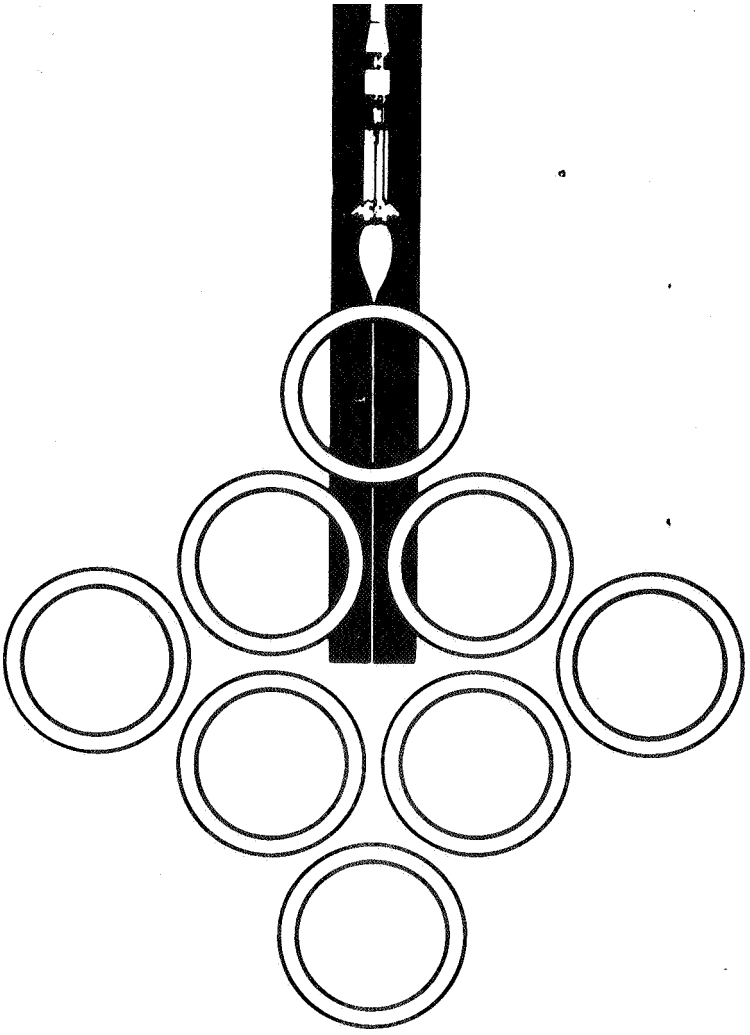

ENGINEERING DEPARTMENT

TECHNICAL REPORT

TR-RE-CCSD-FO-1001-3

July 13, 1967

SATURN IB PROGRAM

TEST REPORT
FOR

PRESSURE TRANSDUCER

Giannini Controls Corporation Part Number 461319

NASA Drawing Number 75M51731-8-2000

SPACE DIVISION CHRYSLER CORPORATION

TEST REPORT

FOR

PRESSURE TRANSDUCER

Giannini Controls Corporation Part Number 461319

NASA Drawing Number 75M51731-8-2000

ABSTRACT

This report presents the results of tests performed on 3 specimens of Pressure Transducer 75M51731-8-2000. The following tests were performed:

1. Receiving Inspection
2. Proof Pressure
3. Seal Leakage
4. Functional
5. Low Temperature
6. High Temperature
7. Vibration
8. Humidity
9. Salt Fog
10. Sand and Dust
11. Explosion
12. Cycle
13. Burst Pressure

The maximum pressure which could be measured by specimens 1, 2, and 3 was 1965, 2005, and 2005 psig, respectively,

The total output resistance of the specimens was out of tolerance during the low and high temperature tests and the measured calibration points were not all within the maximum static error band.

Maximum degradation occurred at approximately 900 cps during each of the vibration sinusoidal sweep tests, The measured calibration points were not all within the maximum static error band after the vibration tests.

The output voltage of specimens 2 and 3 began to fluctuate between 900 and 1100 psig after 500 cycles of the cycle test, There was no output (open circuit) at 985 psig after the cycle test.

TEST REPORT

FOR

PRESSURE TRANSDUCER

Giannini Controls Corporation Part Number 461319

NASA Drawing Number 75M51731-8-2000

July 13, 1967

CHRYSLER CORPORATION SPACE DIVISION - NEW ORLEANS, LOUISIANA

FOREWORD

The tests reported herein were conducted for the John F. Kennedy Space Center by Chrysler Corporation Space Division (CCSD), New Orleans, Louisiana. This document was prepared by CCSD under contract NAS 8-4016, Part VII, CWO 271620.

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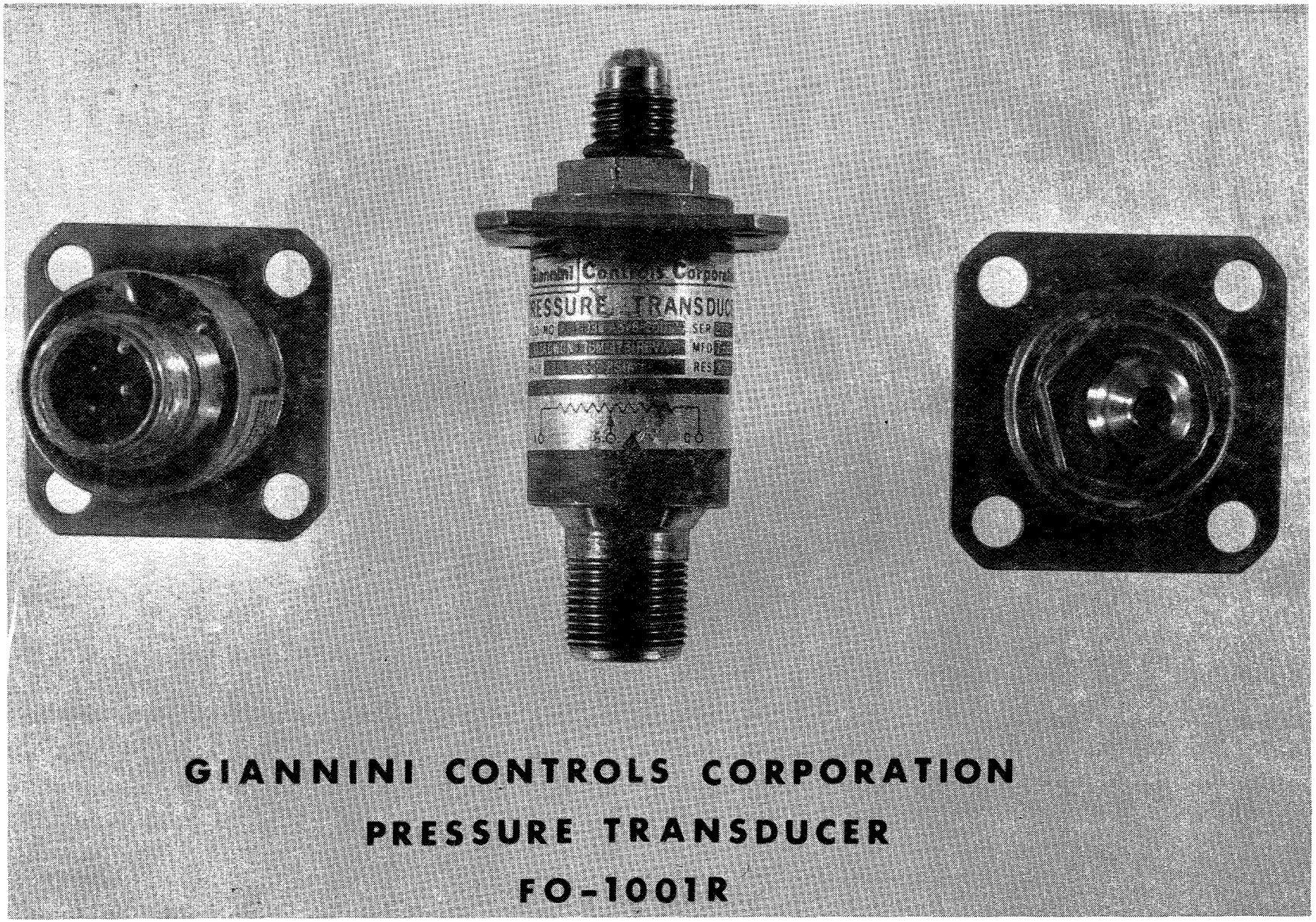

GIANNINI CONTROLS CORPORATION
PRESSURE TRANSDUCER
FO-1001R

CHECK SHEET

FOR

PRESSURE TRANSDUCER

MANUFACTURER: Giannini Controls Corporation, Pasadena, California
MANUFACTURER'S PART NUMBER: 461319
NASA PART NUMBER: 75M51731-8-2000
TESTING AGENCY: Chrysler Corporation Space Division, New Orleans, Louisiana
AUTHORIZING AGENCY: NASA KSC

I. FUNCTIONAL REQUIREMENTS

A.	OPERATING MEDIA:	Dry air, gaseous nitrogen
B.	OPERATING PRESSURE:	2000 psig
C.	LEAKAGE:	3.26×10^{-8} cc He/sec/inch of seal maximum at a pressure differential of 1 atmosphere
D.	PROOF PRESSURE:	3000 psig
E.	BURST PRESSURE:	5000 psig
F.	OPERATING RANGE:	0 to 2000 psig
G.	POWER RATING:	0.5 watt continuous

II. CONSTRUCTION, MECHANICAL

A.	PRESSURE ELEMENT:	Bourdon tube, helical
B.	PNEUMATIC CONNECTION:	MC172-4 style-E
C.	WEIGHT:	0.3 pound

III. CONSTRUCTION, ELECTRICAL

A.	CONNECTOR:	Cannon GS02-10SL-3P-001, hermetically sealed
B.	RESISTANCE:	Potentiometer, 2000 ohms $\pm 5\%$ maximum at 68°F

IV. ENVIRONMENTAL CHARACTERISTICS - MANUFACTURERS SPECIFICATIONS

TEMPERATURE RANGE:	-65 to 200°F

V. LOCATION AND USE

A.	LOCATION:	Saturn IB GSE, LC 34 and LC 37, Apollo Access Arm, S/A 1, 2, 3, 4, LEM
B.	USE:	Hydraulic Accumulator pressure indicator

TEST SUMMARY

PRESSURE TRANSDUCER 75M51731-8-2000

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Receiving Inspection	1,2,3	Visual inspection	To determine if specimens conform with applicable drawings and specifications	S	
Proof Pressure Test	1,2,3	3000 psig for 5 minutes using hydraulic fluid	Maintain 3000 psig	S	
Seal Leakage Test	1,2,3	Pressure differential of 1 atmosphere	Leakage rate shall not exceed 3.26×10^{-8} cc of helium/second/inch of seal	S	
Functional Test					
a. Insulation Resistance	1,2,3	250 vdc applied between pins A, B, C and case	Insulation resistance not less than 20 megohms	S	
b. Total Resistance and Wiper Range	1,2,3	Measure resistance between pins A and C, A and B at 0 psig, and A and B at 2000 psia	Resistance between A and C shall be 2000 (±100) ohms; Resistance between A and B at 2000 psia shall be 97 to 100 percent of total resistance	S	
c. Leakage Check	1,2,3	Apply leak check solution with specimens pressurized at 2000 psia	No leakage of test specimens	S	
d. Response Time	1,2,3	Apply 5 vdc to pins A and C; measure time required for output at A and B to reach 63 percent of final output	63 percent of final output at 500, 1000, 1500, and 2000 psia in less than 5 milliseconds	S	

S - Satisfactory
U - Unsatisfactory

TEST SUMMARY (CONTINUED)

PRESSURE TRANSDUCER 75M51731-8-2000

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
e. Linearity	1,2,3	Pressurize the specimens and measure the output at calibration points between 0 to 1985 to 0 psig	All calibration points within ±1 percent of a straight line between measured end points	S	
f. Hysteresis	1,2,3	Pressyrize the specimens and measure the output at calibration points between 0 to 1985 to 0 psig	Shall not exceed 2.5 percent of the full-scale output measured at 1985 psig	S	
g. Repeatability	1,2	Pressurize the specimens from 0 to 1985 to 0 psig a total of 5 times and measure output at calibration points	Difference between any single output reading and the average reading shall not exceed 0.8 percent	U	
	3			S	
Low Temperature Test	1,2	Stabilize at 5°F, perform a functional test at low temperature, and return to ambient conditions	Determine operating ability at low temperature and after returning to ambient	U	Repeatability and linearity out of tolerance readings
High Temperature Test	2,3	Stabilize temperature at 160°F for 72 hours; increase to 190°F and stabilize; perform functional test	Determine the operating ability at high temperature and after returning to ambient	U	Repeatability and linearity out of tolerance readings
libration Tests					
a. Resonant Frequency Search	2,3	Vibrate specimens from 5 to 3000 to 5 cps at 1g peak for 15 minutes	Determine the resonant frequencies of the test specimens	S	

S - Satisfactory
U - Unsatisfactory

TEST SUMMARY

PRESSURE **TRANSDUCER** 75M51731-8-2000

Environment	Units	Operational Boundary	*Test* Objective	Test **Results**	Remarks
b. Sinusoidal Search	2,3	[illegible]brate specimens at 1/3 octave center frequencies; increase input level until voltage fluctuation of specified maximum level is attained	Determine the highest input level at which voltage fluctuation will not occur, within the specified limits	S	
c. Sinusoidal Sweep	2,3	Vibrate specimens for 15 minutes at levels specified by a test envelope derived from the sinusoidal search	To subject the specimens to the highest possible levels within specified limits, at which no voltage fluctuation occurs	S	
d. Random Excitation	2,3	Vibrate specimens for 5 minutes increasing the input level until voltage fluctuation occurs or until a maximum input level of $0.2g^2$/cps is attained	To subject the specimens to the highest possible level, within specified limits, at which no voltage fluctuation occurs	U	Repeatability and linearity out of tolerance readings during functional test
Humidity Test	1,2	240 hours of humidity environment; vary temperature from ambient to 160°F to ambient during each 24 hour period maintaining 95 percent humidity	Determine if humid environment causes degradation or deterioration of the specimens	U	Repeatability and linearity out of tolerance readings

S - Satisfactory
U - Unsatisfactory

TEST SUMMARY (CONTINUED)

PRESSURE **TRANSDUCER** 75M51731-8-2000

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Salt Fog Test	1,2	5 percent by weight mixture salt solution, collection rate of 0.5 to 3 milliliters per hour; maintain for 240 hours at 95°F	Determine if salt fog environment causes degradation or deterioration of the specimens	U	Out of tolerance (linearity)
Sand and Dust Test	2	Sand and dust density 0.1 to 0.25 grams per cubic foot, air velocity 100 to	Determine if sand and dust environment causes degradation or deterioration of the specimens	U	Repeatability and linearity out of tolerance readings
	3	500 fpm; 2 hours at 77°F and 2 hours at 160°F		U	Repeatability out of tolerance readings
Explosion Test	1	32 percent by volume hydrogen 160°F at 13.1 psig	Operate specimen in explosive atmosphere	S	
Cycle Test	1,2	Pressurize the specimens from 0 to 1985 to 0 psig for 80,000 cycles of operation	Determine the effect of continuous operation on specimen performance	U	Repeatability and linearity out of tolerance readings
	3			U	Repeatability out of tolerance readings
Seal Leakage Test	1,2,3	Pressure differential of 1 atmosphere	Leakage rate shall not exceed 3.26×10^{-8} cc of helium/second/inch of seal	S	
Burst Pressure Test	1,2,3	5000 psig for minutes using hydraulic fluid	Maintain pressure for 5 minutes with no evidence of cracking or rupture	S	

S - Satisfactory

U - Unsatisfactory

SECTION I

INTRODUCTION

1.1 SCOPE

This report presents the results of tests that were performed to determine if Pressure Transducer 75M51731-8-2000 meets the operational and environmental requirements of the John F. Kennedy Space Center. A summary of the test results is presented on pages ix through xii.

1.2 ITEM DESCRIPTION

1.2.1 Three specimens of Pressure Transducer 75M51731-8-2000 were tested. The transducers are manufactured by Giannini Controls Corp. as vendor part number 461319. The transducer operates within a range of 0 to 2000 psia and is of the potentiometric type with a resistance of 2000 ohms.

1.2.2 The transducer is mounted by means of a square flange similar to that used on a box type electrical receptacle. The transducer will be used primarily in the swing arm system and access arm system on Launch Complex 34 and 37.

1.3 APPLICABLE DOCUMENTS

The following documents contain the test requirements for Pressure Transducer 75M51731-8-2000:

a. KSC-STD-164(D), Standard Environmental Test Methods for Ground Support Equipment Installations at Cape Kennedy

b. NASA Drawing 75M51731-8-2000

c. Test Plan CCSD-FO-1001-1R, Revision C

1.4 SPECIMEN ASSIGNMENT NUMBERS

The specimen assignment numbers are as follows:

Specimen	Serial Number
1	278-8
2	278-10
3	278-13

SECTION II

RECEIVING INSPECTION

2.1 TEST REQUIREMENTS

Each specimen shall be visually and dimensionally inspected for conformance with the applicable specifications prior to testing.

2.2 TEST PROCEDURE

A visual and dimensional inspection was performed to determine compliance with NASA drawing 75M51731-8-2000, and to the applicable vendor drawings, to the extent possible without disassembly of the test specimens. At the same time, each test specimen was also inspected for poor workmanship and manufacturing defects.

2.3 TEST RESULTS

The specimens were found to conform with all applicable drawings and specifications.

SECTION III

PROOF PRESSURE TEST

3.1 TEST REQUIREMENTS

3.1.1 The test specimens shall be pressurized to 3000 psig for 5 minutes using hydraulic fluid MIL-H-5606 as the test medium.

3.1.2 The test specimens shall be inspected for leakage and external damage.

3.2 TEST PROCEDURE

3.2.1 The test setup was assembled as shown in figure 3-1, using the equipment listed in table 3-1.

3.2.2 Each specimen was pressurized to 3000 psig and maintained for 5 minutes.

3.2.3 The specimen was depressurized and removed from the test setup and inspected for damage.

3.3 TEST RESULTS

There was no leakage of the test specimens, and there was no evidence of internal or external damage.

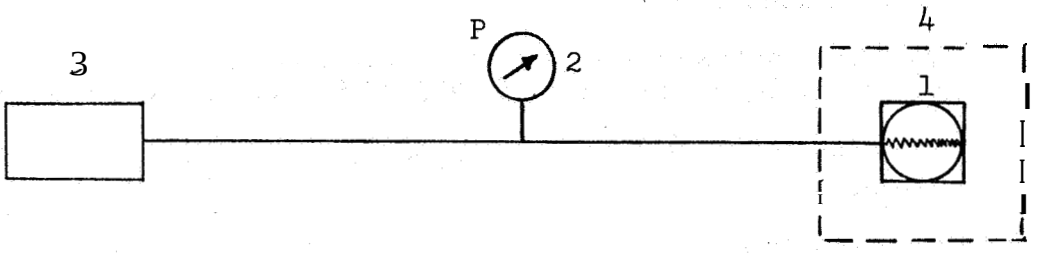


Figure 3-1. Proof Pressure and Burst Test Schematic

Table 3-1. Proof Pressure Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Giannini Controls Corp.	461319	278-8, 278-10, 278-13	Pressure Transducer
2	Pressure Gage	Duragauge	NA	5-12278	0-to 5000-psig ±0.5% FS Cal date 3-10-67
3	Hydraulic Hand Pump	Pine, Inc.	160-3	NA	5000 psi
4	Burst Chamber	CCSD	NA	NA	Burst test only

SECTION IV

SEAL LEAKAGE TEST

4.1 TEST REQUIREMENTS

4.1.1 The seal leakage rate shall not exceed 3.26×10^{-8} cc of helium/second/inch of seal at a pressure differential of one atmosphere.

4.1.2 The seal leakage test shall be performed before the initial functional test and following the cycle test (section XIII).

4.2 TEST PROCEDURE

4.2.1 The test specimen was placed in vacuum chamber 3 and the chamber was then evacuated to maximum vacuum.

4.2.2 Helium was applied to the inlet of the test specimen to create a differential pressure of one atmosphere between the specimen and the vacuum chamber.

4.2.3 Mass spectrometer 2 was used to measure helium leaking from the test specimen.

4.2.4 The vacuum chamber was returned to ambient conditions and the test specimen was removed.

4.3 TEST RESULTS

The seal leakage was less than 3.26×10^{-8} cc of helium/second/inch of seal for each test specimen.

