouple Data: Fluid In - N° 5
Fluid Out - N° 8
Radiator Plate - N° 16

Test No 3

DATA

Time	1745	1800	
TEMP OF / C N[illegible]			
4	122°F	123°F	
5	135	135	
6	126	126	
7	125	125	
8	135	135	
10	124	124	
11	123	124	
12	121	122	
15	122	124	
16	125	125	
18	125	125	

Counter and Data Compressor Card

FIGURE 5

Counter and Data Compressor Card
Front

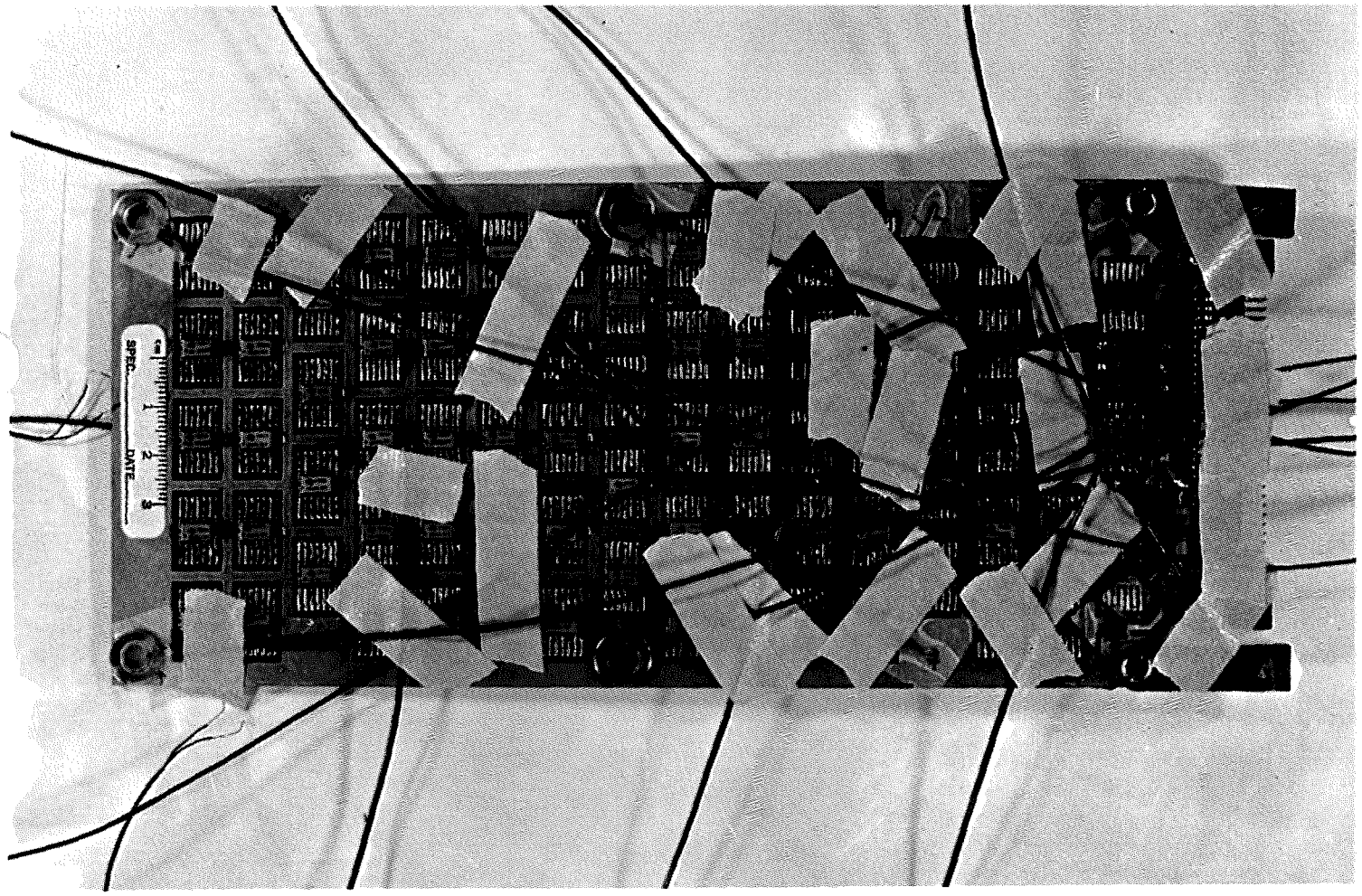
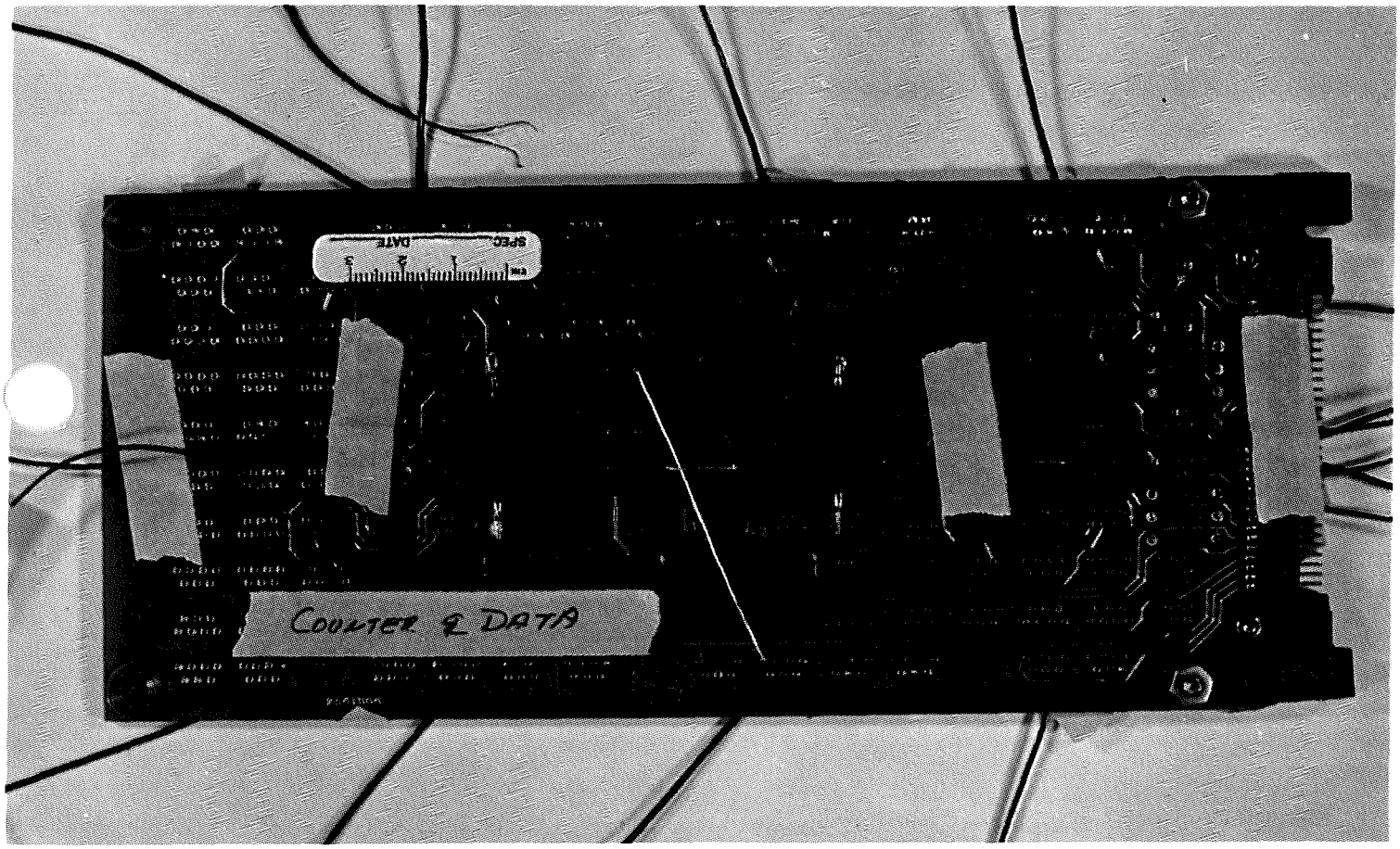


FIGURE 6

Counter and Data Compressor Card
Back



COUNTER & DATA COMPRESSOR

TEST # 1

Chamber Pressure : 24 microns

Test Conditions :

Power to Heaters : 1.0 watt 7.2 volts @ 140 MA

Voltage to Card : None

Radiator Plate Temp: 44°F *

Fluid Flow Rate : 0.058 Lt/sec

Thermocouple Data : Radiator Plate # 16
Fluid Out # 5
Fluid In # 8

Ambient Temperature : 75°F

* Cooling fluid was held @ 0°F

Test № 1

C & D C

Date

Time / TEMP OF №	1415	1445	1515	1545	1615	1645	1715	1745
2	42°F	47°F	50°F	55°F	54°F	55°F	55°F	54°F
3	42	46	47	48	50	53	53	51
4	34	38	39	40	41	43	43	43
5	-4	-2	-2	0	0	1	1	0
6	42	44	45	45	49	51	52	51
7	34	37	38	38	41	42	42	42
8	-4	-2	-2	0	0	1	1	1
9	42	44	45	47	47	56	50	50
10	—	—	—	-	—	—	—	—
11	34	37	38	38	41	42	42	42
12	50	49	54	55	59	61	62	61
13	53	55	56	59	63	65	65	65
14	40	53	54	55	60	61	62	61
15	42	45	46	46	49	50	51	52
16	36	38	39	41	42	43	44	44
18	37	39	40	41	44	43	44	44
19	42	44	46	48	50	51	52	51
20	47	49	51	52	55	58	59	58

COUNTER & DATA COMPRESSOR
TEST #2

Chamber Pressure: 25 microns

Test Conditions

Power to Heaters: 1.5 watts 9.5 volts @ 160 mA

Voltage to Cord: None

Radiator Plate Temp: 40°F *

Fluid Flow Rate: 0.088 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 75°F

Cooling Fluid temp. held @ 0°F

Test # 2 C & DC

DATA

TIME / TEMP OF C No.	1300	1330	1400	1430	1500	1530	1600
2	62°F	65°F	63°F	59°F	58°F	55°F	54°F
3	60	62	60	56	53	53	52
4	51	47	48	45	43	41	41
5	35	6	6	0	0	0	6
6	61	61	57	53	49	49	49
7	50	51	47	44	41	41	41
8	35	6	6	1	0	0	1
9	59	60	56	54	48	49	48
10	—	—	—	—	—	—	—
11	53	53	47	44	41	38	38
12	72	72	69	66	63	62	62
13	75	75	72	70	66	62	61
14	73	71	68	65	63	63	63
15	62	59	56	54	50	51	50
16	65	56	46	44	40	40	40
18	55	54	49	46	43	43	42
19	63	60	58	55	52	51	51
20	69	67	60	63	58	58	57

COUNTER [illegible] COMPRESSOR

TEST # 3

Chamber Pressure: 25 microns

Test Conditions:

Power to Heaters: 1.2 watts 8.5 volts @ 140 MA

Voltage to Cord: None

Radiator Plate Temp: 37°F *

Fluid Flow Rate 0.088 Lt/sec

Thermocouple Data: Radiator Plate #16
Fluid Out #5
Fluid In #8

Ambient Temp: 75°F

* Cooling Fluid temp held @ 0°F

Test № 3 C & D C

Data.

Date 4/5/71

Time	1700	1730	1800	1830	1900	1930		
TEMP °F №								
2	53°F	52°F	51°F	46°F	48°F	48°F		
3	50	51	51	46	47	48		
4	40	41	42	37	37	37		
5	0	1	0	-2	0	0		
6	48	47	47	43	44	44		
7	39	39	41	35	36	38		
8	0	+1	0	-2	0	0		
9	47	47	48	42	44	45		
10	—	—	—	—	—	—		
11	39	40	41	36	36	37		
12	56	56	58	54	56	56		
13	59	59	59	59	58	59		
14	57	56	56	54	55	56		
15	48	48	49	44	45	46		
16	39	39	41	36	37	37		
18	42	42	41	38	38	39		
19	49	48	49	45	44	44		
2	54	54	54	50	51	51		

Counter & Data Compressor
Test # 4

Chamber Pressure: 25 microns

Test Conditions:

Power to Heaters: 0 watts

Voltage to Card: 5.0 volts @ 200 MA

Radiator Plate Temp: 40°F *

Fluid Flow Rate: 0.088 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 75°F

Cooling Fluid temp held @ 0°F

Test N° 4 C&DC

DATA

Date 4/6/71

Time	1000	1030	1100	1130	1200			
TEMP °F / C NO								
2	51°F	47°F	48°F	48°F	48°F			
3	52	42	38	40	39			
4	40	42	38	40	39			
5	0	0	0	-2	0			
6	49	48	47	47	47			
	38	40	37	38	38			
8	0	0	0	0	0			
9	48	49	45	45	45			
10	—	—	—	—	—			
11	43	42	40	40	39			
12	55	54	51	50	50			
13	55	54	51	50	50			
14	54	54	51	50	50			
15	49	50	47	48	46			
16	40	41	39	39	42			
18	44	44	42	42	41			
19	50	50	47	47	46			
0	55	56	53	53	52			

Counter & Data Compressor
Test #5

Chamber Pressure: 38 microns

Test Conditions:

Power to Heaters: 0 watts

Voltage to Cord: 6.0 volts @ 200 MA

Radiator Plate Temp: 125°F

Fluid Flow Rate: 0.0192 Lt/sec

Thermocouple Data: Radiator Plate #16
Fluid Out #5
Fluid In #8

Ambient Temp: 75-75°F

TEST N° 5 C & DC

DATA

DATE 4/7/51

TIME	0900	0930	1000	1030				
TEMP °F / C N°								
2	122°F	124°F	124°F	122°F				
3	120	121	121	120				
4	123	124	124	122				
5	126	127	126	118				
	122	124	123	123				
7	124	125	123	123				
8	126	127	125	126				
9	120	121	121	120				
10	—	—	—	—				
11	124	124	124	124				
12	123	124	124	124				
13	123	124	124	124				
14	126	126	125	125				
15	119	120	120	118				
16	124	124	124	121				
18	123	123	123	121				
	121	122	121	121				
20	123	124	124	123				

COUNTER & DATA COMPRESSOR
TEST # 6

Chamber Pressure : 34 microns

Test Conditions :

Power to Heater : 1.0 watts 7.2 volts @ 140 MA

Voltage to Cord : None

Radiator Plate Temp : 125°F
Fluid Flow Rate : 0.0192 Lt/sec
Thermocouple Data : Radiator Plate #16
Fluid out #5
Fluid In #8

Ambient Temp : 77°F

TEST Nº 6 C & DC

DATA:

DATE 4/8/51

TIME								
TEMP° F / No	1000	1030	1100	1130	1200			
2	119°F	120°F	121°F	121°F	121°F			
3	114	117	117	118	119			
4	120	121	121	121	121			
5	124	124	123	124	123			
6	120	121	123	122	123			
7	121	122	124	123	123			
8	124	125	123	123	124			
9	116	117	118	117	118			
10	—	—	—	—	—			
11	119	120	121	121	121			
12	120	122	124	125	125			
13	124	124	125	125	125			
14	124	125	125	125	125			
15	114	117	117	117	117			
16	122	123	122	123	124			
17	119	120	120	120	120			
19	117	119	120	120	120			
	117	120	121	121	121			

COUNTER & DATA COMPRESSOR
TEST # 7

Chamber Pressure: 34 microns

Test Conditions:

Power to Heaters: 1.2 watts 8.5 volts @ 140 MA

Voltage to Card: None

Radiator Plate Temp: 125°F
Fluid Flow Rate: 0.0192 Lt/sec
Thermocouple Data: Radiator Plate # 16
Fluid Out # 5
Fluid In # 8

Ambient Temperature: 77°F

TEST Nº 7 C & DC

DATA:

DATE 4/8/71

TIME	1300	1330	1400	1430	1500			
TEMP °F / C Nº								
2	123°F	125°F	124°F	124°F	123°F			
3	120	120	120	119	118			
4	123	124	123	123	123			
5	125	127	124	125	128			
6	123	123	124	122	121			
7	124	125	124	123	122			
8	127	126	123	125	128			
9	120	121	121	120	118			
11	123	124	124	124	123			
12	127	128	128	127	126			
13	129	131	130	129	128			
14	129	131	130	129	128			
15	118	121	120	120	120			
16	125	126	125	125	125			
18	123	123	123	122	121			
19	121	122	123	122	121			
21	121	123	122	122	121			

COUNTER & DATA COMPRESSOR
TEST # 8

Chamber Pressure: 27 microns

Test Conditions

Power to Heaters: 1.5 watts 9.5 volts @ 160 MA

Voltage to Card: None

Radiator Plate Temp: 125°F

Fluid Flow Rate: 0.0192 Lt/sec

Thermocouple Data: Radiator Plate #16
Fluid Out #5
Fluid In #8

Ambient Temp: 78 - 79°F

TEST N° 8 C & DC

DATA:

DATE 4/8/71

TIME	1600	1630	1706	1730	1800			
TC N° \ TEMP °F								
2	128°F	123°F	123°F	122°F	125°F			
3	123	120	117	118	121			
4	127	116	116	122	124			
5	121	107	119	124	126			
6	127	121	119	121	125			
	127	117	116	121	125			
8	119	108	121	124	125			
9	123	119	115	120	121			
11	124	120	116	121	122			
12	131	130	126	127	129			
13	135	132	128	131	132			
14	135	131	127	130	132			
15	123	120	117	119	120			
16	126	117	118	125	130			
18	126	120	117	121	123			
19	126	122	118	120	123			
20	126	124	121	121	123			

Housekeeping Multiplexer Card

FIGURE 7

Housekeeping Multiplexer Card
Front

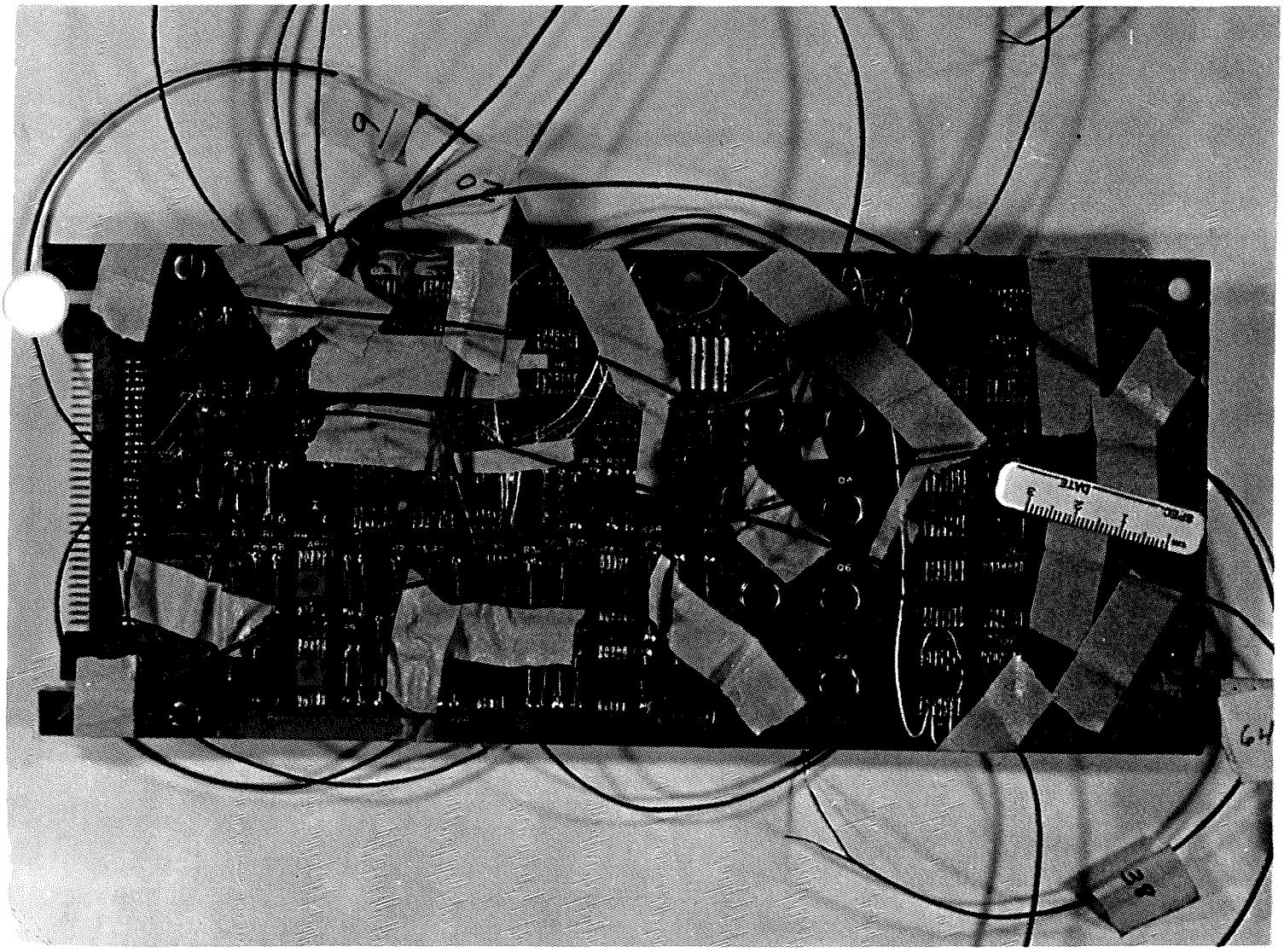
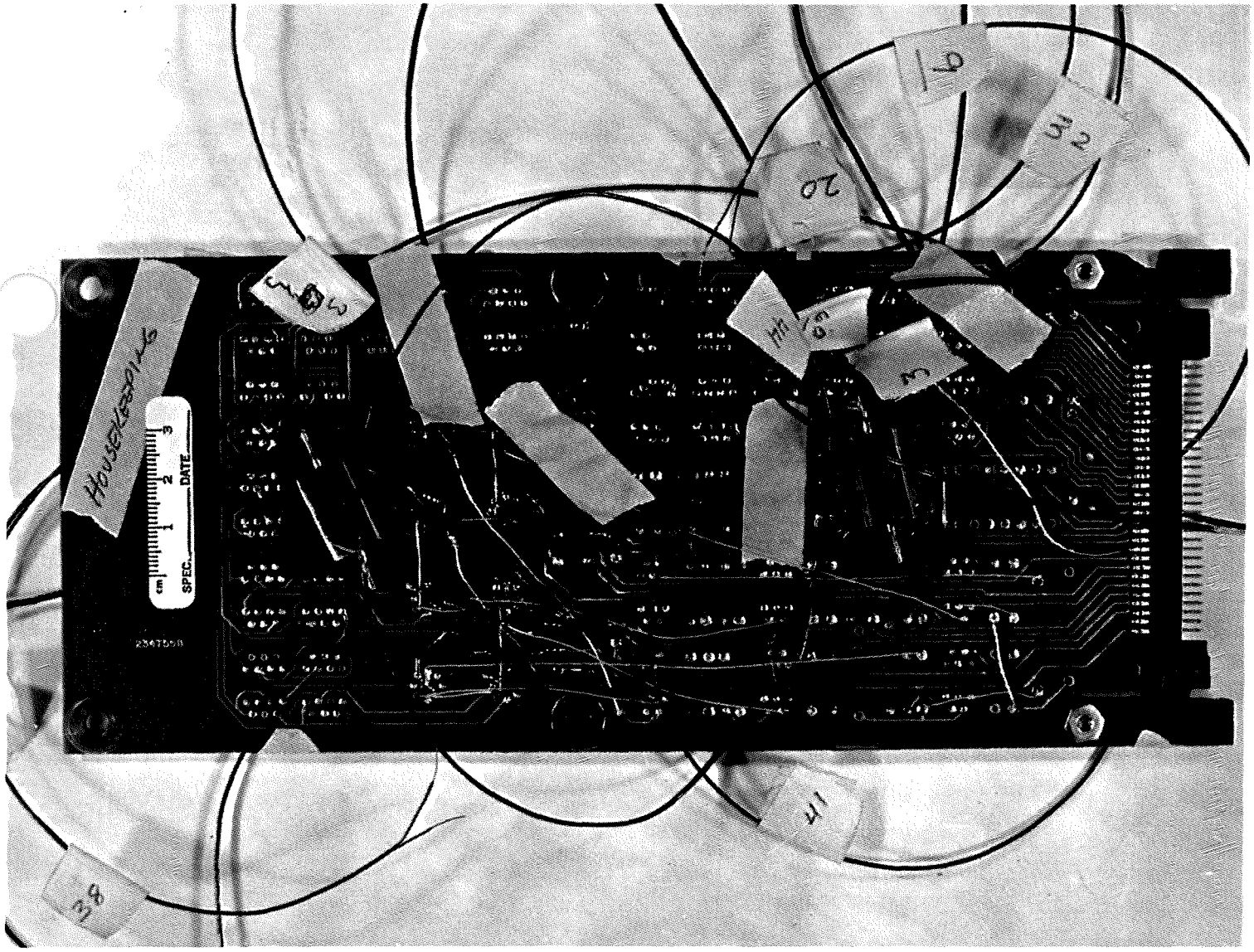


FIGURE 8

Housekeeping Multiplexer Card
Back



HOUSEKEEPING & MULTIPLEXER

Test #1

Chamber Pressure: 75 microns

Test Conditions:

Power to Heaters: None

Voltage to Cord: +12, -12 & +5 volts

Radiator Plate Temp: 125°F*

Fluid Flow Rate: 0.0214 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 79 - 81°F

*Maximum Radiator Plate Temp - 118°F

TEST N° 1 Hskpg Mux.

DATA:

DATE 4/12/71

TIME	1600	1630	1700	1730	1800	1830		
TEMP °F / TC N°								
1	105°F	110°F	112°F	113°F	115°F	115°F		
2	110	113	117	117	119	117		
3	103	109	112	113	116	113		
4	106	109	114	115	117	116		
5	114	120	121	121	122	117		
6	105	110	113	113	116	114		
7	107	111	113	115	116	114		
8	116	121	121	121	122	117		
9	109	111	116	116	118	116		
10	106	110	113	113	115	114		
11	107	111	113	113	116	115		
12	107	112	116	117	118	117		
13	109	112	116	117	118	117		
14	109	112	116	117	118	117		
15	109	112	115	117	118	117		
16	112	116	117	117	118	117		
15	109	113	116	117	118	117		

HOUSE KEEPING & MULTIPLEXER TEST NO 2

Chamber Pressure : 15 microns

Test Conditions :

Power to Heaters : None

Voltage to Card : +12, -12, & +5 volts

Radiator Plate Temp: 0 °F *

Fluid Flow Rate : 0.0103 Lt/sec

Thermocouple Data :

Radiator Plate :-	# 16
Fluid Out	# 5
Fluid In	# 8

Ambient Temp : 72 - 77 °F

* Minimum Radiator Plate Temp 11 °F

TEST No 2

Hskpg. Mux

DATA:

DATE 4/13/71

TIME	0930	1000	1030	1100	1130			
TEMP °F / No								
1	51°F	48°F	48°F	48°F	47°F			
2	41	40	39	39	40			
3	53	49	49	49	49			
4	50	48	47	46	46			
5	6	5	8	7	11			
6	50	49	48	48	46			
7	45	44	42	41	42			
8	6	5	8	7	11			
9	51	48	48	48	49			
10	47	46	45	45	45			
11	48	46	45	45	45			
12	54	52	51	51	51			
13	50	49	47	46	47			
4	45	45	43	43	44			
15	51	48	47	47	47			
16	11	13	18	18	16			
18	44	42	41	41	42			

HOUSEKEEPING & MULTIPLEXER TEST NO 3

Chamber Pressure: 14 microns

Test Conditions:

Power to Heaters: 0.2 watts 2.0 volts @ 100 MA

Voltage to Card: None

Radiator Plate Temp. 0°F *

Fluid Flow Rate .0103 Lt/sec

Thermocouple Data

Radiator Plate	# 16
Fluid Out	# 5
Fluid In	# 8

Ambient Temp. 75°F

* Minimum Radiator Plate Temp: 6°F

TEST No 3

Hskpg. Mux.

DATA:

DATE 4/13/71

TIME	1645	1715	1745	1815				
TEMP °F / TC No								
1	41°F	41°F	41°F	41°F				
2	35	35	34	34				
3	42	42	42	42				
4	41	41	40	40				
5	3	3	4	4				
	42	45	44	44				
7	38	37	37	37				
8	3	3	3	4				
9	41	39	39	39				
10	40	39	39	39				
11	39	39	39	39				
12	44	42	44	44				
13	42	41	41	41				
14	38	37	37	37				
15	39	40	40	40				
16	6	6	6	6				
18	34	34	33	34				

HOUSEKEEPING & MULTIPLEXER
Test # 4

Chamber Pressure : 17 microns

Test Conditions

Power to Heaters : 0.4 watts 3.5 volts @ 120 MA

Voltage to Cord : None

Radiator Plate Temp : 0°F *

Fluid Flow Rate : 0.0103 Lt/sec

Thermocouple Data :

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp. 74-75°F

Minimum Radiator Plate Temp : 10°F

TEST Nº 4

HSKPG. MUX.

DATA!

DATE 4/14/71

TIME	1015	1045	1115	1145	1215	1245		
TEMP °F / Nº								
1	47°F	48°F	47°F	45°F	—	46°F		
2	38	40	39	37		39		
3	47	48	47	45		45		
4	45	47	47	45		45		
5	5	7	5	6		4		
6	49	48	47	48		48		
7	42	42	42	40		40		
8	6	6	5	6		5		
9	45	45	45	43		43		
10	45	45	45	42		42		
11	44	44	45	44		42		
12	49	50	50	50		47		
13	46	47	48	47		44		
14	42	43	42	42		40		
15	42	46	46	45		44		
16	11	11	10	10		10		
18	40	40	41	41		38		

HOUSEKEEPING & MULTIPLEXER TEST #5

Chamber Pressure: 15 microns

Test Conditions

Power to Heater: 0.6 watts - 40 volts @ 145 MA

Voltage to Card: None

Radiator Plate Temp: 0°F *

Fluid Flow Rate: 0.0103 Lt/sec

Thermo couple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 75-77°F

Minimum Radiator Plate Temp 10°F

TEST № 5

HSKPG MUX

DATA:

DATE 4/14/71

TIME	1430	1500	1530	1600	1630	1700	1730
TEMP OF №							
1	49°F	47°F	48°F	46°F	45°F	45°F	46°F
2	45	41	39	38	39	38	39
3	49	48	48	45	45	47	47
4	48	48	47	45	45	46	46
5	6	6	8	8	8	8	9
6	49	48	47	47	47	48	49
7	42	42	41	40	40	40	41
8	6	6	8	8	8	8	12
9	47	47	45	42	42	45	45
10	45	45	44	44	42	44	45
11	46	45	45	41	42	42	42
12	52	53	51	48	48	48	49
13	49	49	49	45	46	46	47
14	43	44	43	41	41	41	42
15	48	49	48	43	43	44	45
16	14	10	13	10	13	13	19
18	41	41	41	38	38	37	39

HOUSEKEEPING & MULTIPLEXER TEST #6

Chamber Pressure: 15 microns

Test Conditions:

Power to Heaters: None

Voltage to Card: +12 volts @ 15 MA
-12 volts @ 15 MA
+5 volts @ 90 MA

Radiator Plate Temp: 125°F *

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 79°F

Maximum Temp Obtained on Radiator Plate - 123°F

TEST No 6

HSKPG MUX

DATA:

DATE 4/15/71

TIME / TEMP °F No	1030	1100	1130	1200	1230	1300		
1	119 °F	113 °F	113 °F	113 °F		113 °F		
2	117	119	117	117		118		
3	119	113	113	113		113		
4	119	115	116	115		116		
5	127	123	120	121		121		
6	108	113	113	113		114		
7	112	116	116	114		115		
8	127	123	121	120		120		
9	112	117	115	116		116		
10	112	116	114	113		115		
11	109	116	116	116		116		
12	111	118	116	117		117		
13	112	118	117	118		117		
14	115	121	120	119		120		
15	111	118	118	117		119		
16	119	123	121	121		121		
18	113	119	117	117		118		

HOUSEKEEPING & MULTIPLEXER
TEST #7

Chamber Pressure: 20 microns

Test Conditions:

Power to Heaters: 0.2 watts - 2.0 volts @ 100 MA

Voltage to Cord: None

Radiator Plate Temp: 125°F *

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 79°F

* Maximum Temp Obtained - 121°F

TEST N° 7

HSKPG MUX

DATA!

