NUCLEAR ROCKET OPERATIONS
SACRAMENTO PLANT

REPORT NO. RN-DR-0129

TO

AEC-NASA SPACE NUCLEAR PROPULSION OFFICE

MECHANICAL SHOCK TEST

TURBINE POWER CONTROL VALVE ACTUATOR

NERVA PROGRAM

CONTRACT SNP-1

SEPTEMBER 1967

MAS-1

NUCLEAR PRODUCTS AND SERVICES GROUP

AEROJET-GENERAL CORPORATION

SACRAMENTO, CALIFORNIA

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REPORT NO. RN-DR-0129

MECHANICAL SHOCK TEST,
TURBINE POWER CONTROL VALVE ACTUATOR

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ABSTRACT

A Turbine Power Control Valve Actuator, Bendix Model NT-D1, was subjected to a mechanical shock test to determine the effect of shock accelerations on the performance of the actuator. Comparison of pretest and posttest performance data indicated that the shock test had no detectable effect on actuator performance.

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I. INTRODUCTION

This report describes the shock tests performed on the Bendix Part Number 2775030 Model NT-D1 Turbine Power Control Valve Actuator (TPCVA) that will be used on the XE-1 and XECF nuclear rocket engine tests.

II. SUMMARY

The shock test was conducted using the Serial Number 17 actuator. Performance reference tests made before and after the shock test did not indicate any change in the performance of the component. Data traces of the position signal showed no perturbation at or following the instant of impact.

III. TECHNICAL DISCUSSION

A. OBJECTIVE

The purpose of the shock test was to determine the effect of shock acceleration on the performance and structure of the actuator.

B. PROCEDURE

The Bendix TPCV Actuator, P/N 2775030, S/N 17, was mounted on the test fixture, Figure 1, and the assembly was attached to the specimen table shown in Figure 2. The appendix shows the electrical and pneumatic connections between the actuator, test console, and helium supply presented in Figure 3. A performance reference test was run before and after the shock testing to determine if actuator performance was adversely affected. The accelerometers were attached as shown in Figure 4.

The actuator was then subjected to one triangular shock pulse in each direction on each of the three axes for a total of six applied shocks. During the shock testing, the actuator was being driven at 0.1 cps 90 degree peak-to-peak triangular wave command signal.

C. RESULTS

The magnitudes, durations, and related directions of application are shown in the oscillograph reproductions of the accelerometer outputs, Figure 5. Typical traces of the actuator output shaft position data are presented in Figure 6. As a comparison of the performance reference data in Figures 7 and 8 indicates, actuator performance was not significantly affected by the application of mechanical shocks below 25 g.

IV. CONCLUSION

Actuator performance is not adversely affected by shock acceleration with amplitude and duration equal to or less than those used in this test. The mechanical shock environment as defined in NDC-123 for the XE-1 will not adversely affect the performance of the TPCV actuator.

Figure 1 - Actuator Mounted on Test Fixture

Figure 2 - Actuator and Test Fixture Mounted on Specimen Table

Figure 3 - Actuator on Specimen Table with Electrical Pneumatic Connections

Figure 4 - Diagram Showing Accelerometer Locations

FRAME NO. 66

DROP NO. 1099

Z AXIS SHOCK, BASE DOWN

33.5g/IN. CALIBRATION FACTOR
 ACTUATOR ACCELERATION = $.66 \times 33.5 = 22.1g$

63 IN/SEC (PAPER SPEED)

Figure 5 - Data Traces of Shock Impulses

FRAME NO. 67

DROP NO. 1100
Z AXIS SHOCK, BASE UP

33.5 g/in. CALIBRATION FACTOR
ACTUATOR ACCELERATION = $(.7)(33.5) = 23.5 \text{ g}$

Figure 5 - Data Traces of Shock Impulses

FRAME NO. 74

DROP NO. 1104

X AXIS HELIUM, CONNECTOR UP

18.4 g/IN CALIBRATION FACTOR
 ACTUATOR ACCELERATION = $.70 \times 18.4 = 12.9g$

Figure 5 - Data Traces of Shock Impulses

FRAME NO. 73

DROP NO. 1103

Y AXIS SHOCK, ELECTRICAL CONNECTOR UP

18.4 g/IN. CALIBRATION FACTOR
 ACTUATOR ACCELERATION = $.7 \times 18.4 = 13g$

63 IN/SEC (PAPER SPEED)

Figure 5 - Data Traces of Shock Impulses

FRAME NO. 72

DROP NO. 1102

Y AXIS SHOCK, ELECTRICAL CONNECTOR DOWN

18.4 g/IN. CALIBRATION FACTOR
 ACTUATOR ACCELERATION = $.66 \times 18.4 = 12.2\text{g}$

63 IN/SEC (PAPER SPEED)

Figure 5 - Data Traces of Shock Impulses

FRAME NO. 67

DROP NO. 1105

X AXIS HELIUM, CONNECTOR DOWN

18.4 g/IN. CALIBRATION FACTOR
 ACTUATOR ACCELERATION = $.70 \times 18.4 = 12.9 \text{ g}$

Figure 5 - Data Traces of Shock Impulses

Figure 6 - Data Traces of Output Shaft Rotation

Figure 6 - Data Traces of Output Shaft Rotation
Sheet 2 of 3

Figure 6 - Data Traces of Output Shaft Rotation

12-2-66 TPCV ACTUATOR S/N 17 SHOCK TEST NO LOAD

GASEOUS He AMB. TEMP.

PRETEST REFERENCE

THRESHOLD $.17^\circ$ P - P

TRANSIENT RESPONSE DATA $\pm 41^\circ$ STEP INPUT

MAX. VEL. IN $470^\circ/\text{SEC}$

OUT $470^\circ/\text{SEC}$ OVERSHOOT 21% SETTLE .375 SEC

Figure 7 - Performance Reference Test Prior to Mechanical Shock Test

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TPCV ACTUATOR S/N 17

SHOCK TEST
POST TEST REF.

NO LOAD

GASEOUS He AMB. TEMP.

THRESHOLD 0.17 P-P

TRANSIENT RESPONSE DATA $\pm 35^\circ$ STEP INPUT

MAX. VEL. IN $517^\circ/\text{SEC}$

OVERSHOOT 20%

SETTLE .35 SEC

OUT $488^\circ/\text{SEC}$

Figure 8 - Performance Test After Mechanical Shock Test

APPENDIX

Drawing 1116842, (Figure 1) which is 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 on drawing No. 1116842 are shown installed in the test console, 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 on Figure 1 are connected to the actuator through harnesses and connectors. The electrical signals are turned on prior to the application of the pneumatic supply pressures. Detailed operating procedures are presented in Aerojet-General Report RN-S-0348, dated February 1967.

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

Appendix

Figure 2 - Test Console and Recorder Equipment

Appendix

Figure 3 - TPCV Actuator Pneumatic Supply Diagram

Appendix

Figure 4 - Schematic Wiring Turbine Power Control Actuator