Table 4-1. Seal Leakage Test Equipment List

Item No.	Item	Manufacturer	Model/Part No.	Serial No.	Remarks
1	Test Specimen	Giannini Controls Corp.	461319	278-8, 278-10, 278-13	Pressure Transducer
2	Mass Spectrometer	VEECO	MS-9AB	012470	
3	Small Vacuum Chamber	CCSD	NA	NA	
4	Pressure Gage	Wallace-Tierman	FA-345	JJ10235	
5	Pressure Regulator	Oxweld	EA-350	NA	
6	Helium Supply	NA	NA	NA	15 psi

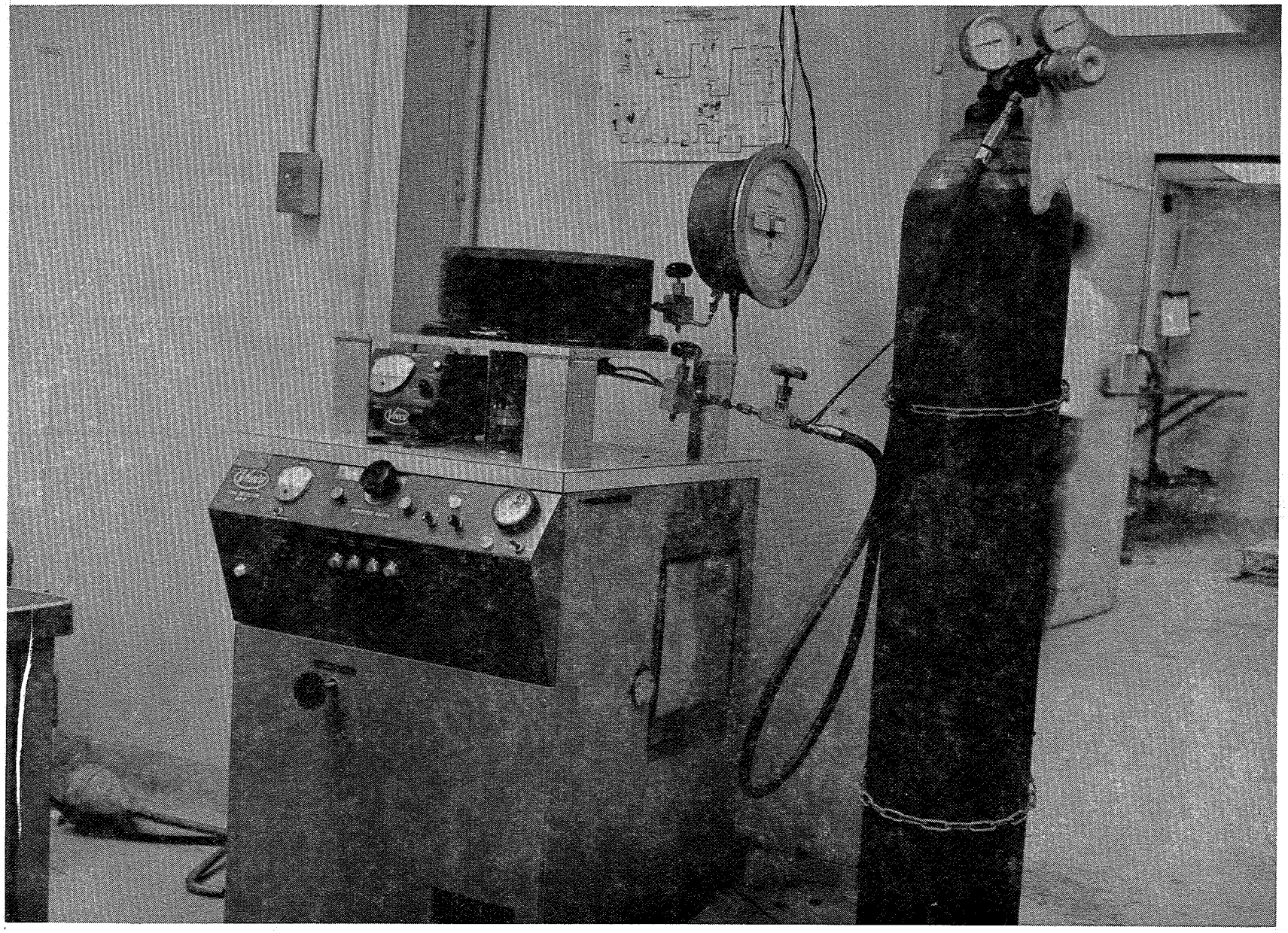


Figure 4-1. Test Setup

SECTION V

FUNCTIONAL TEST

5.1 TEST REQUIREMENTS

5.1.1 The insulation resistance, when measured between each pin and the case, shall not be less than 20 megohms at 250 vdc.

5.1.2 The total resistance of the test specimens, measured between pins A and C, shall be 2000 (±100) ohms.

5.i.3 With 2000 psia pressure applied to the specimen, there shall be no evidence of leakage when a leak detector solution is used.

5.1.4 The resistance measured between pins A and B (wiper range), with 2000 psia applied to the pressure port, shall be between 97 and 100 percent of the total resistance measured between pins A and C.

5.1.5 The response time of the test specimens shall be less than 5 milliseconds for an output of 63 percent of the final reading at 500, 1000, 1500, and 2000 psia.

5.1.6 The maximum static error band (linearity) at any calibration point shall be within ±1 percent of a straight line between the measured end points at zero and 1985 psig.

5.1.7 The repeatability of the output readings shall be such that the difference between any single output reading and the average for all output readings of the same input pressure, under the same conditions of direction of change and environment, shall not exceed 0.8 percent of the average reading.

5.1.8 Hysteresis shall not exceed 2.5 percent of the output reading at 2000 psia.

5.2 TEST PROCEDURE

5.2.1 The test setup was assembled as shown in figure 5–1 using equipment listed in table 5–1.

5.2.2 The insulation resistance between each pin of J1 (figure 5–2) and the specimen case was measured by applying 250 vdc between the pins and case.

5.2.3 Wheatstone Bridge 11 was connected to pins A and C of J1 and the total resistance of the specimen was measured and recorded.

5.2.4 The specimen was checked for evidence of leakage by applying a leak check solution with 2000 psia pressure applied.

5.2.5 Wheatstone Bridge 11 was connected to pins A and B and the resistance of the specimen at zero psig was measured and recorded.

5.2.6 The pressure was increased to 250 psia and the resistance was measured and recorded.

5.2.7 The pressure was increased to 2000 psia in 250 psi increments and then decreased to 250 psia in 250 psi increments. The resistance was measured and recorded at each incremental level.

5.2.8 The pressure was decreased to zero psig and the resistance was measured and recorded.

5.2.9 Paragraphs 5.2.5 through 5.2.8 were repeated 4 times for a total of 5 sets of resistance measurements.

5.2.10 The response time test setup was assembled as shown in figure 5-3 using equipment listed in table 5-1.

5.2.11 Power supply 9 was adjusted to provide a 5 vdc potential across pins A and C of J1.

5.2.12 Pressure was applied to the test specimen in steps of 500, 1000, 1500, and 2000 psia and was returned to zero after each step.

5.2.13 The output at pins A and B of J1 was recorded on oscillograph 10 and the time required to reach 63 percent of the final output for each pressure was computed.

5.3 TEST RESULTS

5.3.1 The insulation resistance was greater than 20 megohms for all test measurements.

5.3.2 The total resistance and wiper range of the specimens were within the specified tolerances.

5.3.3 The response time of each test specimen was less than 5 milliseconds at 500, 1000, 1500, and 2000 psia.

5.3.4 The calibration points of the transducers were all within the maximum static error band (linearity).

5.3.5 The output readings were not repeatable at 0 psig (increasing pressure) for specimen 1 and 0 and 235 psig (increasing pressure) for specimen 2.

5.3.6 The maximum hysteresis of the test specimens was less than 2.5 percent of the output reading at 2000 psia.

5.4 TEST DATA

5.4.1 The calculated and measured calibration points of the test specimens are presented in table 5-2. The calibration points for increasing pressure were calculated using the resistance values obtained at 0 and 1985 psig as end points of a straight line. The calibration points for decreasing pressure were calculated using the resistance values obtained at 1735 and 0 psig as end points,

5.4.2 Linearity of the test specimens (0 to 1985 psig) is shown in figures 5-4, 5-5, and 5-6.

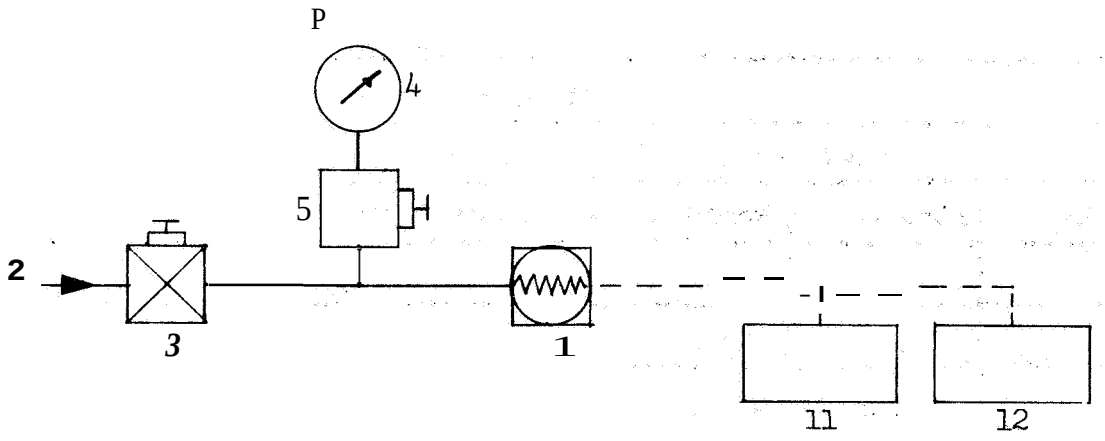
5.4.3 The total resistance and wiper range of the test specimens are presented in table 5-2.

Table 5–1. Functional Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Giannini Control:3 Corp.	461319	278-8, 278-10, 278-13	Pressure Trans-ducer
2	GN_2 Supply	NA	NA	NA	2000 psi
3	Pressure Regulator	Grove	15LHX	NA	3100 psi
4	Pressure Gage	Seegers	SS2170-4000	S-1771	0-to 4000-psig ±0.1% FS Cal date 9-1-66
5	Hand Valve	Robbins	ANA250-4T	NA	1/4-in.
6	Solenoid Valve	Marotta Valve Corp.	MV100	NA	3000 psi, 28 vdc
7	Accumulator	CCSD	NA	NA	
8	Reference Trans-ducer	C.E.C.		3149	0 to 5000 psi
9	Transducer Excitation Supply	Westronics	SG-2A	NA	
10	Oscillograph	C.E.C.	119	NA	
11	Wheatstone Bridge	Minneapolis Honeywell	1071	B271	
12	Megohm Bridge	General Radio	544-B	3782	250 vdc
13	Hand Valve	Robbins	ANA250-4T	NA	1/4-in.

Table 5-2. Initial Functional Test Data

Pressure		Calibration Points (ohms)					
		Specimen 1		Specimen 2		Specimen 3	
Psig	Psia	Calculated	Measured	Calculated	Measured	Calculated	Measured
0	15	33	33	47	47	58	58
235	250	260	256	272	271	291	285
485	500	502	504	512	516	539	540
735	750	744	745	751	759	787	788
985	1000	985	991	990	1003	1035	1037
1235	1250	1227	1232	1230	1244	1283	1287
1485	1500	1469	1469	1469	1485	1531	1534
1735	1750	1710	1711	1708	1721	1779	1776
1985	2000	1952	1952	1948	1948	2027	2027
1735	1750	1715	1715	1728	1728	1785	1785
1485	1500	1473	1477	1474	1490	1536	1541
1235	1250	1230	1238	1244	1251	1287	1292
985	1000	988	996	1002	1008	1038	1043
735	750	746	754	760	768	790	793
485	500	504	512	518	526	541	547
235	250	262	262	275	281	292	293
0	15	34	34	48	48	58	58
Temp. (A to C) Resistance (ohms)		1950		1949		2035	



Note: Refer to table 5-1 for item identification.
All line sizes 1/4-inch.

Figure 5-1. Functional Test Schematic

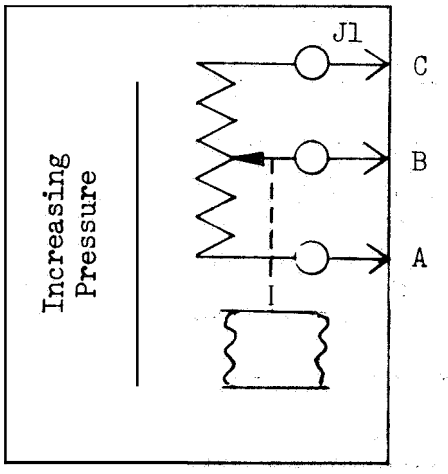
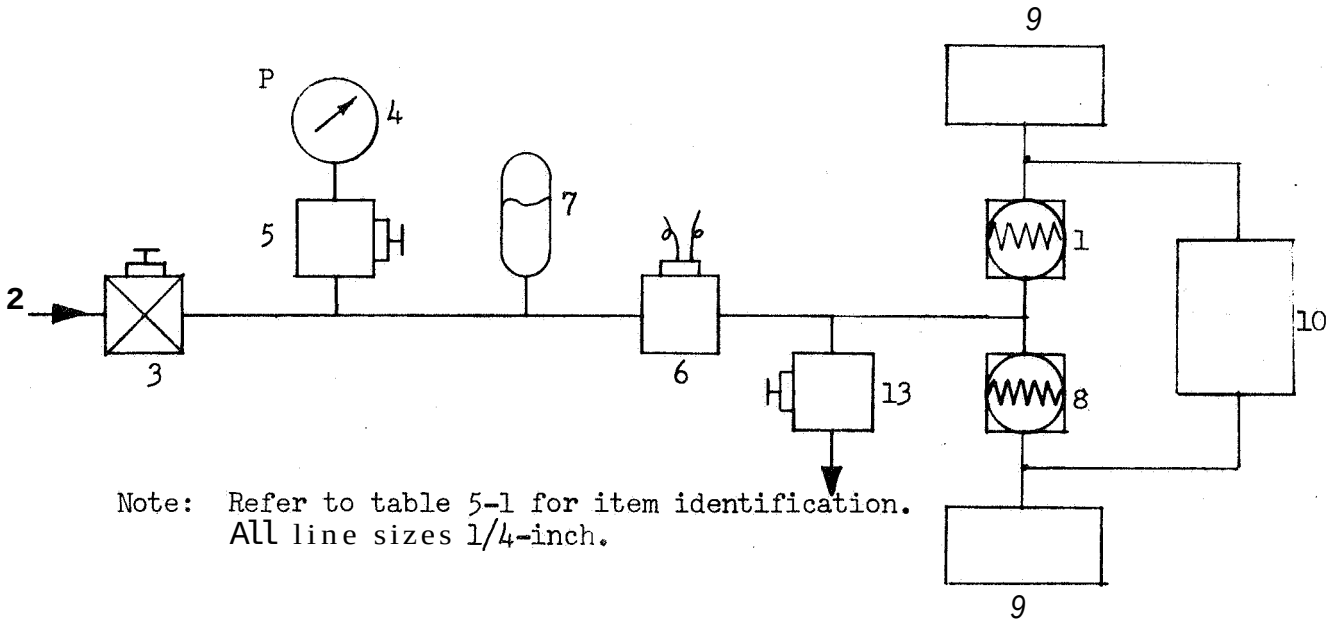


Figure 5-2. Pressure Transducer Electrical Schematic



Note: Refer to table 5-1 for item identification.
All line sizes 1/4-inch.

Figure 5-3. Response Time Test Schematic

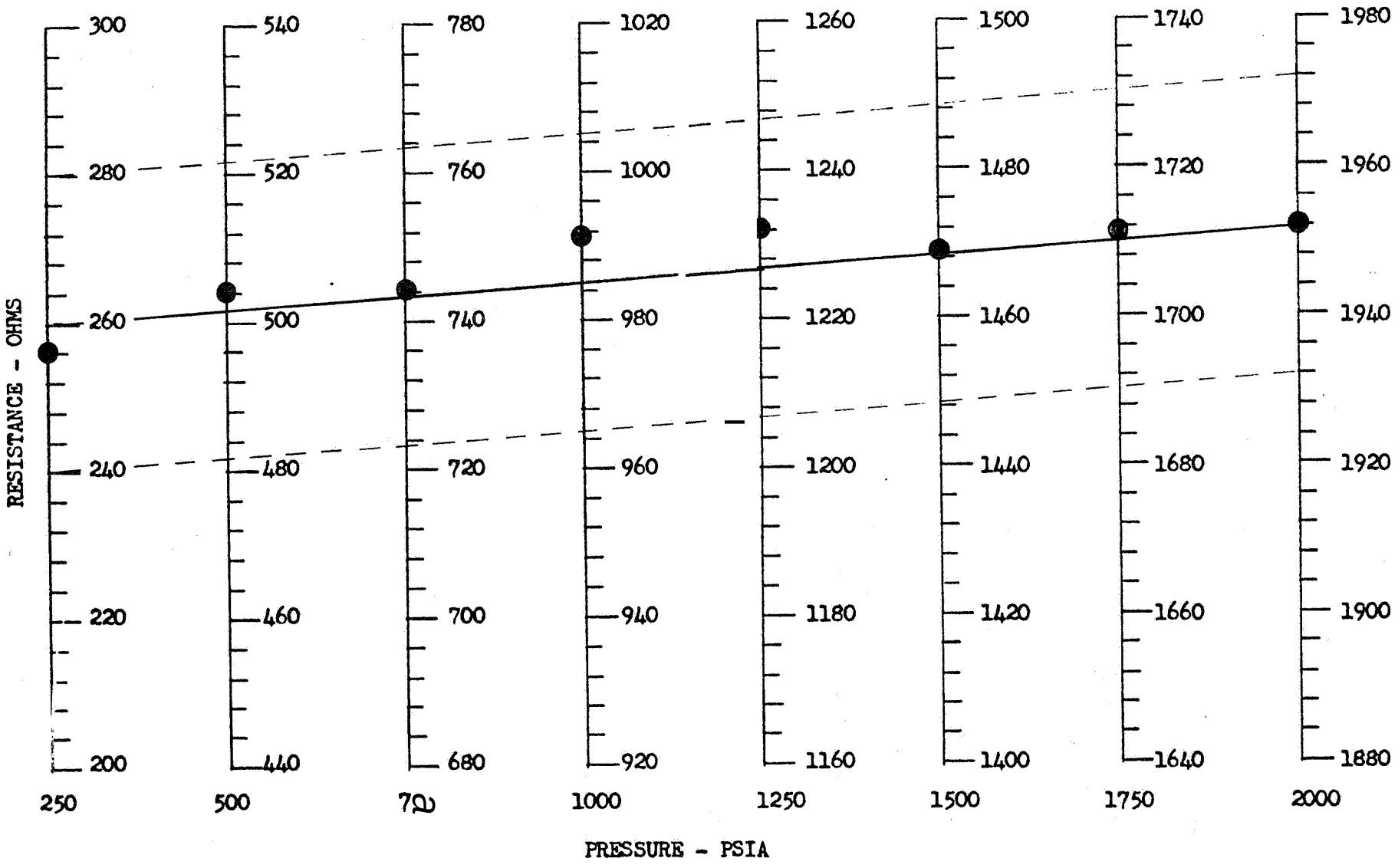


Figure 5-4. Initial Functional Test Linearity (Specimen 1)

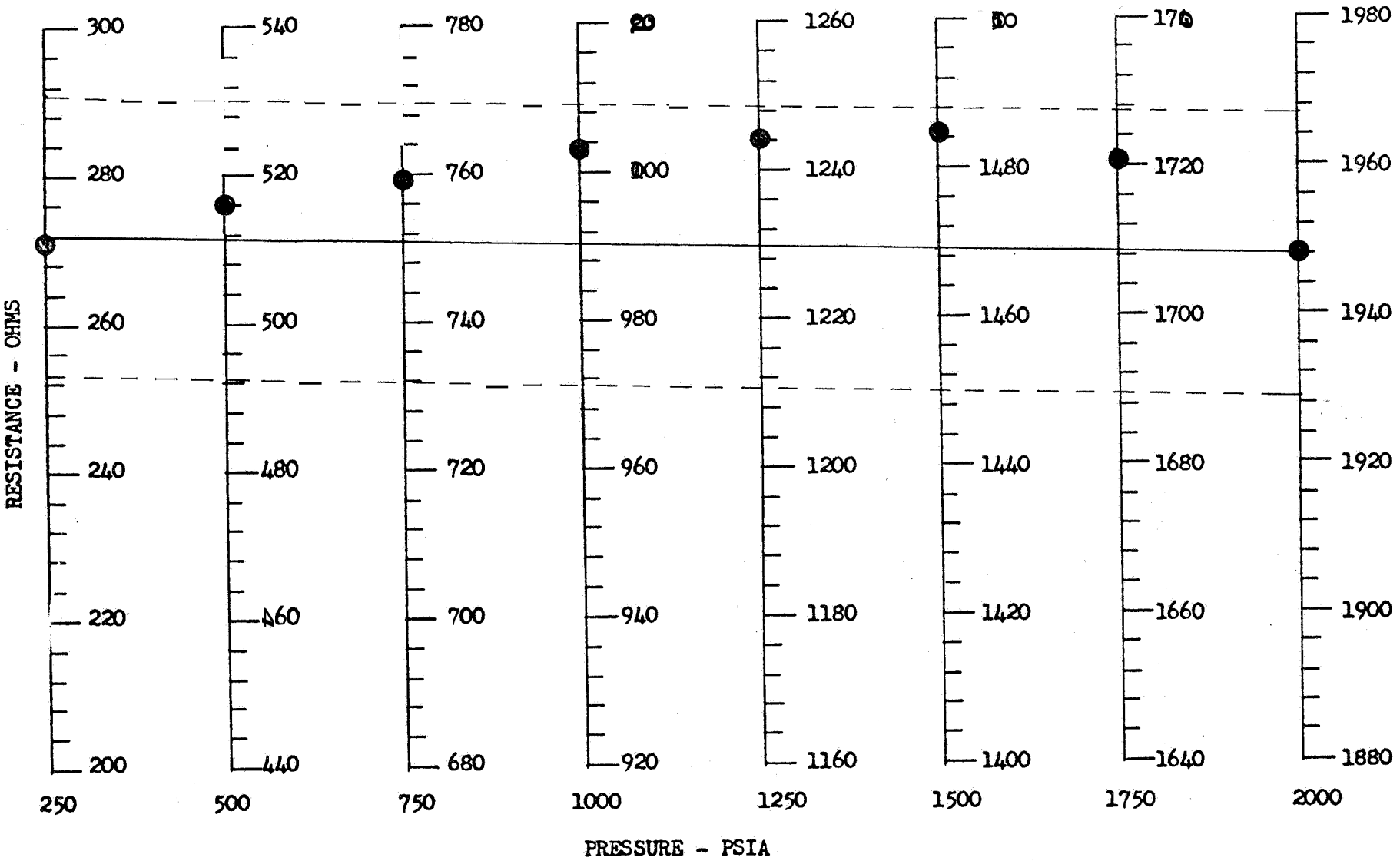


Figure 5-5. Initial Functional Test Linearity (Specimen 2)