DATE 4/15/71

TIME	1630	1700	1730	1800	1830			
TEMP °F / TC N°								
1	104°F	108°F	108°F	112°F	112°F			
2	109	113	116	118	117			
3	104	108	108	112	112			
4	105	109	110	113	113			
5	116	120	125	122	123			
6	105	107	111	112	114			
7	108	110	113	115	115			
8	118	119	125	123	123			
9	106	109	113	114	115			
10	106	108	111	114	113			
11	106	109	113	113	113			
12	106	109	113	113	115			
13	107	110	114	114	115			
14	109	112	117	117	117			
15	107	110	113	116	117			
16	112	116	121	121	120			
18	107	112	116	117	117			

HOUSEKEEPING & MULTIPLEXER
TEST # 8

Chamber Pressure; 25 microns

Test Conditions

Power to Heaters: 0.4 watts - 3.5 watts @ 120 MA

Voltage to Card: None

Radiator Plate Temp: 125°F *

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp. 78-79°F

Minimum Temp Obtained 121°F

TEST N° 8
HSKPG MUX

DATA:

DATE 4/16/71

TIME	0945	1015	1045	1115	1145	1215	1245
TEMP °F / NO							
1	113 °F	113°F	114°F	113°F	114°F		115°F
2	119	118	118	119	120		119
3	113	113	114	114	116		116
4	114	116	117	116	117		117
5	122	122	122	122	123		124
6	116	116	117	117	117		119
7	116	116	117	117	117		118
8	123	122	122	123	123		124
9	115	115	116	116	117		117
10	114	115	116	116	117		117
11	116	116	116	116	117		118
12	117	117	118	119	119		119
13	118	119	120	120	119		120
14	119	119	120	120	119		120
15	117	118	118	119	119		119
16	121	121	121	121	121		121
8	119	119	120	119	119		119

HOUSEKEEPING & MULTIPLEXER TEST # 9

Chamber Pressure: 28 microns

Test Conditions:

Power to Heaters: 0.6 watts - 4.0 volts @ 145 MA

Voltage to Card: None

Radiator Plate Temp: 125°F

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 79 - 81 °F

TEST Nº 9

HSKPG MUX

DATA!

DATE 4/16/71

TIME	1400	1430	1500	1530	1600			
TEMP Nº OF								
1	117°F	117°F	116°F	116°F	117°F			
2	121	121	120	119	120			
3	118	117	117	116	117			
4	121	120	120	119	118			
5	124	124	121	121	123			
6	120	119	120	120	120			
7	120	119	119	117	118			
8	123	124	122	122	124			
9	119	120	120	119	118			
10	119	119	118	116	118			
11	119	119	119	118	117			
12	121	121	121	121	120			
13	123	124	123	122	121			
14	121	121	120	120	121			
15	121	121	121	120	121			
16	125	121	123	122	122			
8	121	121	120	120	120			

Signal Conditioner and Command Decoder Card

FIGURE 9

Signal Conditioner and Command Decoder Card
Front

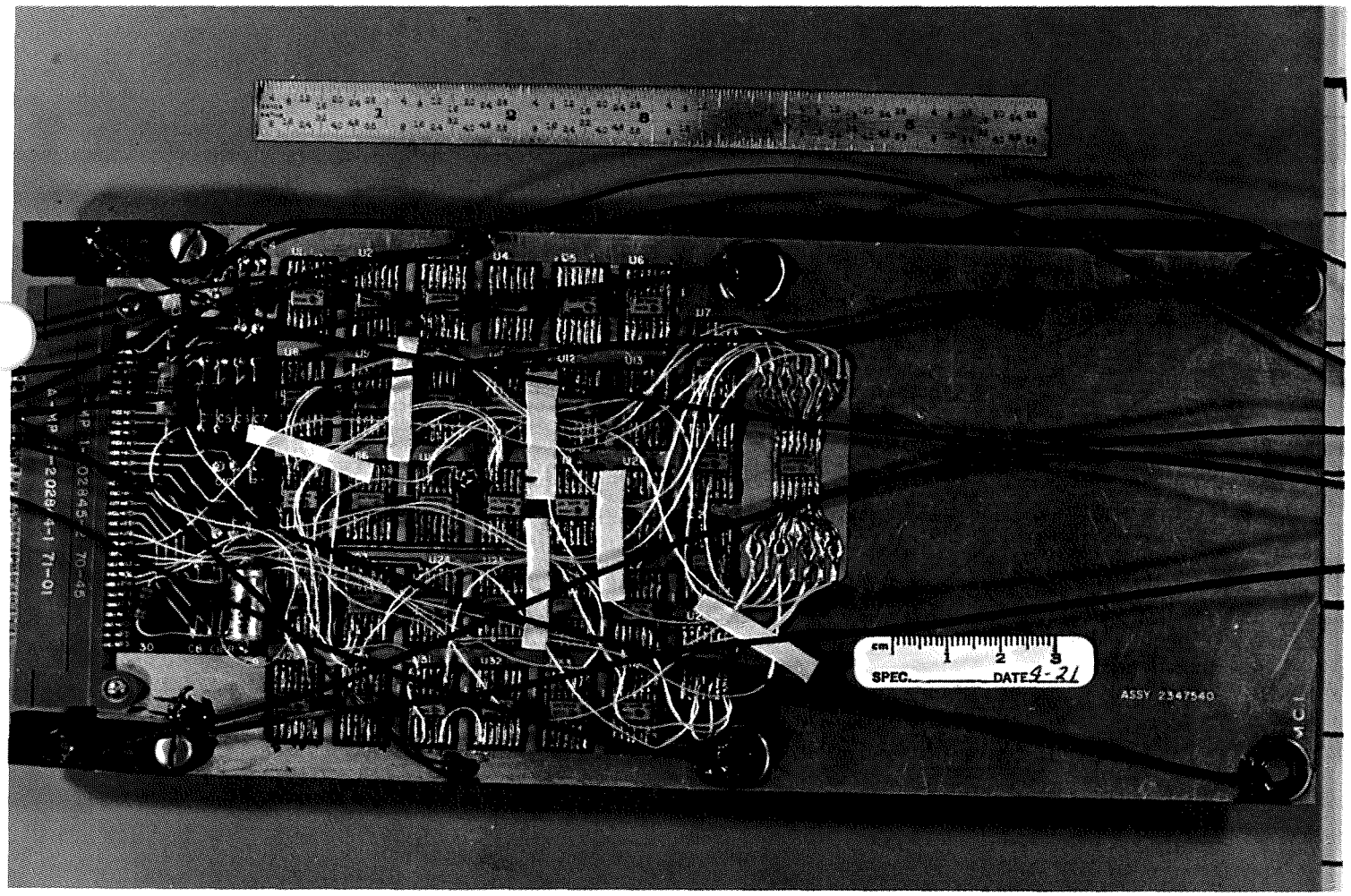
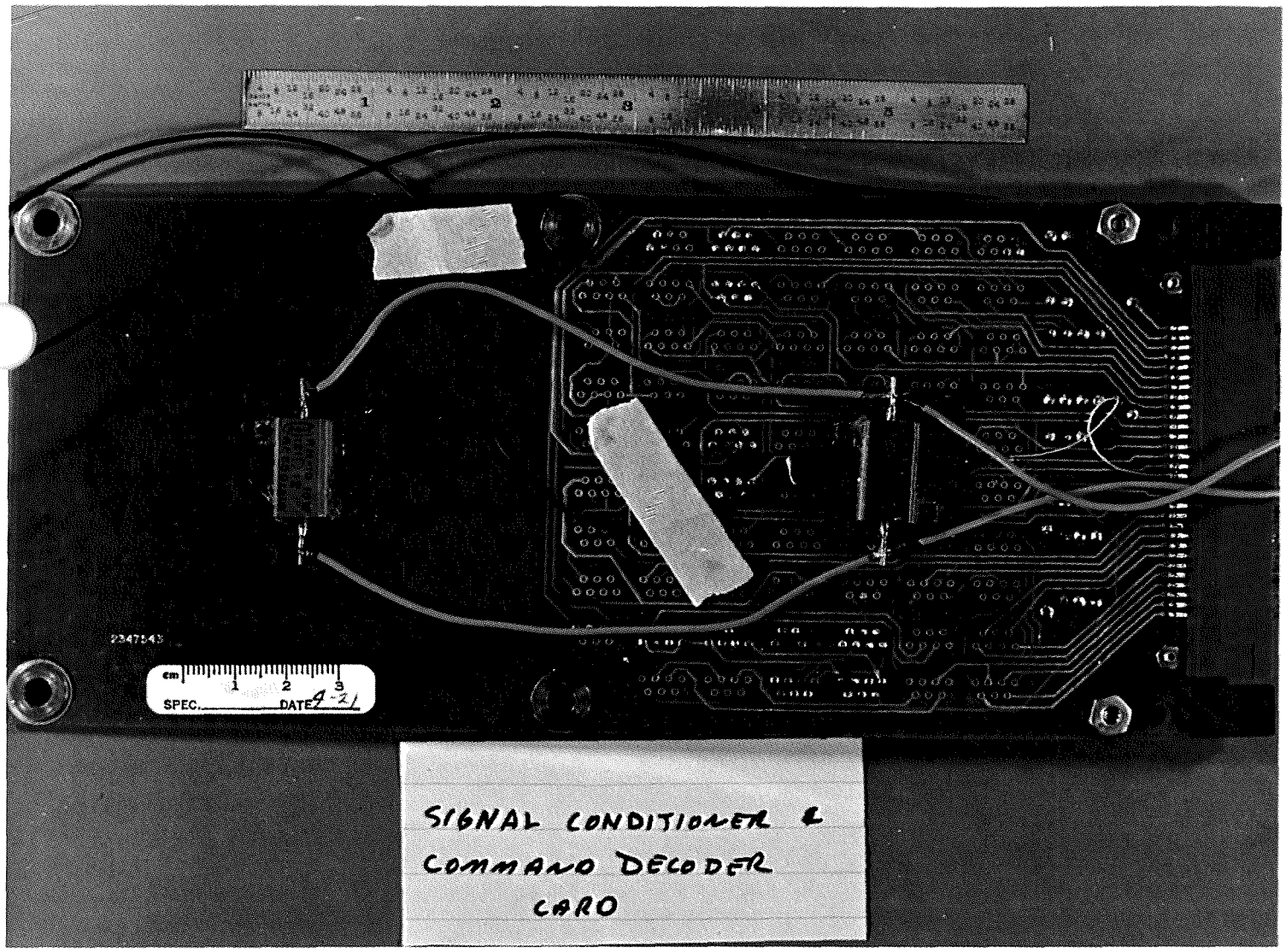


FIGURE 10

Signal Conditioner and Command Decoder Card
Back



SIGNAL CONDITIONER & COMMAND DECODER
TEST #1

Chamber Pressure: 130 to 55 microns

Test Conditions:

Power to Heaters: None

Voltage to Card: +5 volts @ 60 MA

Radiator Plate Temp: 125°F

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 77-80°F

TEST No 1
SC & CD

DATA!

DATE 4/17/51

TIME	1200	1230	1300	1330	1400			
TEMP °F / C No								
1	117 °F	116 °F	116 °F	116 °F	116 °F			
2	117	118	117	117	117			
3	117	117	117	117	117			
4	117	117	117	117	117			
5	125	125	124	125	125			
6	119	117	116	117	117			
7	118	118	117	118	120			
8	125	124	124	124	125			
9	—	—	—	—	—			
11	117	117	117	117	119			
12	119	119	119	119	119			
13.	119	119	119	119	120			
14	121	121	121	121	121			
15	121	120	121	121	121			
16	125	124	124	123	123			

SIGNAL CONDITIONER & COMMAND DECODER
TEST # 2

Chamber Pressure: 45 microns

Test Conditions:

Power to Heaters: 0.2 watts - 3.5 volts @ 60 MA

Voltage to Card: None

Radiator Plate Temp: 125 °F

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 77 °F

TEST Nº 2

SC & CD

DATA:

DATE 4/17/71

TIME	1500	1530	1600	1630	1700			
TEMP °F / Nº								
1	117 °F	117 °F	116 °F	117 °F	116 °F			
2	119	118	117	119	119			
3	117	117	116	118	116			
4	116	116	116	117	116			
5	125	124	124	127	124			
6	117	118	118	118	117			
7	120	121	120	120	120			
8	125	125	124	126	124			
1	117	117	117	119	119			
2	119	119	119	121	120			
3	117	117	117	120	119			
4	120	120	120	122	121			
5	120	121	120	123	123			
6	123	125	124	126	124			

SIGNAL CONDITIONER & COMMAND DECODER
TEST # 3

Chamber Pressure: 25 microns

Test Conditions:

Power to Heaters: 0.3 watts - 4.2 volts @ 72 MA

Voltage to Card: None

Radiator Plate Temp: 125 °F

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 77 °F

TEST No 3
SC & CD

DATA:

DATE 4/19/71

TIME	1000	1030	1100	1130	1200			
TEMP °F / TC No								
1	112°F	115°F	117°F	117°F	117°F			
2	114	117	118	119	119			
3	113	116	118	118	117			
4	112	116	117	117	117			
5	123	126	125	125	124			
6	114	117	120	121	121			
7	115	117	120	120	120			
8	123	125	125	125	124			
11	114	116	118	119	119			
12	116	117	119	120	120			
13	115	117	118	119	119			
14	118	120	121	121	121			
15	118	120	121	121	121			
16	122	124	124	124	123			

SIGNAL CONDITIONER & COMMAND DECODER
TEST # 4

Chamber Pressure: 30 microns

Test Conditions

Power to Heaters: 0.4 watts - 5volts @ 80 MA

Voltage to Cord: None

Radiator Plate Temp: 125°F

Fluid Flow Rate 0.0213 Lt/sec

Thermocouple Data

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 79°F

TEST Nº 4
SC & CO

DATA:

DATE 4/19/71

TIME	1400	1430	1500	1530	1600	1630	1700
TEMP °F / Nº							
1	117 °F	117 °F	118 °F	120 °F	120 °F	120 °F	120 °F
2	121	121	121	123	123	124	124
3	119	119	119	121	121	121	121
4	119	118	119	121	121	121	120
5	125	124	125	127	126	126	126
6	119	120	122	125	125	125	125
7	121	120	122	124	123	123	123
8	125	124	125	126	126	126	126
11	119	120	121	121	121	121	121
12	120	120	122	123	123	123	123
13	120	119	121	122	122	122	122
14	121	121	123	124	124	124	123
15	122	121	123	124	124	124	124
16	123	122	124	124	125	125	125

SIGNAL CONDITIONER & COMMAND DECODER
TEST # 5

Chamber Pressure: 17 micron

Test Conditions

Power to Heaters: None

Voltage to Card: +5 volts @ 60 MA

Radiator Plate Temp: 0°F

Fluid Flow Rate: 0.007 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 77-79 °F

TEST Nº 5
SC & CO

DATA:

DATE 4/20/71

TIME	1400	1430	1500	1530	1600			
TEMP °F / No								
1	11 °F	11 °F	12 °F	14 °F	14 °F			
2	11	11	13	15	15			
3	8	8	9	11	11			
4	10	10	11	14	15			
5	−11	−11	−8	−6	−9			
6	5	5	6	10	11			
7	10	10	11	13	15			
8	−15	−14	−12	−9	−15			
11	8	9	11	13	13			
12	3	3	5	7	8			
13	9	9	11	13	13			
14	0	0	1	3	4			
15	−4	−4	−2	0	0			
16	−7	−6	−6	−3	−3			

SIGNAL CONDITIONER & COMMAND DECODER
TEST #6

Chamber Pressure: 17 microns

Test Conditions

Power to Heaters: 0.2 watts -3.5 volts @ 60 MA

Voltage to Card: None

Radiator Plate Temp: 0°F

Fluid Flow Rate: 0.007 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 79°F

TEST No 6
SC & CD

DATA:

DATE 4/20/71

TIME	1700	1730	1800	1830	1900			
TEMP° OF / No								
1	11 °F	11 °F	18 °F	17 °F	15 °F			
2	12	13	19	18	15			
3	9	10	15	15	13			
4	10	10	16	15	13			
5	-6	-6	-1	-6	-7			
6	8	8	15	12	10			
7	10	11	18	15	14			
8	-9	-8	-6	-10	-9			
11	10	10	15	15	10			
12	6	6	12	11	7			
13	10	10	15	15	11			
14	2	3	7	7	2			
15	0	0	5	5	1			
16	-3	-3	-1	0	-3			

SIGNAL CONDITIONER & COMMAND DECODER
TEST # 7

Chamber Pressure : 16 microns

Test Conditions :

Power to Heaters : 0.3 watts - 4.2 volts @ 72 MA

Voltage to Cord : None

Radiator Plate Temp : 0°F

Fluid Flow Rate : 0.007 Lt/sec

Thermocouple Data :

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp. 75-77°F

TEST Nº 7
SC & CD

DATA:

DATE 4/21/71

TIME	0845	0915	0945	1015	1045	1115		
TEMP °F / Nº								
1	27 °F	18 °F	21 °F	22 °F	20 °F	16 °F		
2	31	20	21	22	22	17		
3	25	16	17	18	18	13		
4	28	18	18	19	19	15		
5	-2	-2	-3	2	-3	-7		
6	22	17	17	16	17	14		
7	27	20	20	22	21	16		
8	-6	-7	-5	-2	-7	-9		
11	26	17	17	18	18	13		
12	19	11	12	14	14	8		
13	26	16	18	19	18	13		
4	14	6	7	9	8	3		
5	11	3	5	8	7	1		
6	6	0	2	5	4	-1		

SIGNAL CONDITIONING & COMMAND DECODER
TEST # 8

Chamber Pressure : 16 microns

Test Conditions

Power to Heaters : 0.4 watts - 5 volts @ 80 M

Voltage to Card : None

Radiator Plate Temp : 0°F

Fluid Flow Rate : 0.007 Lt/sec

Thermocouple Data :

Radiator Plate	# 16
Fluid Out	# 5
Fluid In	# 8

Ambient Temp : 75-77°F

TEST N° 8
SC & CD

DATA!

DATE: 4/21/71

TIME	1330	1400	1430	1500	1530	1600		
TEMP° F / N°								
1	20°F	15°F	16°F	16°F	13°F	13°F		
2	22	18	19	19	14	15		
3	17	13	15	15	8	11		
4	18	17	15	16	13	11		
5	-6	-7	-4	-9	-8	-8		
6	16	13	8	13	8	8		
7	21	17	18	19	15	14		
8	-10	-9	—	-13	-11	-11		
11	20	15	14	14	12	11		
12	16	10	10	11	6	8		
13	20	13	16	15	9	9		
14	11	5	5	5	2	3		
15	8	2	2	4	-3	-2		
16	5	-2	-1	0	-1	-3		

Preamplifier Discriminator Card

FIGURE 11

Preamplifier Discriminator Card
Front

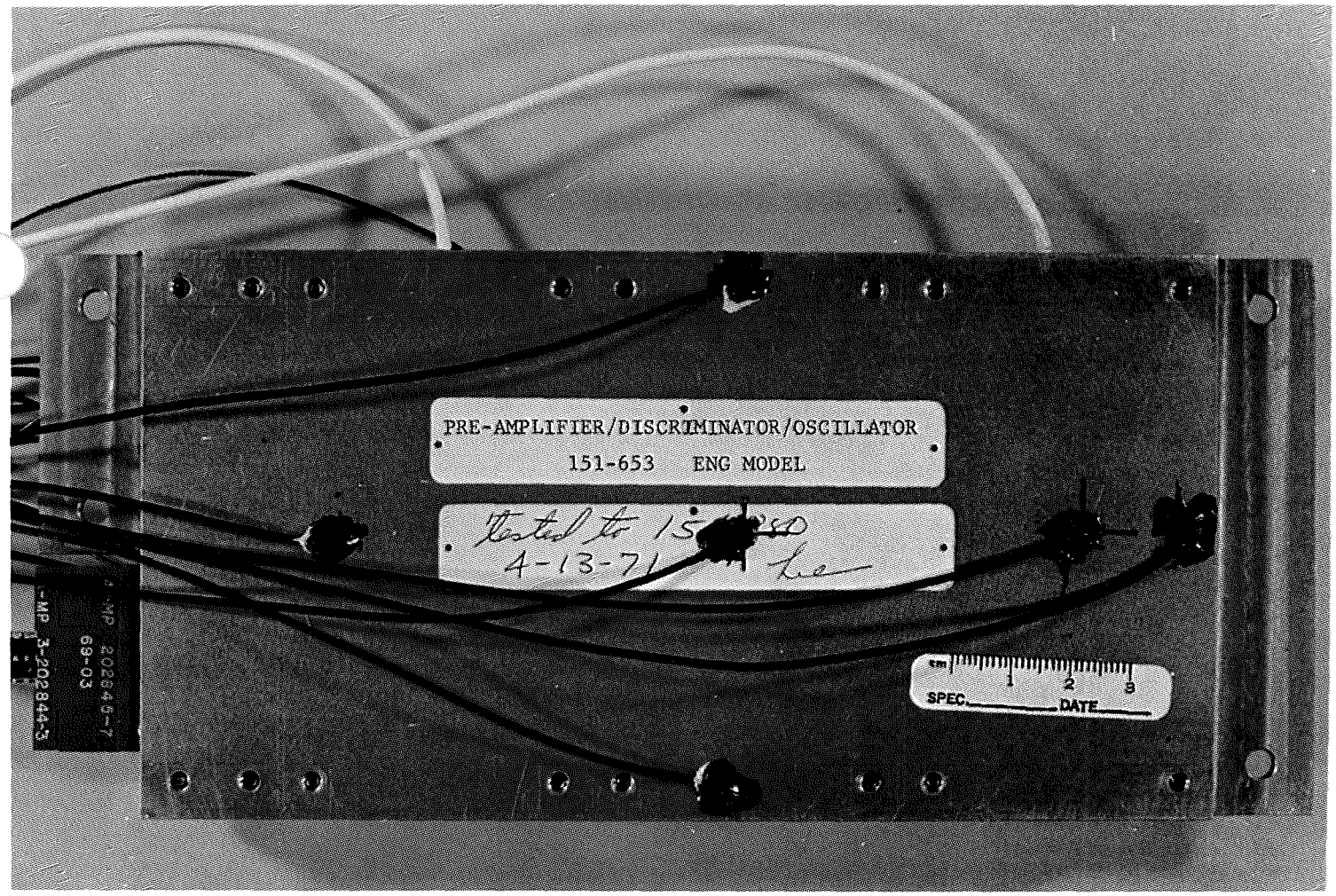
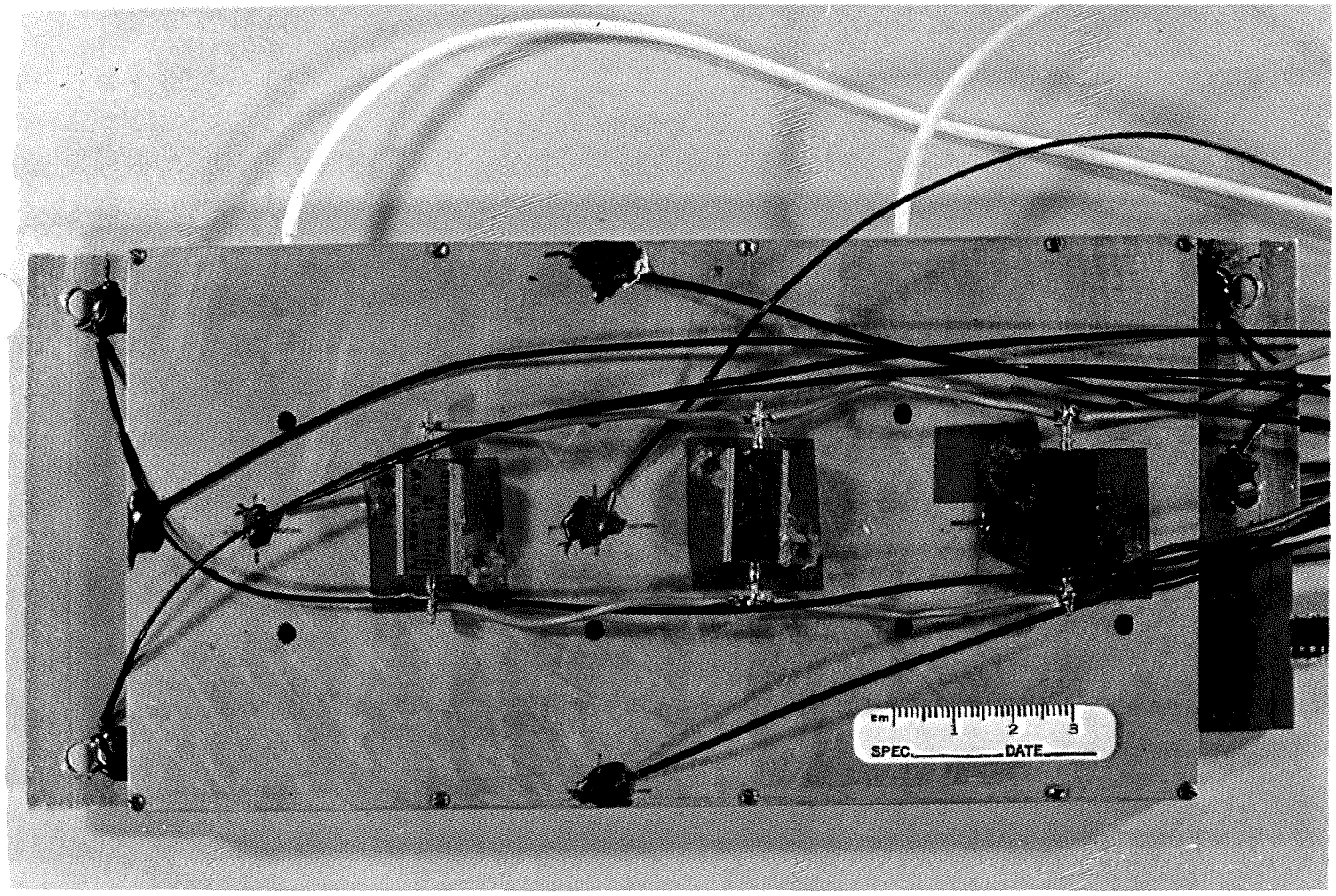


FIGURE 12

Pre-amplifier Discriminator Card
Back



PREAMP / DISCRIMINATOR
TEST # 1

Chamber Pressure: 42 microns

Test Conditions:

Power to Heaters: None

Voltage to Card: +12 volts
-12 volts
+5 volts

Radiator Plate Temp: 125 °F

Fluid Flow Rate: 0.0213 L+/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Imbient Temp: 77 - 79 °F

TEST Nº 1

PREAMP / DISC.

DATA:

DATE 4/25/71

TIME	0830	0900	0930	1000	1030	1106		
TEMP °F / C No								
1	99°F	110°F	113°F	119°F	120°F	121°F		
2	97	107	113	119	120	121		
3	82	94	114	108	121	123		
4	91	104	113	118	120	123		
5	121	121	120	121	121	122		
	92	105	111	118	121	123		
7	92	105	111	118	121	122		
8	121	122	120	121	121	121		
9	92	104	113	117	120	122		
10	92	104	113	116	120	121		
11	102	110	115	117	121	121		
12	102	110	115	117	121	121		
13	91	103	113	117	121	122		
14	91	103	113	117	121	122		
15	91	103	113	117	121	122		
16	109	116	118	118	119	121		
18	84	94	104	106	119	121		
19	91	103	112	119	121	120		
20	84	93	97	103	117	116		

PREAMP / DISCRIMATOR
TEST #2

Chamber Pressure: 41 microns

Test Conditions:

Power to Heaters: 0.2 watts - 3.0 volts @ 70 MA

Voltage to Card: None

Radiator Plate Temp: 125°F

Fluid Flow Rate: 0.0213 Lt/sec.

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp 79°F

TEST Nº 2

PREAMP / DISC

DATA:

DATE 4/25/71

IME	1200	1230	1300	1330	1400			
TEMP °F / Nº								
1	119°F	117°F	117°F	116°F	116°F			
2	119	117	117	115	116			
3	119	118	117	115	116			
4	119	117	116	114	115			
5	123	122	123	122	122			
6	119	116	116	114	115			
7	119	116	115	114	115			
8	121	121	122	121	121			
9	118	114	115	114	115			
10	118	114	115	114	115			
11	119	119	117	117	116			
2	119	119	117	117	116			
3	119	116	116	116	115			
4	119	116	116	116	115			
5	119	117	116	116	115			
6	120	120	120	120	120			
8	115	113	112	113	112			
[illegible]	117	116	114	113	113			
20	108	107	107	106	106			

PREAMP/DISCRIMINATOR
TEST # 3

Chamber Pressure: 35 microns

Test Conditions:

Power to Heaters: 1.0 watts - 6.2 volts @ 160MA

Voltage to Card: None

Radiator Plate Temp: 125°F

Fluid Flow Rate: 0.0213 Lt/sec.

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp. 77-81°F

TEST Nº 3

PREAM/DISC.

DATA!

DATE 4/26/71

TIME / TEMP OF No	1030	1100	1130	1200	1245	1315		
1	116 °F	116 °F	117 °F	117 °F	120 °F	121 °F		
2	116	117	117	117	120	121		
3	119	120	120	121	117	117		
4	119	120	120	121	123	123		
5	114	116	118	119	120	120		
6	119	120	120	121	123	124		
7	119	120	120	121	123	124		
8	114	116	118	119	119	119		
9	117	118	119	120	123	122		
10	118	118	119	120	123	122		
1	116	116	117	118	120	120		
2	116	116	117	118	120	120		
3	116	117	117	118	121	122		
4	117	118	119	118	121	122		
5	117	118	119	118	123	122		
6	114	116	117	117	119	118		
8	115	116	117	118	117	120		
9	118	117	118	119	121	121		
8	112	108	107	109	112	113		

PREAMP / DISCRIMINATOR TEST # 4

Chamber Pressure: 32 microns

Test Conditions:

Power to Heaters: 1.3 watts - 7.5 volts @ 173 MA

Voltage to Card: None

Radiator Plate Temp: 125 °F

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp 78-79 °F

TEST Nº 4

PREAMP / DISC.

DATA:

DATE 4/26/71

TIME	1445	1515	1545	1615	1645	1715		
TEMP °F / TC Nº								
1	124°F	125°F	125°F	126°F	125°F	125°F		
2	125	125	125	126	126	125		
3	120	121	129	131	130	131		
4	128	128	129	129	129	129		
	124	123	122	123	123	123		
6	129	129	128	131	129	129		
7	128	131	128	129	129	129		
8	123	123	122	122	122	122		
9	128	127	129	129	129	129		
10	128	127	129	129	129	129		
11	125	125	125	125	125	124		
12	126	124	124	124	124	124		
13	127	126	125	126	126	126		
14	128	127	127	128	128	128		
15	128	128	127	127	127	127		
16	121	122	121	121	121	121		
	124	123	125	123	123	123		
	126	127	126	125	126	126		
20	112	112	112	113	112	112		

PREAMP / DISCRIMINATOR TEST #5

Chamber Pressure: 30 microns

Test Conditions:

Power to Heaters: 1.5 watts - 8 volts @ 190 MA

Voltage to Card: None

Radiator Plate Temp: 125°F

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 78-80 °F

TEST No 5

PREAMP/DISC

DATA:

DATE 4/26/71

TIME	1830	1900	1930	2000	2030	2100	2130
TEMP °F / TC No							
1	125°F	125°F	125°F	124°F	125°F	124°F	124°F
2	126	127	126	126	127	127	125
3	122	132	131	131	132	131	131
4	129	131	130	130	130	129	129
5	121	121	120	121	121	121	121
6	131	132	129	130	130	130	131
7	129	131	129	130	130	130	131
8	121	121	121	121	121	121	121
9	130	130	129	129	129	129	130
10	130	130	129	129	130	129	130
11	125	125	123	125	124	124	125
12	125	125	123	125	124	124	124
13	126	127	126	126	127	126	127
14	129	129	127	129	127	127	127
15	129	129	127	128	127	127	127
16	121	121	121	121	121	121	121
18	125	125	125	125	125	124	123
19	127	127	126	126	127	127	126
20	113	114	112	112	112	113	113

PREAMP / DISCRIMINATOR
TEST #6

Chamber Pressure: 16 microns

Test Conditions:

Power to Heaters: None

Voltage to Card: +12 volts
-12 volts
+5 volts

Radiator Plate Temp: 0°F

Fluid Flow Rate: 0.004 lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 74 - 79 °F

TEST No 6

PREAMP / DISCRIMINATOR

DATA!

