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NUCLEAR ROCKET OPERATIONS

SACRAMENTO PLANT

REPORT NO. RN-DR-0130

HUMIDITY TEST
MODEL NT-D1 TURBINE-POWER-CONTROL-VALVE ACTUATOR
QUALIFICATION

NERVA PROGRAM

CONTRACT SNP-1

SEPTEMBER 1967

MIST

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ABSTRACT

A Bendix Model NT-D1 turbine-power-control-valve actuator was subjected to a humidity test to determine if elevated temperature and moisture would adversely affect the performance of the unit. Test data indicated that actuator performance was not significantly affected by the humidity test.

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CONTENTS

	<u>Page</u>
I. Introduction	1
II. Summary	1
III. Technical Discussion	1
IV. Conclusions	4

TABLES

<u>No.</u>	<u>Title</u>	<u>Page</u>
1	Electrical-Resistance Measurements	3
2	Humidity-Test Equipment List	3
3	Humidity Cycle No. 1	4
4	Humidity Cycle No. 2	5
5	Humidity Cycle No. 3	6
6	Humidity Cycle No. 4	7

FIGURES

<u>No.</u>	<u>Title</u>	<u>Page</u>
1	Actuator Mounted on the Test Fixture	8
2	Actuator and Test Fixture Installed in Humidity Chamber	9
3	Temperature and Humidity Profile Relative to Time	10
4	Data Trace, Dry-Bulb and Wet-Bulb Temperatures During Test Cycle	11
5	Humidity Test Cycles; TPCV Actuator	12
6	Bode Plot; Performance Reference Test Before Humidity-Test	13
7	Bode Plot; Performance Reference Test During Humidity-Test	14
8	Bode Plot; Performance Reference Test After Humidity-Test	15

APPENDIX

I. INTRODUCTION

This report describes the humidity test performed on the turbine-power-control-valve actuator (Bendix Part Number 2775030, Model NT-D1) that will be used in the XE-1 and XECF nuclear-rocket-engine tests.

II. SUMMARY

The humidity test was conducted with Serial Number 17 actuator. A performance reference test was conducted before, during, and after the humidity test to indicate any change in performance. The data show that performance of the actuator was not affected by the high humidity, even though the pin-to-pin resistances decreased during the high-humidity period.

III. TECHNICAL DISCUSSION

A. OBJECTIVE

The objective of the humidity test was to determine if high humidity would adversely affect the performance of the actuator.

B. PROCEDURE

The turbine-power-control-valve actuator was assembled to the test fixture as shown in Figure 1. Torque values as specified in Report RN-DR-0084 were used to tighten the clamps and seals. The actuator and test fixture were then installed in the humidity chamber as shown in Figure 2. The installation was arranged so the actuator could be operated and the output-shaft seal could be pressurized at any time during the test. The resistances between pins on the electrical connector were measured, and a performance reference test was conducted.

The temperature and humidity controls to the chamber were turned on and were set to control temperature and humidity as indicated in Figure 3. The chamber temperature and humidity were raised as shown, maintained for approximately 6 hr, and then allowed to cool without controlling the humidity. The above cycle was completed four times. Figure 4 is a typical recording of the wet- and dry-bulb temperatures inside the chamber during one cycle.

While the temperature and humidity were at high values, the resistances between the pins of the electrical connector were measured and performance reference tests were run. At the end of the test, the resistance measurements were repeated and a performance reference test was again conducted.

C. RESULTS

The pins used in making the electrical measurements were selected so that the measurements would not cause damage to internal electrical components of the actuator. The resistance measurements between pins of the electrical connector were taken as shown in Table 1. Although the pin-to-pin resistances decreased to about 2% of their original values, the actuator continued to function satisfactorily. Furthermore, the resistances later returned to approximately the same values as were measured before the start of the humidity cycling.

Tabulations of wet-bulb temperatures, relative humidity, and time for each of the humidity cycles are given in Tables 2, 3, 4, 5, and 6. Relative humidity vs time is shown for each of the cycles in Figure 5.

The results of the performance reference tests conducted before, during, and after the humidity test are shown in Figures 6, 7, and 8 respectively.

IV. CONCLUSIONS

The data show that the performance of the actuator was not significantly affected by the humidity test.

TABLE 1

ELECTRICAL-RESISTANCE MEASUREMENTS

<u>Between Pins</u>	<u>Resistance Megohms</u>			
	<u>Before Test</u>	<u>During Test</u>		<u>After Test</u>
		<u>First Reading</u>	<u>Second Reading</u>	
1 and 16	7500	100	200	8000
5 and 17	6500	200	200	5000
4 and 18	6500	200	200	5000

TABLE 2

HUMIDITY-TEST EQUIPMENT LIST

<u>Nomenclature</u>	<u>Manufacturer</u>	<u>Part No./Model No.</u>	<u>Serial Number</u>	<u>Calibration Expiration Date</u>
Insulation tester	Weston	Mod. 799		10 April 1967
Humidity chamber	Blue M & Co.	Mod. CF-7502HA	A-2291	
Portable console	AGC	N/A	N/A	

TABLE 3

HUMIDITY CYCLE NO. 1

<u>Time, hr</u>	<u>Dry-Bulb Temperature, °F</u>	<u>Wet-Bulb Temperature, °F</u>	<u>Relative Humidity, %</u>
0.0	66.2	59.0	67
0.25	86.0	77.0	67
0.50	149.0	140.0	78
0.75	158.0	158.0	100
1.0	158.0	158.0	100
2.0	158.0	158.0	100
3.0	149.0	149.0	100
4.0	136.4	136.4	100
5.0	128.3	128.3	100
6.0	123.8	122.0	100
7.0	120.2	113.0	78
8.0	117.5	109.4	75
9.0	115.7	107.0	72
10.0	113.9	104.9	71
11.0	113.0	102.2	65
12.0	113.0	101.7	66
13.0	112.1	100.8	66
14.0	112.1	100.6	66
15.0	111.6	100.4	66
16.0	111.4	100.4	66
17.0	111.2	100.0	66
18.0	111.0	99.6	66