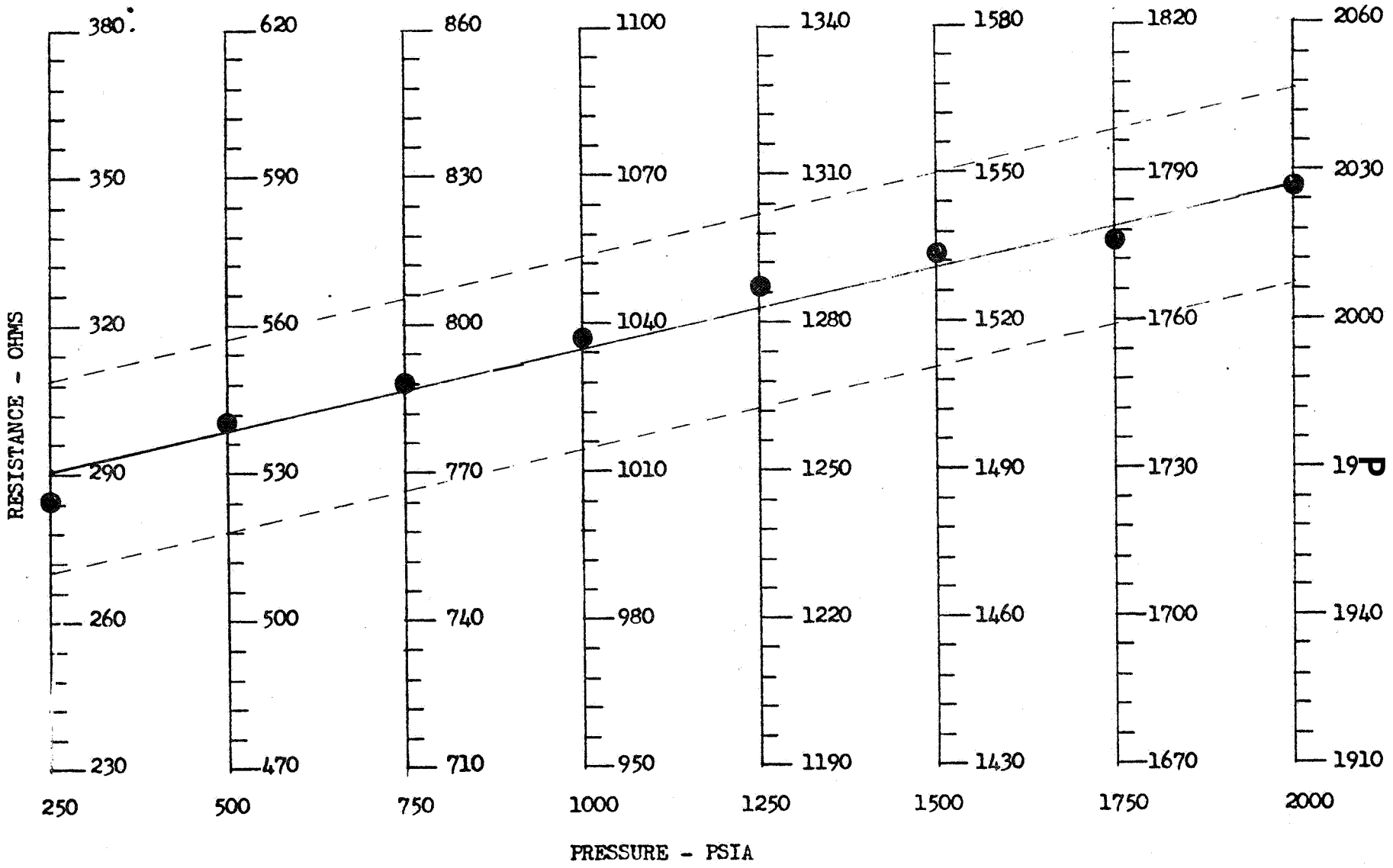


Figure 5-6. Initial Functional Test Linearity (Specimen 3)

SECTION VI

LOW TEMPERATURE TEST

6.1 TEST REQUIREMENTS

6.1.1 Test specimens 1 and 2 shall be subjected to a low temperature test of 5 (-4, +0)°F to determine whether the environment causes degradation or deterioration of the specimens.

6.1.2 A functional test as prescribed in section V shall be performed before the test (if more than 72 hours has elapsed since the last functional test), during the test, and within 1 hour after stabilization at ambient temperature after the test. The response time portion of the functional test may be omitted.

6.2 TEST PROCEDURE

6.2.1 The test specimens were placed in the low temperature chamber and all necessary electrical and pneumatic systems were connected.

6.2.2 A functional test was performed as specified in 6.1.2.

6.2.3 The chamber temperature was decreased at the rate of 1°F per minute and stabilized at 5 (-4, +0)°F.

6.2.4 A functional test was performed when temperature stabilization was attained.

6.2.5 The chamber temperature was returned to ambient upon completion of the functional test.

6.2.6 The test specimens were visually inspected and functionally tested within 1 hour following the return to ambient conditions. The response time portion of the test was omitted.

6.3 TEST RESULTS

6.3.1 The insulation resistance was greater than 20 megohms for all test measurements.

6.3.2 The total resistance of the test specimens was below the specified resistance during the low temperature test.

6.3.3 The test specimens were out of tolerance (linearity) during the low temperature test.

6.3.4 The output readings of specimen 1 were out of tolerance (repeatability) at 0 psig (increasing pressure) before the low temperature test and at 235 psig (increasing and decreasing pressure) during the test. Specimen 2 was out of tolerance at 735 psig (increasing pressure) after the test.

6.3.5 The maximum hysteresis of the test specimens was less than 2.5 percent of the output reading at 2000 psia.

6.4 **TEST** DATA

6.4.1 The calculated and measured calibration points of the test specimens are presented in tables 6–1 and 6–2. The end points recorded during the functional test performed before the low temperature test were used to calculate the calibration points.

6.4.2 Linearity of the test specimens (0 to 1985 psig) is shown in figures 6–1 and 6–2.

6.4.3 The total resistance and wiper range of the test specimens are presented in tables 6–1 and 6–2.

Table 6-1. Low Temperature Test Functional Data for Specimen 1

Pressure		Calculated Calibration Points (ohms)	Measured Calibration Points (ohms)		
psig	psia		Before Test	During Test	After Test
0	15	3	3	8	4
235	250	229	221	220	221
485	500	469	470	458	466
735	750	709	707	690	711
985	1000	948	952	* 926	953
1235	1250	1188	1190	* 1157	1191
1485	1500	1428	1429	* 1385	1427
1735	1750	1668	1667	* 1618	1668
1985	1500	1908	1908	* 1849	1908
1735	1750	1674	1674	* 1620	1667
1485	1500	1433	1433	* 1390	1428
1235	1250	1193	1198	* 1161	1194
985	1000	952	957	* 929	953
735	750	711	712	694	711
485	500	471	471	462	470
235	250	230	226	224	226
0	15	4	4	8	4
Total Resistance (ohms)			1921	1874	1928

* Out of tolerance

Table 6-2. Low Temperature Test Functional Data for Specimen 2

Pressure		Calculated Calibration Points (ohms)	Measured Calibration Points (ohms)		
psig	psia		Before Test	During Test	After Test
0	15	48	48	56	48
235	250	273	268	268	267
485	500	512	516	504	515
735	750	752	756	739	757
985	1000	991	1000	976	1002
1235	1250	1230	1243	* 1209	1245
1485	1500	1469	1481	* 1441	1482
1735	1750	1709	1720	* 1672	1721
1985	1500	1948	1948	* 1889	1945
1735	1750	1729	1729	* 1674	1722
1485	1500	1487	1490	* 1448	1485
1235	1250	1244	1249	* 1217	1248
985	1000	1002	1010	* 982	1005
735	750	760	762	745	762
485	500	518	518	511	519
235	250	276	273	273	277
0	15	48	48	56	48
Total Resistance (ohms)			1949	1890	1947

* Out of tolerance

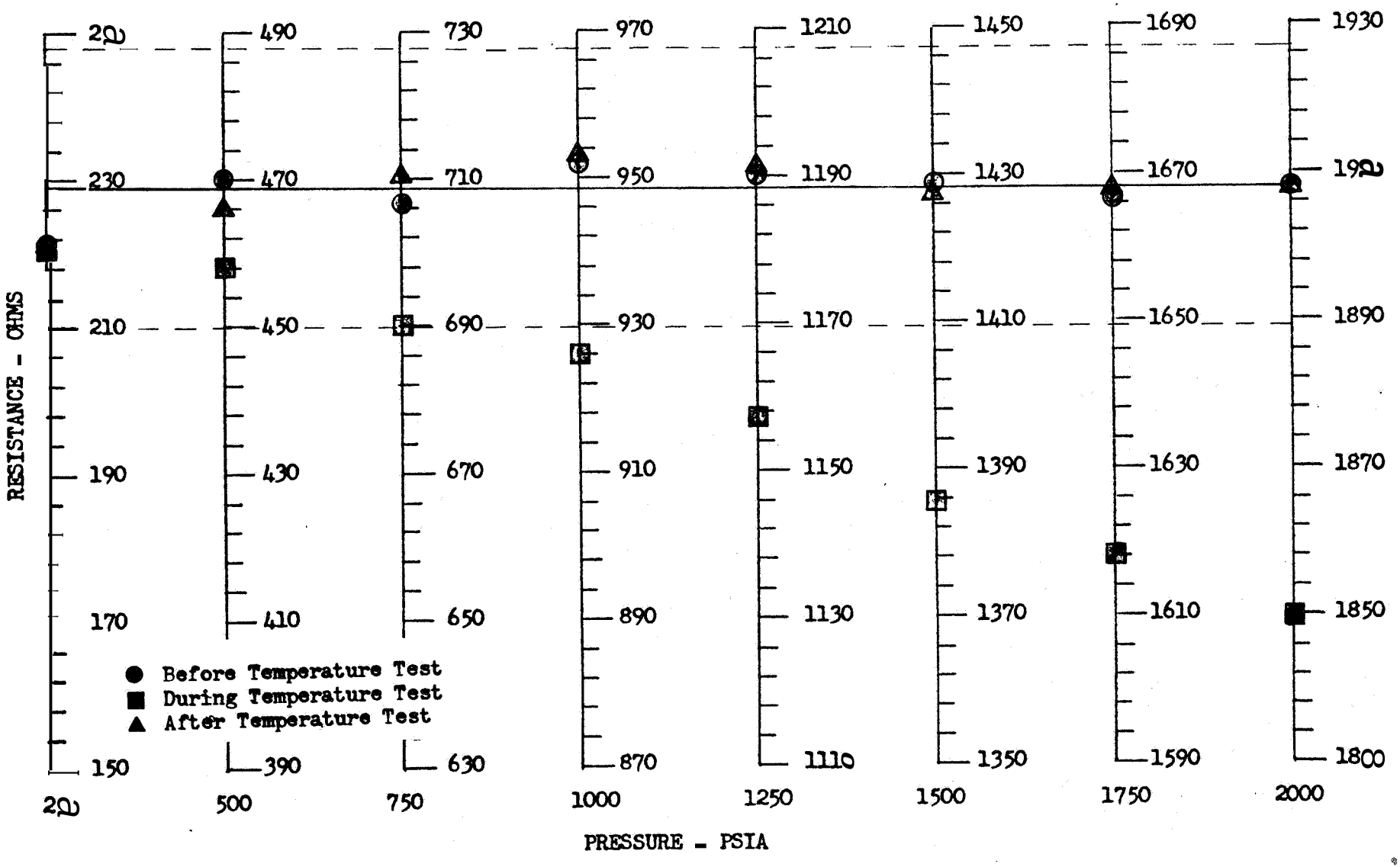


Figure 6-1. Low Temperature Test Linearity (Specimen 1)

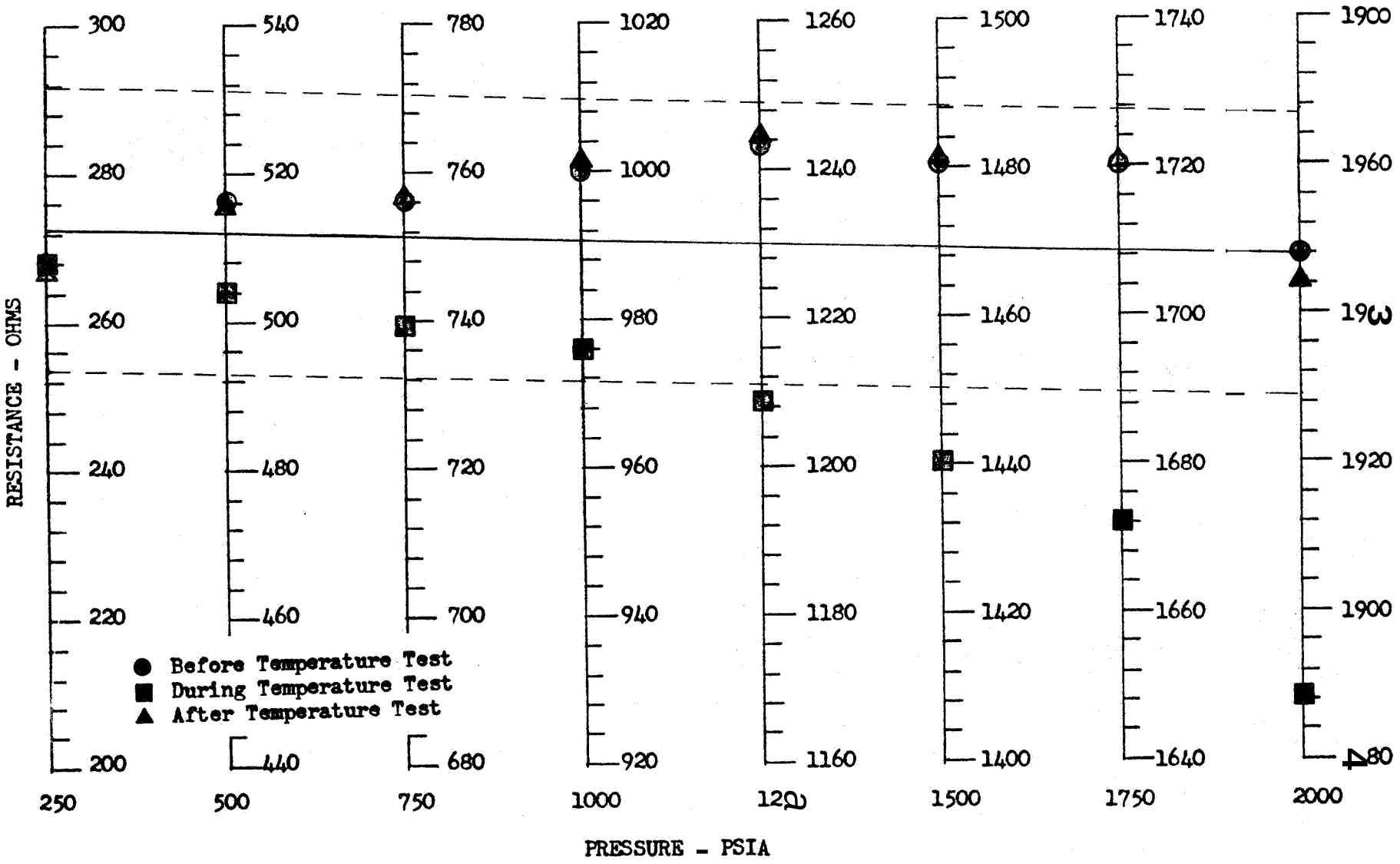


Figure 6-2. Low Temperature Test Linearity (Specimen 2)

SECTION VII

HIGH TEMPERATURE TEST

7.1 TEST REQUIREMENTS

7.1.1 Test specimens 2 and 3 shall be subjected to a high temperature test of 190 (-0, +4)°F to determine whether the environment causes degradation or deterioration of the specimens.

7.1.2 A functional test as prescribed in section V shall be performed before the test (if more than 72 hours has elapsed since the last functional test), during the test, and within 1 hour after stabilization at ambient temperature after the test. The response time portion of the functional test may be omitted.

7.2 TEST PROCEDURE

7.2.1 The test specimens were placed in the high temperature chamber and all necessary electrical and pneumatic systems were connected.

7.2.2 A functional test was performed on specimen 3 as specified in 7.1.2.

7.2.3 The chamber temperature was increased at the rate of one degree per minute and stabilized at 160 (-0, +4)°F for 72 hours.

7.2.4 The chamber temperature was increased at the rate of one degree per minute and stabilized at 190 (-0, +4)°F.

7.2.5 A functional test was performed with the temperature stabilized at 190°F.

7.2.6 The chamber temperature was returned to ambient upon completion of the functional test.

7.2.7 The test specimens were visually inspected and functionally tested within 1 hour following the return to ambient conditions. The response time portion of the test was omitted.

7.3 TEST RESULTS

7.3.1 The insulation resistance was greater than 20 megohms for all test measurements.

7.3.2 The total resistance of test specimen 3 during the high temperature test was greater than the specified resistance of 2000 (±100) psia.

7.3.3 The test specimens were out of tolerance (linearity) during the high temperature test. Test specimen 2 was out of tolerance at 235 psig (decreasing pressure) after the test.

7.3.4 The output readings of specimen 2 were out of tolerance (repeatability') at 735 psig (increasing pressure) before the test and at 0 and 485 psig (increasing pressure) and 0 psig (decreasing pressure) after the test.

7.3.5 The output readings of specimen 3 were out of tolerance (repeatability) at 235 psig (increasing and decreasing pressure) before the test and at 235 psig (increasing pressure) after the test.

7.3.6 The maximum hysteresis of the test specimens was less than 2.5 percent of the output reading at 2000 psia.

7.4 TEST DATA

7.4.1 The calculated and measured calibratkon points of the test specimens are presented in tables 7-1 and 7-2. The end points recorded during the functional test performed before the high temperature test were used to calculate the calibration points.