DATE 4/27/71

TIME	1330	1400	1430	1500	1530	1600	1630	
TEMP °C No °F								
1	32°F	32°F	26°F	25°F	25°F	23°F	27°F	
2	47	45	38	40	37	35	35	
3	60	60	56	58	58	58	59	
4	49	44	43	41	41	39	37	
5	0	+2	-7	-6	-5	-8	-6	
	45	46	40	40	40	39	37	
7	45	46	40	40	40	39	37	
8	-2	+1	-9	-8	-10	-11	-6	
9	45	45	42	41	41	39	38	
10	45	45	42	40	40	39	38	
11	27	26	20	22	22	19	19	
12	41	39	31	35	34	33	31	
13	46	45	39	40	41	39	37	
14	46	46	39	43	41	40	37	
15	47	46	39	42	40	39	37	
16	10	11	3	5	2	3	3	
18	56	55	51	53	53	53	53	
9	48	47	41	40	40	39	37	
20	54	54	48	50	50	51	51	

PREAMP / DISCRIMINATOR
TEST # 7

Chamber Pressure: 16 microns

Test Conditions:

Power to Heaters: 1.0 watts - 6.2 volts @ 160 MA

Voltage to Card: None

Radiator Plate Temp: 0°F

Fluid Flow Rate: 0.004 Lt/sec

Thermocouple Data:

Radiator Plate	# 16
Fluid Out	# 5
Fluid In	# 8

Ambient Temp: 78 - 79°F

TEST Nº 7

PREAMP / DISCRIMINATOR

DATA!

DATE 4/27/71

TIME	1730	1800	1830	1900	1930	2000		
TEMP °F / C Nº								
1	27 °F	25°F	20°F	21°F	22°F	22°F		
2	38	38	32	28	31	33		
3	58	61	59	59	60	60		
4	40	40	37	37	37	37		
5	-2	-5	-7	-5	-3	-2		
	41	38	36	36	37	36		
7	41	38	36	36	37	36		
8	-5	-10	-11	-9	-6	-6		
9	40	39	36	36	37	37		
10	42	40	38	38	38	39		
11	21	19	16	21	19	19		
12	32	30	32	28	28	28		
13	36	35	34	33	33	33		
14	39	37	34	37	34	36		
15	36	34	34	34	35	34		
16	4	-7	-1	3	4	4		
18	53	53	53	53	53	52		
	37	33	32	34	34	34		
20	48	47	48	47	47	47		

PREAMP/DISCRIMINATOR TEST #8

Chamber Pressure: 16 microns

Test Conditions:

Power to Heaters: 1.3 watts - 7.5 volts @ 173 MA

Voltage to Cord: None

Radiator Plate Temp: 0 °F

Fluid Flow Rate: 0.004 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp: 78 - 79 °F

TEST Nº 8

PREAMP / DISC

DATA:

DATE 4/27/71

TIME	2100	2130	2200	2230	2300	2330		
TEMP °F / IC Nº								
1	23 °F	24 °F	21 °F	22 °F	22 °F	23 °F		
2	34	33	33	36	37	38		
3	58	60	59	61	60	60		
4	38	39	40	40	39	39		
5	-5	-6	-6	-6	-6	-4		
	38	40	38	39	38	38		
7	38	40	38	39	38	38		
8	-8	-10	-11	-10	-10	-6		
9	37	40	37	40	37	40		
10	40	43	41	42	40	42		
11	20	19	18	20	19	21		
12	29	32	28	32	30	32		
13	34	35	35	37	36	37		
14	37	40	38	38	38	41		
15	35	37	36	38	37	38		
16	-1	0	1	3	2	6		
18	53	53	53	53	53	54		
	36	37	37	37	36	39		
20	48	48	47	50	48	49		

PREAMP / DISCRIMINATOR TEST # 9

Chamber Pressure: 17 microns

Test Conditions:

Power to Heaters: 1.5 watts - 8 volts @ 190 MA

Voltage to Card: None

Radiator Plate Temp: 0 °F

Fluid Flow Rate: 0.004 Lt/sec

Thermo couple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

Ambient Temp. 79-80 °F

TEST Nº 9

PREAMP / DISCRIMINATOR

LITA:

DATE 4/28/71

TIME	0030	0100	0130	0200	0230	0300		
TEMP °F / C Nº								
1	24°F	24°F	27°F	25°F	27°F	27°F		
2	38	38	42	39	41	42		
3	61	60	62	59	61	62		
4	43	44	45	44	45	47		
5	-6	-6	-3	-6	-6	-5		
6	45	42	47	42	45	46		
	45	42	46	44	45	47		
8	-7	-11	-6	-9	-9	-9		
9	43	42	46	43	38	45		
10	44	43	47	47	47	48		
11	22	21	23	24	22	25		
12	33	34	36	34	34	35		
13	35	37	41	41	41	44		
14	43	42	45	46	43	44		
15	41	40	42	44	42	44		
16	4	3	6	4	0	1		
18	55	53	55	57	54	56		
19	43	40	41	43	40	41		
	51	49	51	54	51	54		

Low and High Voltage Power Supply Card

FIGURE 13

Low and High Voltage Power Supply Card
Front

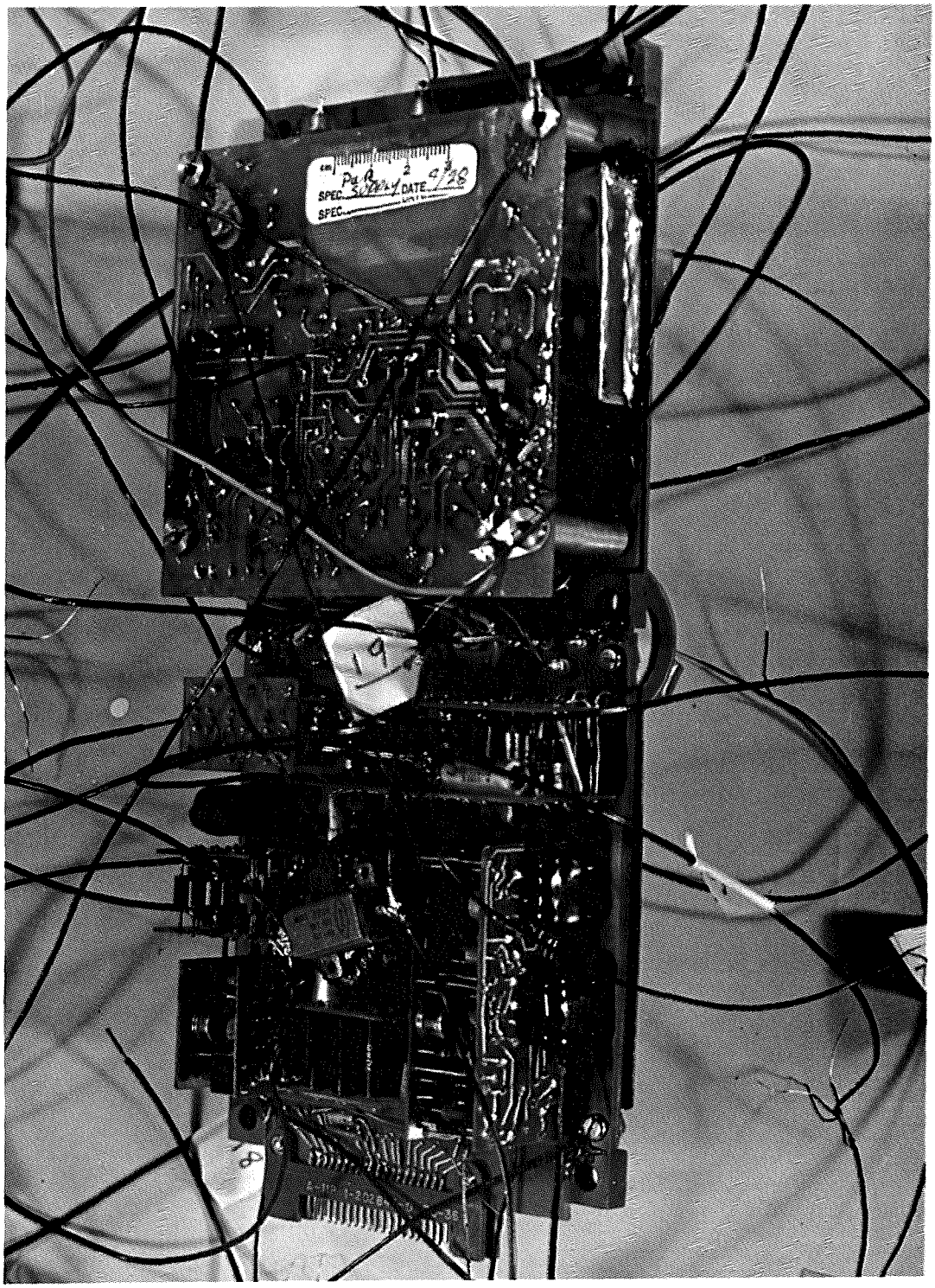
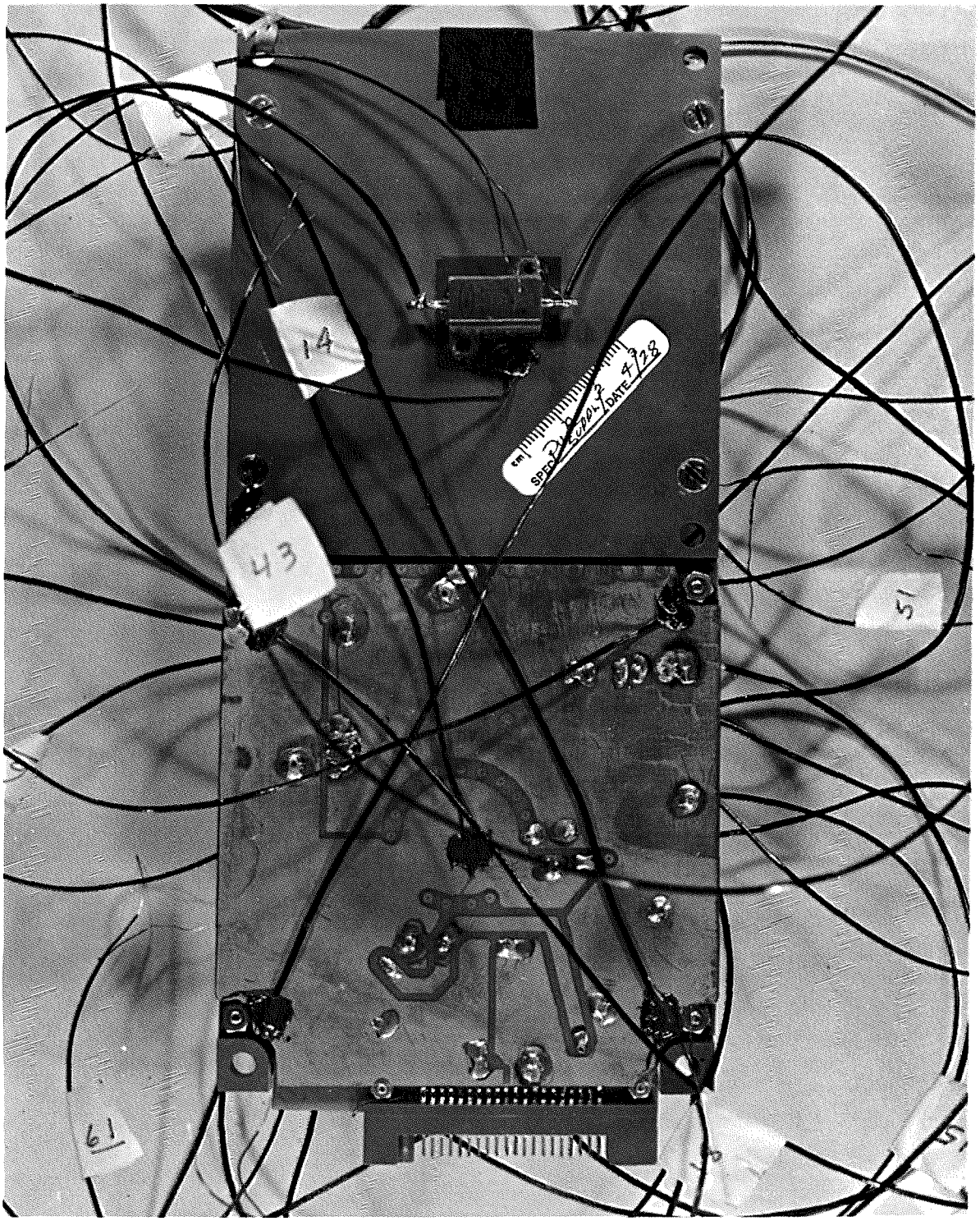


FIGURE 14

Low and High Voltage Power Supply Card
Back



TEST Nº 1

L & HUPS

DATA:

DATE 4/28/71

TIME	2115	2145	2215	2245	2315	2345	0015	0045
TEMP °F / Nº								
1	28°F	24°F	19°F	20°F	19°F	18°F	21°F	21°F
2	26	19	16	16	17	20	19	17
3	60	60	58	58	59	59	60	58
4	22	18	15	16	16	17	19	15
5	-8	-9	-7	-5	-2	-1	-3	-8
7	16	10	9	11	9	11	11	9
8	-12	-11	-8	-5	-6	-4	-7	-10
9	11	8	8	9	8	11	10	6
10	28	23	19	21	21	20	21	18
11								
12	12	19	16	18	19	18	19	17
13								
14	14	10	10	14	12	13	14	10
15	25	22	18	17	20	19	20	16
16	0	-2	-2	3	0	1	2	-1
18	45	42	40	41	40	43	41	40
19								
20								

LOW & HIGH VOLTAGE POWER SUPPLY
TEST #2

Chamber Pressure: 16 microns

Ambient Temp: 77-79 °F

Test Conditions

Power to Heaters: 1.5 watts - 6.25 volts @ 240 MA

Voltage to Card: None

Radiator Plate Temp: 0°F

Fluid Flow Rate: 0.004 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

TEST Nº 2

L & HV PS

TA!

DATE 4/29/71

NE	0900	0930	1000	1030	1100	1130		
EMP / 10 °F								
1	30 °F	24 °F	20 °F	19 °F	19 °F	18 °F		
2	25	20	18	17	16	18		
3	55	55	53	52	52	53		
4	24	20	17	17	16	16		
5	-9	-8	-3	-7	-7	-10		
7	17	11	12	10	9	9		
8	-13	-12	-7	-10	-10	-14		
9	15	9	10	9	9	8		
10	34	25	21	20	17	19		
12	29	20	20	19	19	18		
14	18	11	13	14	12	11		
15	34	22	22	20	18	18		
16	1	-1	2	-1	-2	-2		
18	45	40	40	39	38	39		

LOW & HIGH VOLTAGE POWER SUPPLY
TEST #3

Chamber Pressure: 20 microns

Ambient Temp: 78-79 °F

Test Conditions:

Power to Heaters: 1.8 watts - 7.0 volts @ 260 MA

Voltage to Card: None

Radiator Plate Temp: 0°F

Fluid Flow Rate: 0.004 Lt/sec

Thermocouple Data:

Radiator Plate:	#16
Fluid Out	#5
Fluid In	#8

TEST No 3

LEHVPS

DATA:

DATE 4/29/71

TIME	1700	1730	1800	1830	1900			
TEMP °F / TC No								
1	20 °F	20 °F	21 °F	20 °F	21 °F			
2	19	19	21	20	21			
3	44	44	45	45	47			
4	20	19	21	21	20			
5	-3	-6	-6	-5	-3			
	12	14	11	10	13			
8	-7	-8	-9	-9	-7			
9	11	9	10	9	11			
10	21	21	22	21	22			
12	20	19	20	21	20			
14	15	14	16	13	16			
15	20	19	21	22	21			
16	3	3	4	4	5			
18	33	34	34	34	36			

LOW & HIGH VOLTAGE POWER SUPPLY
TEST #4

Chamber Pressure: 22 microns

Ambient Temp: 77-78 °F

Test Conditions

Power to Heaters: None

Voltage to Card: 28 volts @ 410 MA

Radiator Plate Temp: 0°F

Fluid Flow Rate: 0.004 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

TEST Nº 4

L&HUPS

4 TA:

DATE 4/29/71

TIME	1330	1400	1430	1500	1530			
TEMP° F / Nº								
1	18 °F	20 °F	19 °F	19 °F	15 °F			
2	22	23	19	18	15			
3	38	54	53	52	44			
4	15	16	13	9	9			
5	-4	-10	-13	-13	-12			
7	11	10	7	6	4			
8	-7	-11	-15	-17	-15			
9	9	9	7	2	2			
10	26	23	20	19	16			
12	18	19	18	17	19			
14	15	12	13	9	8			
15	18	19	18	16	15			
16	2	-3	-4	-6	-6			
18	40	40	38	38	33			

LOW & HIGH VOLTAGE POWER SUPPLY
TEST #5

Chamber Pressure: 55 to 75 microns

Ambient Temp: 79-80 °F

Test Conditions:

Power to Heaters: 1.2 watts - 5.5 volts @ 220 MA

Voltage to Card: None

Radiator Plate Temp: 125 °F

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

TEST No 5

L&H VPS

DI. A!

DATE 4/29/71

TIME	2045	2115	2145	2315	2345	0015		
TEMP OF No								
1	77°F	97°F	108°F	118°F	119°F	120°F		
2	91	107	109	122	119	121		
3	86	108	112	121	119	120		
4	96	111	113	124	123	122		
5	125	123	118	125	123	122		
7	99	121	113	121	121	121		
8	126	121	120	126	123	122		
9	104	113	112	122	123	121		
10	81	104	108	118	118	118		
12	91	108	109	118	118	119		
14	103	112	112	121	121	120		
15	79	100	106	116	118	116		
16	116	117	120	122	121	120		
18	95	112	112	118	120	117		

LOW & HIGH VOLTAGE POWER SUPPLY
TEST # 6

Chamber Pressure: 50 microns

Ambient Temp. 80-81°F

Test Conditions:

Power to Heaters: 1.5 watts - 6.25 volts @ 240 MA

Voltage to Card: None

Radiator Plate Temp: 125°F

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data:

Radiator Plate	# 16
Fluid Out	# 5
Fluid In	# 8

TEST Nº 6

L & H V PS

DATA:

DATE 4/29/71

TIME	0130	0200	0230	0300	0330			
TEMP °F / Nº								
1	122 °F	121 °F	121 °F	121 °F	121 °F			
2	123	121	123	125	122			
3	121	121	121	122	122			
4	124	121	124	126	124			
5	124	123	122	123	121			
7	123	123	122	123	122			
8	124	123	123	124	122			
9	124	123	123	124	123			
10	121	120	121	121	121			
12	121	121	120	123	121			
14	122	121	121	123	121			
15	120	120	119	121	121			
16	124	122	121	122	121			
18	122	121	121	121	120			

LOW & HIGH VOLTAGE POWER SUPPLY
TEST #7

Chamber Pressure: 37 microns

Ambient Temp: 79 °F

Test Conditions:

Power to Heaters: 1.8 watts - 7.0 volts @ 260 MA

Voltage to Card: None

Radiator Plate Temp: 125°F

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

TEST Nº 7

L & HV PS

DATA:

DATE 4/30/71

TIME	0930	1000	1030	1100	1130	1200		
TEMP °F / NO								
1	117° F	121 °F	121 °F	122 °F	121 °F	121 °F		
2	121	123	123	122	121	121		
3	121	123	123	122	121	121		
4	124	124	124	125	124	124		
5	124	120	120	120	121	120		
7	123	123	122	121	121	122		
8	124	120	120	120	120	120		
9	123	123	122	121	121	122		
10	117	121	121	121	120	121		
12	121	121	121	121	121	121		
14	121	121	121	121	121	121		
15	114	117	118	120	120	120		
16	121	121	120	120	120	120		
18	120	121	120	120	120	120		

LOW & HIGH VOLTAGE POWER SUPPLY
TEST #8

Chamber Pressure: 33 microns

Ambient Temp: 77-81 °F

Test Conditions:

Power to Heaters: None

Voltage to Cord: 28 volts @ 410 MA

Radiator Plate Temp: 125 °F

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

TEST No 8

L & H U P S

DATA:

DATE 4/30/71

TIME	1370	1400	1430	1530	1600	1630		
TEMP °F / No								
1	121 °F	121 °F	121 °F	124 °F	125 °F	123 °F		
2	121	123	122	125	126	125		
3	121	122	122	125	126	124		
4	122	122	122	125	126	124		
5	120	121	123	122	124	122		
7	121	121	123	124	124	123		
8	120	121	123	124	124	122		
9	121	121	123	124	124	123		
10	121	121	123	124	124	123		
12	120	120	122	124	124	123		
14	121	121	124	125	125	124		
15	119	120	124	122	122	122		
16	119	120	122	124	124	122		
18	121	121	124	125	125	124		

Emission Control Card

FIGURE 15

Emission Control Card
Front

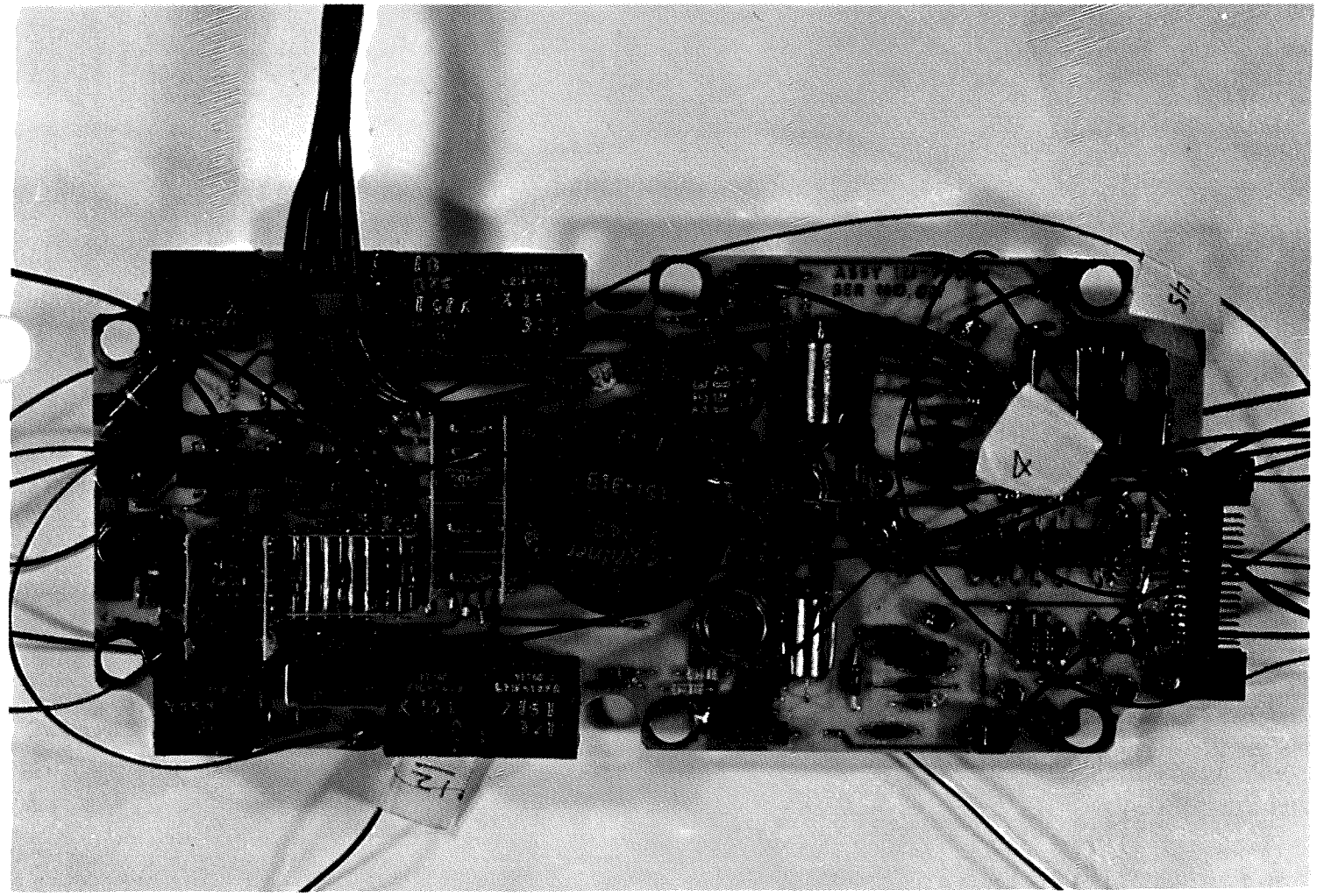
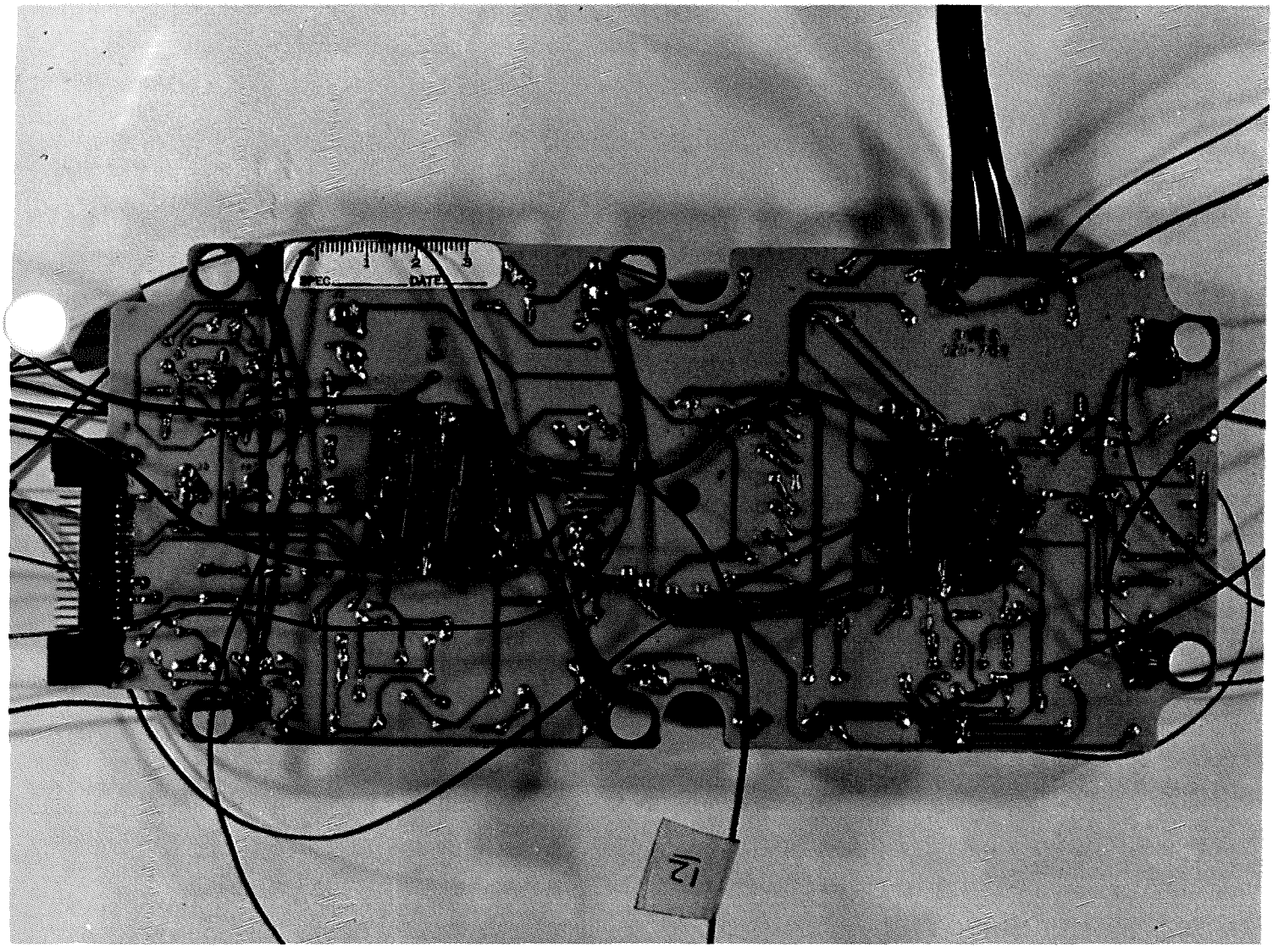


FIGURE 16

Emission Control Card
Back



EMISSION CONTROL
TEST #1

Chamber Pressure: 90 - 55 microns

Ambient Temp: 79-81°F

Test Conditions:

Power to Heaters: 2 watts - 11 volts @ 182 MA

Voltage to Card: None

Radiator Plate Temp 125 °F

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

TEST Nº 1
E/C

DATA:

DATE 4/30/71

TIME / TEMP / Nº OF	0030	0100	0130	0200	0230	0300		
1	138 °F	143 °F	146 °F	146 °F	148 °F	150 °F		
2	113	118	118	121	121	122		
3	115	116	117	118	121	121		
4	116	116	117	118	120	121		
5	125	122	121	122	122	123		
7	133	138	139	141	143	144		
8	126	123	121	122	123	123		
9	112	116	119	122	122	123		
10	110	115	118	120	120	121		
12	115	115	116	118	119	120		
13	118	120	121	122	122	123		
14	116	118	119	120	120	121		
15	116	120	121	122	123	124		
16	121	121	121	123	121	—		
18	115	116	117	120	120	121		
19	162	163	165	166	168	169		
20	121	121	122	123	124	125		

Emission Control
Test # 2

Chamber Pressure: 45 microns

Ambient Temp. 79-80 °F

Test Conditions:

Power to Heaters: 3 watts - 13.5 volts @ 225 MA

Voltage to Carel: None

Radiator Plate Temp: 125° F

Fluid Fluid Rate: 0.0213 Lt/sec

Thermocouple Data

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

TEST Nº 2

E / C

DATA:

DATE 5/1/71

TIME	0900	0930	1000	1030	1100	1130		
TEMP °F / Nº								
1	163 °F	165 °F	168 °F	172 °F	170 °F	170 °F		
2	116	119	121	125	124	123		
3	116	119	121	125	124	123		
4	116	119	120	122	121	121		
5	126	124	121	120	118	118		
	159	158	162	165	165	164		
8	120	124	120	126	119	118		
9	121	124	128	131	130	129		
10	117	120	125	129	129	128		
12	114	119	123	125	124	124		
13	121	125	127	128	128	126		
14	117	119	122	123	123	122		
15	120	124	127	129	129	129		
16	119	121	122	122	122	121		
18	116	120	122	124	124	123		
19	193	195	198	201	201	201		
20	122	125	128	131	129	129		

Emission Control
Test # 3

Chamber Pressure: 45 microns

Ambient Temp: 80-81 °F

Test Conditions:

Power to Heaters: 4 watts - 15.7 volts @ 255 MA

Voltage to Card: None

Radiator Plate Temp: 125 °F

Fluid Flow Rate: 0.0213 Lt/sec

Thermocouple Data

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

TEST No 3
E IC

DATA:

DATE 5/1/71

TIME	1230	1300	1380	1460	1430	1500		
TEMP OF / No								
1	182°F	186°F	186°F	184°F	184°F	184°F		
2	126	128	130	126	128	128		
3	126	132	130	127	128	128		
4	124	127	127	123	121	122		
5	120	120	118	117	117	120		
7	176	178	179	177	178	178		
8	120	120	118	117	117	120		
9	135	139	138	137	135	136		
10	133	137	136	136	133	133		
12	127	129	130	127	127	127		
13	132	134	135	131	131	132		
14	126	127	127	124	124	125		
15	133	137	136	134	133	133		
16	123	127	125	121	121	123		
18	128	131	131	127	126	128		
19	218	223	222	221	220	220		
20	134	138	137	133	133	134		

EMISSION CONTROL
TEST # 4

Chamber Pressore: 15 microns

Ambient Temp: 75-77 °F

Test Conditions:

Power to Heaters: 2 watts - 11 volts @ 182 MA

Voltage to Card: None

Radiator Plate Temp: 0 °F

Fluid Flow Rate: 0.064 Lt/sec

Thermocouple Data:

Radiator Plate	#16
Fluid Out	#5
Fluid In	#8

TEST Nº 4
E/C

DATA!