TABLE 4

HUMIDITY CYCLE NO. 2

<u>Time, hr</u>	<u>Dry-Bulb Temperature, °F</u>	<u>Wet-Bulb Temperature, °F</u>	<u>Relative Humidity, %</u>
0.0	109.4	99.5	72
0.25	151.7	146.3	86
0.50	154.0	149.9	90
0.75	155.3	151.7	92
1.0	156.2	151.7	89
2.0	157.0	154.4	94
3.0	161.6	156.2	85
4.0	163.4	156.2	85
5.0	163.4	156.2	85
6.0	163.4	154.4	79
6.5	158.0	156.2	96
7.0	149.0	147.2	97
8.0	138.2	136.4	95
9.0	131.0	127.4	90
10.0	127.4	116.6	75
11.0	127.0	113.0	72
12.0	119.0	110.0	75
13.0	116.0	107.6	71
14.0	114.8	104.9	67
15.0	113.9	104.0	71
16.0	113.0	102.2	71
17.0	113.0	102.2	71
18.0	111.2	101.3	73
19.0	111.2	100.4	69
20.0	111.2	100.4	69
21.0	111.2	100.4	69
22.0	110.3	99.5	70
23.0	109.4	99.5	71
24.0	109.4	99.5	72

TABLE 5HUMIDITY CYCLE NO. 3

<u>Time, hr</u>	<u>Dry-Bulb Temperature, °F</u>	<u>Dry-Bulb Temperature, °F</u>	<u>Relative Humidity, %</u>
0.0	109.4	98.6	67
0.25	136.4	136.4	100
0.50	158.0	158.0	100
0.75	162.5	162.5	100
1.0	164.3	164.3	100
2.0	162.5	162.5	100
3.0	161.6	161.6	100
4.0	161.6	161.6	100
5.0	161.6	158.9	100
6.0	161.6	158.0	100
6.5	156.2	156.2	100
7.0	149.0	148.1	95
8.0	127.4	125.6	95
9.0	123.8	120.2	88
10.0	122.0	109.4	65
11.0	118.4	106.7	66
12.0	116.6	104.0	65
13.0	114.8	103.1	65
14.0	113.0	102.2	72
15.0	112.1	101.3	67
16.0	111.2	100.4	67
17.0	110.3	99.5	67
18.0	110.3	99.5	67
19.0	110.3	99.5	67
20.0	110.3	99.5	67
21.0	109.4	98.6	66
22.0	109.4	98.6	66
23.0	109.4	98.6	66
24.0	109.4	98.6	66

TABLE 6

HUMIDITY CYCLE NO. 4

<u>Time, hr</u>	<u>Wet-Bulb Temperature, °F</u>	<u>Wet-Bulb Temperature, °F</u>	<u>Relative Humidity, %</u>
0.0	108.5	98.6	70
0.25	149.0	149.0	100
0.50	162.6	162.6	100
0.75	163.4	163.4	100
1.0	164.3	164.3	100
2.0	163.4	163.4	100
3.0	163.4	163.4	100
4.0	163.4	163.4	100
5.0	162.5	162.5	100
6.0	162.5	162.5	100
7.0	158.9	158.9	100
8.0	142.7	142.7	100
9.0	130.1	130.1	100
10.0	124.7	124.7	100
11.0	119.3	119.3	100
12.0	116.6	108.5	75
13.0	114.8	104.9	71
14.0	113.0	102.0	68
15.0	111.2	101.3	71
16.0	110.3	100.4	71
17.0	110.3	99.5	70
18.0	109.4	98.6	68
19.0	108.5	98.6	70
20.0	108.5	98.6	70
21.0	108.5	97.7	69
22.0	108.5	97.7	69
23.0	108.5	97.7	69
24.0	108.5	97.7	69

Figure 1 - Actuator Mounted on the Test Fixture

Figure 2 - Actuator and Test Fixture Installed in Humidity Chamber

Figure 3 - Temperature and Humidity Profile Relative to Time

Figure 4 - Data Trace, Dry-Bulb and Wet-Bulb Temperatures During Test Cycle

Figure 5 - Humidity Test Cycles; TPCV Actuator

Figure 6 - Bode Plot; Performance Reference Test Before Humidity-Test

Figure 7 - Bode Plot; Performance Reference Test During Humidity-Test

Figure 8 - Bode Plot; Performance Reference Test After Humidity-Test

APPENDIX

Drawing 1116842, (Figure 1) an electrical schematic diagram of the TPCV-actuator test console, shows the electrical connections necessary to operate and control the TPCV actuator. The components shown schematically in Figure 1 are shown installed in the test console in Figure 2. The actuator is powered by a pneumatic supply that is connected to the actuator, shown in Figure 3. The TPCV-actuator electrical schematic is shown in Figure 4.

The electrical supplies and signal sources shown in Figure 1 are connected to the actuator through harnesses and connectors. The electrical signals are applied prior to application of the pneumatic supply pressures. Detailed operating procedures are described in Aerojet Report RN-S-0348, dated February 1967.

Figure 1 - Electrical Schematic Diagram of TPCV-Actuator Test Console

Figure 2 - Test Console and Recorder Equipment

Appendix

Figure 3 - TPCV Actuator Pneumatic Supply Diagram

Figure 4 - Schematic Wiring Turbine Power Control Actuator