7.4.2 Linearity of the test specimens (0 to 1985 psig) is shown in figures 7-1 and 7-2.

7.4.3 The total resistance and wiper range of the test specimens are presented in tables 7-1 and 7-2.

Table 7-1. High Temperature Test Functional Data for Specimen 2

Pressure		Calculated Calibration Points (ohms)	Measured Calibration Points (ohms)		
psig	psia		Before Test	During Test	After Test
0	15	48	48	50	49
235	250	273	267	275	272
485	500	512	515	530	516
735	750	751	757	* 784	756
985	1000	990	1002	*1036	1001
1235	1250	1228	1245	*1290	1242
1485	1500	1467	1482	*1540	1481
1735	1750	1706	1721	*1788	1719
1985	1500	1945	1945	*2026	1946
1735	1750	1722	1722	*1797	1725
1485	1500	1481	1485	*1549	1490
1235	1250	1239	1248	*1300	1252
985	1000	998	1005	*1049	1009
735	750	757	762	* 794	765
485	500	516	519	* 540	522
235	250	255	277	* 285	* 277
0	15	48	48	50	49
Total Resistance (ohms)			1947	2068	1954

* Out of tolerance

Table 7-2. High Temperature Test Functional Data for Specimen 3

Pressure		Calculated Calibration Points (ohms)	Measured Calibration Points (ohms)		
psig	psia		Before Test	During Test	After Test
0	15	58	58	50	58
235	250	291	283	285	288
485	500	538	537	548	541
735	750	785	786	* 806	788
985	1000	1033	1033	* 1065	1036
1235	1250	1281	1285	* 1325	1288
1485	1500	1528	1534	* 1583	1534
1735	1750	1776	1777	* 1839	1780
1985	1500	2023	2023	* 2100	2027
1735	1750	1783	1783	* 1847	1784
1485	1500	1534	1538	* 1592	1539
1235	1250	1286	1288	* 1336	1292
985	1000	1037	1039	* 1074	1043
735	750	789	788	* 813	793
485	500	540	543	554	548
235	250	292	288	291	292
0	15	58	58	50	58
Total Resistance (ohms)			2035	2161	2038

* Out of tolerance

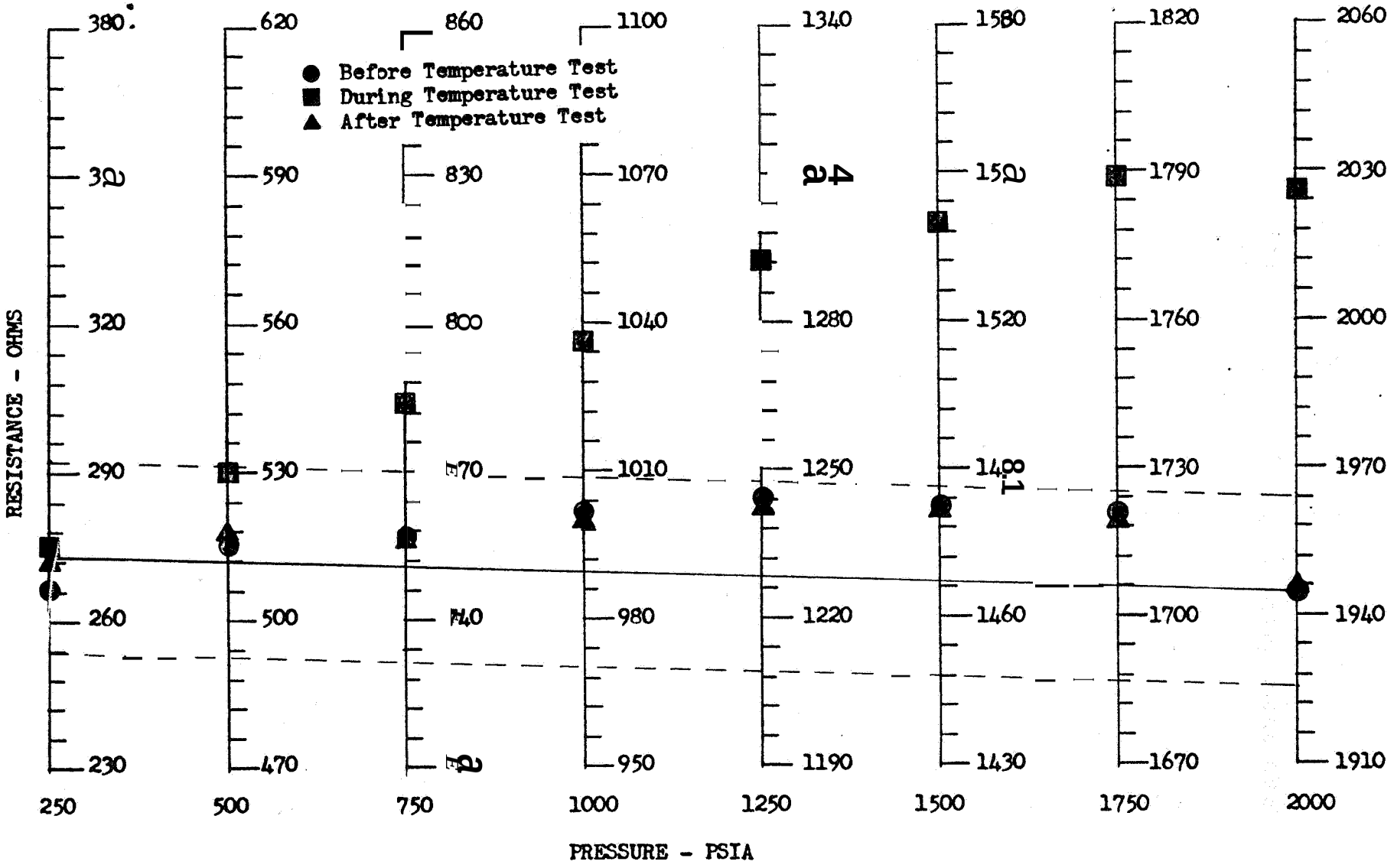


Figure 7-1. High Temperature Test Linearity (Specimen 2)

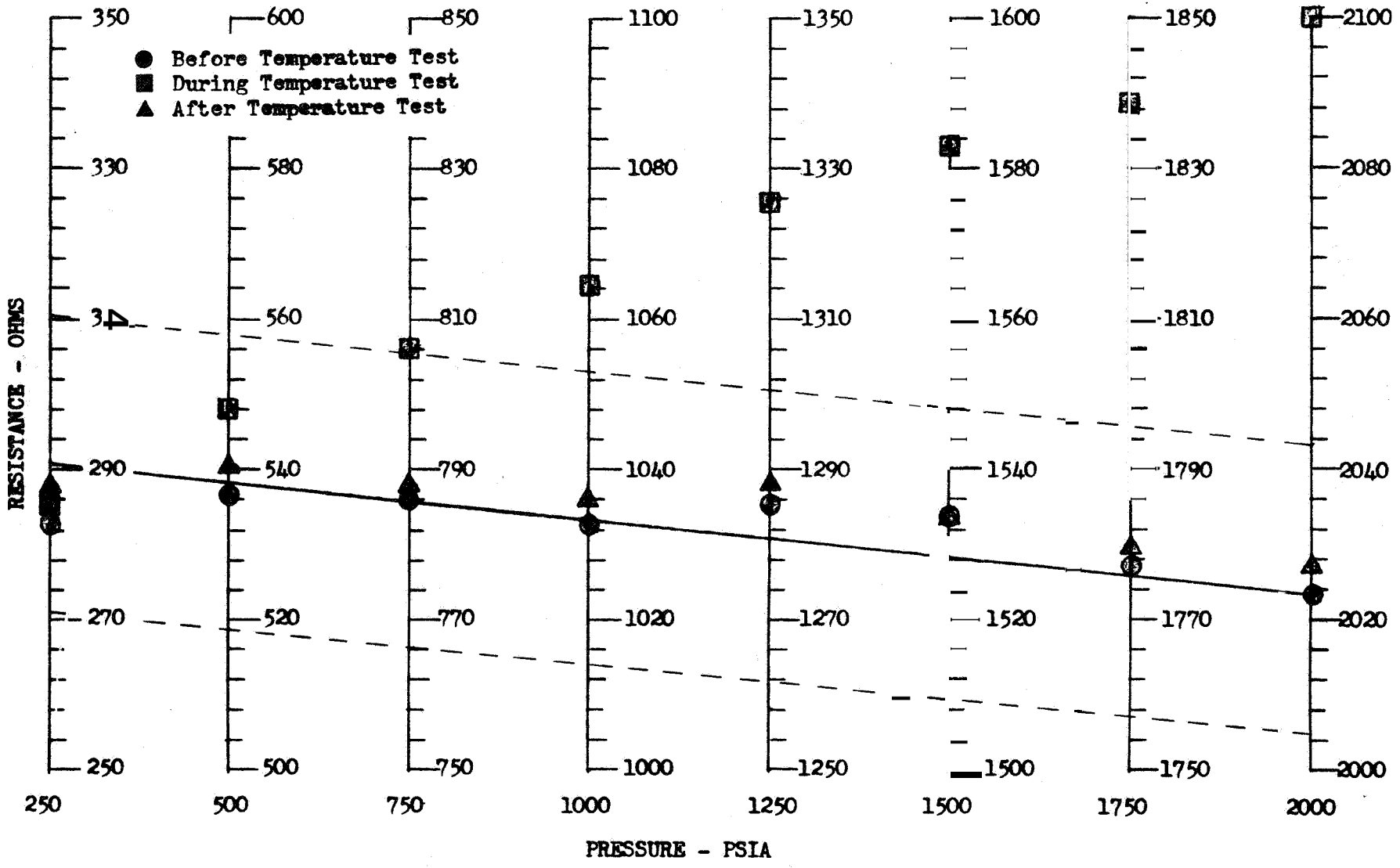


Figure 7-2. High Temperature Test Linearity (Specimen 3)

SECTION VIII

VIBRATION TESTS

8.1 TEST REQUIREMENTS

8.1.1 Test specimens 2 and 3 shall be subjected to sinusoidal and random excitation to determine the capability of the specimens to operate satisfactorily during and after vibration testing.

8.1.2 The tests shall be performed in the axes specified in figure 8-1 and shall be conducted in accordance with section 9, procedure Ia of KSC-STD-164(D).

8.1.3 Acceleration shall be measured at the test specimen from accelerometers mounted on the specimens.

8.1.4 The test specimen shall be pressurized to 1000 psia and 28 vdc shall be applied to pins A and C of J1 during the vibration tests. The output voltage from pins A and B of J1 shall be continuously monitored for voltage fluctuation.

8.1.5 At the resonant frequencies during the resonant frequency sweep, the test specimen shall be functioned at zero psig and from 250 to 2000 psia in 250 psi increments. The output voltage maximum dynamic error band of any calibration point shall be within ± 2 percent of a straight line between the measured end points at zero and 1985 psig.

8.1.6 A functional test shall be performed prior to the vibration tests and at the completion of each axis of vibration. The response time portion of the test may be omitted.

8.2 TEST PROCEDURE

8.2.1 The test specimens were installed on a vibration fixture and the fixture was mounted on the vibrator. All necessary electrical and pneumatic systems were connected.

8.2.2 A functional test was performed as specified in 8.1.6.

8.2.3 The resonant frequency search was conducted while vibrating the specimens at 1g peak from 10 to 3000 to 10 cps.

8.2.4 The sinusoidal search was performed while vibrating the test specimens at the 1/3-octave center frequencies given in table 8-1. The input level was increased until functional degradation occurred or until the maximum level was attained.

8.2.5 The sinusoidal sweep test was conducted at levels specified by a test envelop derived from data obtained in the sinusoidal search.

8.2.6 A resonant frequency sweep test was conducted at 1g peak from 10 to 2000 cps. The test specimens were functioned as specified in 8.1.5.

8.2.7 The random excitation test was conducted by vibrating the specimens initially at 1 Grms and then gradually increasing the input level until degradation occurred.

8.2.8 A functional test was performed after the random excitation test.

8.2.9 Steps 8.2.3 through 8.2.8 were performed in both the X- and Y-axes.

8.3 TEST RESULTS

8.3.1 The output of the test specimens, which were pressurized at 1000 psia, was recorded on an oscillograph and monitored with a digital voltmeter. There were indications of voltage fluctuation on the oscillograph during the vibration tests, but the average output voltage remained unchanged and no voltage fluctuation was noted on the digital voltmeter. However, wiper arm chatter was treated as specimen degradation and the vibration input levels were reduced accordingly.

8.3.2 The test specimens were pressurized as specified in 8.1.5 during the resonant frequency sweep at 280, 1100, and 1900 cps in the X-axis and at 300, 750, and 1600 cps in the Y-axis. The linearity of the specimens was within the specified tolerance.

8.3.3 The highest vibration level attained without voltage fluctuation during the random vibration tests was 1.5 Grms in the X-axis and 4.0 Grms in the Y-axis.

8.3.4 The specimens were out of tolerance (linearity) during the functional tests performed after the X- and Y-axes vibration tests.

8.3.5 The measurements taken at the calibration points during the functional tests were not all repeatable (table 8-9).

8.3.6 The maximum hysteresis of the test specimens was less than 2.5 percent of the output reading at 2000 psia.

8.4 TEST DATA

8.4.1 The measured calibration points obtained during the resonant frequency sweep tests are presented in tables 8-3 through 8-6.

8.4.2 The calculated and measured calibration points of the test specimens obtained during the functional tests are presented in tables 8-7 and 8-8. The end points recorded during the functional test performed before the vibration tests were used to calculate the calibration points.

8.4.3 Linearity of the test specimens (0 to 1985 psig) is shown in figures 8-2 and 8-3.

8.4.4 The total resistance and wiper range of the test specimens are presented in tables 8-7 and 8-8.

8.4.5 Measurements obtained at calibration points during the functional tests which were not repeatable are indicated in table 8-9.

Table 8-1. One-Third Octave Center Frequencies

1/3-Octave Bandwidth Frequencies (cps)	Maximum Input (g level)
10	1.3
12.5	2.0
16	3.4
20	5.1
25	8.2
32	13.0
40	21.0
50	21.0
62	21.0
80	21.0
100	21.0
125	21.0
160	21.0
200	21.0
250	21.0
320	21.0
400	21.0
500	21.0
630	21.0
800	21.0
1000	21.0
1250	21.0
1600	21.0
2000	21.0

Table **8-2.** Sinusoidal Sweep Input Levels

x-Axis		Y-Axis	
Frequency (cps)	Input Level	Frequency (cps)	Input Level
10 to 40	0.25-inch DA	10 to 40	0.25-inch DA
40 to 200	20.0g peak	40 to 500	21.0g peak
200 to 400	8.0g peak	500 to 650	10.0g peak
400 to 650	18.0g peak	650 to 900	1.0g peak
650 to 1200	1.0g peak	900 to 2000	5.0g peak
1200 to 1500	18.0g peak	2000 to 900	5.0g peak
1500 to 2000	3.5g peak	900 to 650	1.0g peak
2000 to 1500	3.5g peak	650 to 500	10.0g peak
1500 to 1100	20.0g peak	500 to 40	21.0g peak
1100 to 650	1.0g peak	40 to 10	0.25-inch DA
650 to 400	18.0g peak		
400 to 200	8.0g peak		
200 to 40	20.0g peak		
40 to 10	0.25-inch DA		

Table 8-3. Specimen 2 Linearity During **X-Axis** Resonant Frequency Sweep

Pressure (psig)	280 cps		1100 cps		1900 cps	
	Calculated Calibration Points (volts)	Measured Calibration Points (volts)	Calculated Calibration Points (volts)	Measured Calibration Points (volts)	Calculated Calibration Points (volts)	Measured Calibration Points (volts)
0	0.9	0.9	0.8	0.8	0.9	0.9
235	4.0	4.1	3.9	4.3	4.0	4.3
485	7.2	7.5	7.2	7.6	7.2	7.6
735	10.5	10.7	10.5	10.9	10.5	10.9
985	13.8	13.9	13.8	14.0	13.8	14.0
1235	17.1	16.9	17.1	17.0	17.1	17.1
1485	20.3	20.1	20.4	20.2	20.3	20.2
1735	23.6	23.5	23.7	23.6	23.6	23.6
1985	27.1	27.1	27.1	27.1	27.0	27.0

Table 8-4. Specimen 3 Linearity During X-Axis Resonant Frequency Sweep

Pressure (psig)	280 cps		1100 cps		1900 cps	
	Calculated Calibration Points (volts)	Measured Calibration Points (volts)	Calculated Calibration Points (volts)	Measured Calibration Points (volts)	Calculated Calibration Points (volts)	Measured Calibration Points (volts)
0	0.7	0.7	0.7	0.7	0.9	0.9
235	3.9	4.2	3.9	4.3	4.1	4.3
485	7.3	7.8	7.3	7.8	7.4	8.0
735	10.7	11.2	10.7	11.3	10.8	11.3
985	14.1	14.4	14.1	14.6	14.2	14.6
1235	17.5	17.2	17.5	17.3	17.6	17.4
1485	20.9	20.7	20.9	20.9	20.9	21.0
1735	24.3	24.3	24.3	24.3	24.3	24.4
1985	27.7	27.7	27.8	27.8	27.8	27.8

Table 8-5. Specimen 2 Linearity During Y-Axis Resonant Frequency Sweep

Pressure (psig)	300 cps		750 cps		1600 cps	
	Calculated Calibration Points (volts)	Measured Calibration Points (volts)	Calculated Calibration Points (volts)	Measured Calibration Points (volts)	Calculated Calibration Points (volts)	Measured Calibration Points (volts)
0	0.9	0.9	0.8	0.8	0.8	0.8
235	4.0	4.0	3.9	4.1	3.9	4.0
485	7.2	7.5	7.2	7.5	7.2	7.6
735	10.5	10.8	10.5	10.9	10.5	11.0
985	13.8	13.9	13.8	14.0	13.8	14.0
1235	17.1	16.9	17.1	17.0	17.1	17.1
1485	20.3	20.2	20.4	20.3	20.4	20.2
1735	23.6	23.7	23.7	23.8	23.7	23.7
1985	27.1	27.1	27.1	27.1	27.1	27.1

Table 8-6. Specimen 3 Linearity During Y-Axis Resonant Frequency Sweep

Pressure (psig)	300 cps		750 cps		1600 cps	
	Calculated Calibration Points (volts)	Measured Calibration Points (volts)	Calculated Calibration Points (volts)	Measured Calibration Points (volts)	Calculated Calibration Points (volts)	Measured Calibration Points (volts)
0	1.4	1.4	1.2	1.2	1.2	1.2
235	4.4	4.1	4.3	4.3	4.3	4.1
485	7.7	7.6	7.5	7.7	7.5	7.7
735	10.9	11.0	10.8	11.1	10.8	11.2
985	14.2	14.2	14.1	14.3	14.1	14.1
1235	17.4	16.9	17.4	17.1	17.4	17.1
1485	20.7	20.3	20.6	20.4	20.6	20.3
1735	23.9	23.8	23.9	23.9	23.9	23.7
1985	27.3	27.3	27.4	27.4	27.3	27.3

Table 8-7. Vibration Functional Test Data for Specimen 2

Pressure		Calculated Calibration Points (ohms)	Measured Calibration Points (ohms)		
psig	psia		Before Vibration Tests	After X-Axis Test	After Y-Axis Test
0	15	49	49	52	53
235	250	274	272	* 249	257
485	500	513	516	504	509
735	750	751	756	744	754
985	1000	990	1001	987	995
1235	1250	1229	1242	* 1205	* 1203
1485	1500	1468	1481	1451	* 1439
1735	1750	1707	1719	1694	1692
1985	1500	1946	1946	* 1915	* 1903
1735	1750	1725	1725	1707	* 1698
1485	1500	1483	1490	1471	* 1453
1235	1250	1242	1252	* 1222	* 1220
985	1000	1000	1009	1009	1005
735	750	759	765	774	771
485	500	517	522	522	522
235	250	276	277	269	273
0	15	49	49	52	53
Total Resistance (ohms)			1954	1935	1916

* Out of tolerance

Table 8-8. Vibration Functional Test Data for Specimen 3

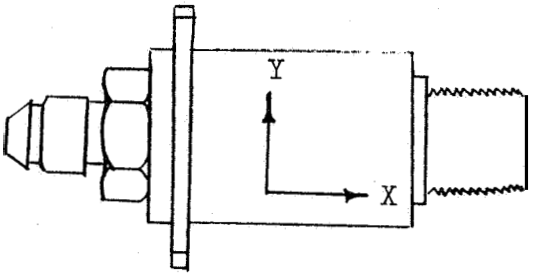
Pressure		Calculated Calibration Points (ohms)	Measured Calibration Points (ohms)		
psig	psia		Before Vibration Tests	After X-Axis Test	After Y-Axis Test
0	15	58	58	63	74
235	250	291	288	* 270	286
485	500	539	541	527	538
735	750	787	788	773	787
985	1000	1035	1036	1023	1035
1235	1250	1283	1288	* 1254	* 1249
1485	1500	1531	1534	* 1507	* 1501
1735	1750	1779	1780	* 1754	* 1748
1985	1500	2027	2027	* 1995	* 1984
1735	1750	1784	1784	1768	* 1762
1485	1500	1535	1539	1522	1519
1235	1250	1286	1292	1276	1267
985	1000	1038	1043	1040	1036
735	750	789	793	797	809
485	500	540	548	545	559
235	250	292	292	293	312
0	15	58	58	63	74
Total Resistance (ohms)			2038	2018	2008

* Out of tolerance

Table 8-9. Repeatability of Test Specimens During Vibration Functional Tests

Pressure (psia)	Specimen 2		Specimen 3	
	X-Axis	Y-Axis	X-Axis	Y-Axis
15	U	S	U	U
250	U	U	U	S
500	U	S	U	U
750	S	S	U	S
750	U	S	U	S
500	U	S	S	S
250	U	S	S	S
15	U	S	U	U

U - Measurements not repeatable.
S - Measurements were repeatable.