DATE 5/3/71

TIME / TEMP° OF Nº	1100	1130	1200	1230	1300	1330	1400	
1	96°F	96°F	96°F	95°F	95°F	94°F	94°F	
2	25	42	43	43	42	43	42	
3	43	60	61	60	66	67	66	
4	16	36	37	38	37	36	36	
5	9	8	6	4	-10	-10	-8	
	75	95	92	94	92	93	93	
8	-18	-16	-13	-11	-22	-18	-18	
9	50	64	64	63	66	63	63	
10	50	64	64	63	66	63	63	
12	29	46	46	47	47	47	46	
13	31	43	47	48	48	48	47	
14	23	41	41	42	41	42	42	
15	40	56	55	55	56	55	55	
16	8	6	8	10	6	4	8	
18	37	55	55	56	58	59	60	
19	110	115	114	116	116	114	114	
20	37	53	53	53	53	53	55	

EMISSION CONTROL
TEST # 5

Chamber Pressure: 38 microns

Ambient Temp: 75-78 °F

Test Conditions:

Power to Heaters: 3 watts - 13.5 volts @ 225 MA

Voltage to Cord: None

Radiator Plate Temp: 0 °F

Fluid Flow Rate: 0.004 Lt/sec

Thermocouple Data

Radiator Plate	# 16
Fluid Out	# 5
Fluid In	# 8

TEST Nº 5
E/C

DATA :

DATE 5/4/71

TIME	1630	1700	1730	1800	1830	1900	1930	2000
TEMP° F / Nº								
1	119 °F	117 °F	117 °F	114 °F	116 °F	115 °F	114 °F	116 °F
2	52	52	47	47	47	47	48	48
3	61	59	57	56	57	57	57	56
4	42	41	39	39	40	41	40	41
5	-9	-15	-13	-11	-9	-8	-10	-9
	117	115	112	111	115	112	112	112
8	-17	-19	-16	-14	-14	-14	-14	-12
9	75	73	71	72	71	71	71	72
10	74	72	69	69	70	69	69	69
12	53	51	48	48	50	49	49	49
13	55	55	51	52	54	52	51	52
14	46	46	43	45	46	45	44	45
15	52	52	50	50	51	51	51	51
16	11	9	9	11	12	13	12	14
18	58	60	55	56	56	55	56	56
19	139	150	145	145	146	145	146	147
20	62	60	56	59	60	60	59	60

EMISSION CONTROL TEST # 6

Chamber Pressure: 42 microns

Ambient Temp: 78-80 °F

Test Conditions

Power to Heaters: None

Voltage to Card: + 27.5 volts
+ 5 volts

Radiator Plate Temp: 0°F

Fluid Flow Rate: 0.004 Lt/sec

Thermocouple Data

Radiator Plate	#16
Fluid out	#5
Fluid In	#8

TEST No 6
E/C

DATA:

DATE 5/13/71

TIME	2045	2115	2145	2400	0030	0100	0130	0200
TEMP° F / No								
1	64°F	64°F	64°F	64°F	63°F	63°F	63°F	64°F
2	60	60	60	59	56	59	60	62
3	59	59	59	59	53	54	55	55
4	39	38	39	37	32	36	38	41
5	-5	-5	4	-12	-9	-3	-1	2
	72	73	73	73	71	69	73	76
8	-8	-9	0	-19	-13	-6	-2	3
9	78	78	78	79	78	78	79	82
10	65	65	66	64	64	64	64	67
12	-	-	43	43	42	42	43	46
13	56	56	55	54	54	55	59	61
14	43	43	44	41	41	42	43	46
15	46	46	46	44	43	44	48	51
16	10	13	17	5	8	10	16	19
18	59	60	62	58	55	56	59	59
19	64	65	69	64	63	64	64	67
20	67	67	67	61	60	60	64	67

EMISSION CONTROL
TEST # 7

Chamber Pressure: 19 microns

Ambient Temp: 77 °F

Test Conditions:

Power to Heaters: 4 watts 15.7 volts @ 255 MA

Voltage to Card: None

Radiator Plate Temp: 0 °F

Fluid Flow Rate: 0.004 Lt/sec

Thermo couple Data

Radiator Plate	#16
Fluid Out	# 5
Fluid In	# 8

TEST Nº 7
E/C

DATA:

DATE 5/4/71

TIME	2100	2130	2200	2230	2300	2330	2400
TEMP °F / TC Nº							
1	133 °F	136 °F	136 °F	136 °F	136 °F	136 °F	136 °F
2	55	55	55	57	57	55	57
3	60	61	62	61	61	61	61
4	46	46	48	48	48	46	48
5	-8	-8	-7	-7	-9	-8	-7
	129	131	133	133	133	133	133
8	-10	-8	-9	-9	-12	-9	-8
9	77	80	81	82	83	81	82
10	75	77	78	79	79	77	78
12	56	56	57	60	57	57	58
13	60	60	62	63	63	61	61
14	51	52	53	53	53	53	53
15	57	59	59	59	59	59	59
16	19	20	21	21	19	20	21
18	60	62	64	61	62	62	62
19	174	175	175	176	176	175	176
20	69	68	69	69	69	69	69

EMISSION CONTROL
TEST # 8

Chamber Pressure : 27 microns

Ambient Temp: 79-80 °F

Test Conditions:

Power to Heaters: None

Voltage to Cards: +27.5 volts
+ 5 volts

Radiator Plate Temp: 125 °F

Fluid Flow Rate: 0.016 Lt/sec

Thermocouple Data:

Radiator Plate	# 16
Fluid Out	# 5
Fluid In	# 8

TEST Nº 8
E/C

DATA!

DATE 5/4/71

TIME	1000	1030	1100	1130	1200	1245		
TEMP °F / Nº								
1	123 °F	124 °F	131 °F	134 °F	137 °F	137 °F		
2	125	128	134	136	138	137		
3	114	117	123	126	129	127		
4	113	116	120	125	125	124		
5	114	120	126	123	124	123		
7	122	127	131	139	139	138		
8	118	120	127	123	123	122		
9	129	134	137	143	145	145		
10	118	120	123	129	131	132		
12	112	116	126	125	125	125		
13	127	134	137	141	141	142		
14	113	119	121	127	126	125		
15	116	120	125	129	129	129		
16	116	119	124	125	125	124		
18	117	121	125	129	131	131		
19	123	128	132	138	138	139		
20	131	134	140	145	145	145		

LMS ENGINEERING THERMAL VACUUM TESTS

I INTRODUCTION

Following the thermal/vacuum tests on the individual circuit boards, the boards were assembled onto the engineering model radiation plate, electrically tied together with a special test cable, and the unit covered with a thermal bag. The assembled unit was then placed in the 4' x 8' thermal vacuum chamber and tested at various radiator plate temperatures and electrically cycled by means of the LMS Engineering Test Set.

II PURPOSE

The purpose of this test is to establish the thermal profile for the various circuits and selected components when assembled and functioning at various temperatures in a vacuum environment.

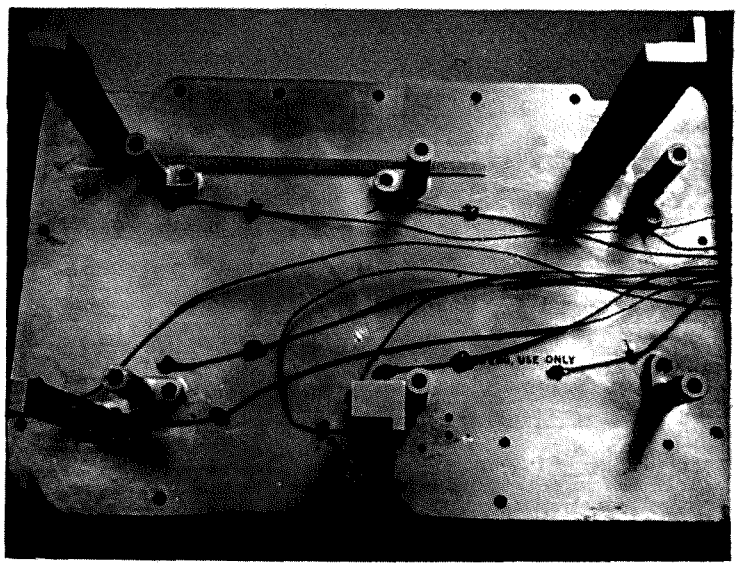
III TEST EQUIPMENT

The LMS Engineering Thermal/Vacuum Tests were conducted in the Bendix 4' x 8' thermal vacuum chamber. The LMS electronics were assembled onto the engineering model radiator plate and covered with the thermal bag. Each of the circuit boards, the radiator plate and the thermal bag were instrumented with thermocouples to record the temperature of selected portions of the LMS assembly. Figures 17 thru 22 show these components ready for assembly. Figure 23 shows the LMS assembled and ready for installation in the chamber, while Figure 24 shows the instrument inside the chamber and the LMS engineering test set (ETS) set up.

IV TEST PROCEDURES

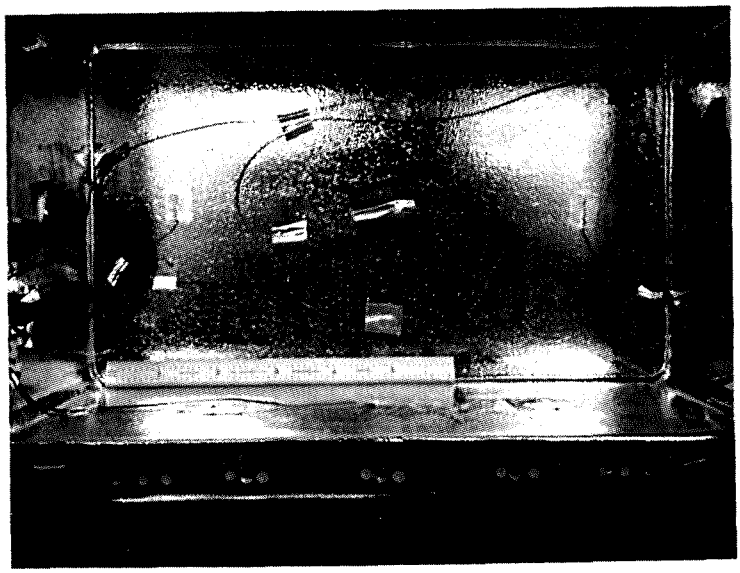
The following document, BSD No. 2365599, represents the test procedures followed in these tests.

FIGURE 17

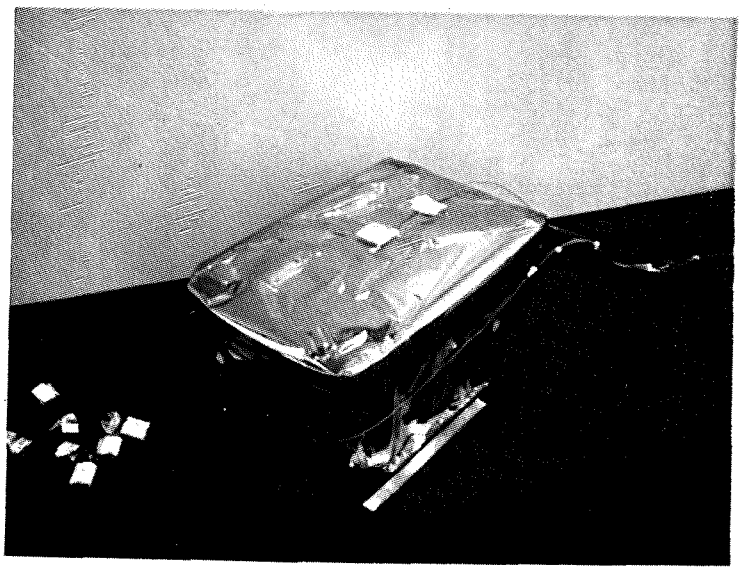


Radiator Plate

FIGURE 18



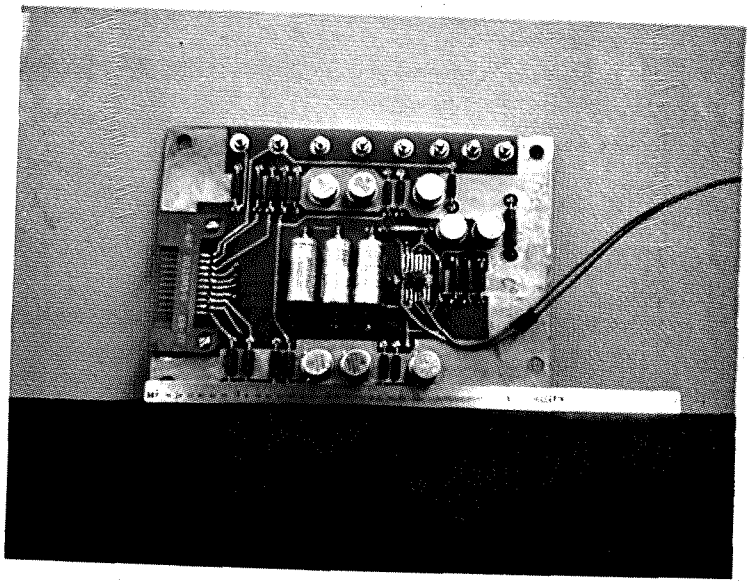
Interior



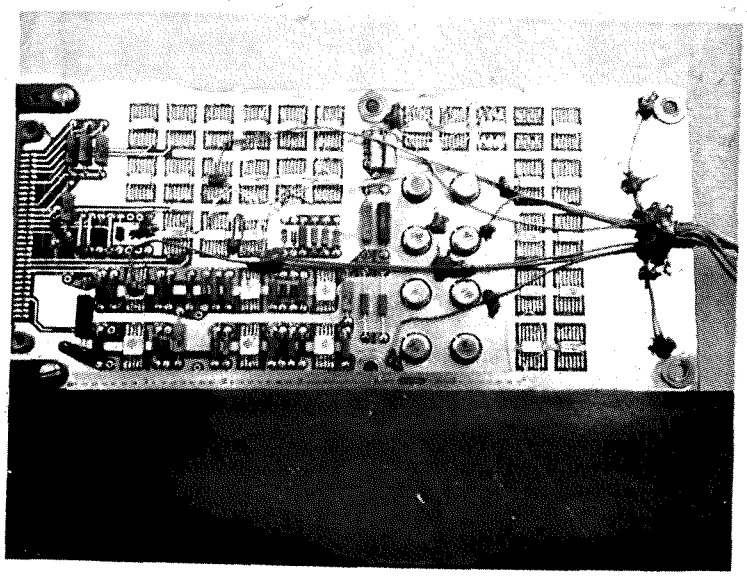
Exterior

LMS Thermal Bag

FIGURE 19

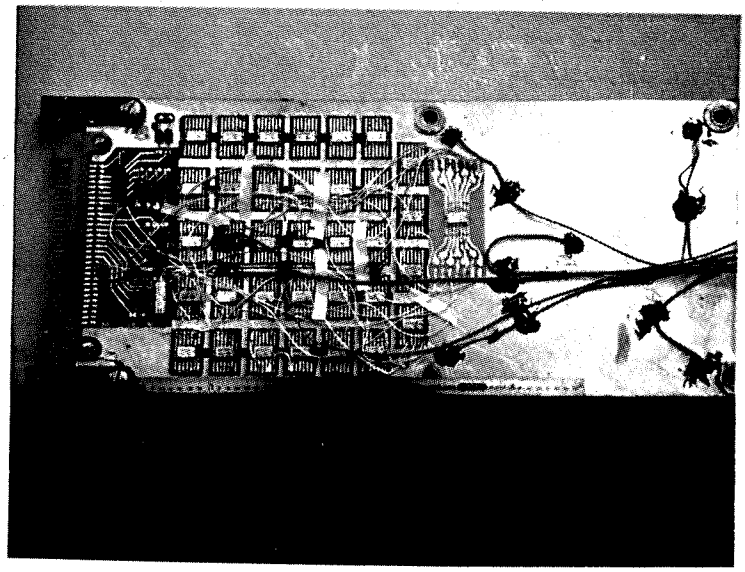


Control and Monitor

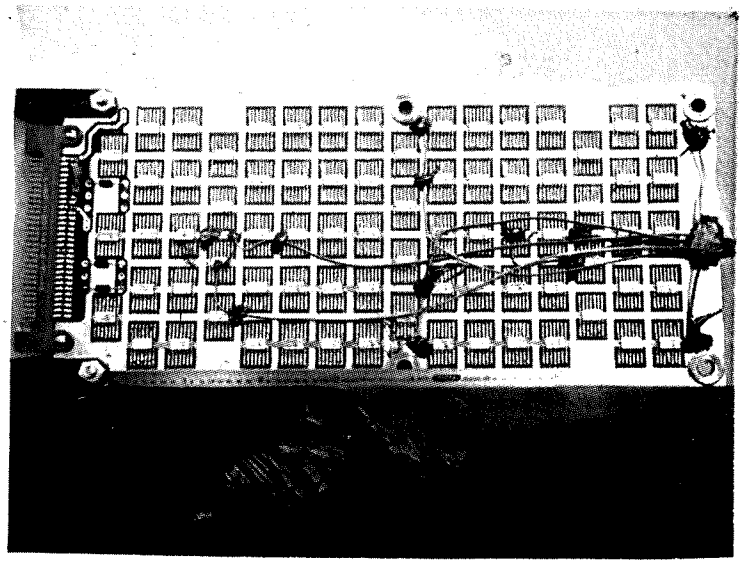


Housekeeping Multiplexer

FIGURE 20

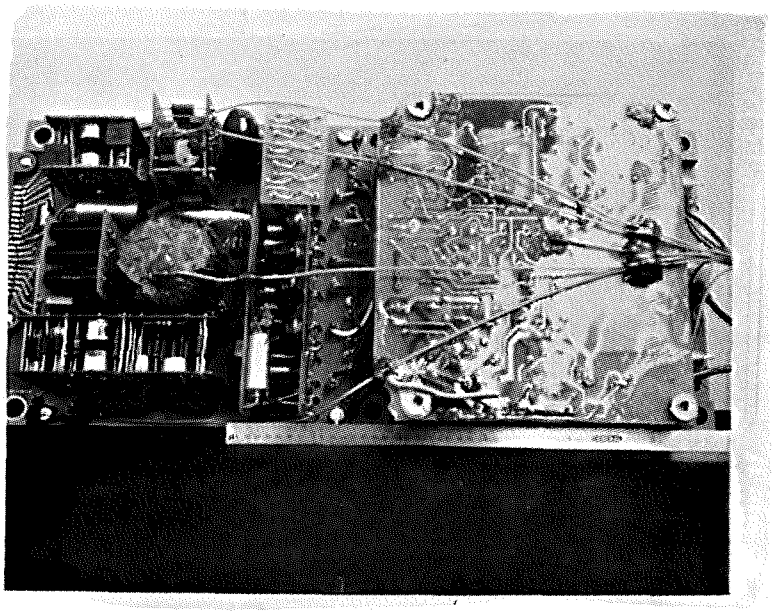


Signal Command & Decoder

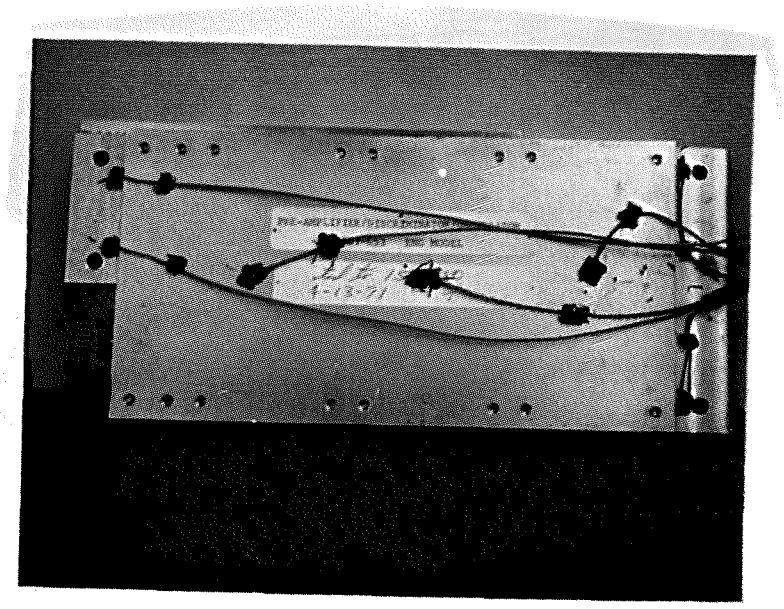


Counter and Data Compressor

FIGURE 21

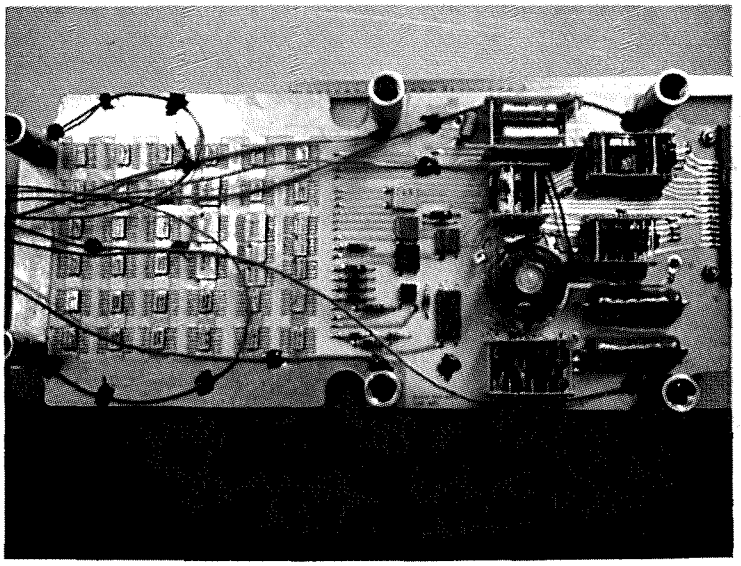


High & Low Voltage Supply

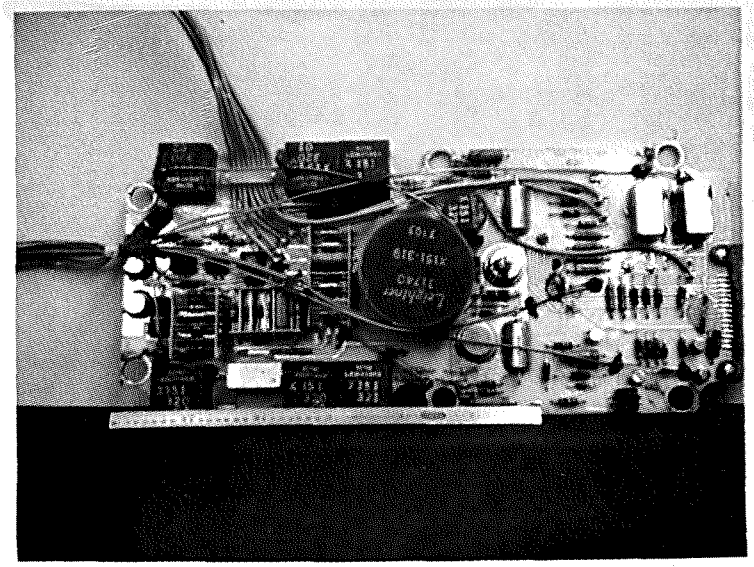


Pre-amplifier/Discriminator

FIGURE 22

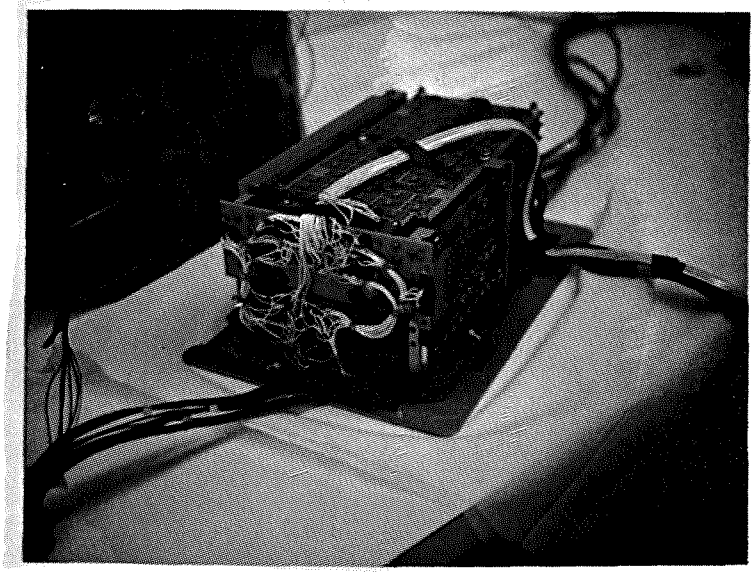


Emission Control



Emission Control

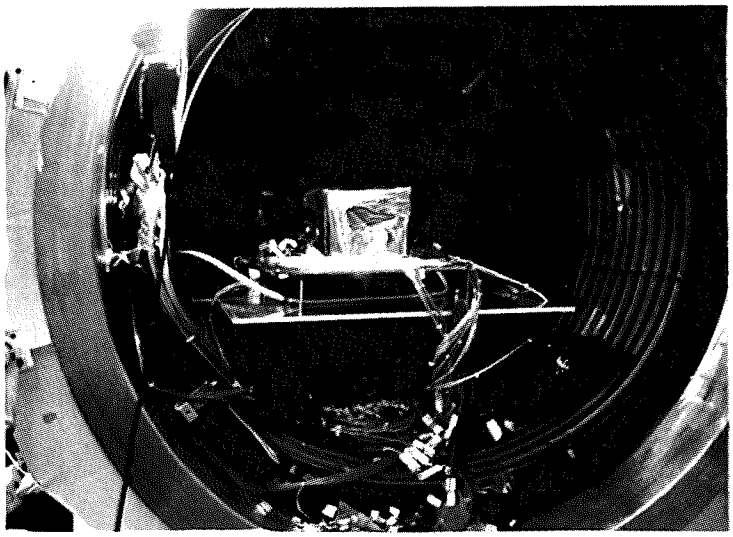
FIGURE 23



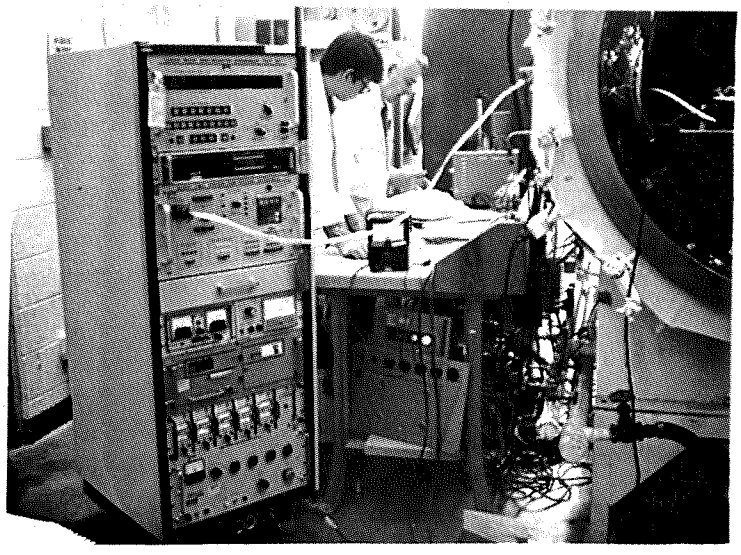
LMS Electronics Assembled

LMS with Thermal Bag

FIGURE 24



LMS in 4' x 8' Chamber



ETS Tied-in to LMS

V CONCLUSIONS

As with the previous thermal/vacuum test, no conclusions were drawn from the data. Instead, the data were forwarded to the Thermal Engineering group for analysis and correlation with computor simulation of identical conditions. Figures 25 to 48 are printouts of the data recorded during these tests.