Axes of Vibration

(for reference only)

Figure 8–1. Axes of Vibration

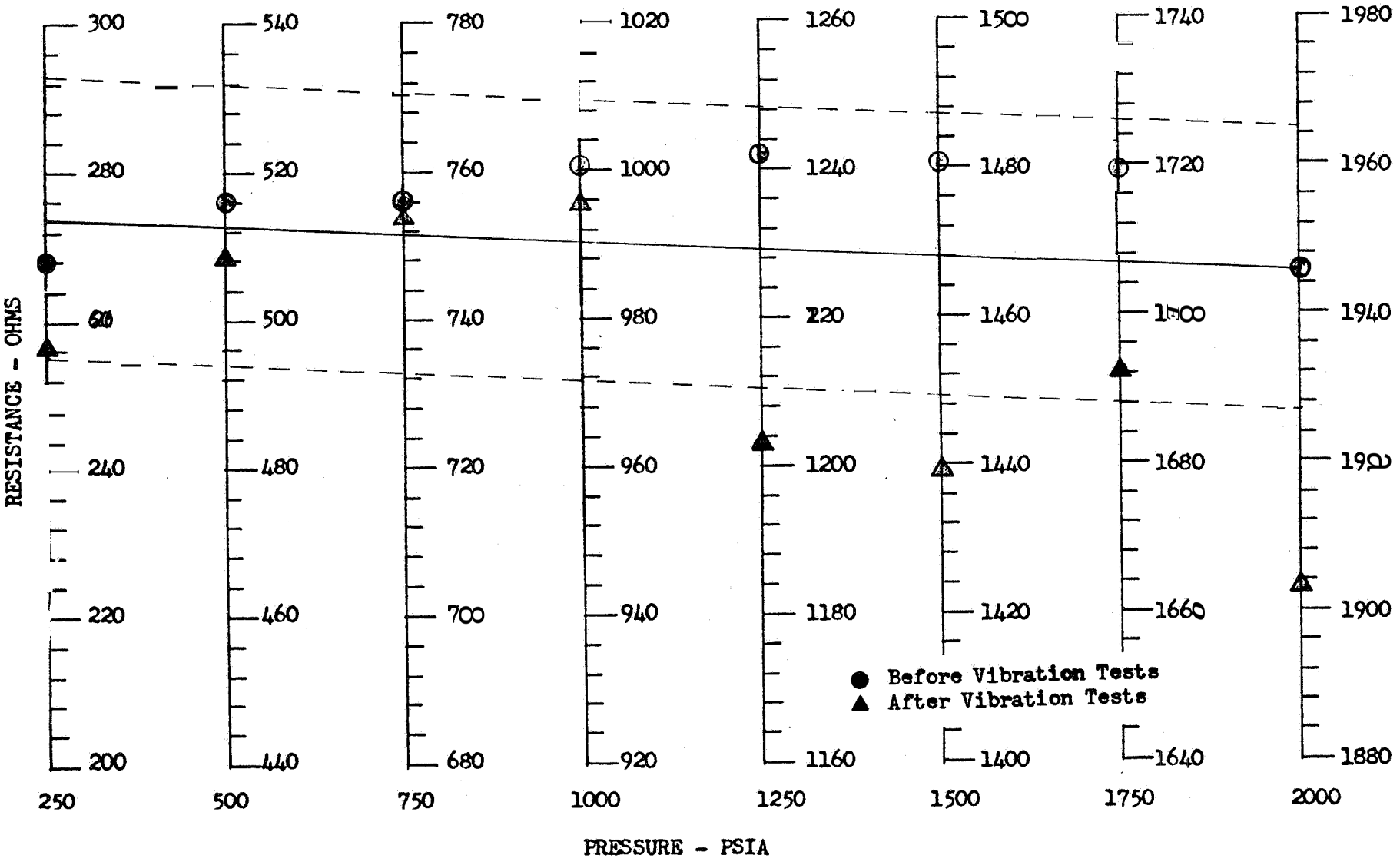


Figure 8-2. Vibration Test Linearity (Specimen 2)

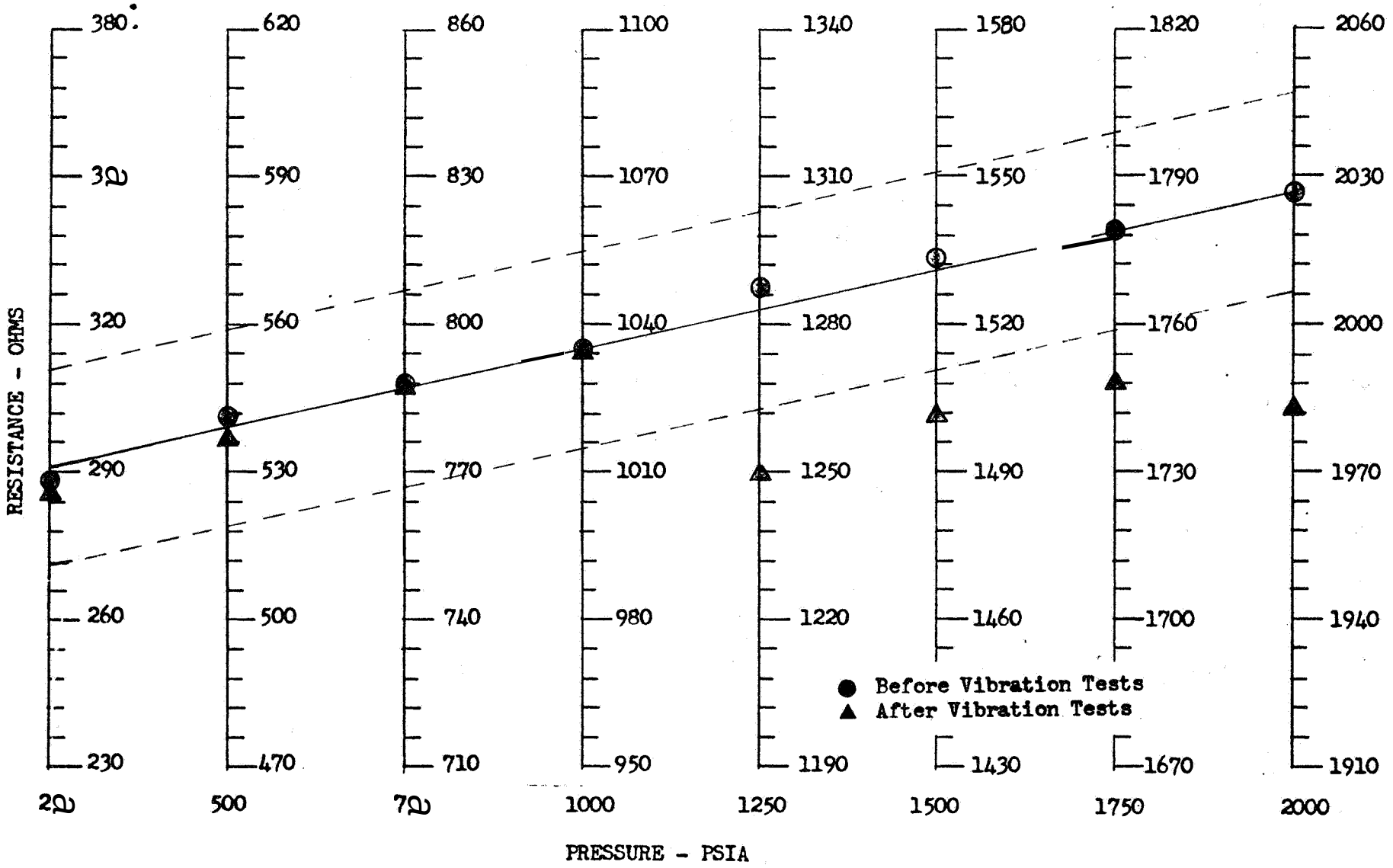
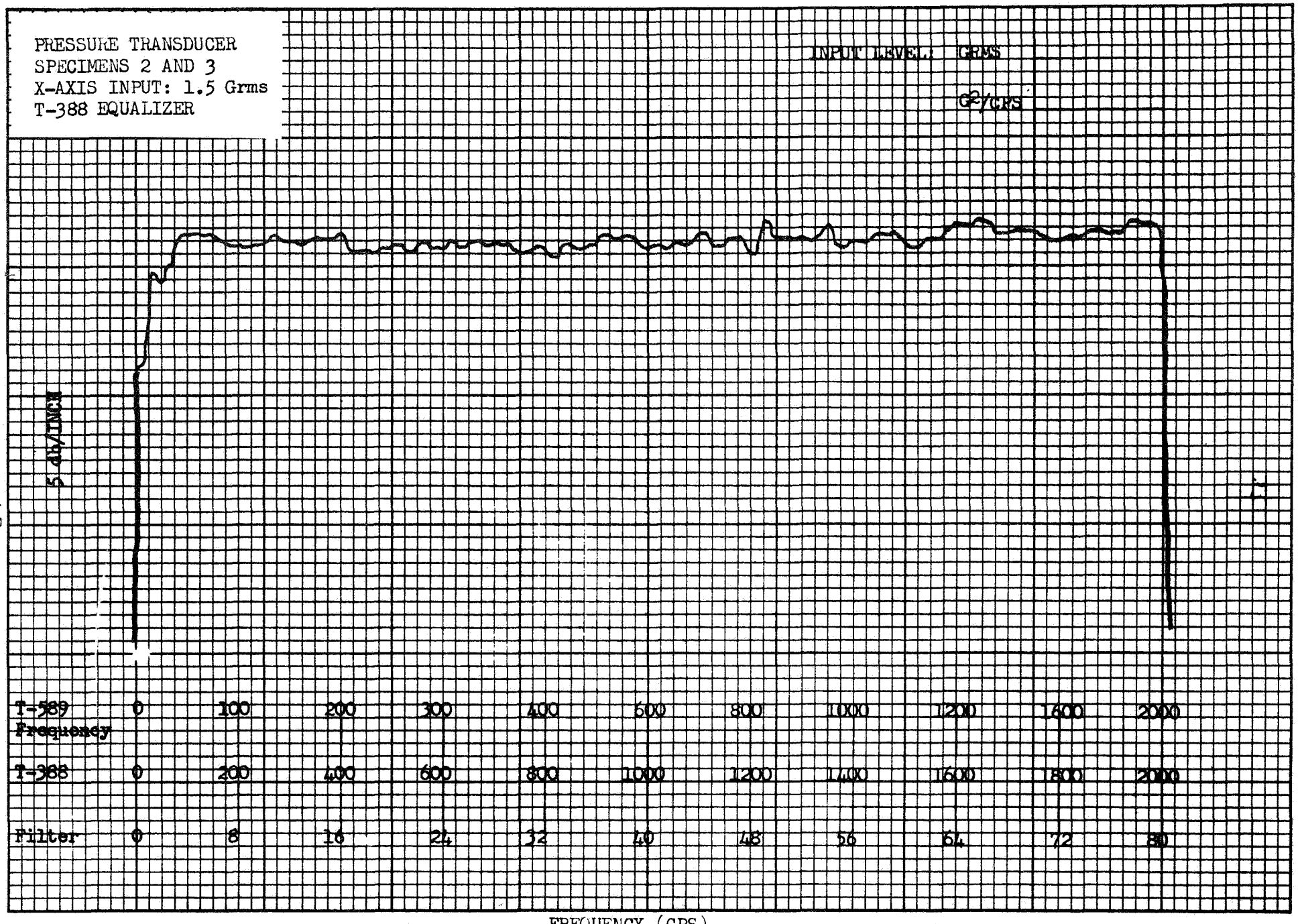


Figure 8-3. Vibration Test Linearity (Specimen 3)



RELATIVE g^2/CPS IN db (5 db/INCH)

Figure 8-4. Typical Random Equalization Plot (Specimens 2 and 3, X-Axis)

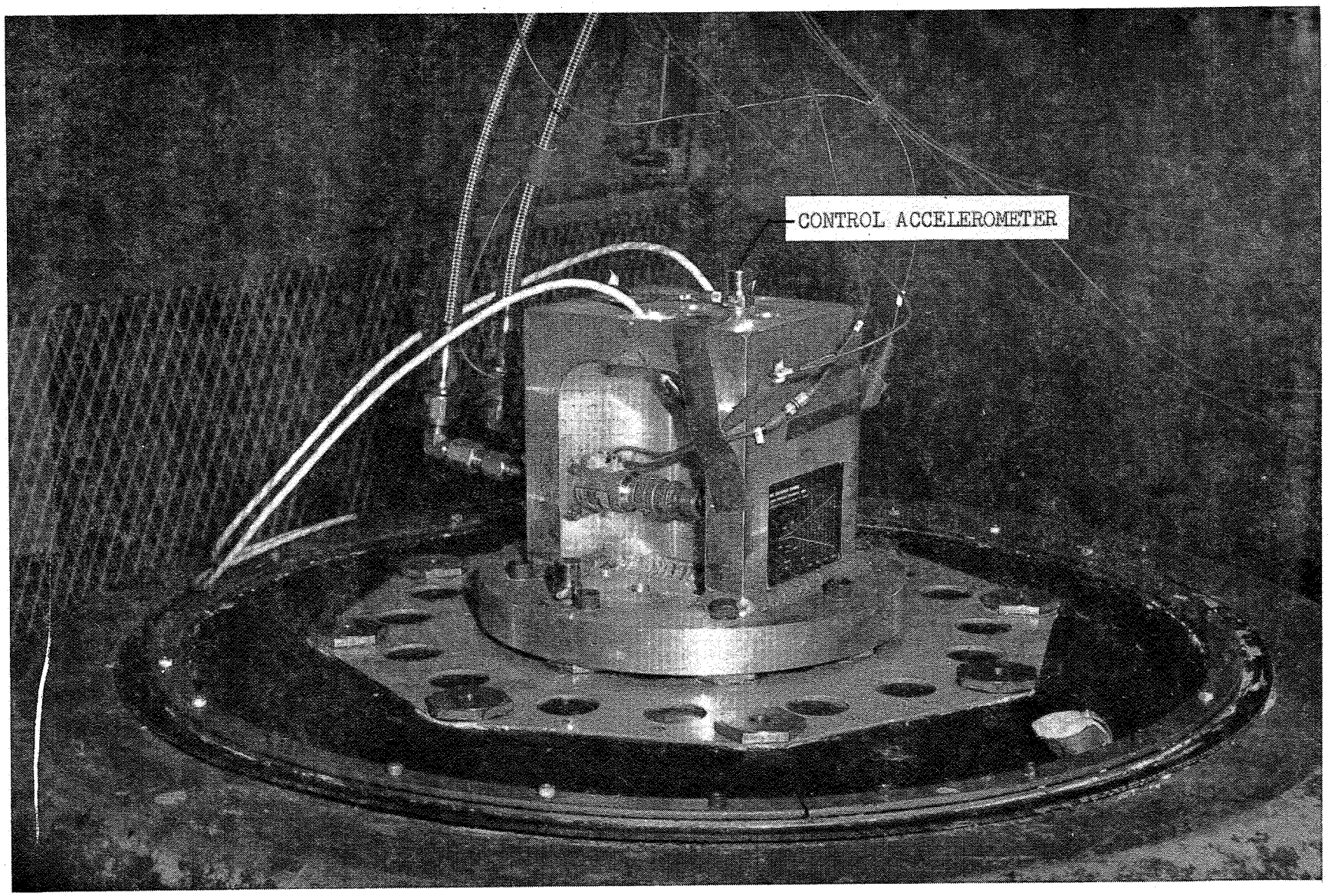


Figure 8-5 Vibration Setup (Y-Axis)

SECTION IX

HUMIDITY TEST

9.1 TEST REQUIREMENTS

9.1.1 A humidity test shall be performed on test specimens 1 and 2 to determine whether the environment causes degradation or deterioration of the specimens.

9.1.2 The specimens shall be exposed to the humidity environment for a period of 240 hours.

9.1.3 A functional test as prescribed in section V shall be performed before the test (if more than 72 hours has elapsed since the last functional test) and within 1 hour after completion of the humidity test. The response time portion of the test may be omitted.

9.1.4 The humidity test shall be conducted in accordance with section 12 of KSC-STD-164(D).

9.2 TEST PROCEDURE

9.2.1 A functional test was performed prior to placing the specimens in the humidity chamber.

9.2.2 The test specimens were placed in the humidity chamber with the initial temperature between 68 and 100°F, uncontrolled humidity.

9.2.3 During the first 2-hour period the chamber temperature was increased to 160°F and the relative humidity was increased to 95 (-0, +5) percent. The temperature and humidity were maintained for a 6-hour period.

9.2.4 During the next 16 hours the temperature was reduced at a linear rate to ambient while maintaining the 95 percent relative humidity.

9.2.5 The steps taken in 8.2.3 and 8.2.4 were repeated 9 times for a total exposure of 240 hours.

9.2.6 At the conclusion of the test the specimens were removed from the chamber and a functional test was performed.

9.3 TEST RESULTS

9.3.1 The insulation resistance was greater than 20 megohms for all test measurements.

9.3.2 Test specimen 1 was out of tolerance (linearity) before the humidity test. Test specimen 2 was out of tolerance (linearity) before and after the humidity test.

9.3.3 The output readings of specimen 1 were out of tolerance (repeatability) at 250 and 750 psia (increasing pressure) before the humidity test and at 250 psia (decreasing pressure) after the humidity test. Specimen 2 was out of tolerance at 250 psia (increasing and decreasing pressure) before the humidity test.

9.3.4 The maximum hysteresis of the test specimens was less than 2.5 percent of the output reading at 2000 psia.

9.4 TEST DATA

9.4.1 The calculated and measured calibration points of the test specimens are presented in tables 9-1 and 9-2. The end points recorded during the functional test performed before the humidity test were used to calculate the calibration points.

9.4.2 Linearity of the specimens (0 to 1985 psig) is shown in figures 9-1 and 9-2.

9.4.3 The total resistance and wiper range of the specimens are presented in tables 9-1 and 9-2.

Table 9–1. Humidity Test ,Functional Data for Specimen 1

Pressure		Calculated Calibration Points (ohms)	Measured Calibration Points (ohms)	
psig	psia		Before Test	After Test
0	15	45	45	49
235	250	268	270	271
485	500	506	515	510
735	750	744	758	752
985	1000	982	999	995
1235	1250	1220	* 1240	1237
1485	1500	1458	1477	1476
1735	1750	1696	* 1718	1711
1985	2000	1934	1934	1932
1735	1750	1719	1719	1711
1485	1500	1478	1481	1476
1235	1250	1236	1246	1244
985	1000	995	1001	1001
735	750	754	762	758
485	500	513	520	518
235	250	272	275	277
0	15	45	45	49
Total Resistance (ohms)			1928	1932

* Out of tolerance

Table 9-2. Humidity Test Functional Data for Specimen 2

Pressure		Calculated Calibration Points (ohms)	Measured Calibration Points (ohms)	
psig	psia		Before Test	After Test
0	15	43	43	43
235	250	263	266	264
485	500	497	505	497
735	750	731	* 751	747
985	1000	966	* 989	* 988
1235	1250	1200	1199	1198
1485	1500	1434	1436	1433
1735	1750	1668	1679	1674
1985	2000	1902	1902	1895
1735	1750	1681	1681	1672
1485	1500	1445	1442	1433
1235	1250	1209	1207	1205
985	1000	973	* 994	* 996
735	750	737	* 759	* 757
485	500	501	510	509
235	250	265	273	276
0	15	43	43	43
Total Resistance (ohms)			1913	1912

* Out of tolerance

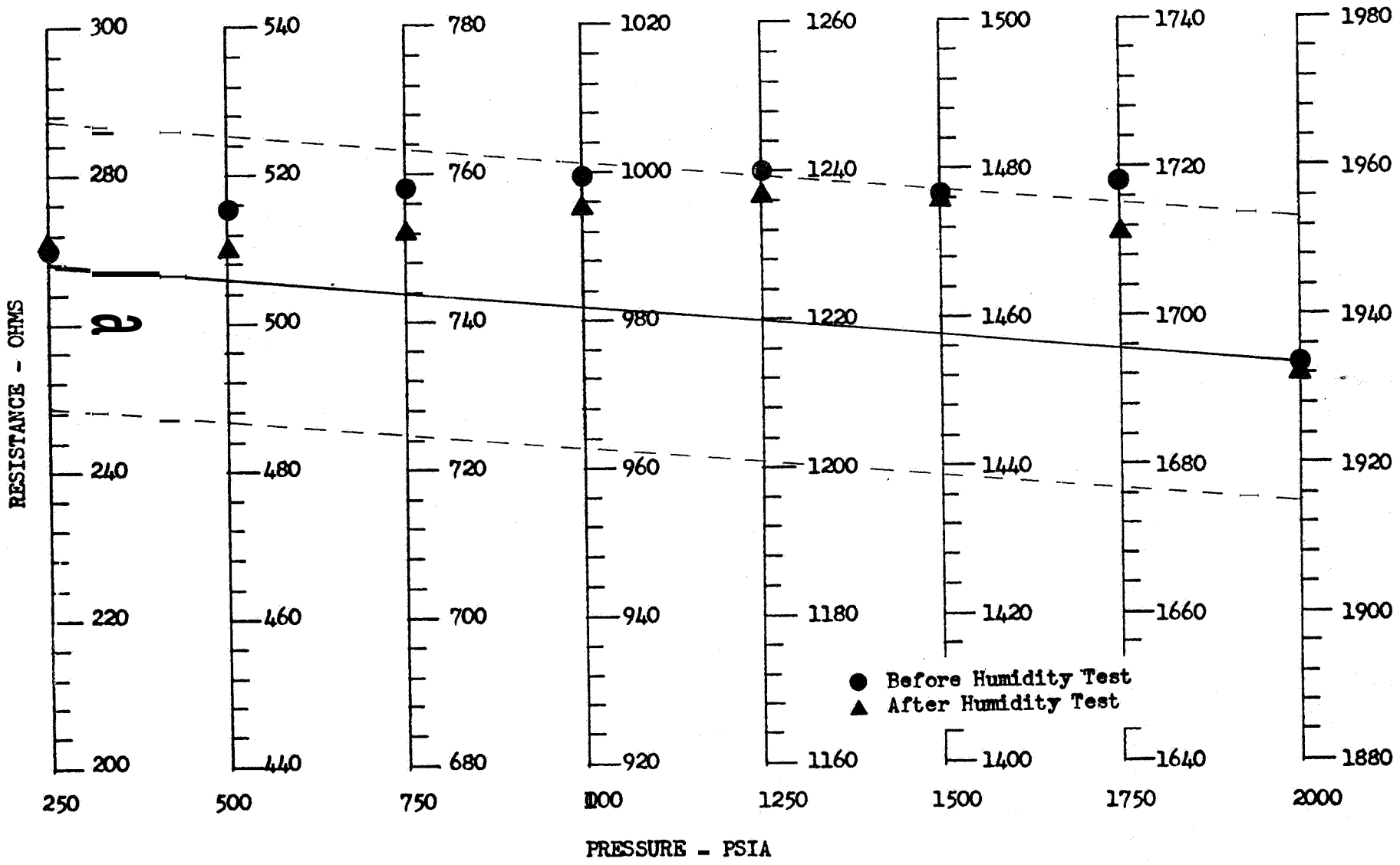


Figure 9-1. Humidity Test Linearity (Specimen 1)

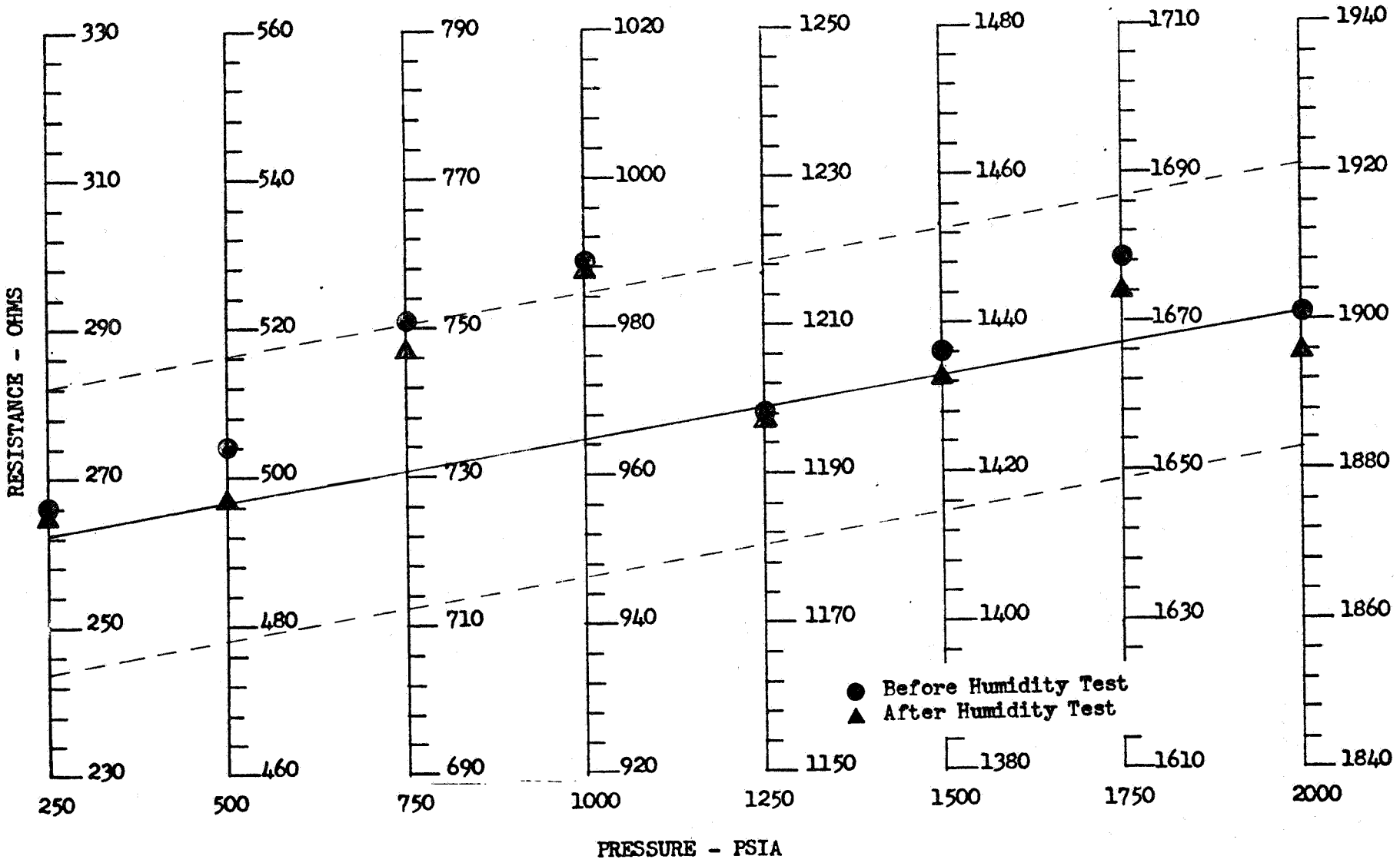


Figure 9-2. Humidity Test Linearity (Specimen 2)

SECTION X

SALT FOG TEST

10.1 TEST REQUIREMENTS

10.1.1 Test specimens 1 and 2 shall be subjected to a salt fog test to determine the extent of the degradation or deterioration resulting from the environmental exposure.

10.1.2 The test shall be conducted in accordance with section 17 of KSC-STD-164(D).

10.1.3 The salt solution shall be a 5 percent by weight mixture and shall have a pH factor of 6.5 to 7.2. The test temperature shall be 95 (-4, +2)°F.

10.1.4 A functional test as prescribed in section V shall be performed prior to exposure (if more than 72 hours has elapsed since the last functional test) and within 1 hour after removal from the salt fog environment. The response time portion of the test may be omitted.

10.2 TEST PROCEDURE

10.2.1 The test specimens were inspected for corrosion, dirt, and oily films prior to the salt fog test and were cleaned before being installed in the salt fog chamber.

10.2.2 The specimens were placed in the chamber in a manner which would permit the fog to reach all sides of the specimens without condensate dripping on them.

10.2.3 The specimens were exposed to the salt fog environment for 240 hours.

10.2.4 A functional test was performed according to 10.1.4 after removal from the chamber.

10.2.5 The specimens were visually inspected for rust and corrosion.

10.3 TEST RESULTS

10.3.1 The panel side of the mounting flange was rusted on both specimens.

10.3.2 The insulation resistance was greater than 20 megohms for all test measurements.

10.3.3 Test specimen 1 was out of tolerance (linearity) at one calibration point after the salt fog test. Test specimen 2 was out of tolerance before and after the salt fog test.

10.3.4 The maximum hysteresis of the test specimens was less than 2.5 percent of the output reading at 2000 psia.

10.4 TEST DATA

10.4.1 The calculated and measured calibration points of the test specimens are presented in tables 10-1 and 10-2. The end points recorded during the functional test performed before the salt fog test were used to calculate the calibration points.

10.4.2 Linearity of the test specimens (0 to 1985 psig) is shown in figures 10-1 and 10-2.

10.4.3 The total resistance and wiper range of the test specimens are presented in table 10-1 and 10-2.

Table 10-1. Salt Fog Test Functional Data for Specimen 1

Pressure		Calculated Calibration Points (ohms)	Measured Calibration Points (ohms)	
psig	psia		Before Test	After Test
0	15	49	49	49
235	250	272	271	264
485	500	509	510	514
735	750	746	752	755
985	1000	983	995	997
1235	1250	1220	1237	1237
1485	1500	1458	1476	1474
1735	1750	1695	1711	* 1726
1985	2000	1932	1932	1937
1735	1750	1711	1711	1722
1485	1500	1471	1476	1482
1235	1250	1232	1244	1246
985	1000	992	1001	1009
735	750	753	758	764
485	500	513	518	523
235	250	274	277	275
0	15	49	49	49
Total Resistance (ohms)			1932	1926

* Out of tolerance

Table 10-2. Salt Fog Test Functional Data for Specimen 2

Pressure		Calculated Calibration Points (ohms)	Measured Calibration Points (ohms)	
psig	psia		Before Test	After Test
0	15	43	43	44
235	250	262	264	264
485	500	495	497	502
735	750	729	747	* 751
985	1000	962	* 988	* 987
1235	1250	1195	1198	1197
1485	1500	1428	1433	1439
1735	1750	1662	1674	* 1686
1985	2000	1895	1895	1907
1735	1750	1672	1672	* 1688
1485	1500	1437	1433	1447
1235	1250	1202	1205	1211
985	1000	968	996	**
735	750	733	* 757	* 761
485	500	498	509	512
235	250	264	276	273
0	15	43	43	44
Total Resistance (ohms)			1912	1910

* Out of tolerance
** Data not available

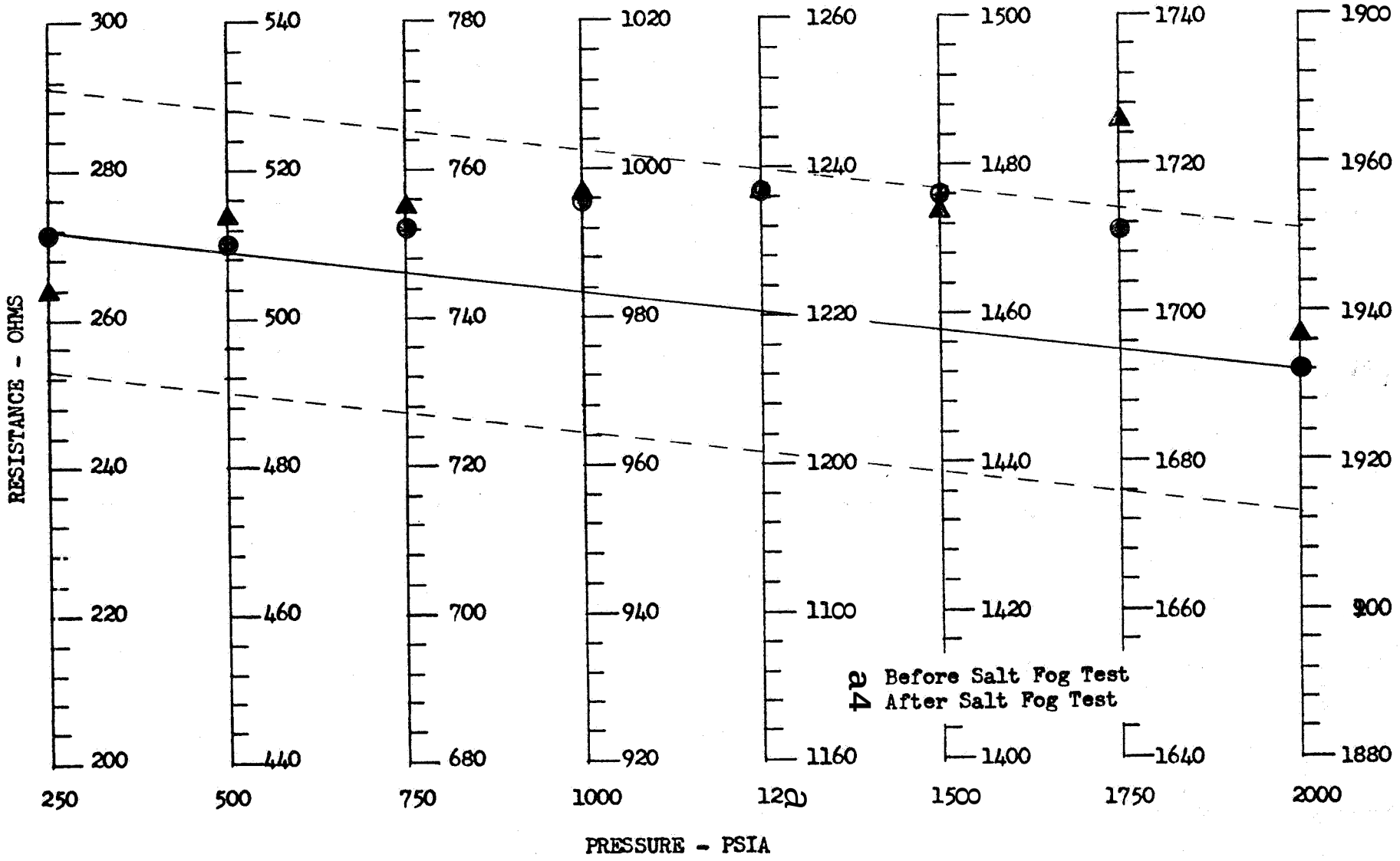


Figure 10-1. Salt Fog Test Lin[illegible] (Specimen 1]

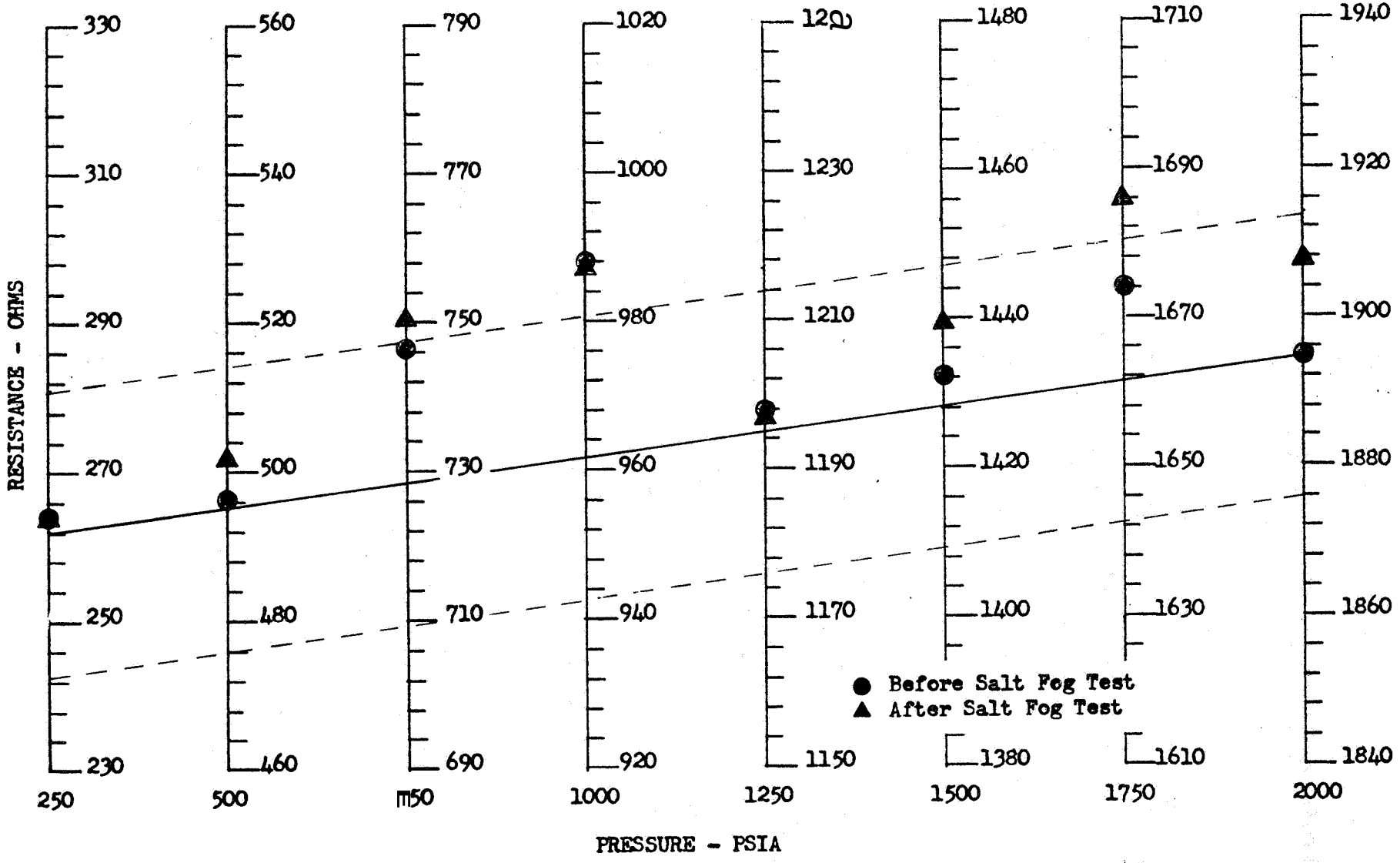


Figure 10-2. Salt Fog Test Linearity (Specimen 2)

SECTION XI

SAND AND DUST TEST

11.1 TEST REQUIREMENTS

11.1.1 A sand and dust test shall be performed on test specimens 2 and 3 to determine if the environment causes degradation or deterioration of the specimens.

11.1.2 The test shall be conducted in accordance with section 16 of KSC STD-164(D).

11.1.3 A functional test as prescribed in section V shall be performed before the test (if more than 72 hours has elapsed since the last functional test) and after completion of the sand and dust test. The response time portion of the test may be omitted.

11.2 TEST PROCEDURE

11.2.1 A functional test was performed on the test specimens prior to the sand and dust test.

11.2.2 The test specimens were placed in the sand and dust test chamber. The temperature was increased to and maintained at 77°F for a period of 2 hours.

11.2.3 At the completion of the 2-hour period, the temperature was increased to and maintained at 160°F for an additional 2-hour period.

11.2.4 The temperature was returned to ambient and the specimens were removed from the chamber.

11.2.5 The sand and dust density within the chamber was maintained between 0.1 and 0.5 gram per cubic foot and the sand and dust velocity was maintained between 100 and 500 feet per minute.

11.2.6 A functional test was performed after the sand and dust test.

11.3 TEST RESULTS

11.3.1 Visual inspection of the test specimens revealed no evidence of deterioration.

11.3.2 The insulation resistance was greater than 20 megohms for all test measurements.

11.3.3 Test specimen 2 was out of tolerance (linearity) before and after the sand and dust test.

11.3.4 The output readings of specimen 2 were out of tolerance (repeatability) at 0 and 235 psig (increasing pressure) and at 0 psig (decreasing pressure) after the sand and dust test. Specimen 3 was out of tolerance at 0 psig (increasing and decreasing pressure) before and after the sand and dust test and at 235 psig

after the test.

11.3.5 The maximum hysteresis of the test specimens was less than 2.5 percent of the output reading at 2000 psia.

11.4 TEST DATA

11.4.1 The calculated and measured calibration points of the test specimens are presented in tables 11-1 and 11-2. The end points recorded during the functional test performed before the sand and dust test were used to calculate the calibration points.

11.4.2 Linearity of the test specimens (0 to 1985 psig) is shown in figures 11-1 and 11-2.

11.4.3 The total resistance and wiper range of the test specimens are presented in tables 11-1 and 11-2.

Table 11-1. Sand and Dust Test Functional Data for Specimen 2

Pressure		Calculated Calibration Points (ohms)	Measured Calibration Points (ohms)	
psig	psia		Before Test	After Test
0	15	44	44	44
235	250	264	264	264
485	500	499	502	501
735	750	734	751	750
985	1000	968	987	* 989
1235	1250	1203	1197	1198
1485	1500	1438	1439	1437
1735	1750	1672	1686	1679
1985	2000	1907	1907	1900
1735	1750	1688	1688	1681
1485	1500	1451	1447	1442
1235	1250	1214	1211	1204
985	1000	977	**	* 999
735	750	740	* 761	* 760
485	500	503	512	511
235	250	267	273	273
0	15	44	44	44
Total Resistance (ohms)			1910	1909

* Out of tolerance
** Data not available

Table **11-2.** Sand and **Dust Test Functional Data for Specimen 3**

Pressure		Calculated Calibration Points (ohms)	Measured Calibration Points (ohms)	
psig	psia		Before Test	After Test
0	15	59	59	61
235	250	288	288	288
485	500	531	537	536
735	750	774	786	787
985	1000	1017	1033	1033
1235	1250	1260	1250	1252
1485	1500	1504	1495	1499
1735	1750	1747	1743	1746
1985	2000	1990	1990	1991
1735	1750	1750	1750	1751
1485	1500	1506	1502	1505
1235	1250	1263	1259	1261
985	1000	1019	1035	1035
735	750	785	796	797
485	500	531	547	541
235	250	288	298	294
0	15	59	59	62
Total Resistance (ohms)			2001	2010

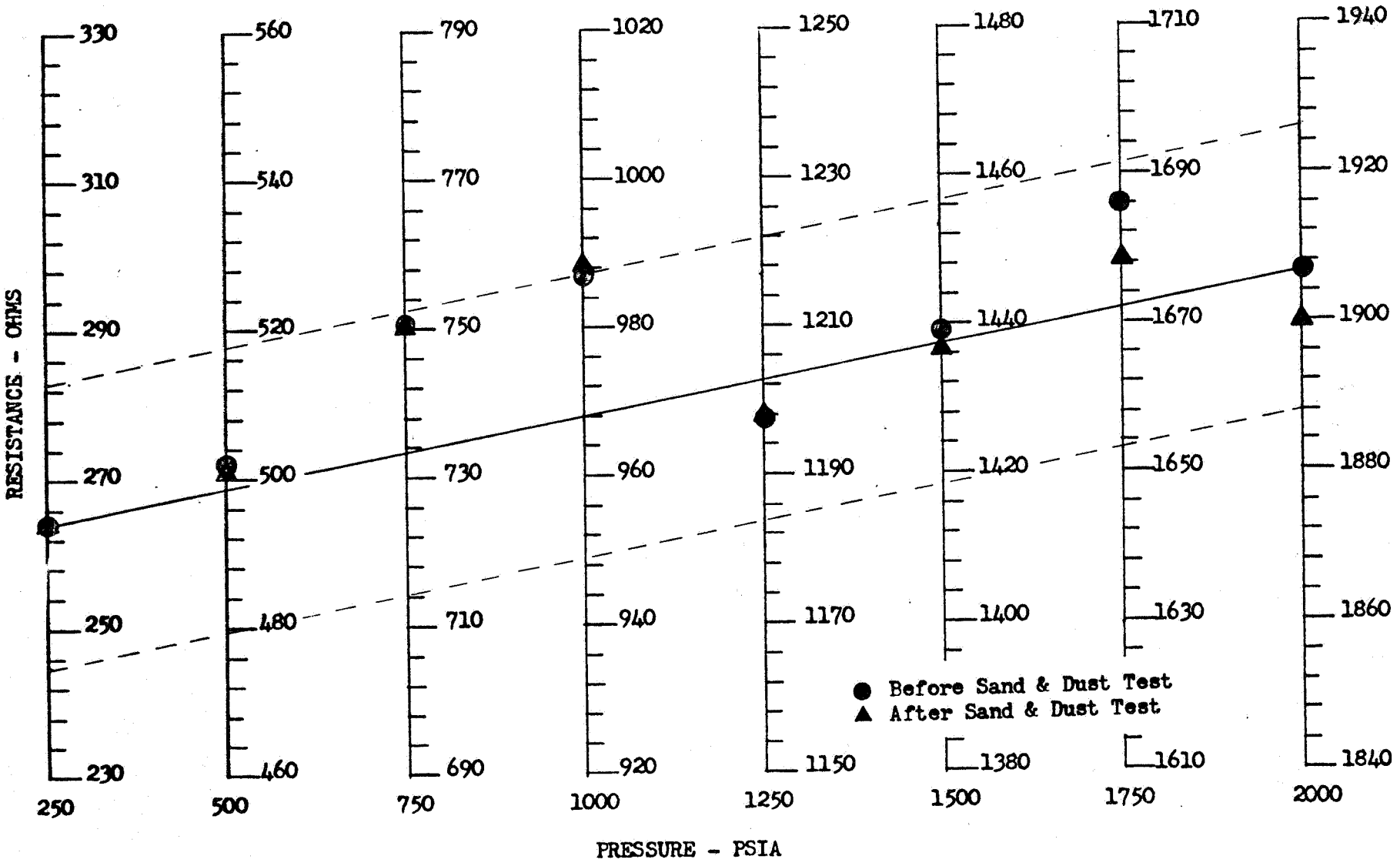


Figure 11-1. Sand and Dust Test Linearity (Specimen 2)