Figure 25

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

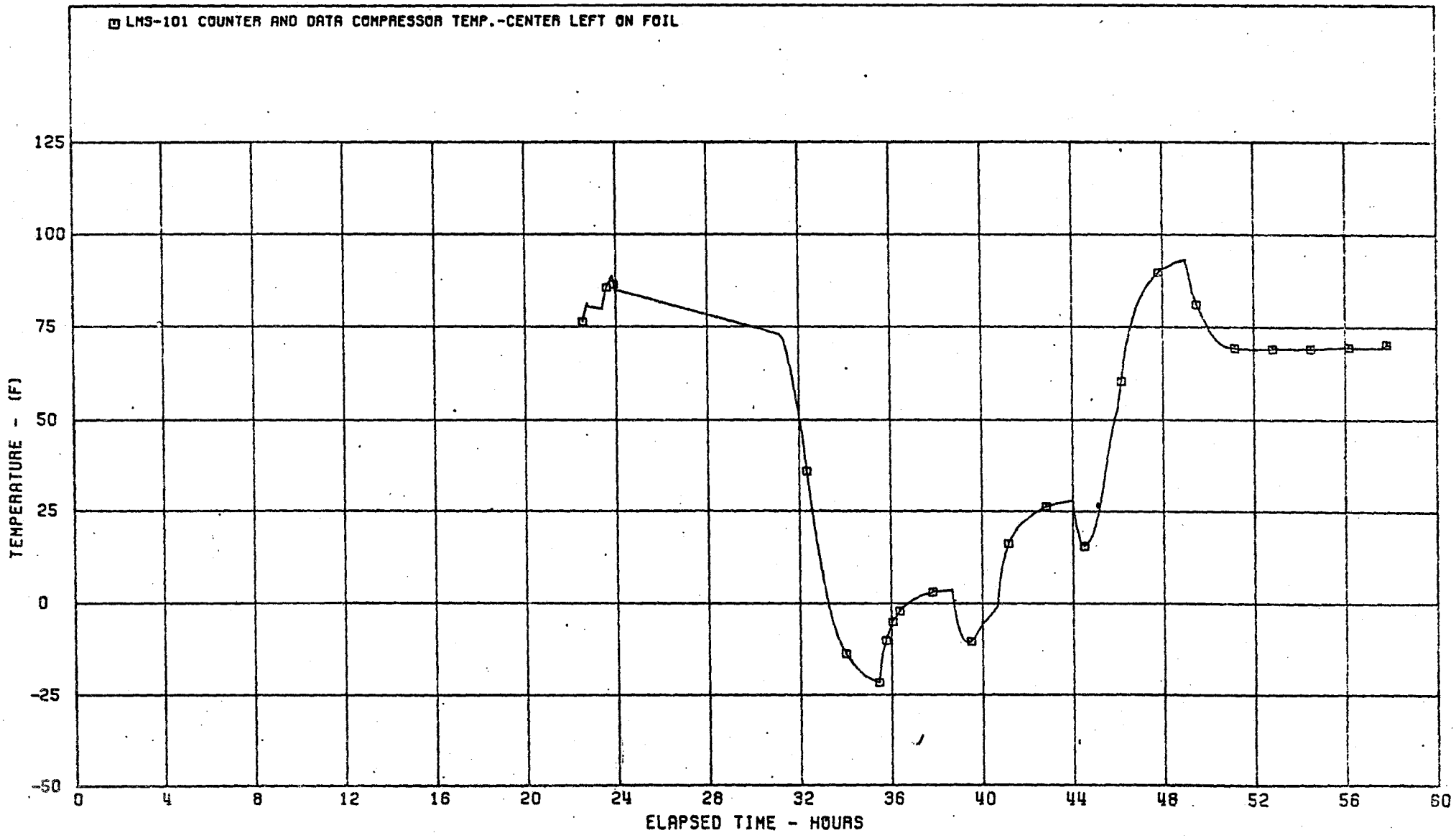


Figure 26

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

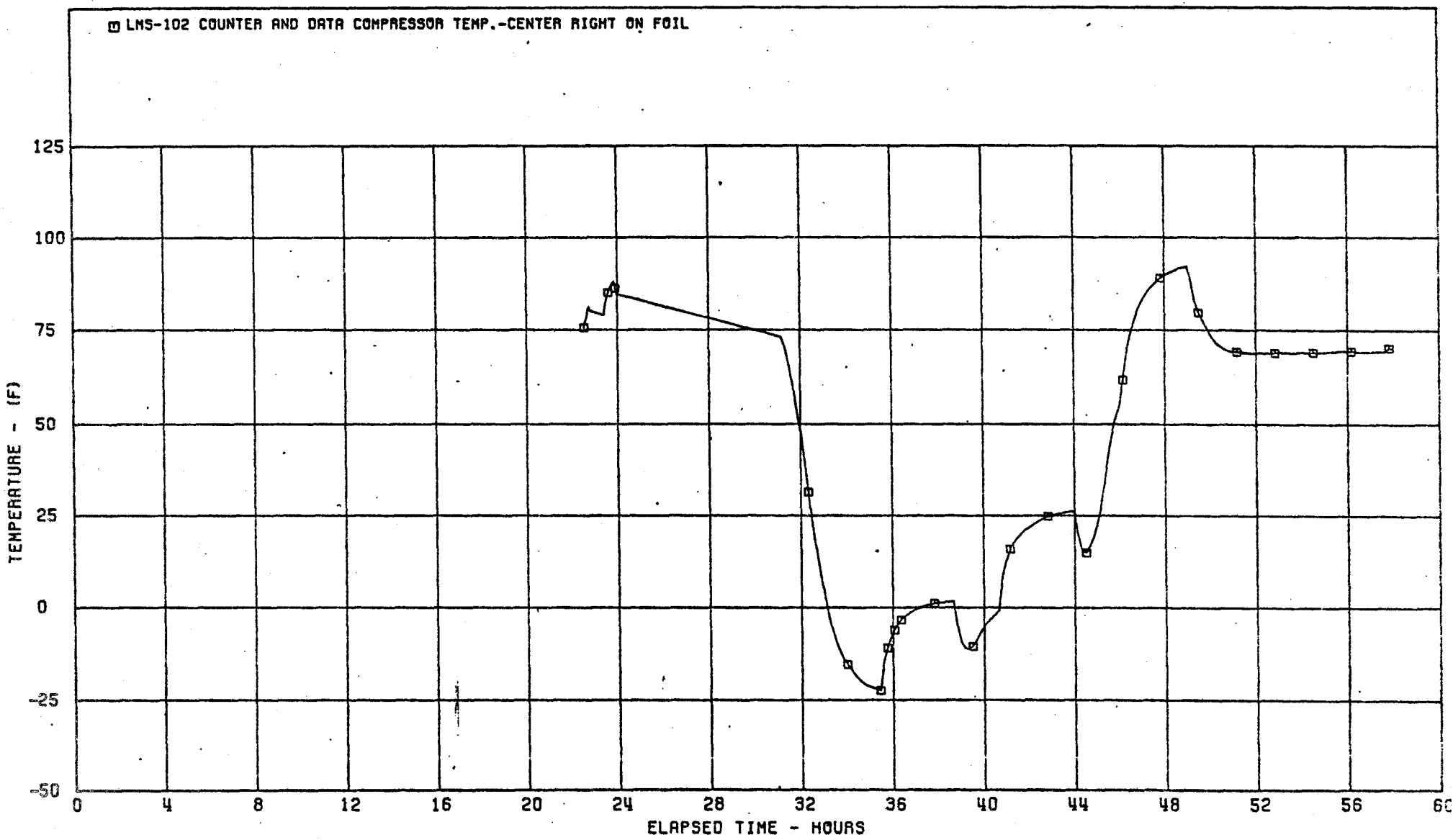


Figure 27

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

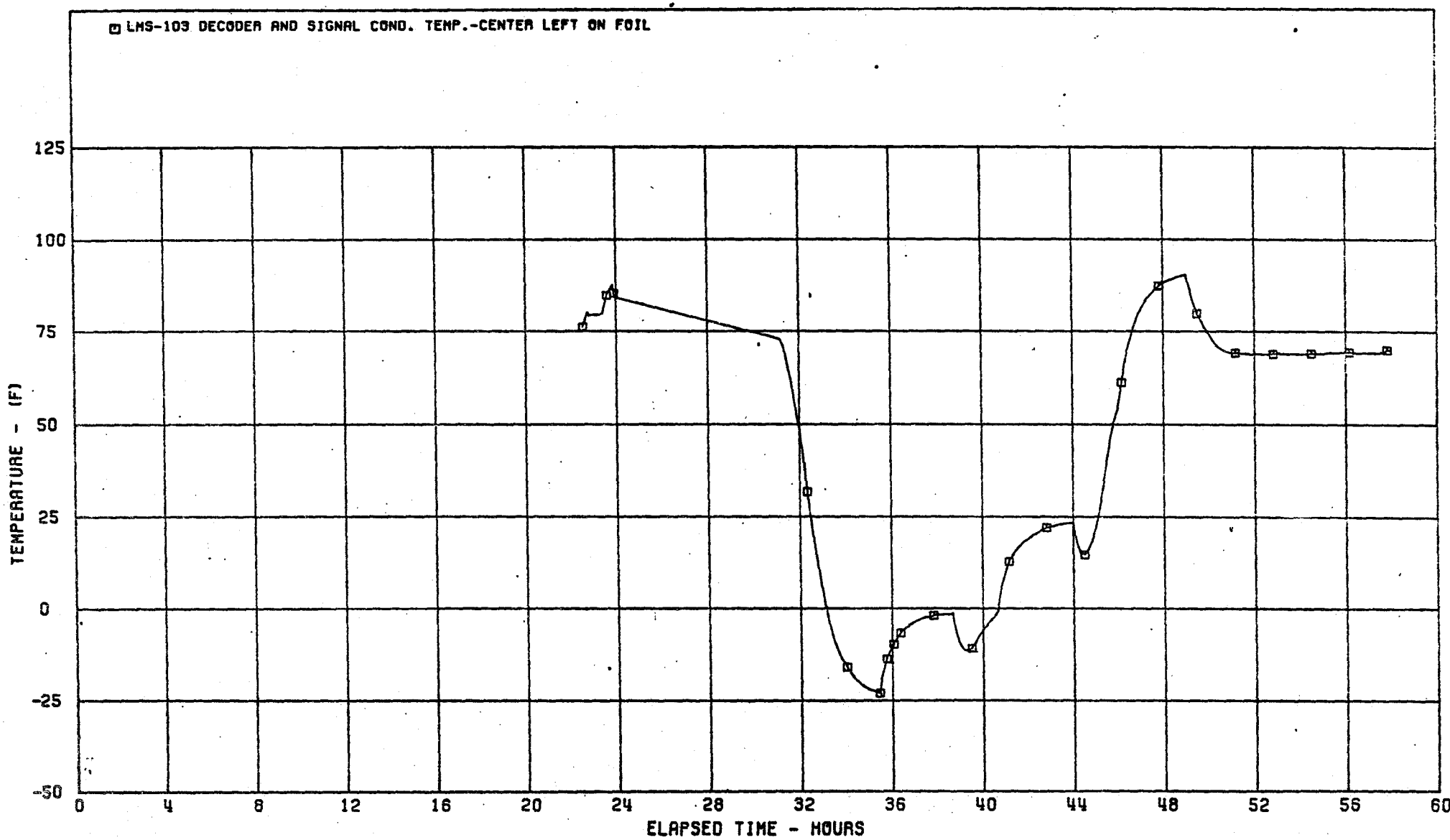


Figure 28

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 0F 05/11/71

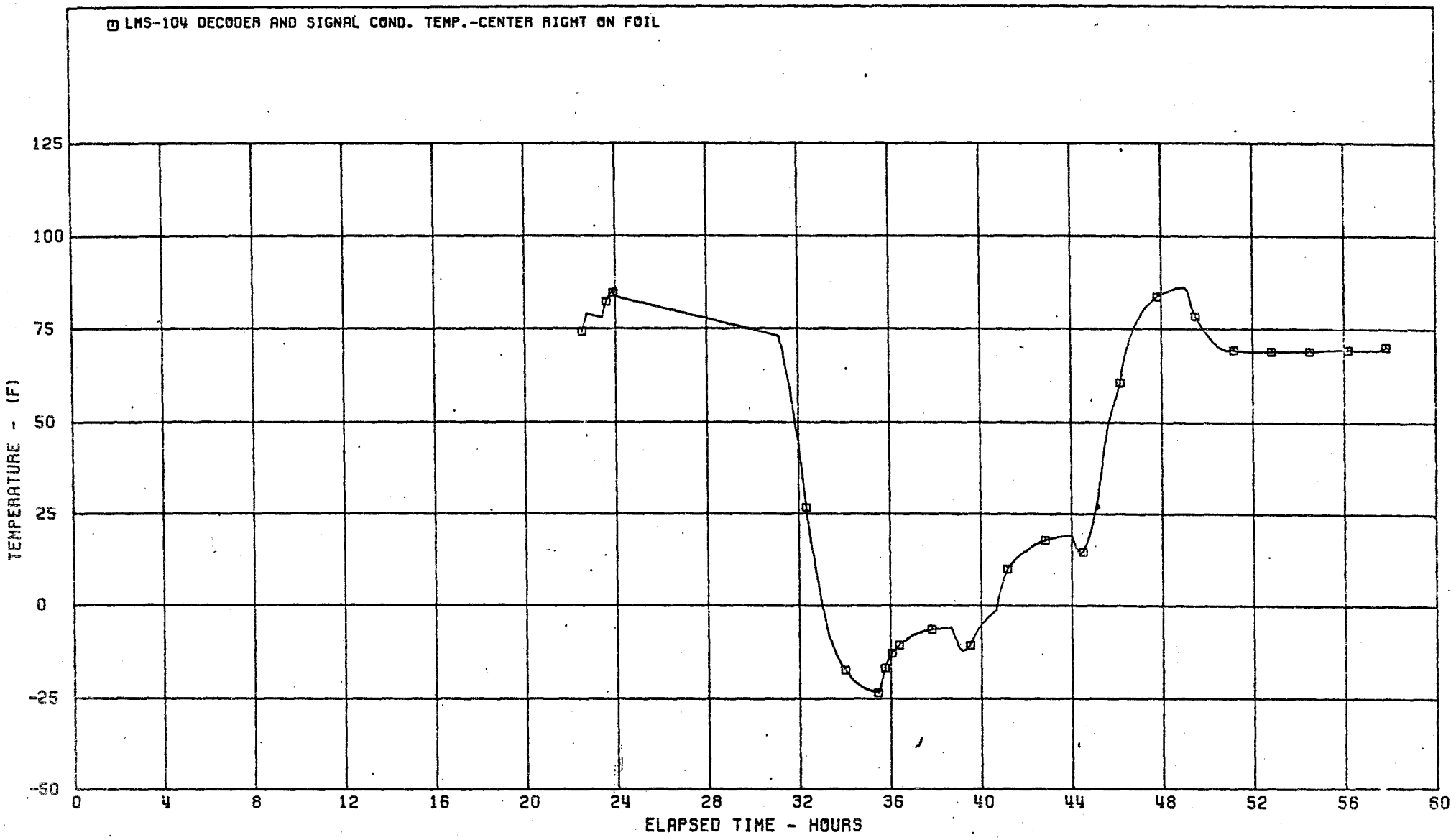


Figure 29

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

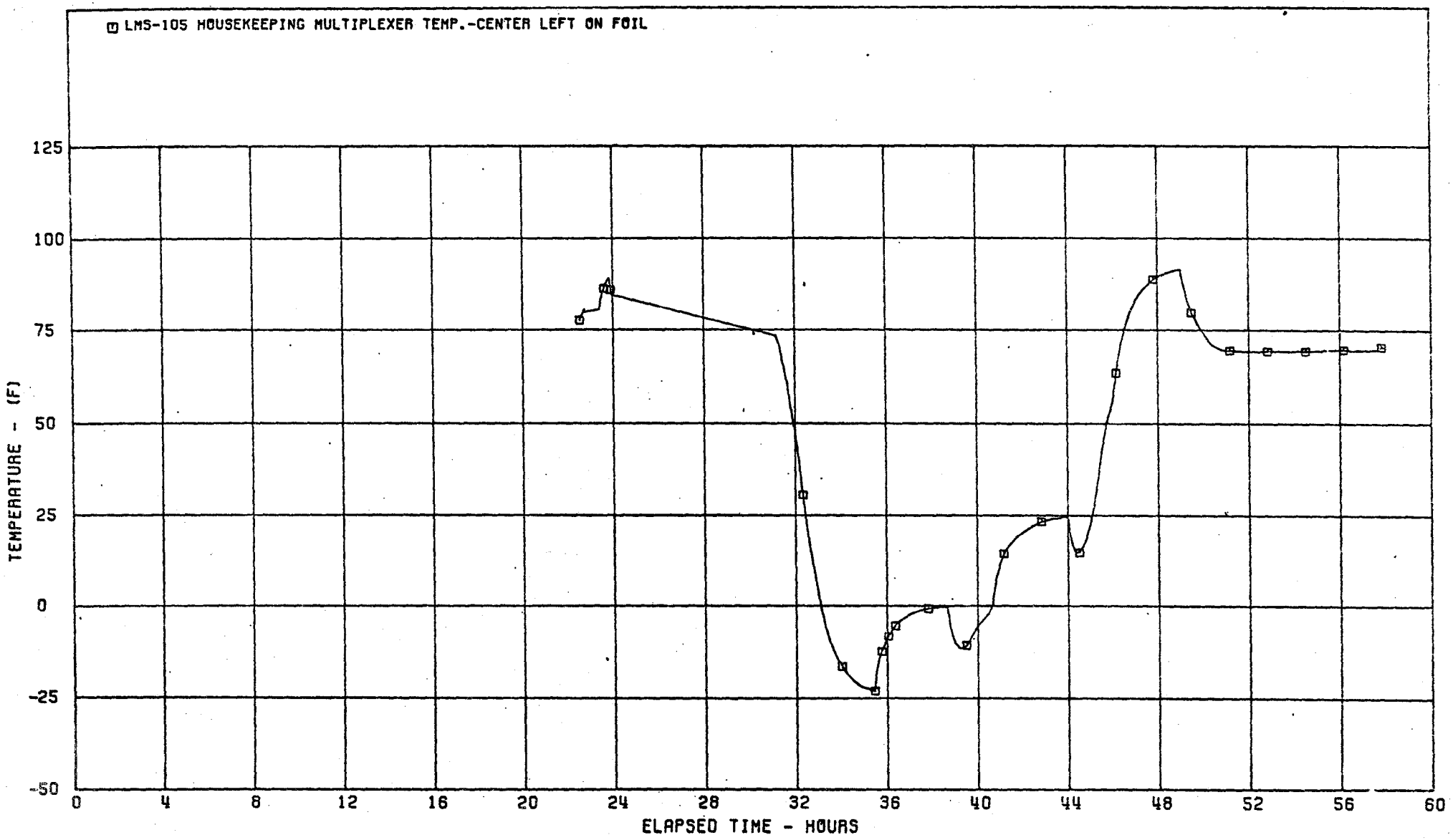


Figure 30

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

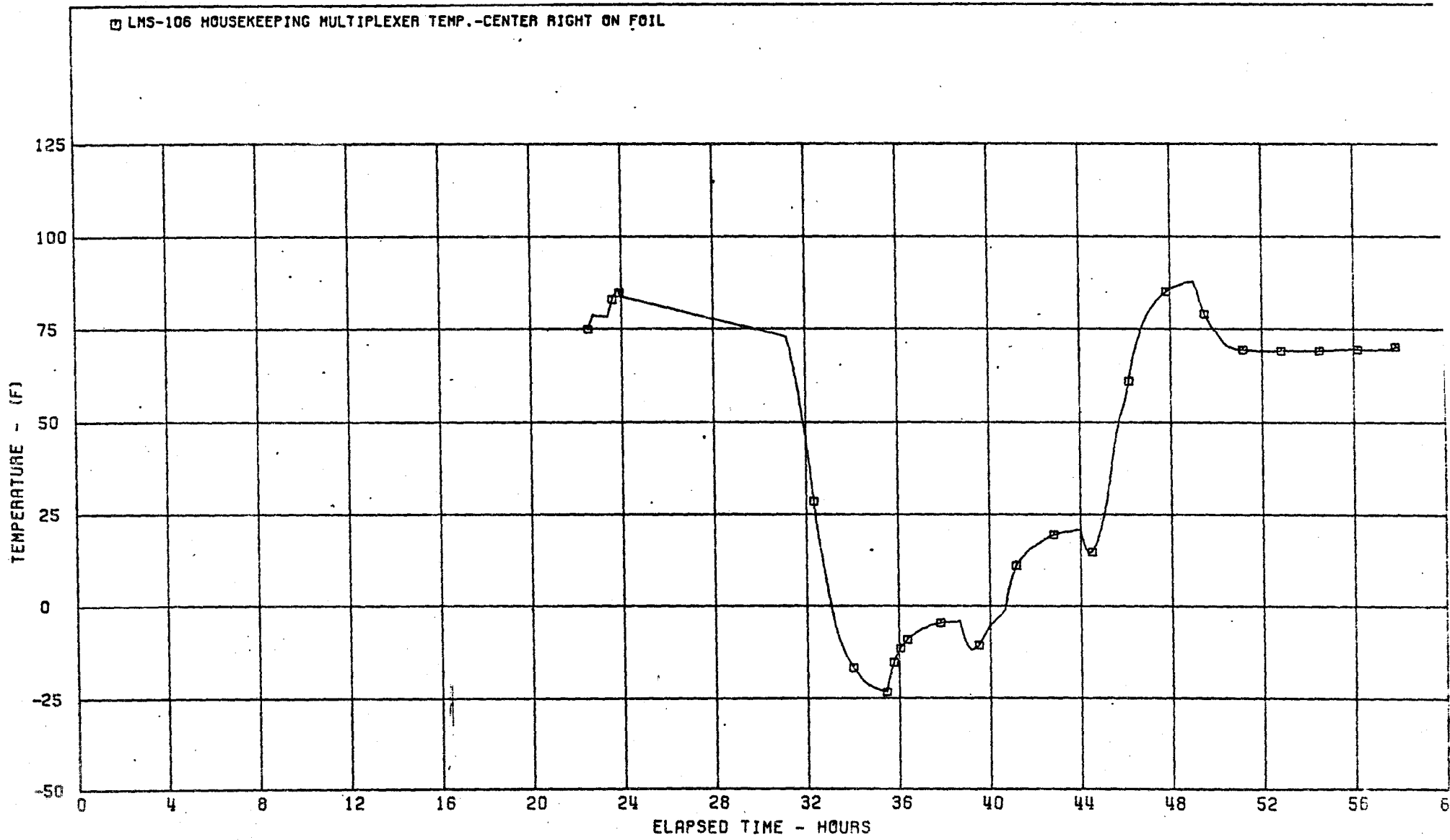


Figure 31

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 0F 05/11/71

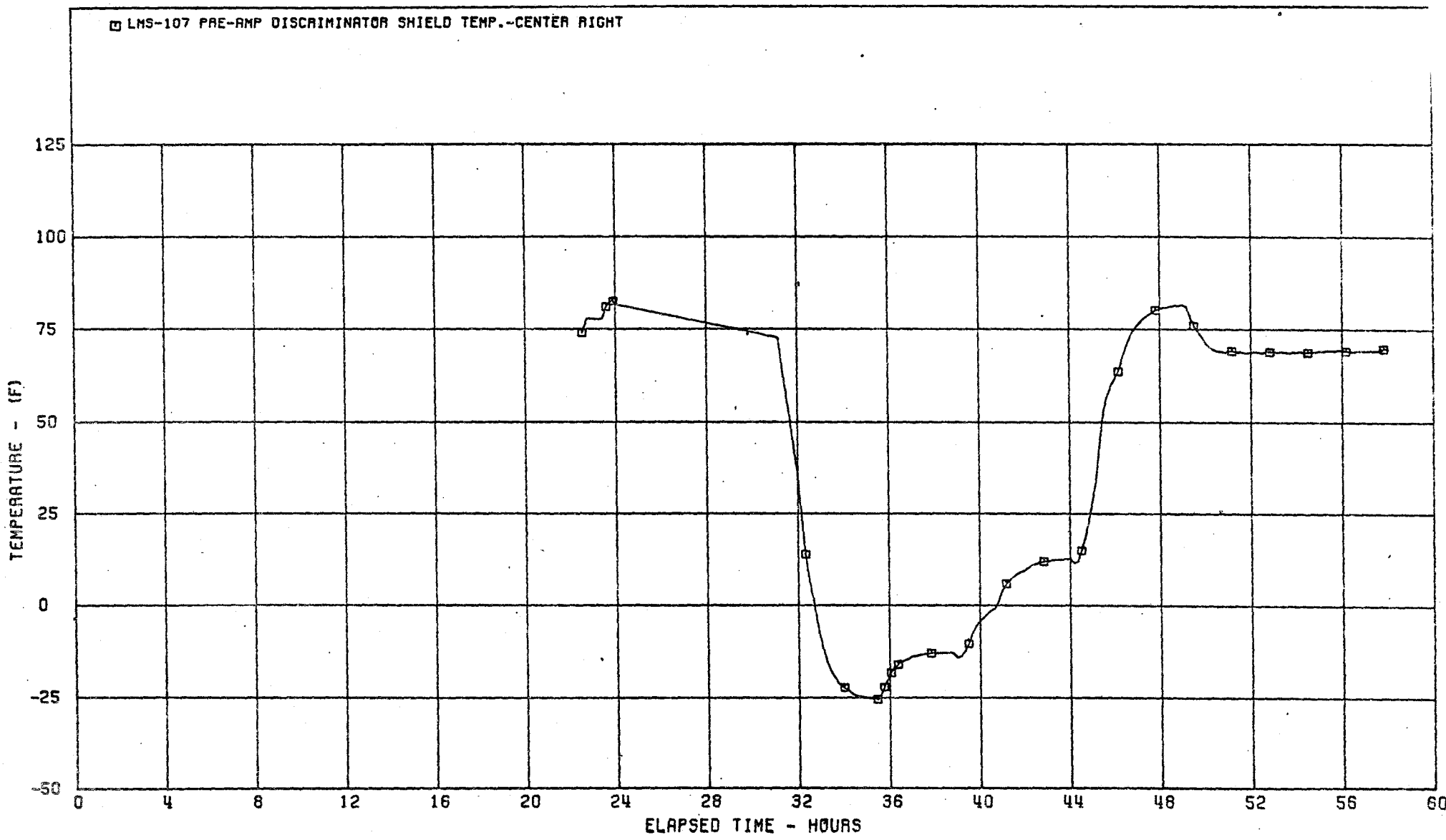


Figure 32

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

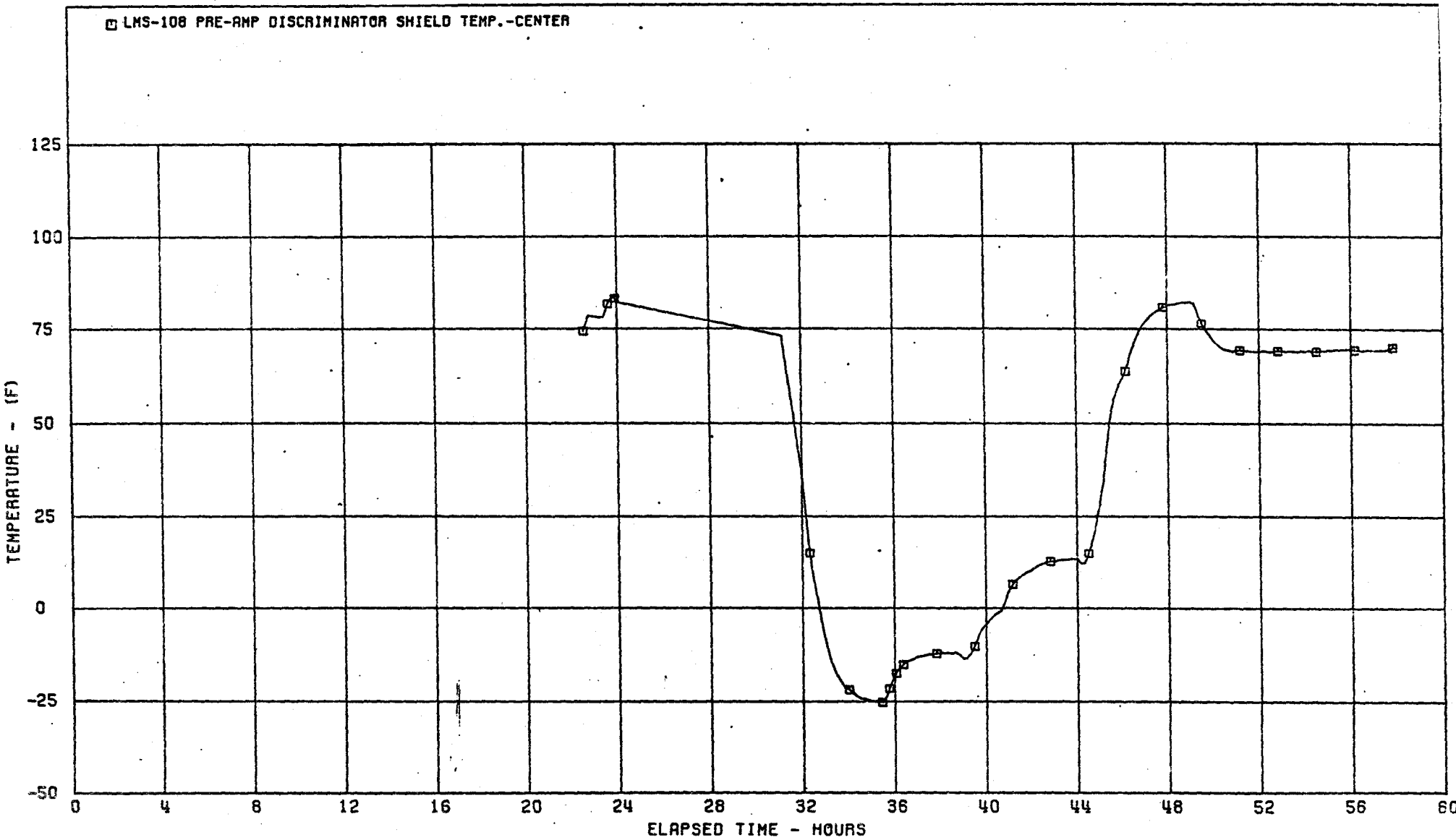


Figure 33

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

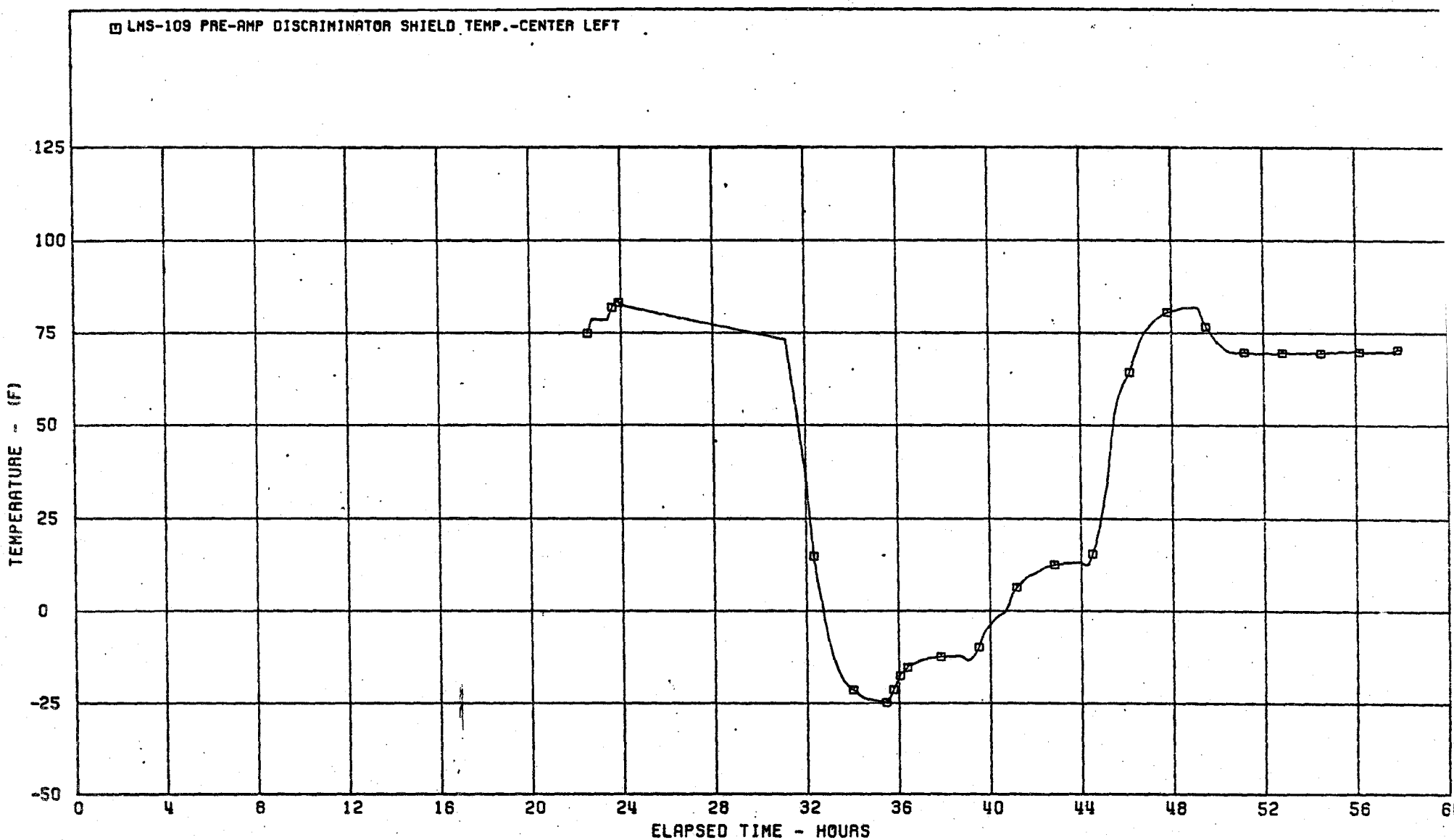


Figure 34

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

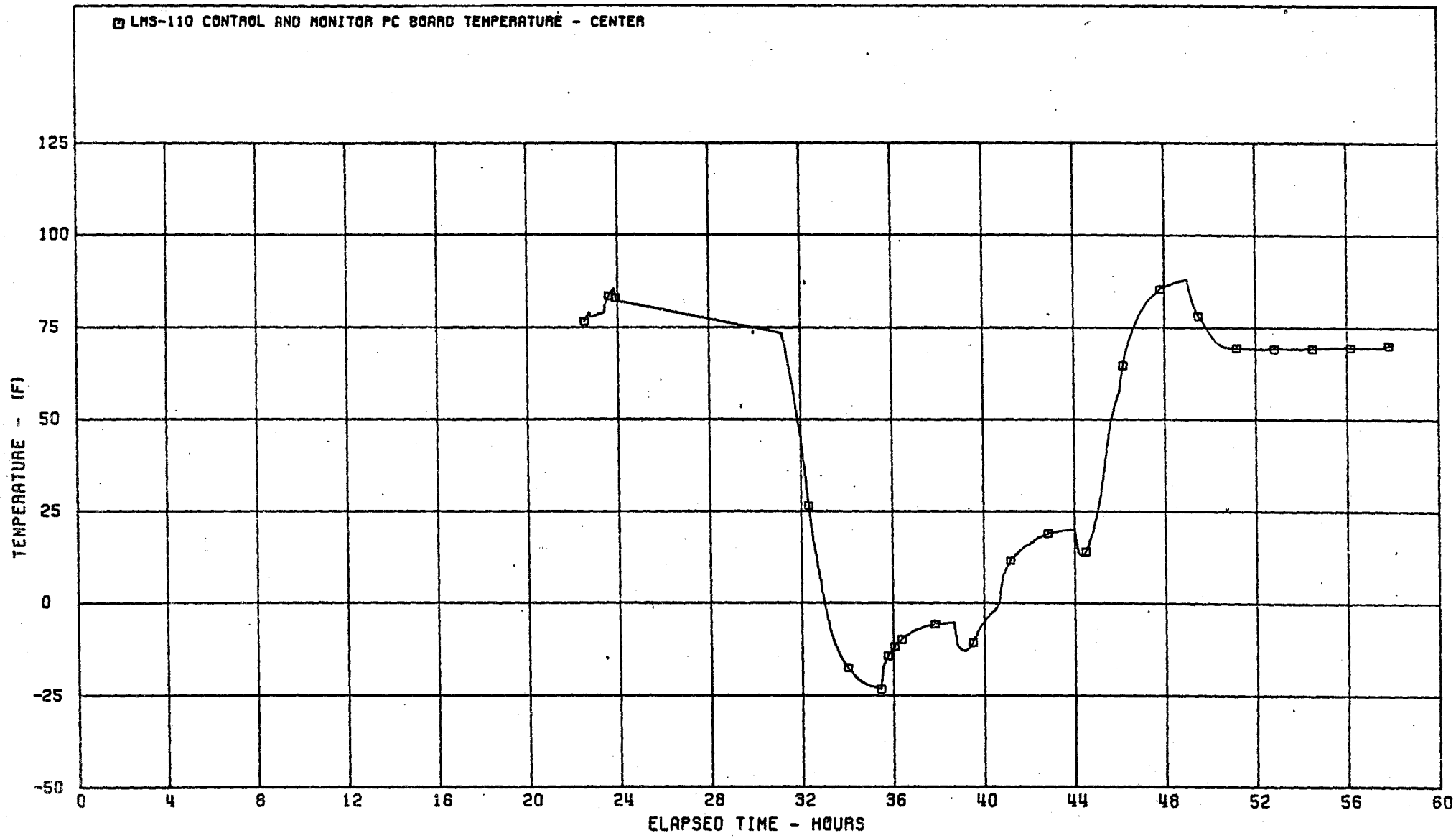


Figure 35

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

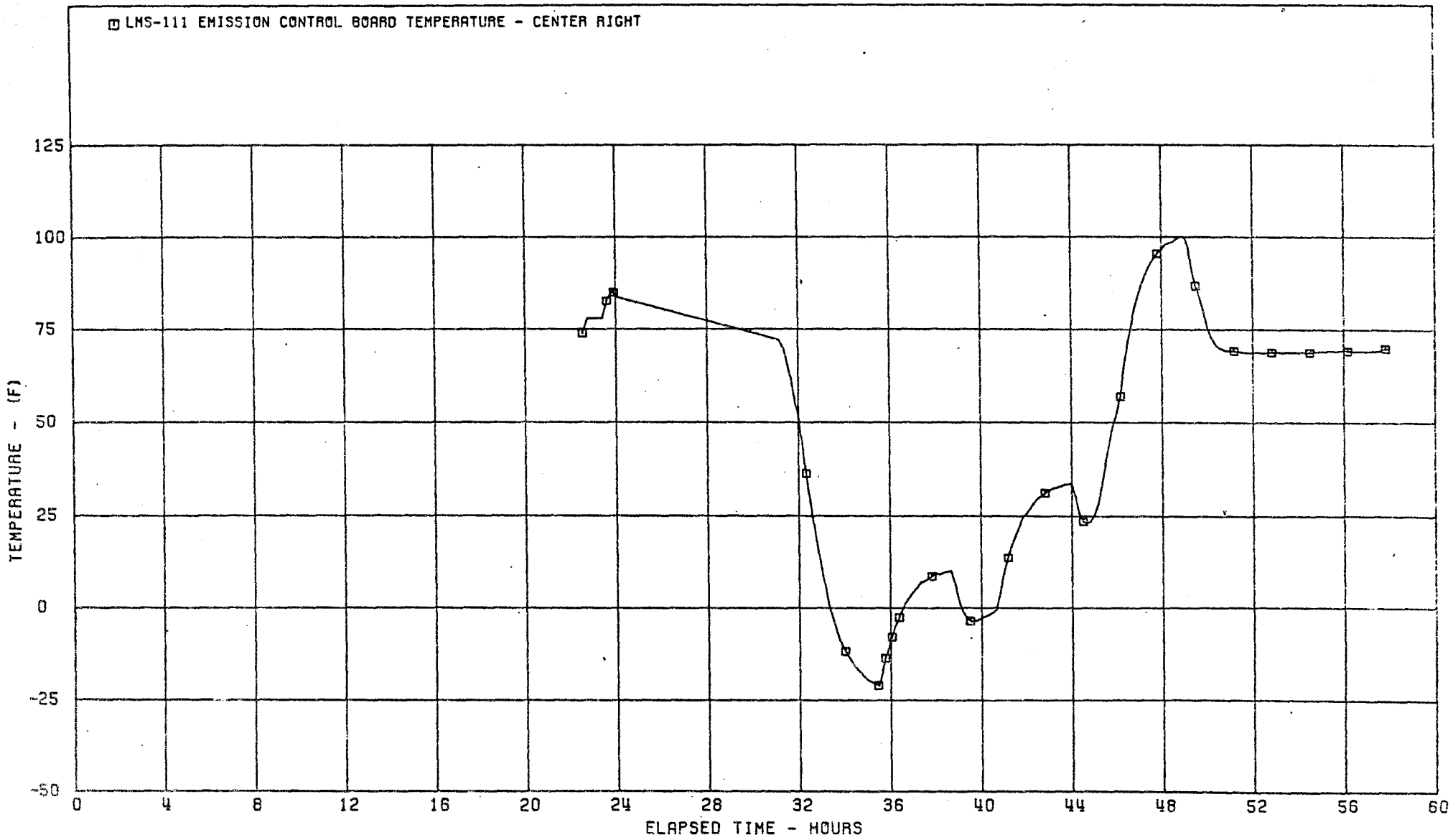


Figure 36

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

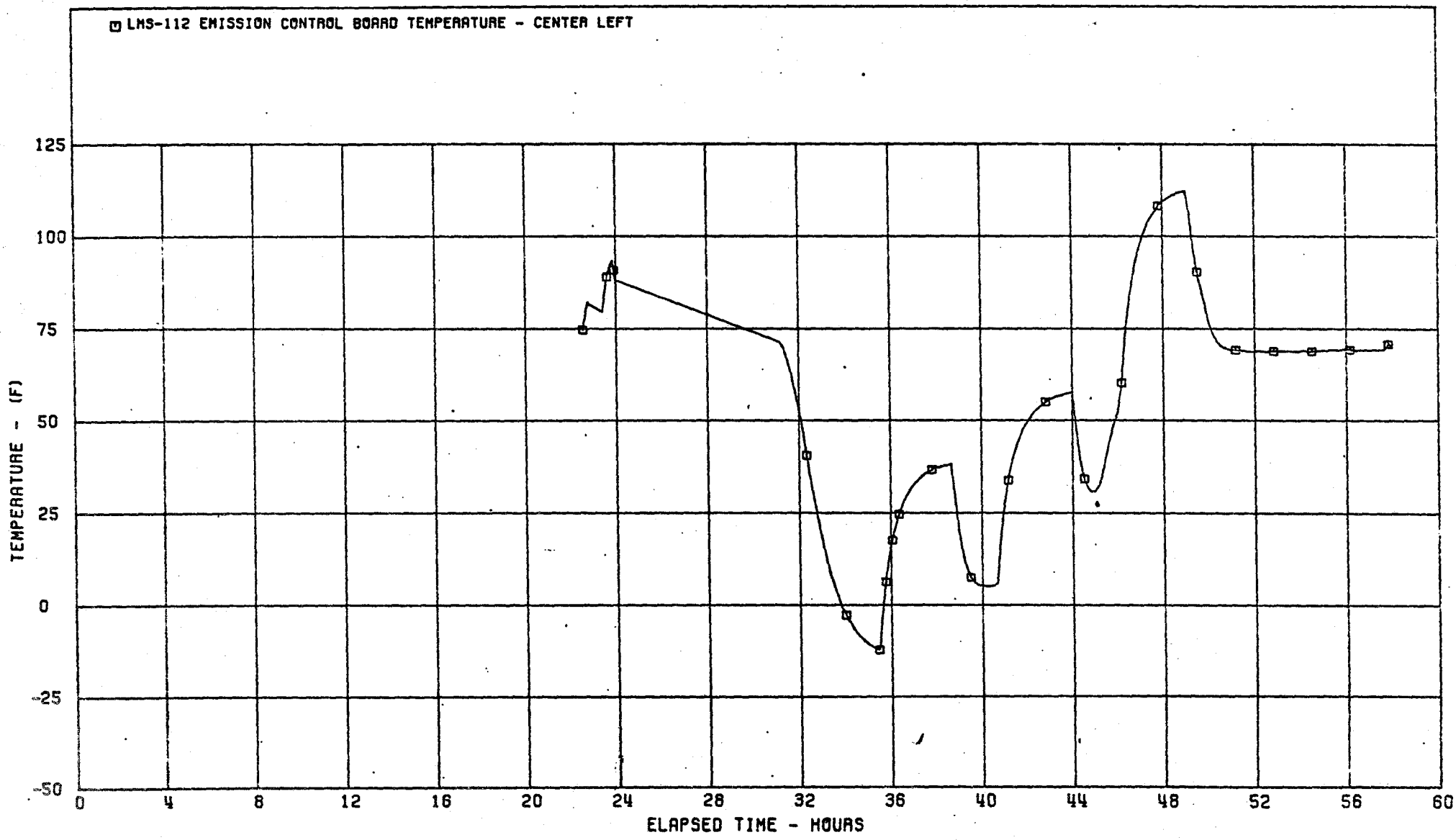


Figure 37

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

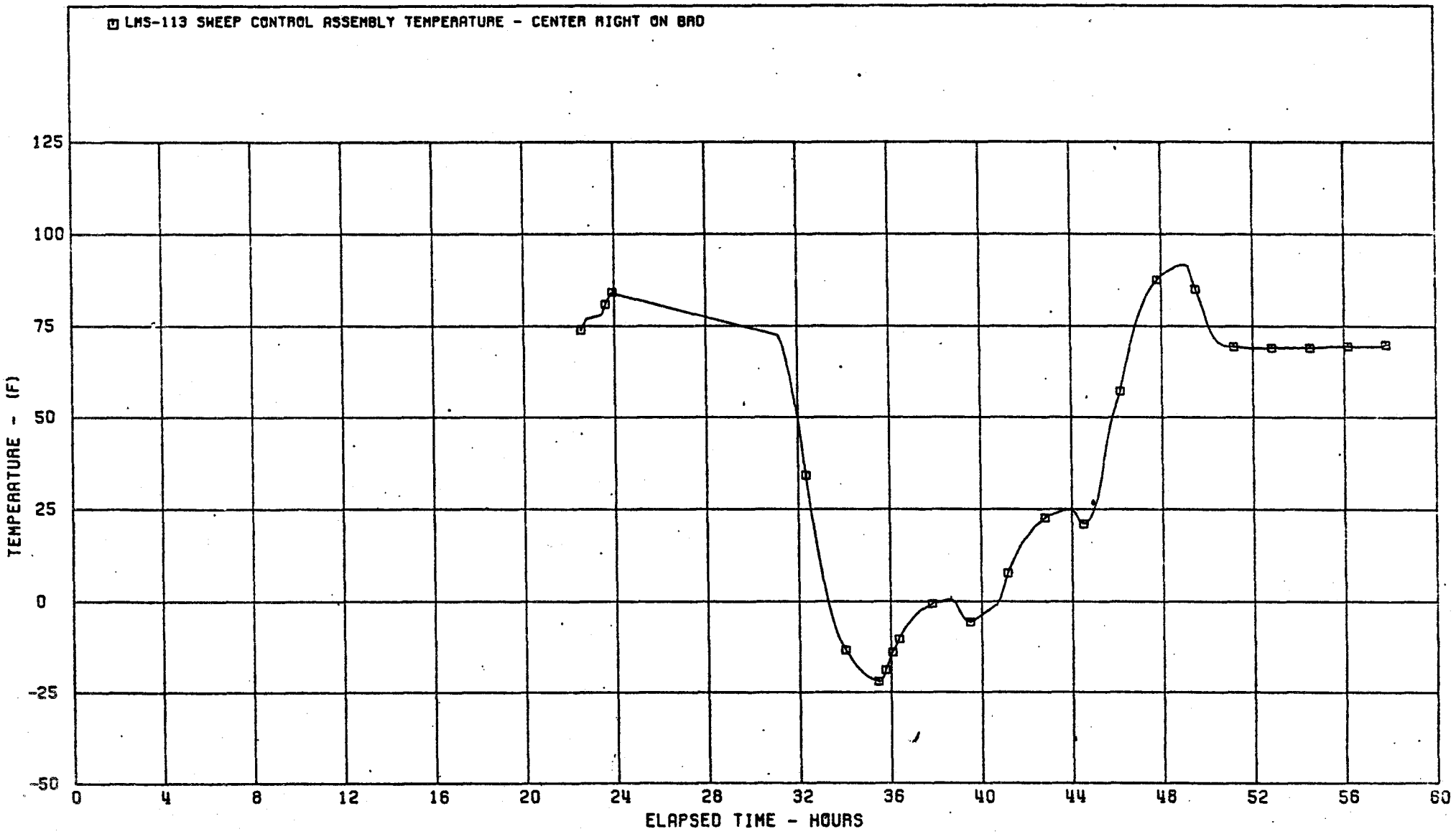


Figure 38

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

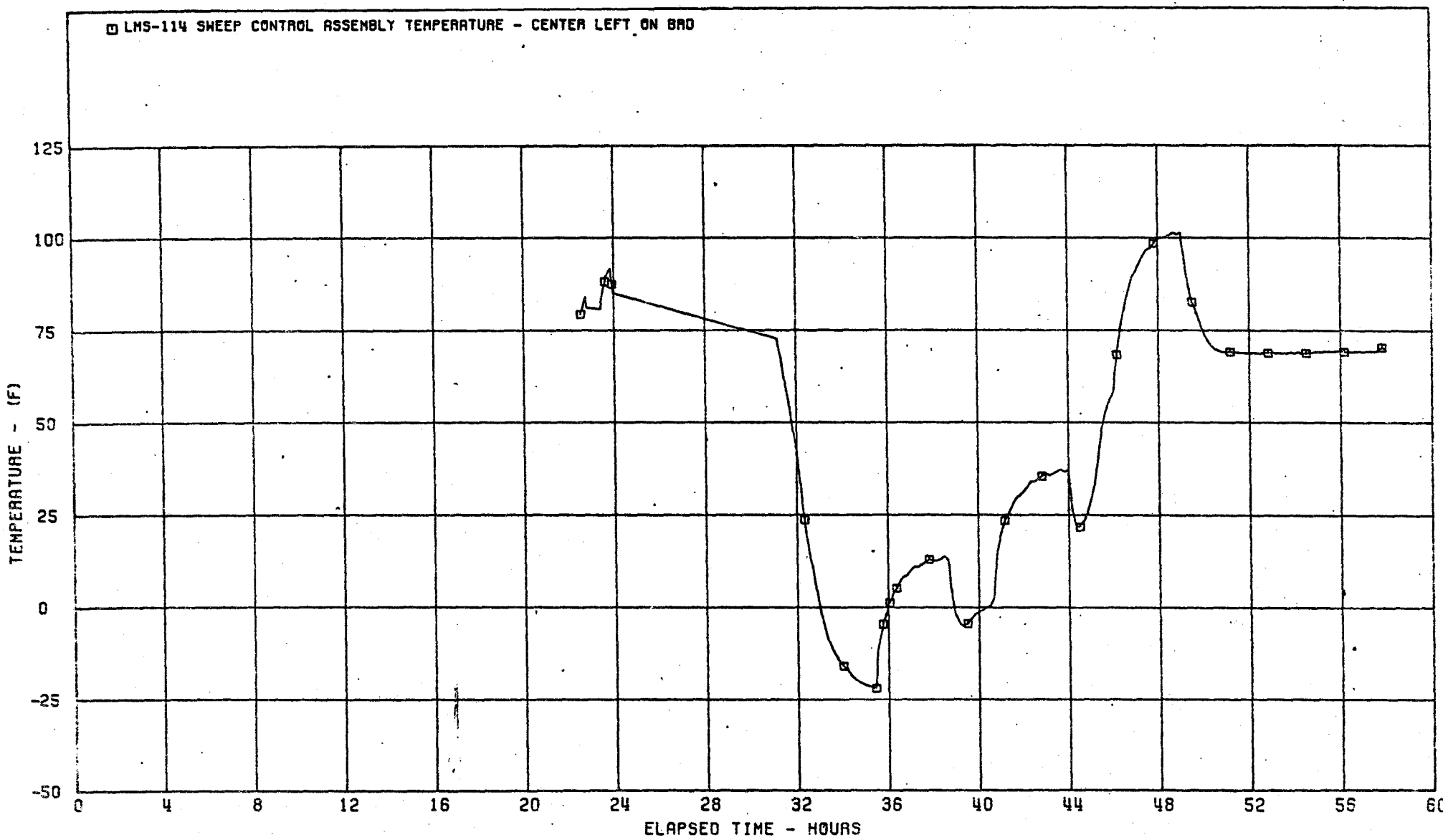


Figure 39

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 0F 05/11/71

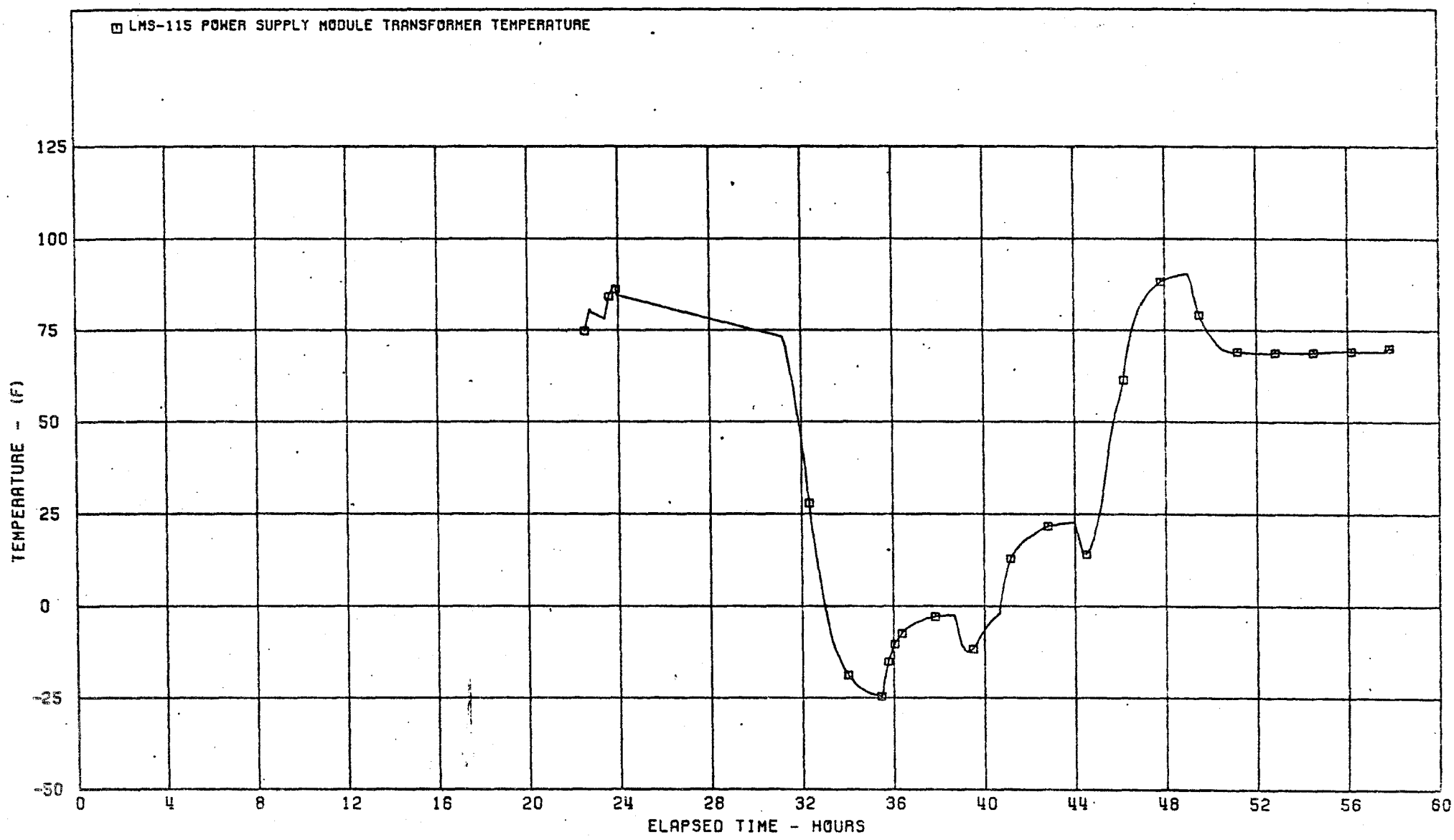


Figure 40

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

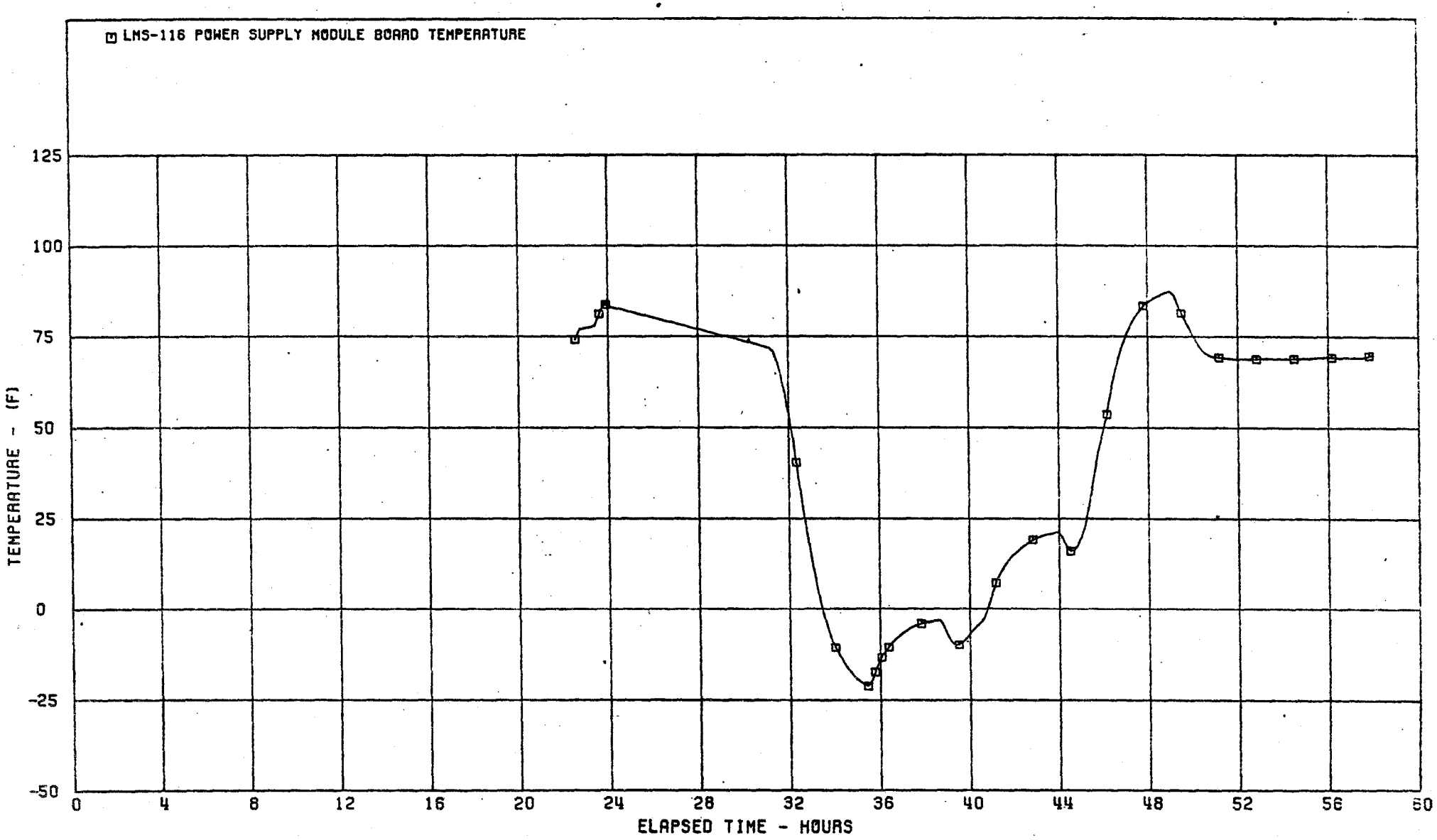


Figure 41

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

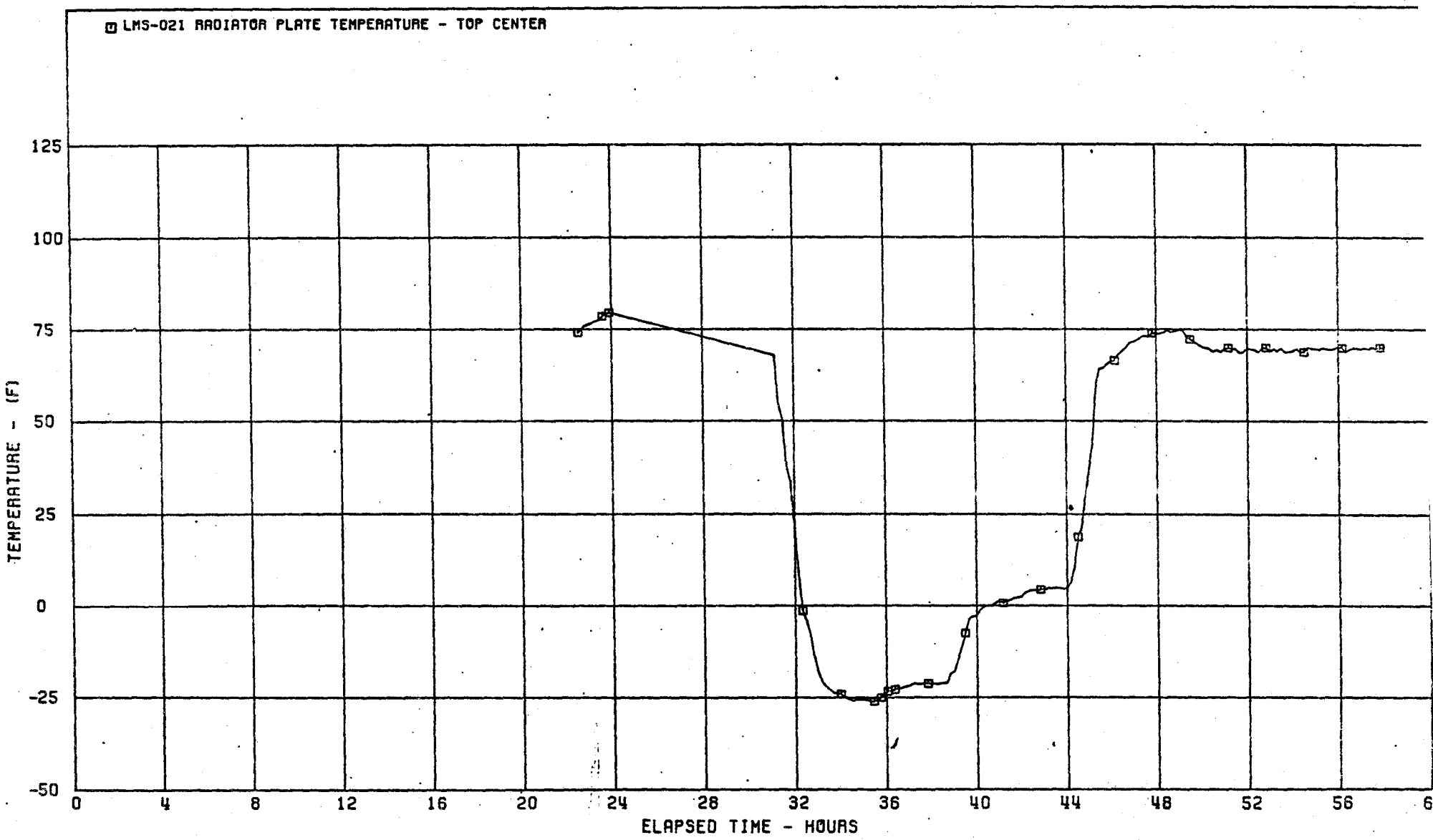


Figure 42

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

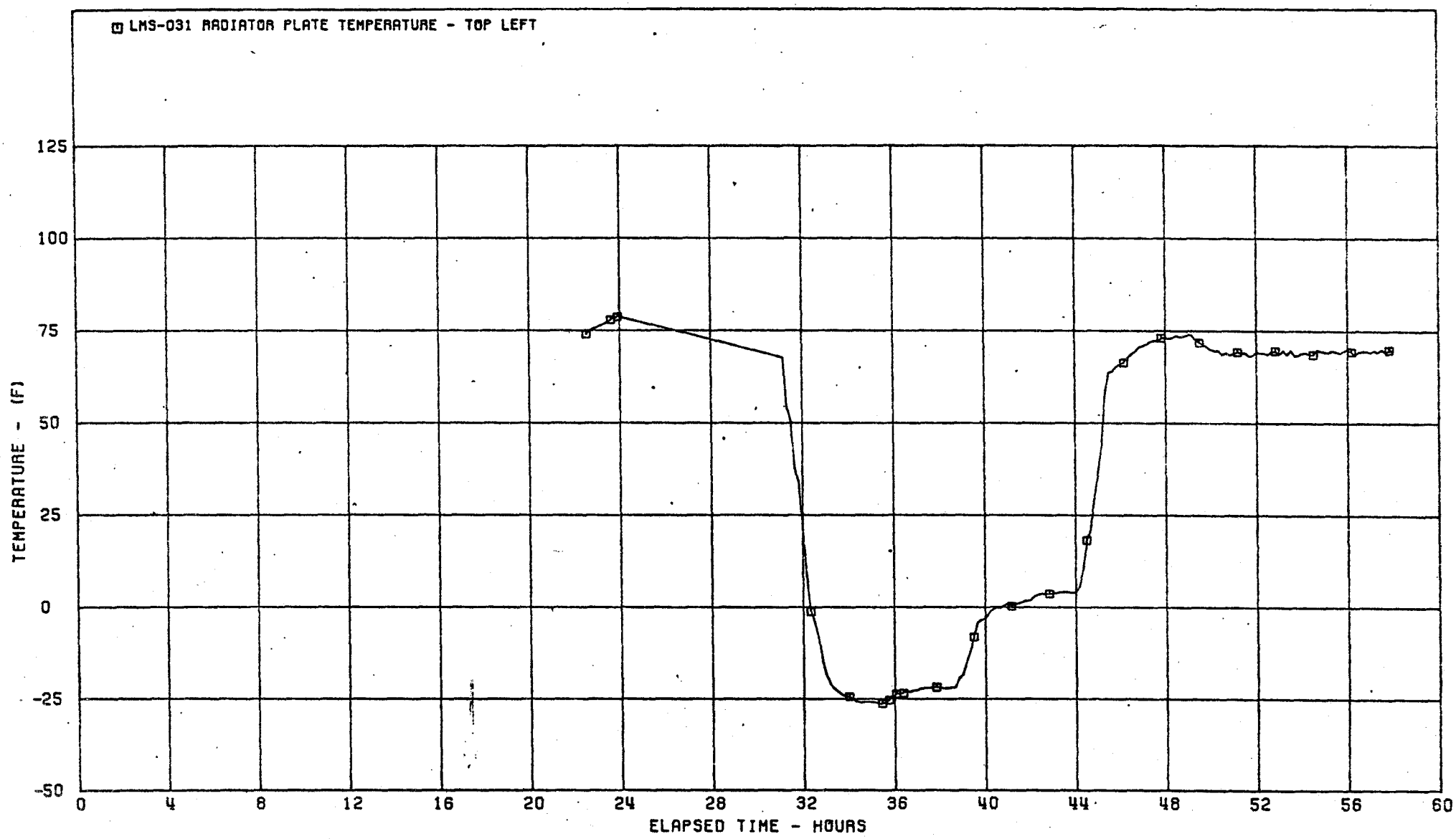


Figure 43

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

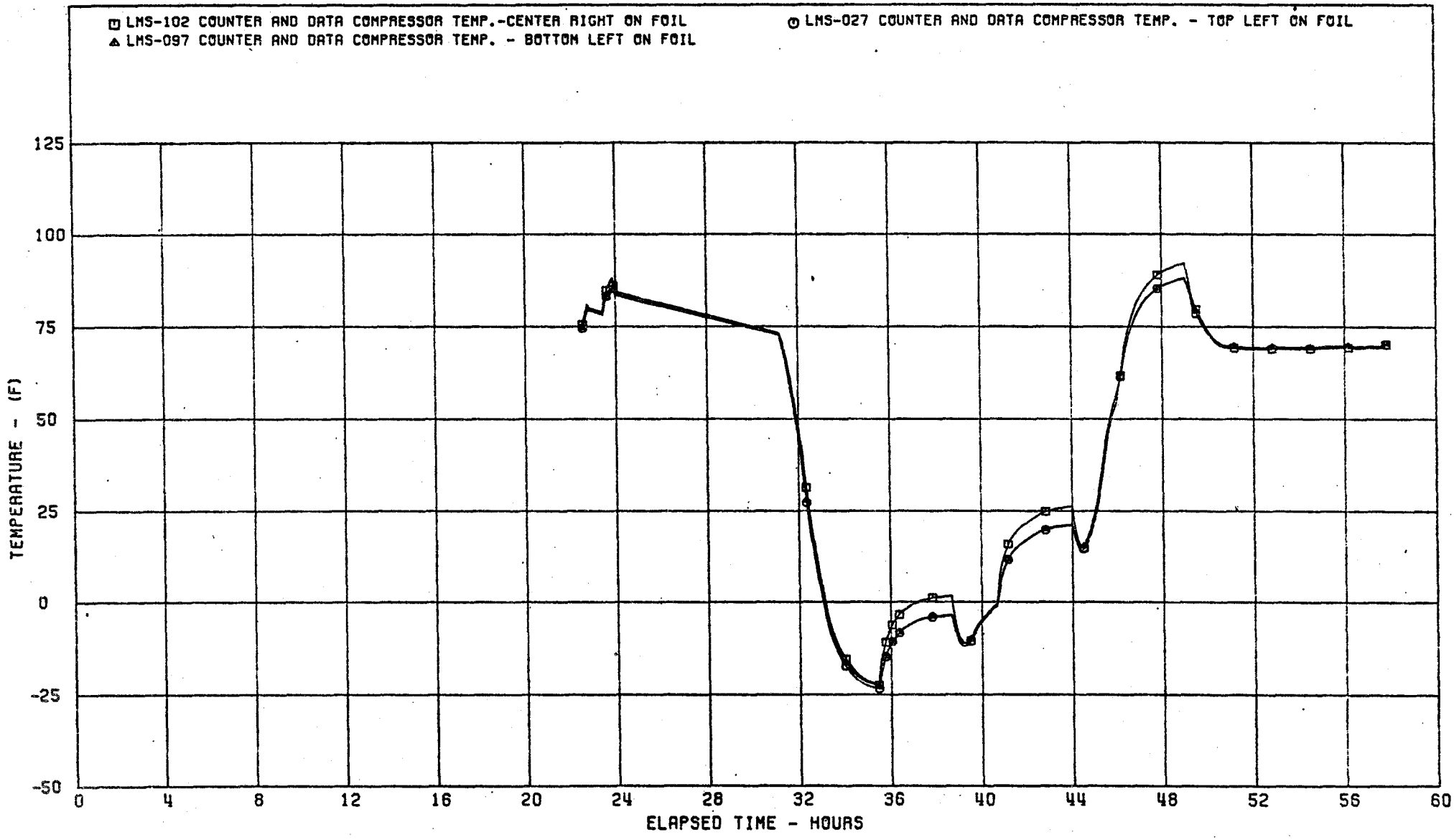


Figure 44

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71

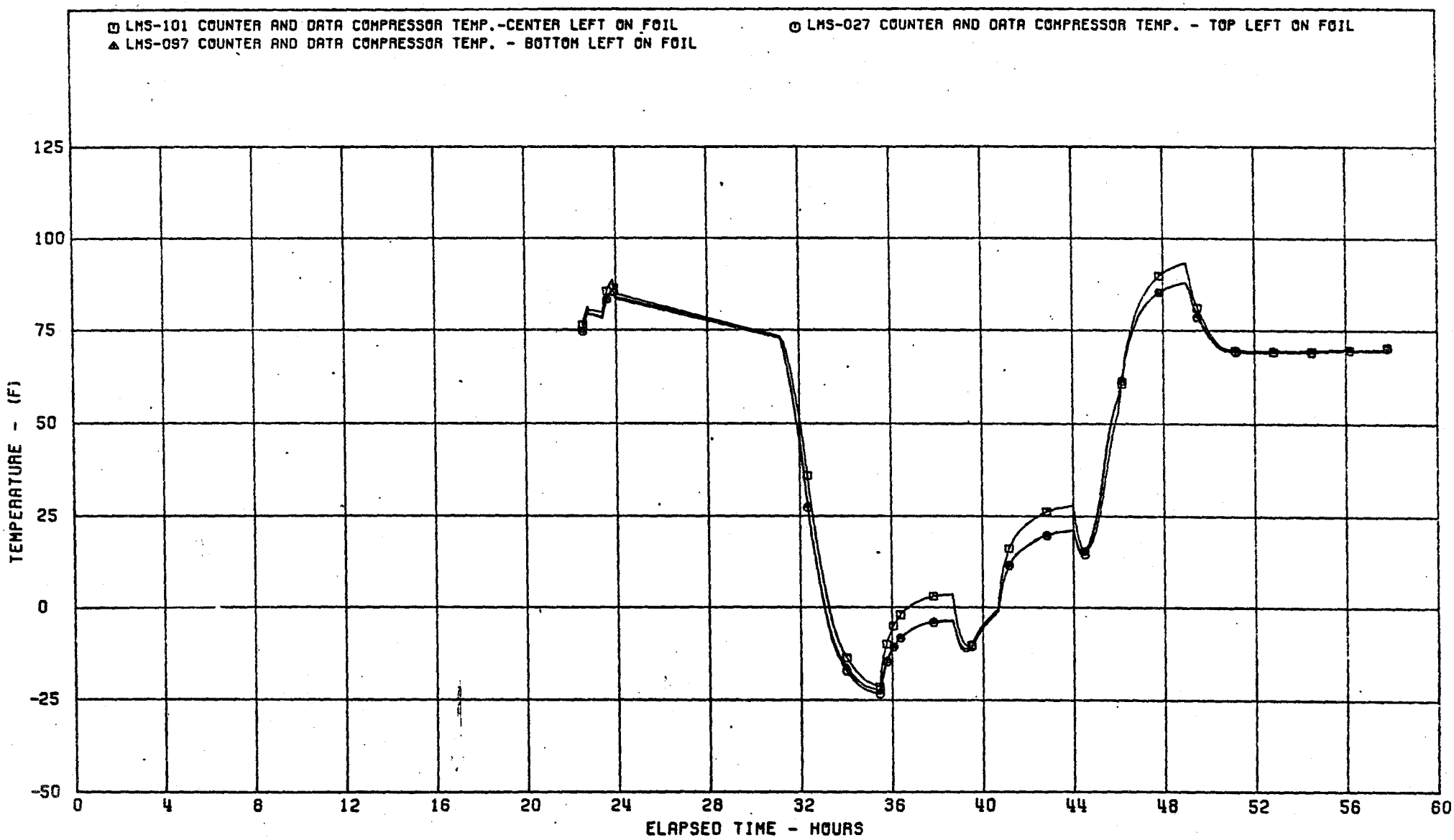


Figure 45

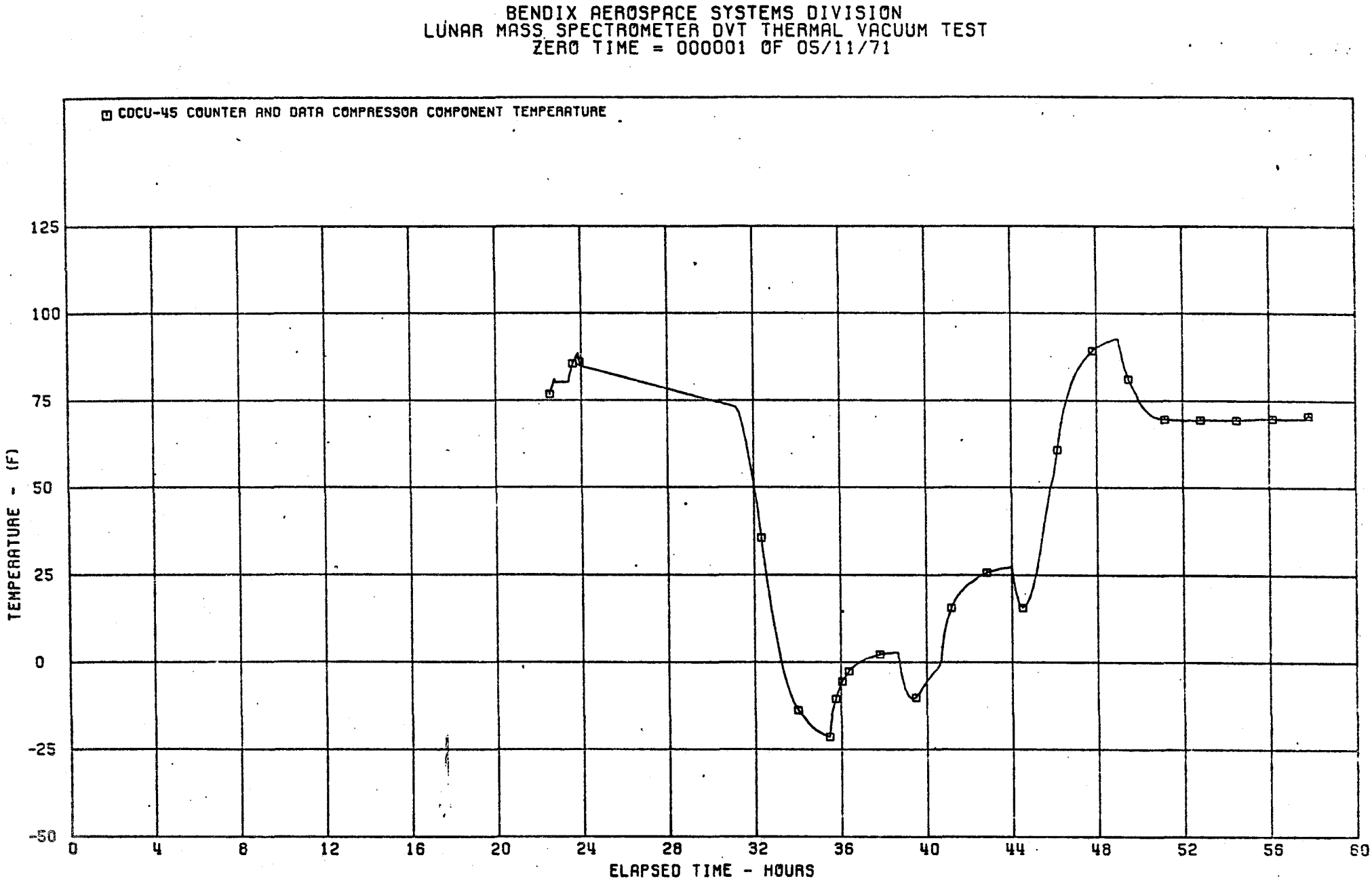

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71
COCU-45 COUNTER AND DATA COMPRESSOR COMPONENT TEMPERATURE
TEMPERATURE - (F)
125
100
75
50
25
0
-25
-50
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
ELAPSED TIME - HOURS

Figure 46

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 0F 05/11/71