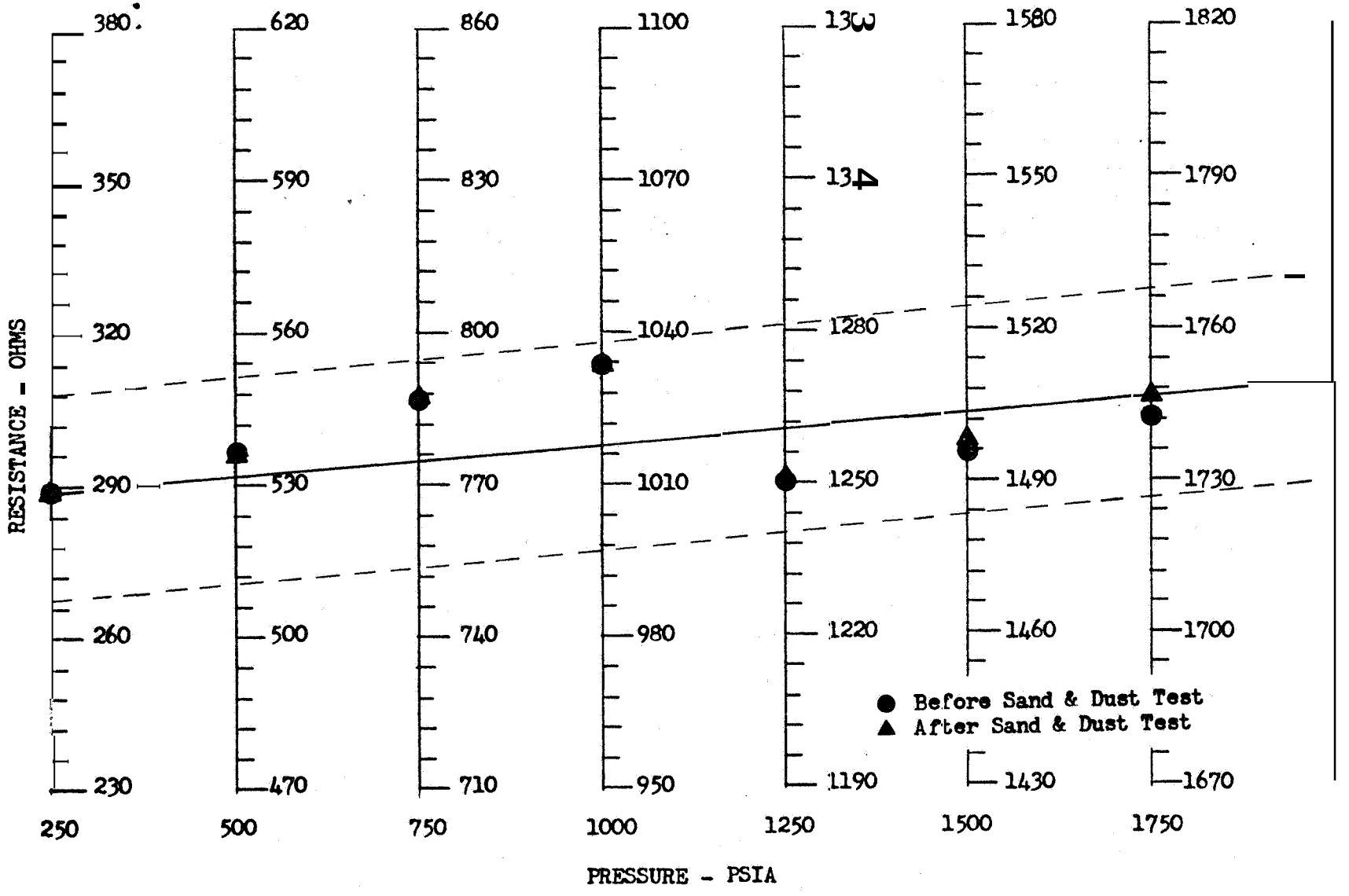


Figure 11-2. Sand and Dust Test Linearity (Specimen 3)

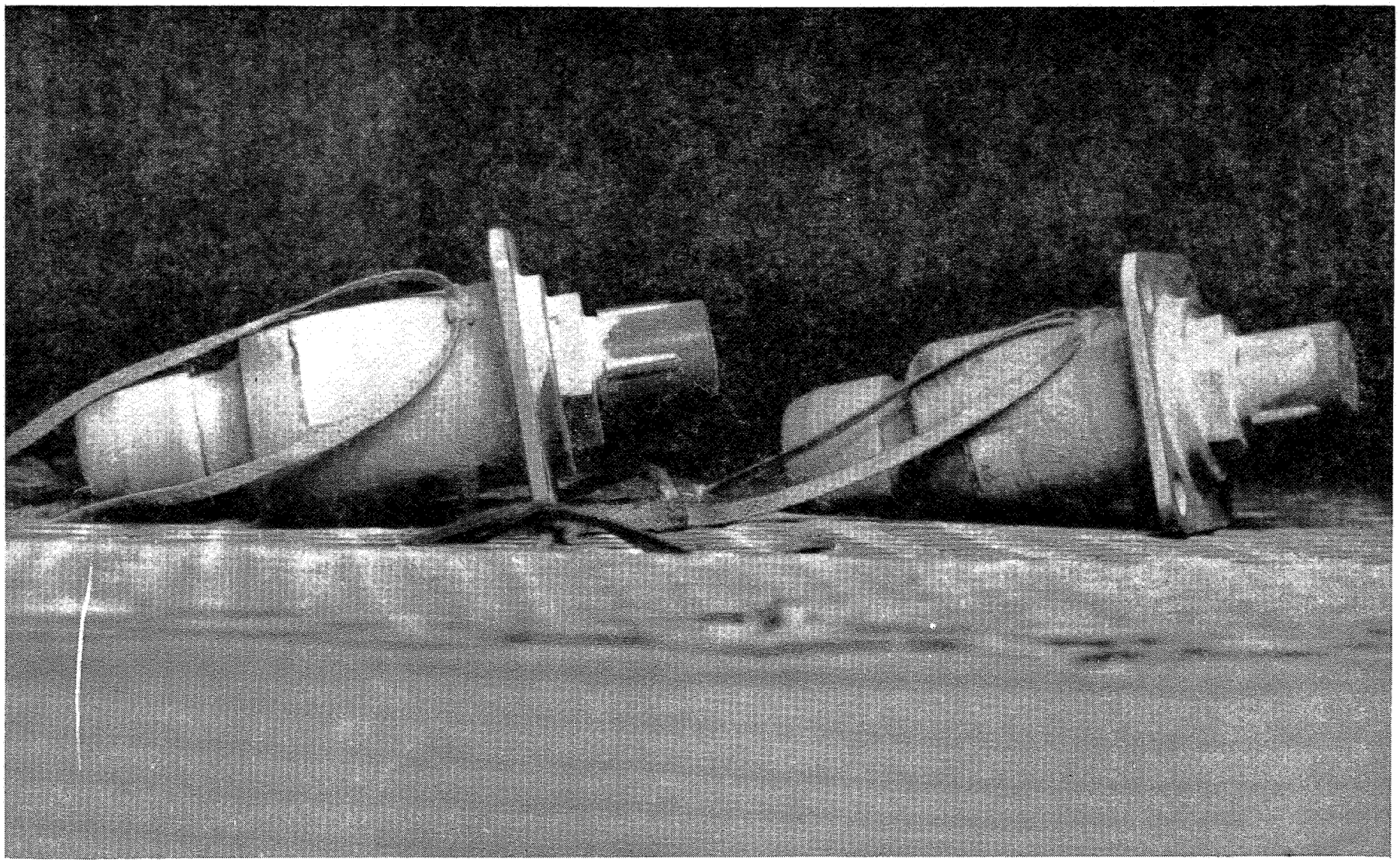


Figure 11-3. Sand and Dust Test Setup

SECTION XII

EXPLOSION TEST

12.1 TEST REQUIREMENTS

12.1.1 Test specimen 1 shall be subjected to an explosion test (ignition proof test) to determine the explosion-producing characteristics of the specimens when operated in an explosive atmosphere.

12.1.2 The explosive mixture shall be composed of 32(±5) percent by volume of hydrogen-in-air, and the test chamber pressure shall be 13.1 psig at a temperature of 160 (-4, +2)°F.

12.1.3 The specimen shall be operated while in the explosive atmosphere, using gaseous helium as the pressure medium.

12.1.4 A functional test shall be performed after the explosion test is completed.

12.2 TEST PROCEDURE

12.2.1 The specimen was placed in the test chamber and all necessary electrical and pneumatic systems were connected.

12.2.2 The temperature within the test chamber was stabilized at 160°F and the pressure was decreased to 13.1 psia.

12.2.3 The explosive atmosphere was injected into the chamber and the internal pressure was adjusted to 13.1 psia.

12.2.4 The specimen was operated through a range of 0 to 1985 psig with 28 vdc applied to pins A and C.

12.2.5 The explosive atmosphere was verified and the chamber pressure was adjusted to 14.7 psia. Paragraph 12.2.4 was repeated.

12.2.6 The explosive atmosphere was verified and the chamber was purged with gaseous nitrogen.

12.3 TEST RESULTS

12.3.1 The specimen operated successfully in the specified explosive atmosphere.

12.3.2 The test specimen was out of tolerance (linearity) at one calibration point before the explosion test.

12.4 TEST DATA

12.4.1 The calculated and measured calibration points of the test specimens are presented in table 12-1. The end points recorded during the functional test performed before the explosion test were used to calculate the calibration points.

12.4.2 Linearity of the test specimen (0 to 1985 psig) is shown in figure 12-1.

12.4.3 The total resistance and wiper range of the specimen are presented in table 12-1.

Table 12–1. Explosion Test Functional Data for Specimen 1

Pressure		Calculated Calibration Points (ohms)	Measured Calibration Points (ohms)	
psig	psia		Before Test	After Test
0	15	49	49	42
235	250	272	264	270
485	500	510	514	517
735	750	748	755	756
985	1000	986	997	999
1235	1250	1224	1237	1239
1485	1500	1461	1474	1476
1735	1750	1699	* 1726	1713
1985	2000	1937	1937	1936
1735	1750	1722	1722	1720
1485	1500	1481	1482	1479
1235	1250	1240	1246	1243
985	1000	999	1009	1003
735	750	758	764	762
485	500	517	523	521
235	250	276	275	275
0	15	49	49	46
Total Resistance (ohms)			1926	1939

* Out of tolerance

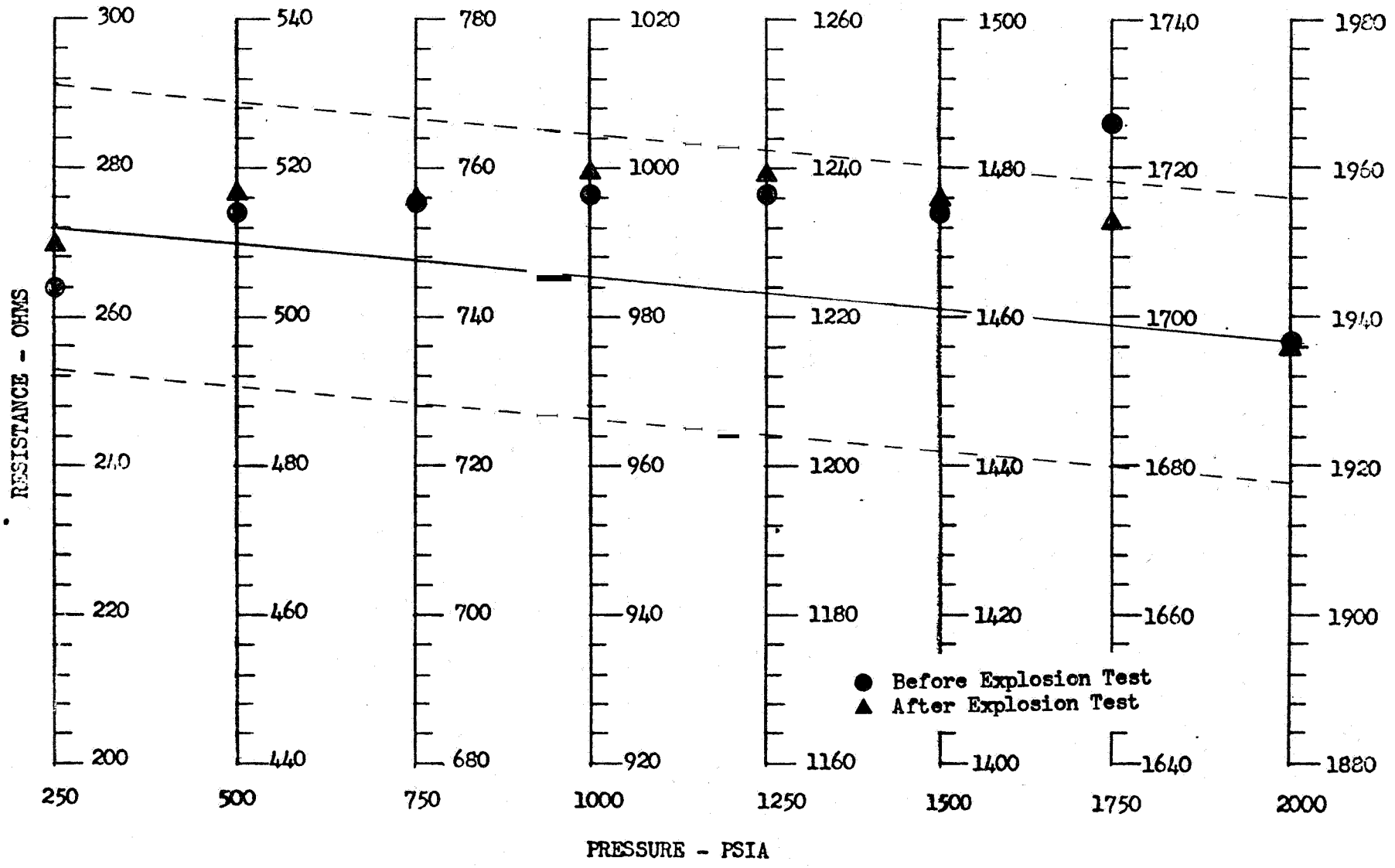


Figure 12-1. Explosion Test Linearity (Specimen 1)

SECTION XIII

CYCLE TEST

13.1 TEST REQUIREMENTS

13.1.1 The test specimens shall be subjected to 80,000 cycles of operation. A cycle shall consist of pressurizing the specimen through the range of zero to 1985 to zero psig.

13.1.2 Specimens 1 and 2 shall have 28 vdc applied to pins A and C of J1. Specimen 3 shall have 5 vdc applied to the same pins.

13.1.3 The output of the test specimens shall be continuously monitored.

13.1.4 A functional test as prescribed in section V shall be performed prior to the cycle test (if more than 72 hours has elapsed since the last functional test) and at 500, 1000, 5000, 10,000, and 80,000 cycles. The response time portion of the test may be omitted.

13.1.5 A seal leakage test as prescribed in section IV shall be performed after the cycle test.

13.2 TEST PROCEDURE

13.2.1 The test setup was assembled as shown in figure 13-1 using the equipment listed in table 13-1.

13.2.2 The repeat cycle timers were adjusted so that each cycle had a time duration of 4 seconds (pressurized for 2 seconds, depressurized for 2 seconds).

13.2.3 Pressure regulator 3 was adjusted to limit the pressure to the test specimens at 1985 psig.

13.2.4 The test specimens were monitored for proper operation during the cycle test.

13.2.5 Functional tests were performed as prescribed in 13.1.4.

13.2.6 Voltage calibration measurements were recorded on the strip chart recorders after each 10,000 cycles of operation.

13.3 TEST RESULTS

13.3.1 The output voltage of specimen 1 began to fluctuate at 235 psig (increasing and decreasing pressure) after 70,000 cycles of operation.

13.3.2 The output voltage of specimen 2 began to fluctuate between 900 and 1100 psig (increasing and decreasing pressure) after 500 cycles of operation. After 4800 cycles there was no output voltage at zero psig. There was no output voltage (open circuit) at 985 psig (decreasing pressure) during the voltage calibration

tests performed at 20, 30, 40, and 80 thousand cycles. The resistance measured during the functional test performed after the cycle test was within the specified tolerance at zero psig and was zero (open circuit) at 985 psig (decreasing pressure).

13.3.3 The output voltage of specimen 3 began to fluctuate between 900 and 1100 psig (increasing and decreasing pressure) after 500 cycles of operation. There was no output voltage at 985 psig (increasing and decreasing pressure) during the voltage calibration tests after each 10,000 cycles. The resistance measured during the functional test performed after the cycle test was zero (open circuit) at 985 psig decreasing pressure.

13.3.4 Specimen 1 was out of tolerance (linearity) at one calibration point before the cycle test and at 500 cycles and was out of tolerance at two calibration points at 1000, 5000, and 10,000 cycles. Specimen 2 was out of tolerance at two calibration points before the cycle test, one calibration point at 5000 cycles, and five calibration points at 80,000 cycles.

13.3.5 The maximum hysteresis of the specimens was less than 2.5 percent of the output reading at 2000 psia.

13.4 TEST DATA

13.4.1 The calculated and measured calibration points of the specimens are presented in tables 13-2, 13-3, and 13-4. The end points recorded 'during the functional test performed before the cycle test were used to calculate the calibration points.

13.4.2 Linearity of the specimens (0 to 1985 psig) is shown in figures 13-2, 13-3, and 13-4.

13.4.3 The total resistance and wiper range of the specimens are presented in tables 13-2, 13-3, and 13-4.

13.4.4 Out of tolerance repeatability measurements are presented in table 13-5.

Table 13-1. Cycle Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Giannini Controls Corporation	461319	278-8, 278-10, 278-13	Pressure Transducer
2	Gaseous Nitrogen Supply	NA	NA	NA	3100 psi
3	Pressure Regulator	Grove	15LHX	NA	3100 psi
4	Pressure Gage	Seegers	SS2170-4000	S-1771	0-to 4000-psig ±0.1% FS Cal date 7-1-67
5	Solenoid Valve	Marotta Valve Corp.	MV100	NA	3000 psi, NC
6	Solenoid Valve	Marotta Valve Corp.	MV109	NA	3000 psi, NC
7	Repeat Cycle Timers	Industrial Timer Corp.	ET-15S	NA	2 seconds each
8	Strip Chart Recorder	Westronics, Inc.	D11AT/U.5	D11A1220	3 pens
9	Power Supply	Kepco	SM-36-5M	C-40222	50-vdc, 5 amp
10	Hand Valve	Robbins	ANA 250-4T	NA	1/4-in.
11	Hand Valve	Robbins	ANA 250-4T	NA	1/4-in.
12	Hand Valve	Robbins	ANA 250-4T	NA	1/4-in.
13	Hand Valve	Robbins	ANA 250-4T	NA	1/4-in.