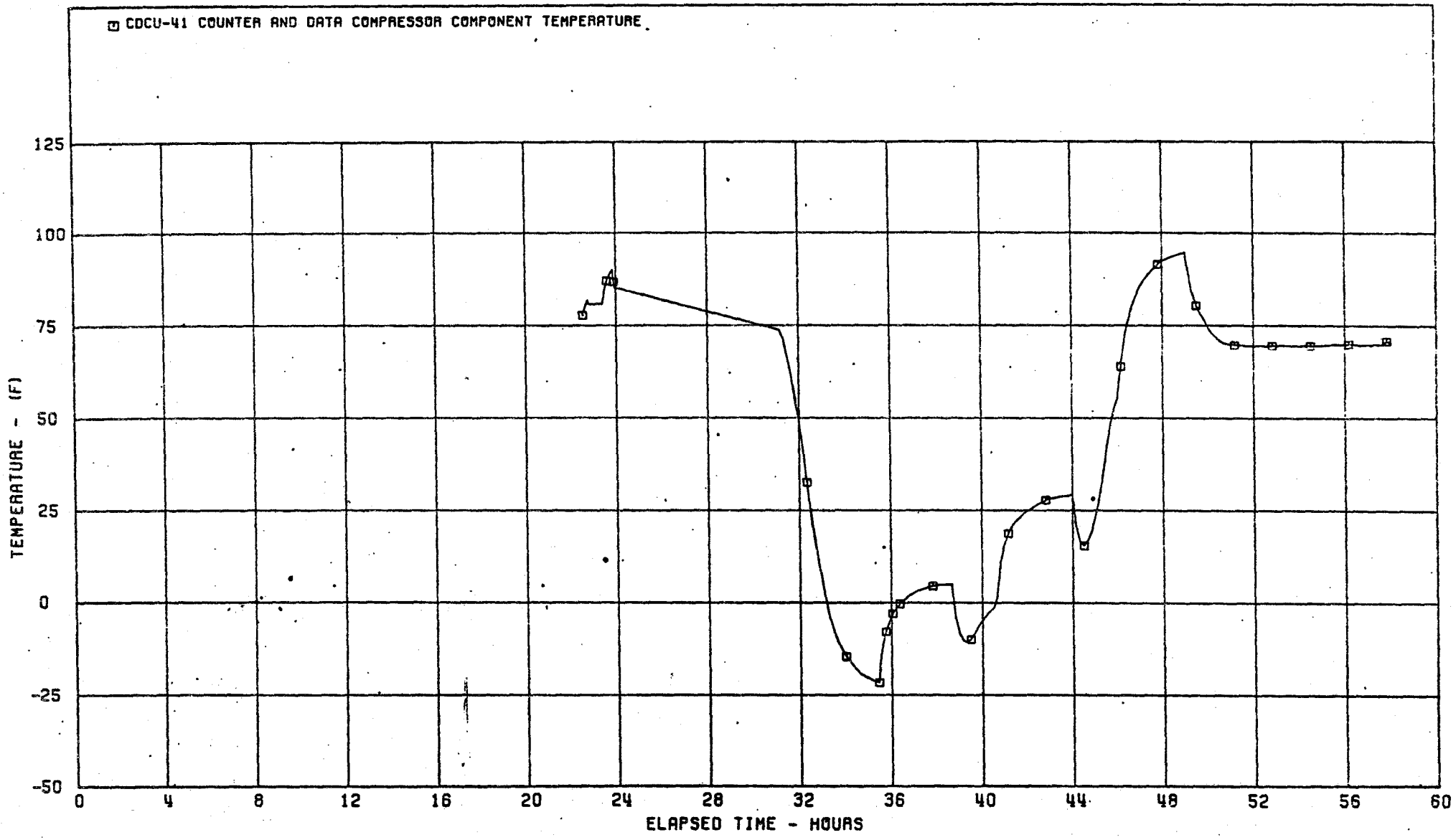
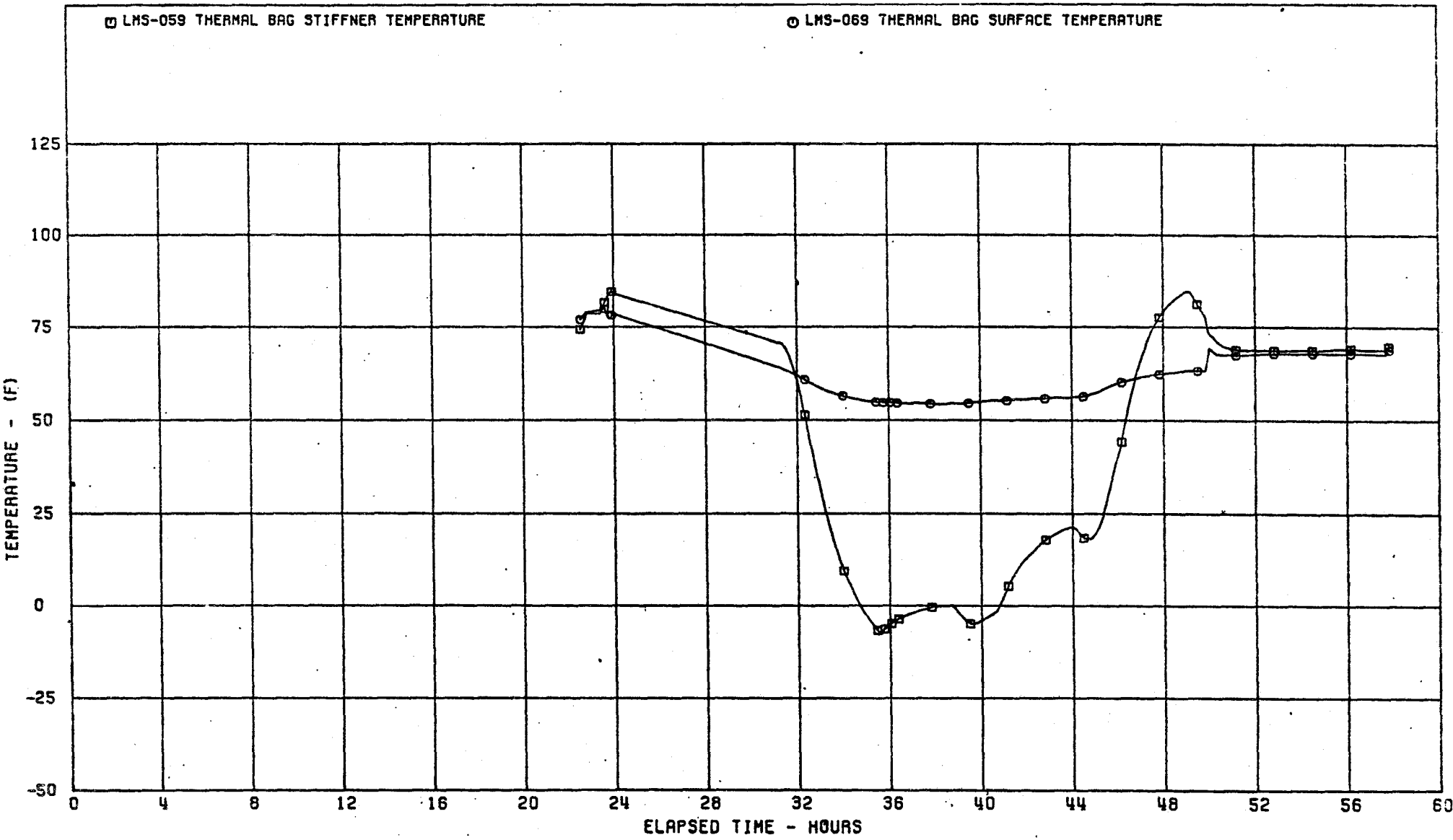


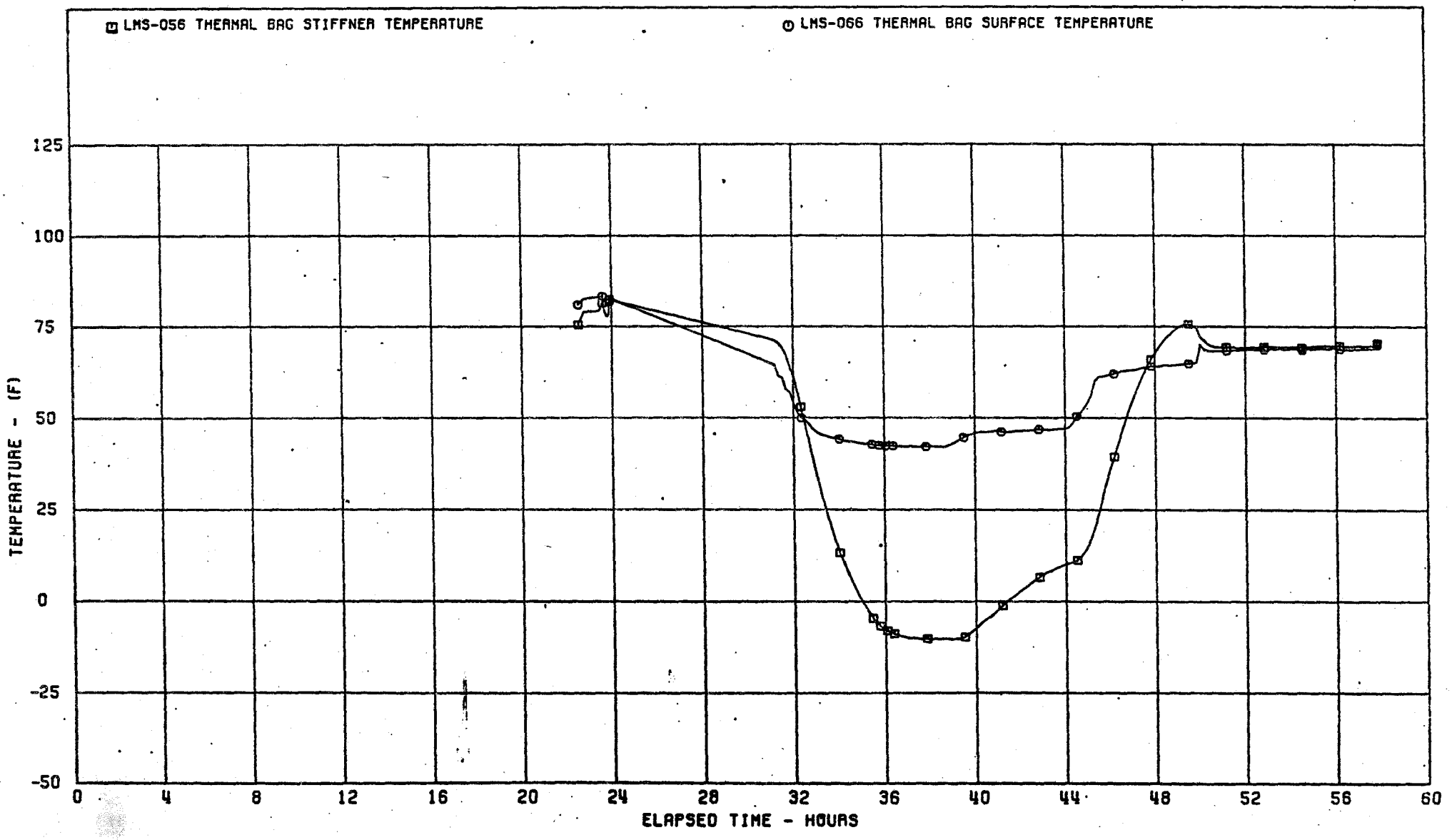
Figure 47

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71



Page 48

BENDIX AEROSPACE SYSTEMS DIVISION
LUNAR MASS SPECTROMETER DVT THERMAL VACUUM TEST
ZERO TIME = 000001 OF 05/11/71



RELIABILITY		REVISIONS			CONFIG MGT
APPD	PREDICTION	LTR	DESCRIPTION	DATE	APPV'D

DRAWING AND PART APPLICATION

EFFECTIVITY		
END ITEM NO.		
NEXT ASSY		
PART NO		

CONTENTS

QWA 11013

CONTR NO.		
PREP.	T Cunningham	
CHECKED		
TEST		
QUAL CONT	W. Tighe 5/10	
ENGR	AS Tighe 5/10	
SYS SPT		

THE BENDIX CORPORATION
AEROSPACE SYSTEMS DIVISION - ANN ARBOR, MICHIGAN

TITLE LMS Engineering Thermal/Vacuum Test Procedure

SIZE	CODE IDENT NO.	DRAWING NUMBER	REV
A	07038	23b5599	
SCALE	WEIGHT	SHEET 1 of	

DRAWING CLASS A ☐ B ☐ C ☒

1.0 PURPOSE OF TEST

The purpose of this test is to provide technical design data on the thermal characteristics of the LMS (ALSEP) Experiment that can be used to establish the design requirements necessary for acceptable operation of the Experiment in the expected Lunar Environment.

2.0 SCOPE

This test simulates the expected Lunar Environmental conditions of temperature and pressure for Lunar Night, and Lunar Noon. This corresponds to radiator plate temperatures of -25, 0, 70, and 100 (250°F at a pressure of 1×10^{-6} Torr or less.

The LMS radiator plate will be temperature controlled by placing it on a temperature conditioned fluid heat exchanger plate. Temperature levels on the LMS are monitored to yield data from which the design of the LMS can be evaluated to assure its optimal operation in the expected Lunar Environment.

3.0 APPLICABLE DOCUMENTS

3.1 ALSEP SPECIFICATIONS

AL 900132 Lunar Mass Spectrometer Performance Specification

3.2 BENDIX STANDARD TEST METHODS

STM 1009 Helium Leak Check Procedure (Veeco MS9-AB)

STM 1017 Hewlett-Packard Data Acquisition System Operating Procedure

STM 1023 Model 751 Ultra-High Vacuum Ionization Gage Control

STM 1027 Helium Leak Check Procedure (Veeco MS12-AB)

STM 1036 Operating Procedure for NRC 4 ft x 8 ft VACUUM CHAMBER

4.0 PARTICIPANTS

4.1 REQUIRED

LMS Test Conductor
Bendix Test Operations Engineer (TOE)
LMS Thermal Engineering Representative

4.2 OPTIONAL - NOTIFICATION REQUIRED

LMS DVT Project Engineer
LMS Operations Representative

5.0 EQUIPMENT REQUIRED

5.1 EQUIPMENT REQUIRED FOR DESIGN VERIFICATION MODEL TESTING OF LEAM

Item	Mfgr.	Part No. or Model	Qty.	Control No.	Calib. * Date
4' x 8' Thermal Vacuum Chamber	National Research Corp.	N/A	1	N/A	N/A**
Control Console (Chamber)	Bendix	N/A	1	N/A	N/A
Vacuum Gage Control	National Research Corp.	751	1	50639	09-27-71
Ion Gage (North)	National Research Corp.	551AS	1	55028	093071
Ion Gage (South)	National Research Corp.	551AS	1	55261	093071
Alphatron Vacuum Gage	National Research Corp.	520	1	50560	070571
Heat Exchanger	Tenney	____	1	14321	11-10-71
Heat Exchanger Plate	Bendix	N/A		N/A	N/A
Data Acquisition System	Hewlett-Packard	2010J	1	143298	110471
Reference "J" Junctions (Voltage and Current Junctions)	R.I. Controls	RJ4801		____	____

*Must be completed prior to testing.
**N/A - Not Applicable

5.2 EQUIVALENT ITEMS

Item	Mfgr.	Part No. or Model	Qty.	*Control No.	*Calib. Date

*Must be completed prior to testing.

6.0 PROCEDURE

During the test the LMS will be mounted on a Heat Exchanger Plate that is in a Thermal/Vacuum Chamber to simulate the expected Lunar Surface environment. A typical test set up is shown in Figure 1.

6.1 ENVIRONMENTAL TEST SETUP

6.1.1 Verify installation of thermocouples on the Heat Exchanger Plate in the approximate locations shown in Figure 1 ✓

6.1.2 Mount the Heat Exchanger Plate inside the chamber in the location shown in Figure 2 ✓

6.1.3 Connect trichoroethylene lines from heat exchanger plate to chamber feedthru's. ✓

6.1.4 Helium leak check the heat exchanger plate fluid lines per STM 1009 or STM 1027, as applicable. ✓

6.1.5 Connect heat exchanger plate fluid lines from the Tenney Heat Exchanger to the feedthru. ✓

6.1.6 Install 85 chromel constantan and 10 copper constantan thermocouple feedthru leads in any unused chamber port. (Refer to Table I for T/C's listing). ✓

6.1.7 Install three (3) thermocouples on the inner wall of the test chamber. Record location SEE NOTE. ✓

6.1.8 Connect chamber and heat exchanger plate thermocouples to chamber feedthrus (Refer to Table I for T/C listing). ✓

NOTE: CH 037 TOP OF CHAMBER
CH 038 BOTTOM " "
CH 039 LEFT " "
CH 040 RIGHT " "

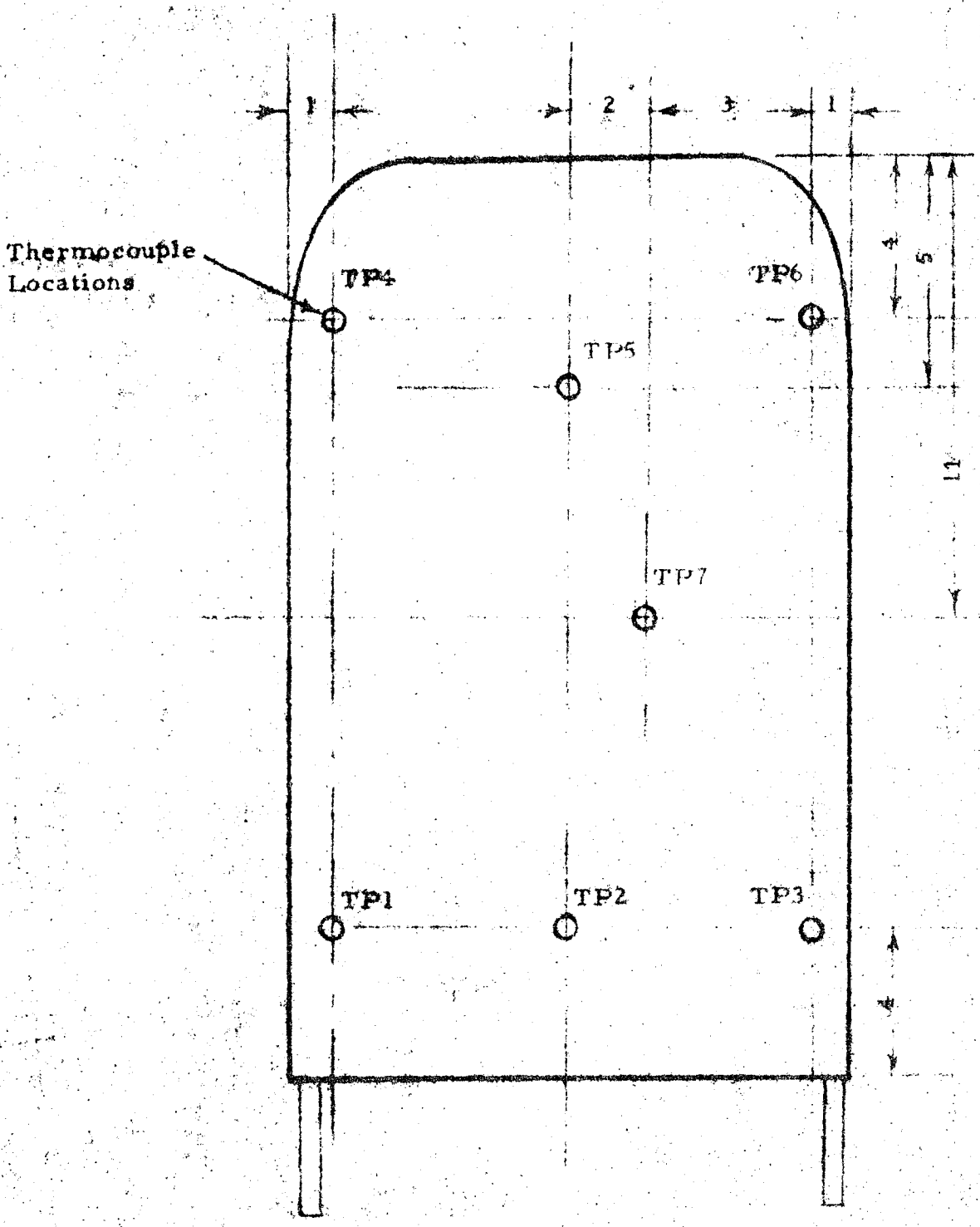


Figure 1. Heat Exchange Plate

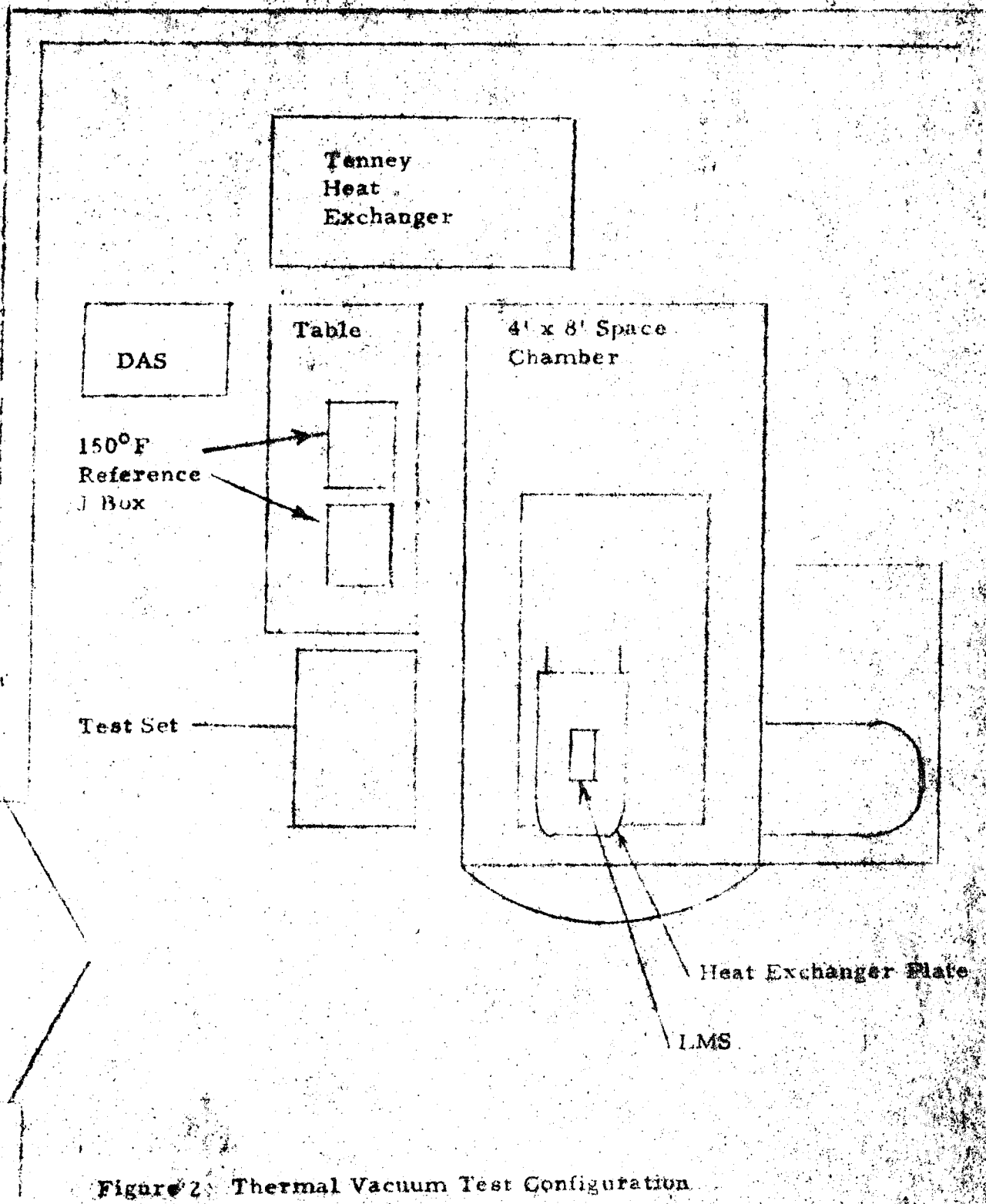


Figure 2. Thermal Vacuum Test Configuration

6.1.9 Install 150°F thermocouple references and connect to T/C feedthru leads. (Refer to STM1017). ✓

6.1.10 Record feedthru lead number and reference J-Box number and identification in Table I (Paragraph 7.1) for corresponding T/C number and Data Acquisition System (DAS) channel assignment. ✓

6.1.11 Set up Ice Reference Standard and connect to 150°F reference. ✓

NOTE: Maintain the ice reference during the entire test by verifying sufficient ice in the water.