Table 13-2. Cycle Test Functional Data for Specimen 1

Pressure		Calculated Calibration Points	Measured Calibration Points (ohms)					
			Cycles of Test					
psig	psia	ohms	0	500	1000	5000	10,000	80,000
0	15	42	42	43	43	53	49	52
235	250	266	270	271	272	274	274	264
485	500	505	517	516	515	518	518	495
735	750	745	756	758	760	759	758	740
985	1000	982	999	998	1000	1000	1001	979
1235	1250	1220	1239	1239	* 1240	* 1241	* 1241	1220
1485	1500	1459	* 1476	1478	1478	1477	1476	1457
1735	1750	1697	1713	* 1718	* 1717	* 1718	* 1719	1695
1985	2000	1936	1936	1938	1938	1938	1940	1920
1735	1750	1720	1720	1723	1722	1722	1726	1703
1485	1500	1479	1479	1485	1483	1481	1485	1464
1235	1250	1237	1243	1244	1245	1246	1246	1226
935	1000	996	1003	1004	1005	1003	1006	987
735	750	755	762	764	763	764	765	748
485	500	514	521	523	522	525	523	501
235	250	273	275	278	277	279	284	270
0	15	46	46	47	53	58	57	52
Total Resistance (ohms)			1939	1932	1938	1938	1940	**

* Out of tolerance
** Data not available

Table 13-3. Cycle Test Functional Data for Specimen 2

Pressure		Calculated Calibration Points	Measured Calibration Points (ohms)					
			Cycles of Test					
psig	psia	ohms	0	500	1000	5000	10,000	80,000
0	15	43	43	43	43	43	46	* 67
235	250	263	266	262	263	261	265	259
485	500	498	505	506	506	511	506	506
735	750	732	749	750	749	749	749	* 752
985	1000	967	* 994	984	985	* 988	985	984
1235	1250	1201	1205	1203	1201	1200	1198	1187
1485	1500	1436	1443	1441	1440	1434	1436	1428
1735	1750	1670	1681	1678	1675	1677	1673	1670
1985	2000	1905	1905	1900	1900	1892	1893	* 1879
1735	1750	1687	1687	1686	1684	1683	1683	1678
1485	1500	1451	1452	1448	1451	1444	1449	1438
1235	1250	1214	1213	1209	1208	1206	1206	1195
985	1000	978	* 1000	995	993	993	993	0
735	750	742	759	759	757	755	758	757
485	500	505	515	512	512	519	515	515
235	250	269	275	272	269	270	275	267
0	15	47	47	48	48	48	53	* 67
Total Resistance (ohms)			1919	1911	1912	1908	1907	1902

* Out of tolerance

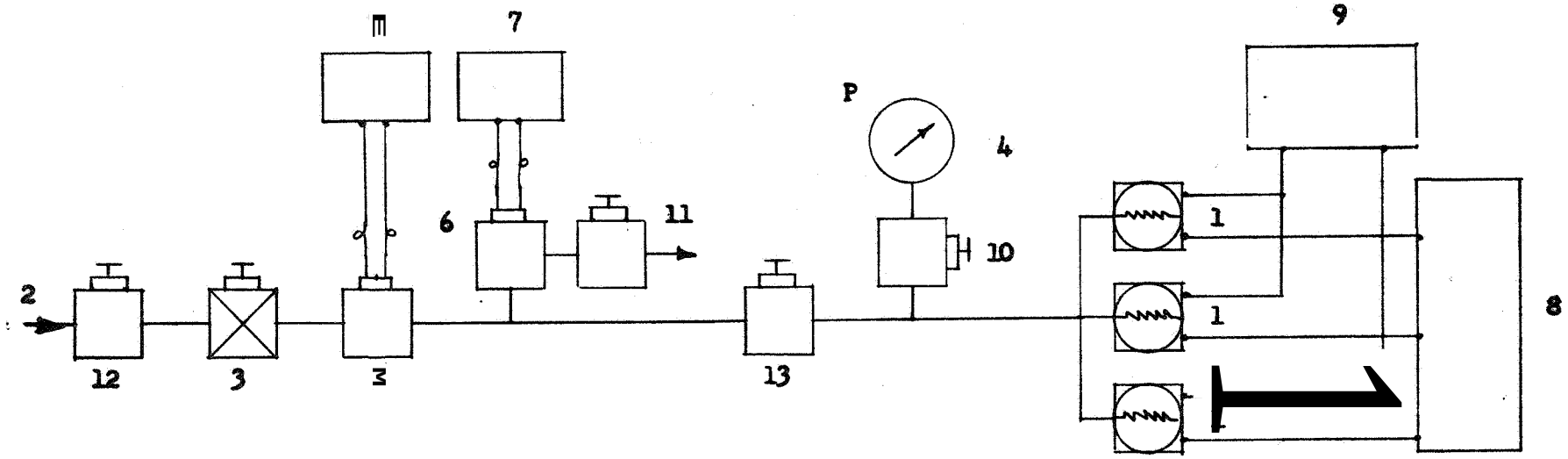
Table 13-4. Cycle Test Functional Data for Specimen 3

Pressure		Calculated Calibration Points	Measured Calibration Points (ohms)					
			Cycles of Test					
psig	psia	ohms	0	500	1000	5000	10,000	80,000
0	15	58	58	58	58	58	58	63
235	250	287	288	286	291	285	286	290
485	500	530	540	540	537	537	537	542
735	750	773	787	787	786	787	782	788
985	1000	1017	1032	1034	1031	1032	1032	1032
1235	1250	1260	1250	1255	1253	1252	1257	1260
1485	1500	1503	1500	1500	1502	1498	1502	1505
1735	1750	1746	1745	1748	1749	1742	1748	1755
1985	2000	1990	1990	1988	1991	1992	1988	1990
1735	1750	1750	1750	1753	1751	1751	1758	1761
1485	1500	1507	1506	1507	1509	1507	1510	1515
1235	1250	1264	1260	1260	1262	1260	1263	1266
985	1000	1021	1033	1035	1037	1036	1035	0
735	750	778	797	792	792	797	792	797
485	500	534	547	547	542	547	546	547
235	250	291	297	297	296	298	298	298
0	15	63	63	63	63	63	63	67
Total Resistance (ohms)			2002	2009	1209	2005	2004	2006

Table 13-5. Repeatability of Specimens **During** Cycle Test Functional Tests

Specimen	Pressure (psig)	Cycles of Operation					
		0	500	1000	5000	10,000	80,000
1	+235	U	U	U	S	S	S
	-235	U	S	U	S	S	S
2	+235	U	S	U	U	U	U
	-485	U	S	S	S	S	S
	-235	U	S	S	S	U	S
3	+235	S	U	U	U	S	S
	+485	U	S	S	S	S	S
	-235	U	U	U	S	S	S

S - Satisfactory
U - Unsatisfactory



Note: All line sizes 1/4 - inch. Refer to Table 13-1 for item identification

Figure 13-1. C le Test Schematic

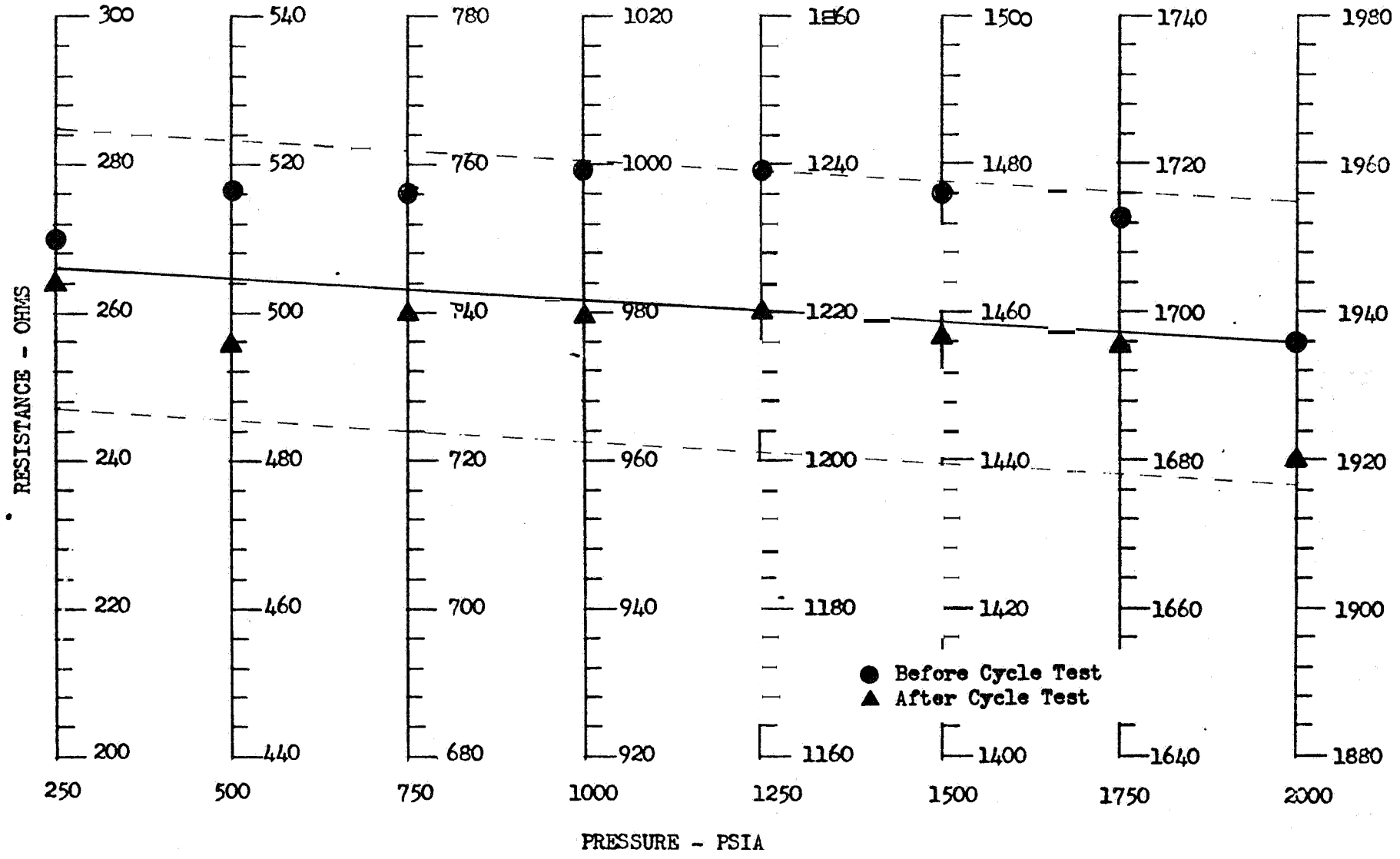


Figure 13-2. Cycle Test Linearity (Specimen 1]

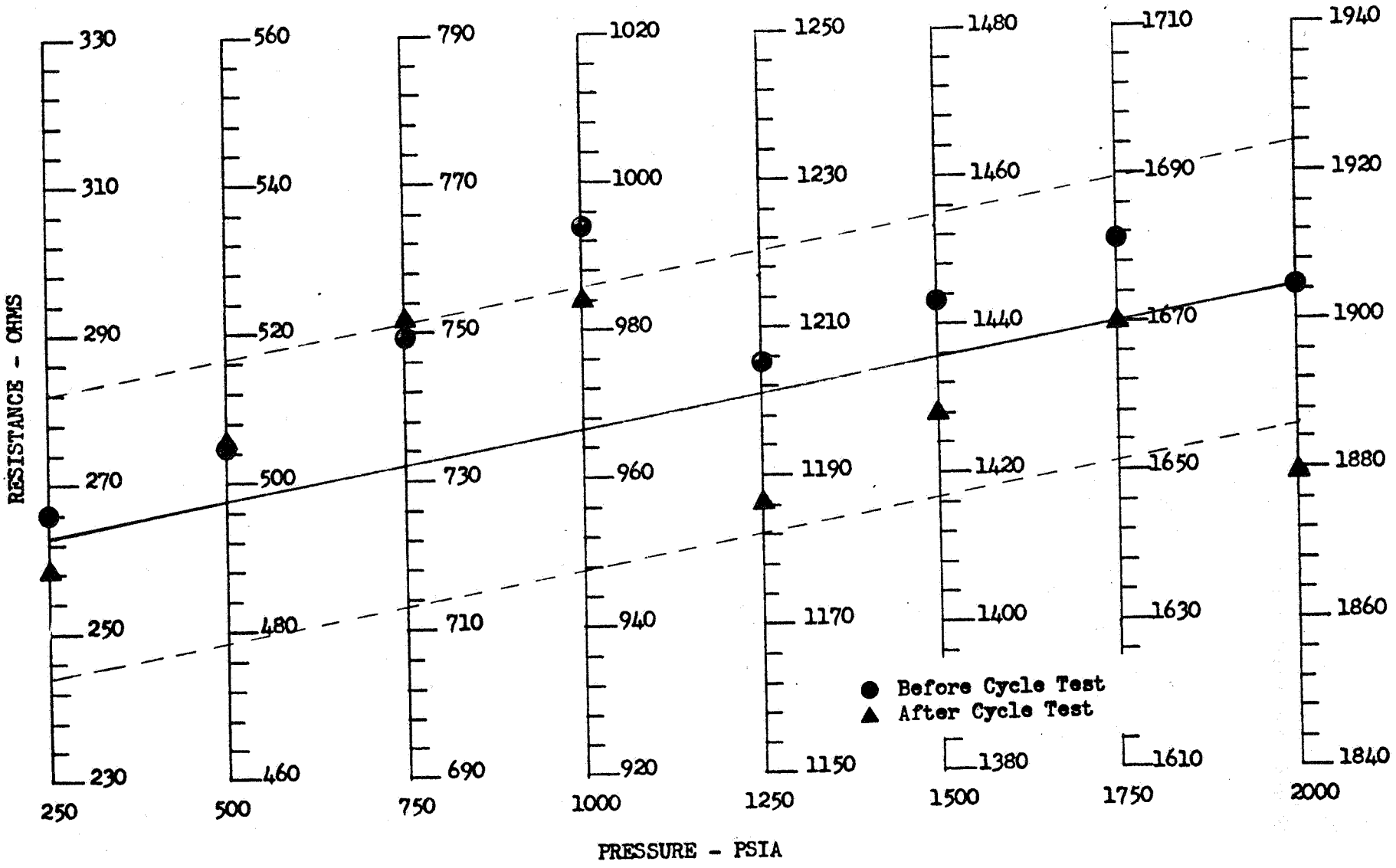


Figure 13-3. Cycle Test Linearity (Specimen 2)

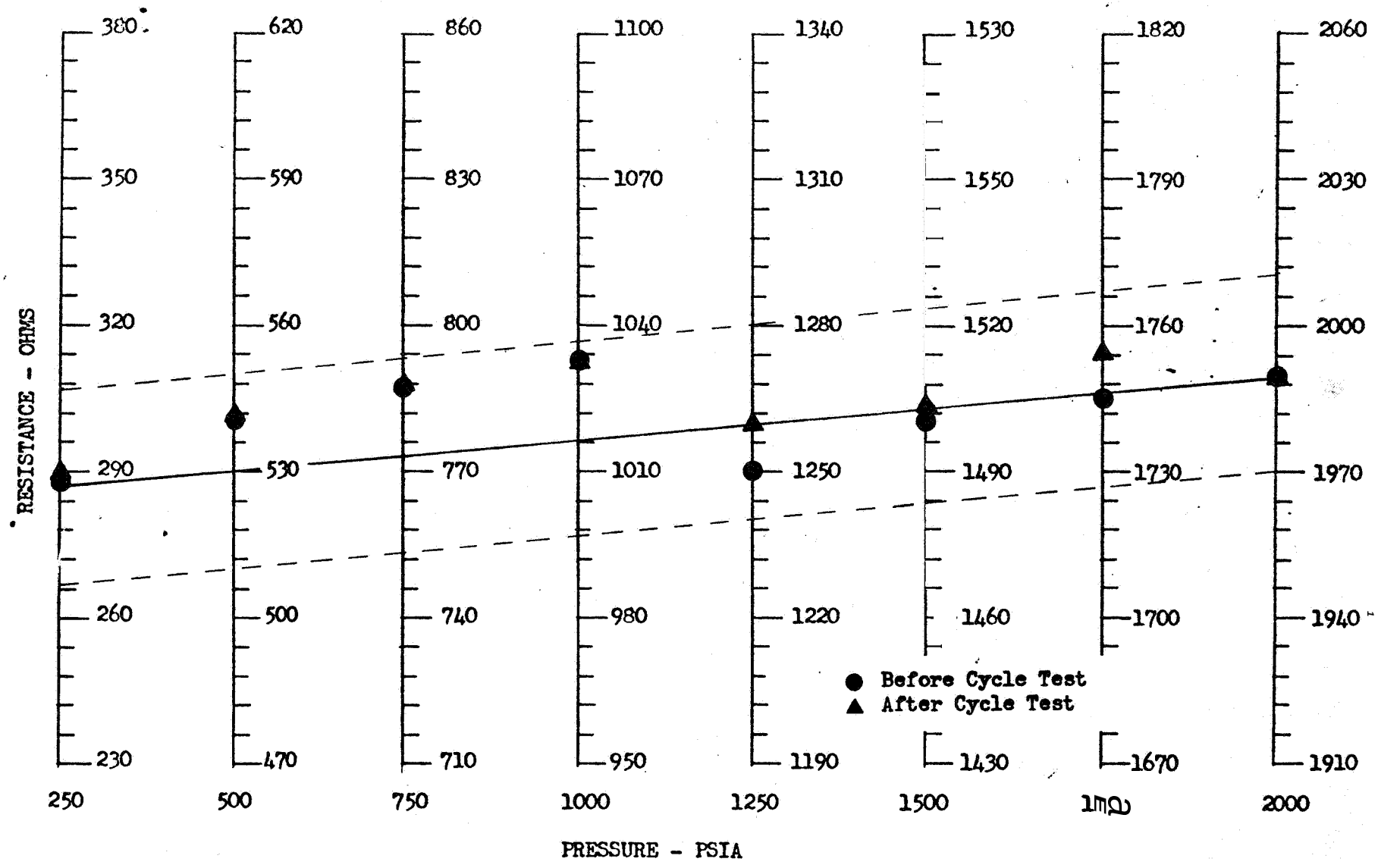


Figure 13-4. Cycle Test Linearity (Specimen 3)

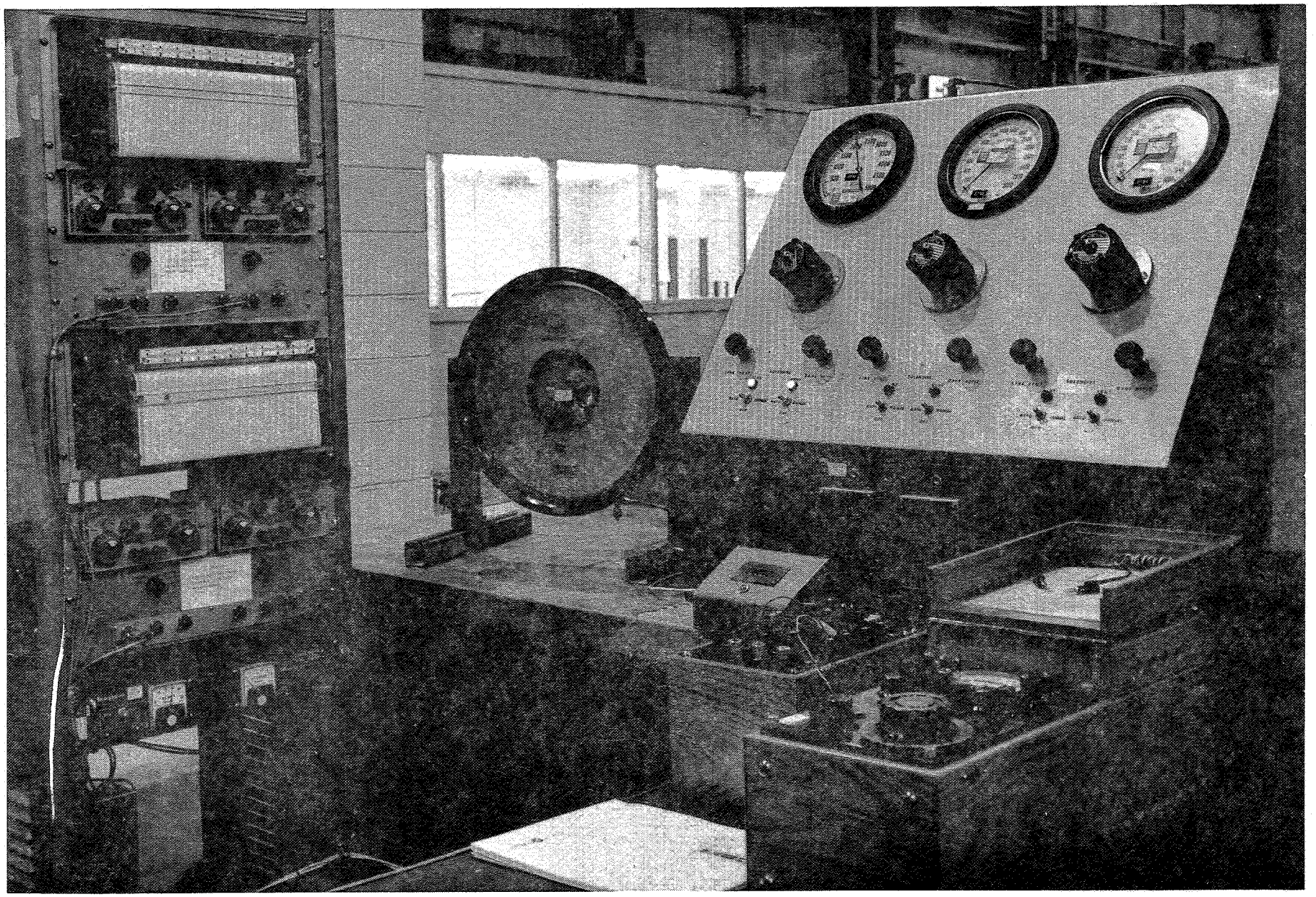


Figure 13-5. Cycle Test Setup

SECTION XIV

BURST PRESSURE TEST

14.1 TEST REQUIREMENTS

14.1.1 A burst pressure test shall be performed on specimens 2 and 3.

14.1.2 The test specimens shall not burst when subjected to a pressure of 5000 psig for 5 minutes.

14.1.3 Hydraulic fluid MIL-H-5606 shall be used as the pressure medium.

14.2 TEST PROCEDURE

14.2.1 Each specimen was placed in the burst chamber and connected to the hydraulic pressure system as shown in figure 3-1.

14.2.2 The pressure was increased to 5000 psig and maintained for 5 minutes.

14.2.3 The specimens were inspected for evidence of cracking or rupture after the test.

14.3 TEST RESULTS

There was no leakage of the specimens and no indication of internal or external

APPROVAL

TEST REPORT

FOR

PRESSURE TRANSDUCER

Giannini Controls Corporation Part Number 461319

NASA Drawing Number 75M51731-8-2000

SUBMITTED BY:

C. L. Foy

C. L. Foy
Test and Evaluation Section

APPROVALS

R. W. Claunch

R. W. Claunch
Program Supervisor

V. J. Vehko

V. J. Vehko, Director
Engineering Department

DISTRIBUTION

Chrysler Corporation Space Division

H. T. O'Bryan	Test and Evaluation Section	2
R. W. Claunch	Program Supervisor, CCSD-Michoud	2
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