6.1.12 Install electrical power and signal leads in chamber feedthru for LMS. ✓

6.1.13 Mount the LMS on the LMS thermal vacuum test fixture (Figure 3) using 6-32 x .5" flat-head screws through the test fixture and radiator plate into the thermal bag nut plates. ✓

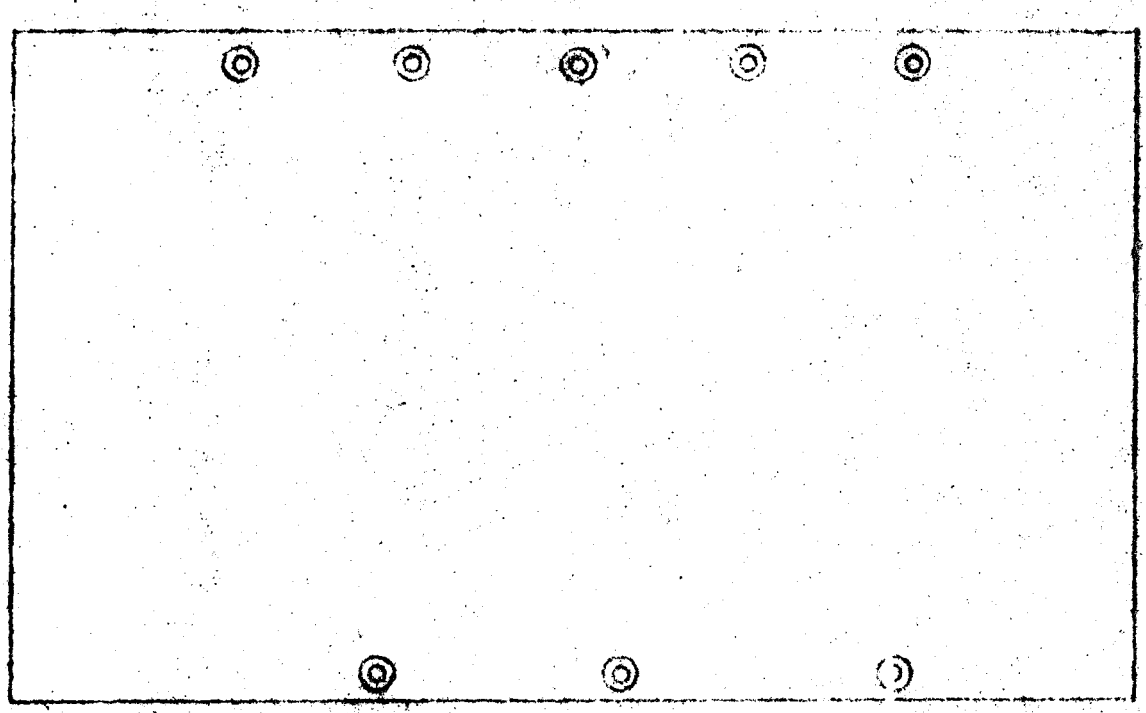
6.1.14 Coat the heat exchanger plate with Dow Corning heat sink compound No. 340. ✓

6.1.15 Place LMS thermal vacuum test fixture on the coated area of the heat exchanger plate. ✓

Record Location (CENTER)

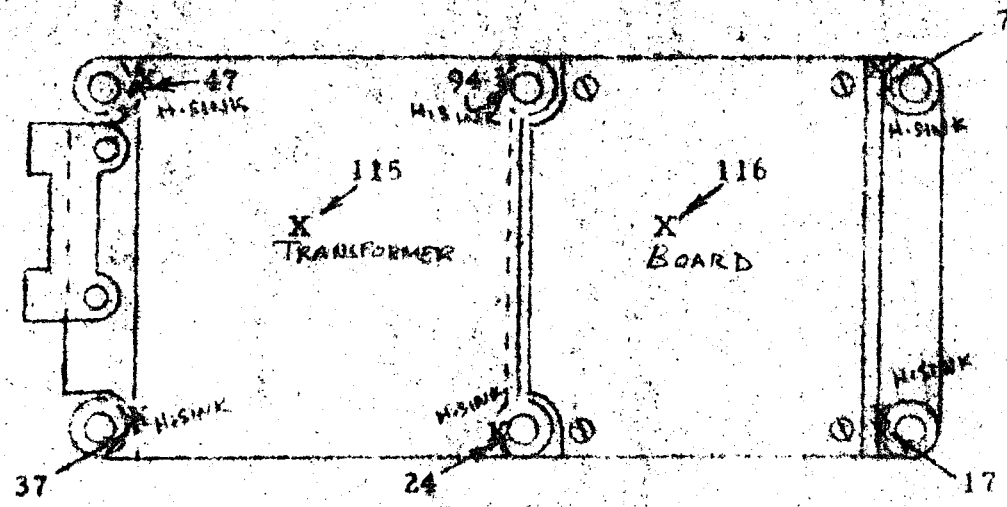
6.1.16 Connect LMS thermocouple leads to thermocouple feedthrus. ✓

NOTE: The approximate locations of the LMS thermocouples are shown in Figures 4 thru 9

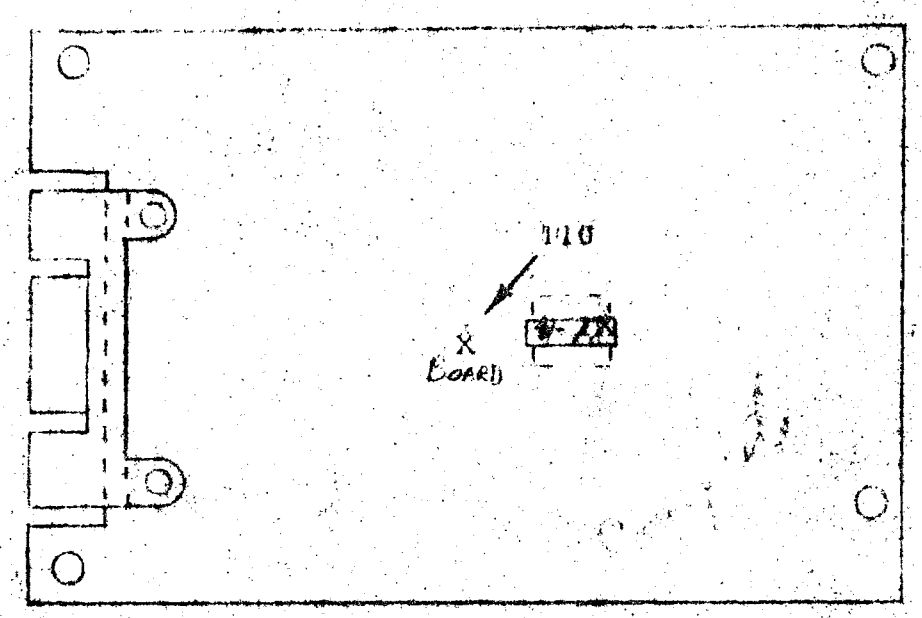


LMS Thermal Vacuum
Test Fixture

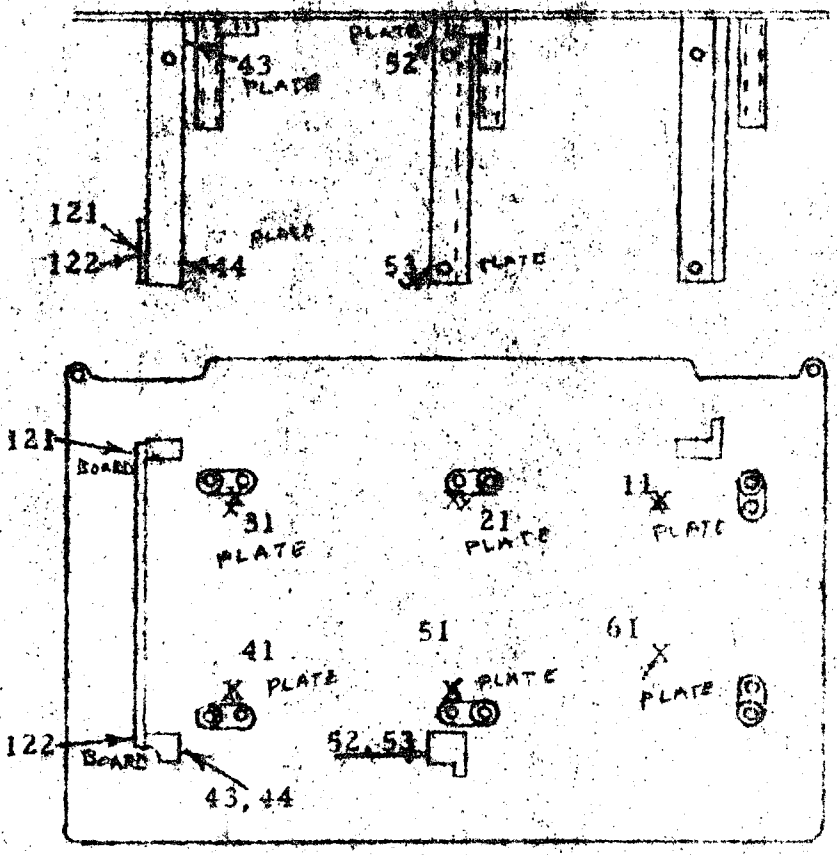
Figure 5



Power Supply Module
Scale 1/2
Figure 4

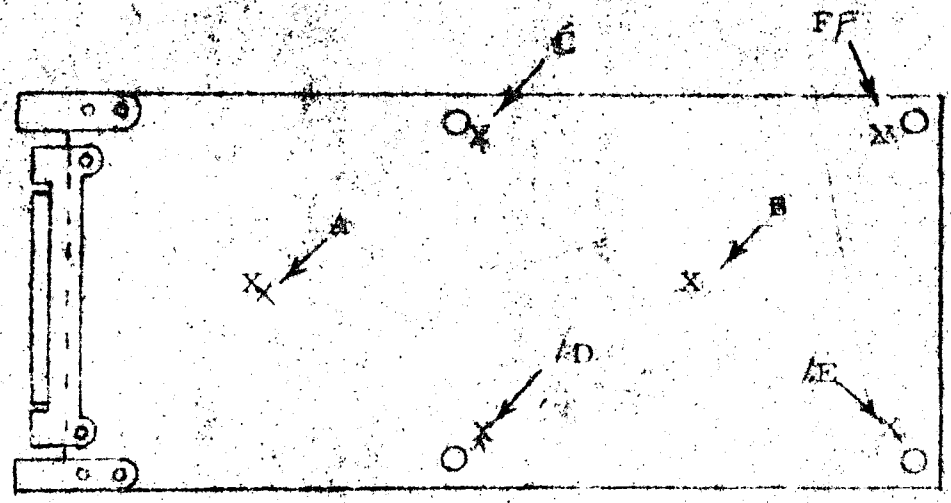


Control and Monitor PC Board
Full Size
Figure 5



Radiator Plate
Scale 1/3
Figure 6

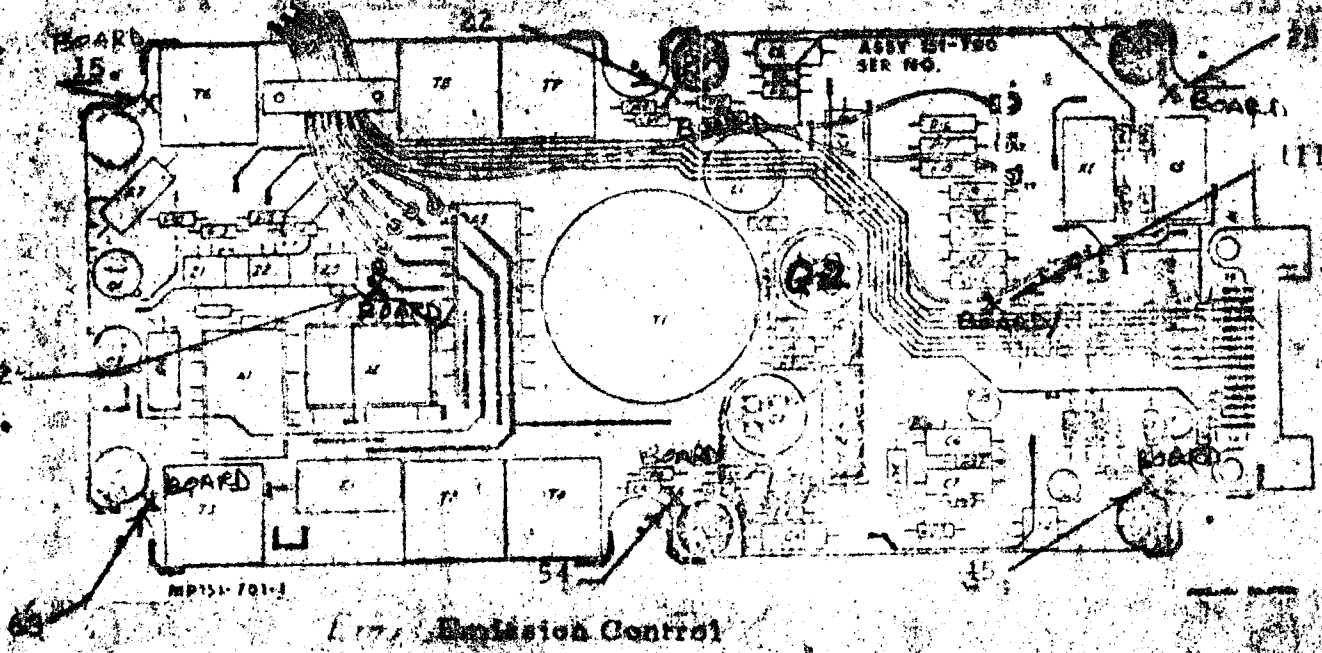
Fig



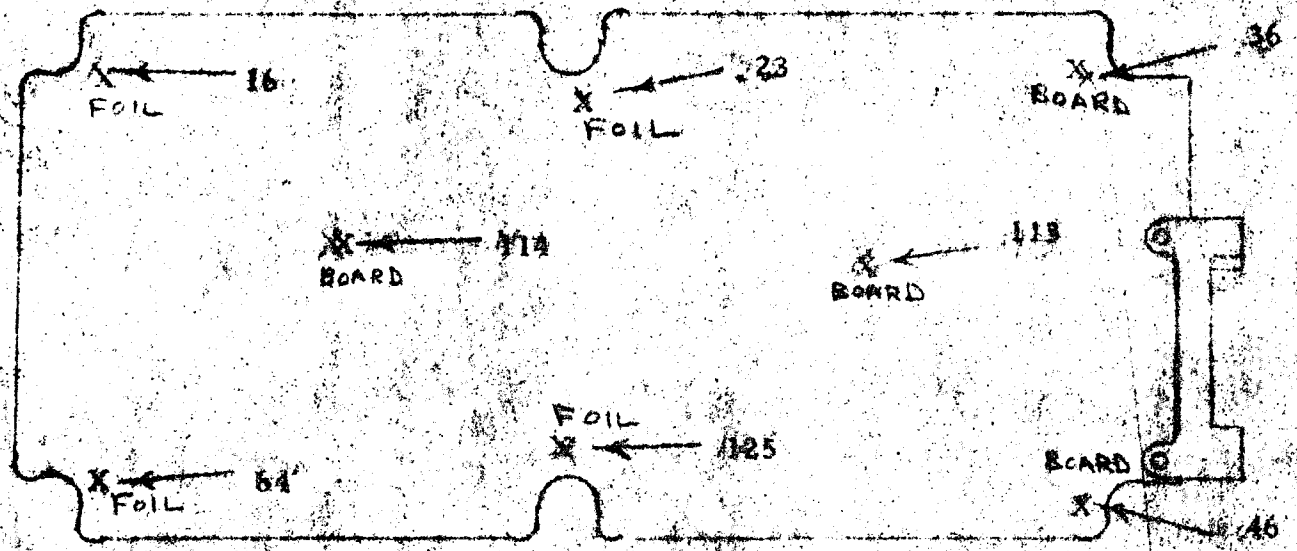
Scale 1/2

PC Board	Location	T/C
Housekeeping Multiplexer	A	105 Foil
	B	106 Foil
	C	25 Foil
	D	9 Foil
	E	8 Foil
	F	18 Foil
	AR-1	AR-1
	U-14	U-14
Decoder and Signal Conditioning	A	103 Foil
	B	104 Foil
	C	26 Foil
	D	96 Foil
	E	9 Foil
	F	19 Foil
	U-16	U-16
Counter and Data Compressor	A	101 Foil
	B	102 Foil
	C	27 Foil
	D	97 Foil
	E	99 Foil
	F	29 Foil
	U-45	U-45
	U-41	U-41

Figure 7



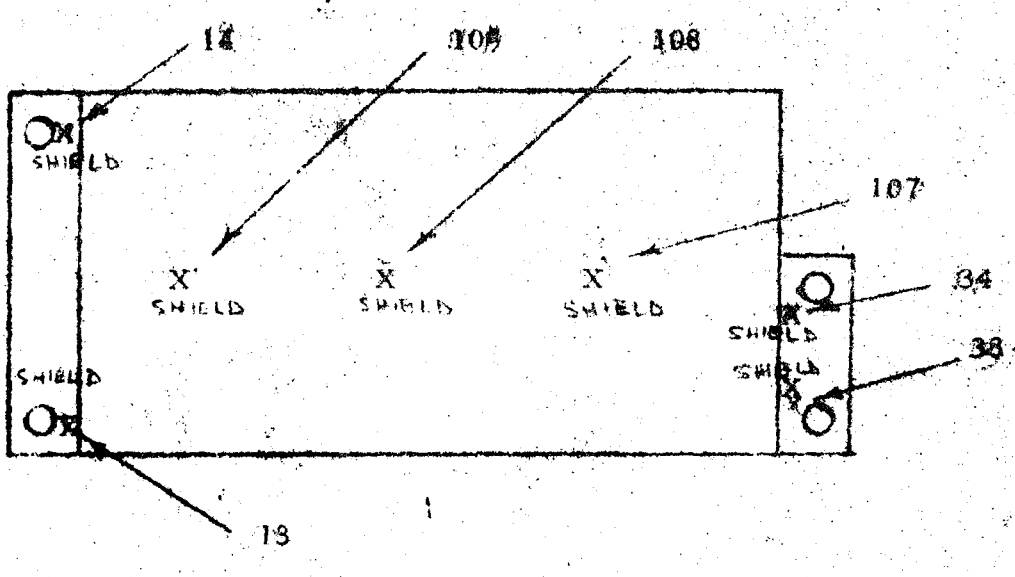
Emission Control



Sweep Control

Analyser Control Elect. Assy

Figure 8



Pre-Amp Discriminator

Figure 9

Complete

6.1.17	Connect electrical power and signal leads from the pass through to the LMS.	
6.1.18	Place the LMS test set next to the test chamber.	
6.1.19	Connect electrical power and signal leads from the test set to the pass through.	
6.1.20	Install high voltage load in the test chamber. Record location	
6.1.21	Connect high voltage to load per engineering instructions.	
6.1.22	Set up the Data Acquisition System per STM 1017.	
6.1.23	Connect two 150°F reference J Boxes to the DAS using channel code assignment in Table I (Paragraph 7.1) and STM 1017.	
	J - Box #1	
	J - Box #2	
6.1.24	Turn on 150°F thermocouple reference J-Box references.	
6.1.25	Start the DAS in accordance with STM 1017.	
6.1.26	Check all DAS channels for circuit continuity. Attach the tape with all questionable channels clearly identified in Table I, (Paragraph 7.0).	
6.1.27	Take photographs of the LMS on the heat exchanger plate and place in Paragraph 8.0.	
6.1.28	Take photographs of the test setup outside the chamber and place in Paragraph 8.0.	

6.2 AMBIENT FUNCTIONAL CHECKOUT

6.2.1 Instruct the LMS test conductor to proceed with the Ambient Functional Test.

6.2.1.1 SET TENNEY TO 70°F

1

6.3 TEST PROCEDURE

6.3.1 Obtain clean degaussed magnetic tape for the Data Acquisition System (DAS) from the Bendix Data Center. Record the tape identification Number (I.D.). 139

6.3.2 Refer to STM 1017 for procedure to install magnetic tape and winding. Place magnetic tape in the DAS and wind FORWARD until the silver reflective marker is reached. ✓

NOTE: If it appears that the silver reflective marker at the beginning of the magnetic tape is missing, DO NOT APPLY A MARKER. Return tape to the Computing Center for marking and then repeat paragraphs 6.3.1 and 6.3.2. ✓

6.3.3 Refer to STM 1017 for scanning and printout check of magnetic and paper tape recorders. Using a one (1) second sample time at continuous scanning intervals, obtain four (4) complete sequential scans through all DAS channel. Operate both the magnetic and paper tape printouts. N/A

6.3.4 Remove the magnetic tape from the DAS and take it to the Bendix Data Center for evaluation. This tape must be dumped and returned with the tape dump to the Environmental Test Operations Engineer for evaluation.

NOTE: If the computer dump was not successful, repeat paragraphs 6.3.1 through 6.3.4. N/A

6.3.5 Obtain another clean degaused magnetic tape from the Bendix Data Center. Record the tape I.D. number. #139 N/A

VERIFY RECORDED DATA ON TAPE WITH MAGNETIC VIEWER. ✓

6.3.6 Record the date and time (use 24 hour day time).

a) Date: 5-11-71

b) Time: 22:30 ✓

6.3.7 Turn on the DAS magnetic and paper tapes data recording channels and adjust to a scanning rate of one channel per second and one scan every ten minutes. ✓

6.3.8 The Test Conductor shall notify the Test Operations Engineer to initiate chamber pump down to 1×10^{-5} Torr or less per STM 1036. ✓

6.3.9 Record date and time of start of pump down.

a) Date: 5-12-71

b) Time: 00:00 (24 hr day)

6.3.10 Set the Tenney heat exchanger to -25°F. Adjust as required to establish the heat exchanger plate at -25°F ± 2°F. ✓ START AT 0700 hrs

6.3.11 Maintain temperature setting until test item equilibrium is established. 1130 5/12/71

NOTE: Equilibrium shall be determined by the thermal engineering representative. FUNCTIONAL EQUILIBRIUM @ 1440

6.3.12 Instruct the LMS Test Conductor to proceed with the -25°F functional test. ✓

6.3.13 Repeat paragraphs 6.3.10 thru 6.3.12 at

0 ± 2°F EQUIB @ 2000 5-12-71 ✓

70 ± 2°F EQUIB @ 0100 5/13/71 ✓

100 ± 2°F DID NOT RUN NA

125 ± 2°F DID NOT RUN NA

6.4 POST TEST OPERATIONS

6.4.1 The Test Conductor shall notify the Test Operations Engineer to re-establish room ambient conditions. ✓

6.4.2 Open chamber door and remove LMS test item. Use caution in handling and deliver immediately to Project Engineer. ✓

6.4.3 Verify that DAS magnetic tape is sent to the Bendix Data Center. Deliver dump to Project Engineer. ✓

5/13/71

7.0 DATA

7.1 TABLE 1 – DATA CHANNEL LISTING AND STATUS FOR DAS

DAS Channel	Data Symbol	Feedthru Number	Ref. J Box No.	Thermal Box Ident.	Channel Status Remarks
000	ice ref 1	—	1	1A	
001	LMS 7	1		1B	
002	LMS 8	2		1C	
003	LMS 9	3		1D	
004	LMS 11	4		1E	
005	LMS 13	5		1F	
006	LMS 14	6		1G	
007	LMS 15	7		1H	
008	LMS 16	8		1i	
009	LMS 17	9		1J	
010	LMS 18	10		2A	
011	LMS 19	11		2B	
012	LMS 21	12		2C	
013	LMS 22	13		2D	
014	LMS 23	14		2E	
015	LMS 24	15		2F	
016	LMS 25	16		2G	
017	LMS 26	17		2H	
018	LMS 27	18		2i	
019	LMS [illegible]69	19		2J	
020	LMS 29	20		3A	
021	LMS 31	21	1	3B	

7.1 TABLE I (CONTINUED)

DAS Channel	Data Symbol	Feedthru Number	Ref. J Box No.	Ref. J Box Ident.	Channel Status Remarks
022	LMS 33	22	1	3C	
023	LMS 34	23		3D	
024	LMS 35	24		3E	
025	LMS 36	25		3F	
026	LMS 37	A 1		3G	
027	LMS 41	A 2		3H	
028	LMS 43	A 3		3J	
029	LMS 44	A 4		3J	"OPEN"
030	LMS 45	A 5		4A	
031	LMS 46	A 6		4B	
032	LMS 47	A 7		4C	"OPEN"
033	LMS 51	A 8		4D	
034	LMS 52	A 9		4E	
035	LMS 53	A 10		4F	
036	LMS 54	A 11		4G	
037	~~LMS 55~~	A 12		4H	CHAMBER "TOP"
038	~~LMS 56~~	A 13		4J	CHAMBER "BOTTOM"
039	~~LMS 57~~	A 14		4J	CHAMBER "LEFT"
040	~~LMS 58~~	A 15		5A	CHAMBER "RIGHT"
041	LMS 59	A 16		5B	
042	LMS 61	A 17		5C	
043	LMS 63	A 18		5D	
044	LMS 64	A 19		5E	
045	LMS 65	A 20	1	5F	

7.1 TABLE I (CONTINUED)

DAS Channel	Data Symbol	Feedthru Number	Ref. J Box No.	Ref. J Box Ident.	Channel Status Remarks
046	LMS 66	A 21	1	5G	
047	LMS 67	A 22	1	5H	
048	LMS 68	A 23	1	5J	
049	LMS 94	A 24	1	5J	
050	LMS 95	26	2	1A	
051	LMS 96	27		1B	
052	LMS 97	28		1C	
053	LMS 99	29		1D	
054	LMS 101	30		1E	
055	LMS 102	31		1F	
056	LMS 103	32		1G	
057	LMS 104	33		1H	
058	LMS 105	34		1J	
059	LMS 106	35		1J	
060	LMS 107	36		2A	
061	LMS 108	37		2B	
062	LMS 109	38		2C	
063	LMS 110	39		2D	
064	LMS 111	40		2E	
065	LMS 112	41		2F	
066	LMS 113	42		2G	
067	LMS 114	43		2H	
068	LMS 115	44		2J	
069	LMS 116	45	2	2J	

7.1, TABLE I (CONTINUED

DAS Channel	Data Symbol	Feedthru Number	Ref. J Box No.	Ref. J Box Ident.	Channel Status Remarks
070	LMS 121	46	2	3A	
071	LMS 122	47		3B	
072	LMS 125	48		3C	
073	TP 1	1		3D	
074	TP 2	2		3E	
075	TP 3	3		3F	
076	TP 4	4		3G	
077	TP 5	5		3H	
078	TP 6	6		3i	
079	4 x 8-1	7		3J	
080	~~LMS~~ 58	8		4A	
081	4 x 8-3	9		4B	
082	SHORT	10		4C	
083	ice ref @ of	Box 1		4D	
084	PS AR1	B 1		4E	
085	DSC U16	B 2		4F	
086	HM AR1	B 3		4G	
087	HM U14	B 4		4H	
088	C&DC U45	B 5		4i	
089	C&DC U41	B 6		4J	
090	C&M U1	B 7		5A	
091	EC Q2	B 8	2	5B	
092	T-BAC 1	11	2	5C	TOP REAR
093	" 2	12	2	5D	TOP RIGHT
094	" 3	13	2	5E	TOP FRONT
095	" 4	14	2	5F	TOP LEFT
096	LMS 55	15	2	5G	
098	56	16	2	5H	
099	57	17	2	5i	
080	58	8	2	4A	

PER I CONST

OPEN

0 PHOTOGRAPHS

Take photographs of test setup

Photograph failures when possible

Identify photos on reverse, and identify the top edge.

thru tab on end of photo

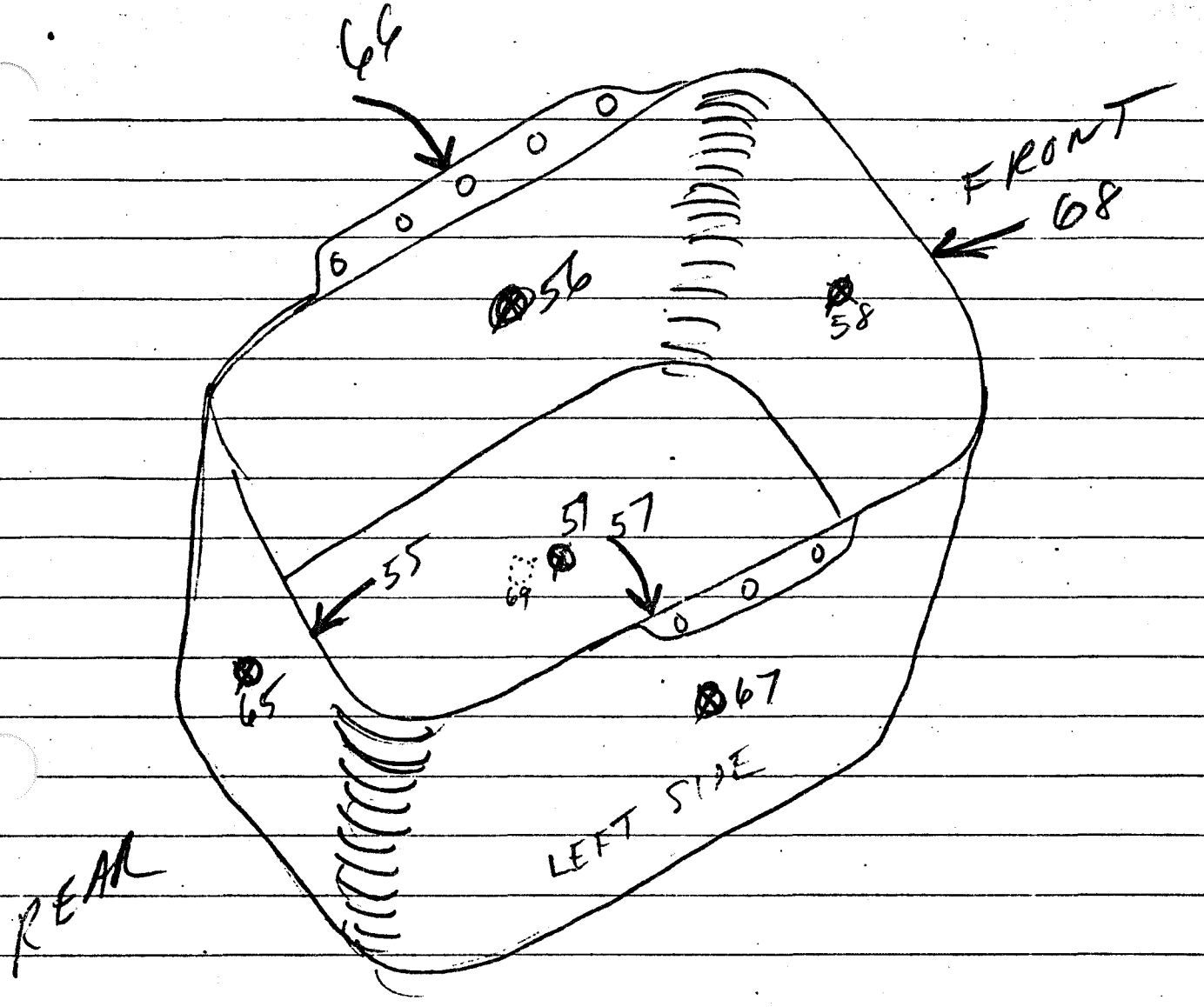
Write caption at right of each photo. Identify test item, test equipment, failure, axis, etc.

16.0 SIGN-OFF SHEET

16.1 Test Witness Sign-Off Sheet

The test item _____, Part Number _____, Serial Number _____, has been tested and witnessed in accordance with the foregoing procedure.

Test Conductor _____ Date _____



TB 1	OK				
TB 2	OK				
TB 3	OK				
TB 4	OK				
TB 5	~~#~~ 57	⌐ COPPER	67	OUTSIDE	CHROMEL
TB 6	55	⌐ COPPER	65	OUTSIDE	CHROMEL
TB 7	58	⌐ COPPER	68	"	CHROMEL
8	56	⌐ COPPER	66	"	CHROMEL
	~~#~~ 59	CHROMEL INSIDE	69	OUTSIDE	CHROMEL