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REPORT NO. RN-DR-0084

ELECTRO-PNEUMATIC SERVO
ACTUATOR EVALUATION PROCEDURE

MARCH 1967

NERVA PROGRAM

CONTRACT SNP-1

MASTER

AEROJET-GENERAL CORPORATION
SACRAMENTO, CALIFORNIA

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ELECTRO-PNEUMATIC SERVO
ACTUATOR EVALUATION PROCEDURE

ROCKET ENGINE OPERATIONS - NUCLEAR

MARCH 1967

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ELECTRO-PNEUMATIC SERVO
ACTUATOR EVALUATION PROCEDURE

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ABSTRACT

Engineering evaluation procedures for Bendix Actuator P/N 2775030, the NERVA turbine power control valve actuation subsystem, are defined by this document. Test equipment is listed. Actuator system tests described are: step response, linearity, system error, closed loop frequency response, threshold and stall torque.

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1.0 SCOPE

This document establishes the engineering evaluation procedure for the turbine power control valve (TPCV) actuator (Bendix Actuator P/N 2775030).

2.0 APPLICABLE DOCUMENTS

2.1 AEROJET-GENERAL CORPORATION DRAWINGS (SEE APPENDIX A)

AGC Dwg. 094232: Interface Control Drawing

AGC Dwg. 1118758: Schematic Diagram - Electrical, TPCV Actuator
Test Console

AGC Dwg. 1118757: Schematic Diagram - Electrical, Modified TPCV
Servo Amplifier

2.2 OTHER DOCUMENTS

Bendix Report CNPI-121: Assembly and Test Record

Instruction Manual Model 9687 DC Servo Amplifier/Burr Brown
Actuator Log Book

3.0 REQUIREMENTS

3.1 GENERAL

All actuator tests required by this document shall be performed under the direction of a Controls Systems Department engineer. The evaluation shall be under the surveillance of a representative of the

Product Assurance Division and the approval signature of the representative shall be entered on the data forms at the completion of the evaluation.

3.1.1 Configuration, Application and Performance - All parts removal and replacement shall be recorded on Forms I and II (Appendix B) and shall also be made part of the log book.

3.1.2 Operating Time - The meter reading of the fluid power elapsed time indicator shall be recorded at the beginning and end of each test. The difference of the readings (i.e., the duration of the test) shall be recorded with the data on the actuator test-data sheet Form III (Appendix B) and in the actuator log book.

3.2 TEST FACILITY

3.2.1 Description - The test facility to be used in performing this test is in the REON Controls Laboratory, Bldg. 2004, Sacramento Plant.

3.2.2 Facility Test Equipment - The facility is equipped with a pneumatic supply system capable of delivering GN_2 or GHe filtered and desiccated to the following: Particle Size - 2 micron; Dew Point - 100°F .

The facility has a load stand capable of loading the actuator output shaft in friction from 0 lb.in. to 50 lb.in., a spring rate of 1.5 lb.in./degree, and an inertia of $0.004 \text{ in. lb sec}^2$.

3.2.3 Test Equipment - Test equipment consists of the following:

<u>Component</u>	<u>Manufacturer</u>	<u>Part No./Model No.</u>	<u>Serial No.</u>
Function Generator	Hewlett/Packard	202A	325-13248
Power Supply	Power Design	TW 400S	
Recorder	Brush	Mark 200 RF 1783	528
Recorder Preamplifier	Brush	---	---
Test Console	AGC	Dwg. 1118758	
Precision Vacuum Tube Voltmeter (VTVM) or Digital Voltmeter	Fluke	825A	835
Oscilloscope			
Torque Wrench			
Torque Meter	Lebow	1214	6563
Servo Amplifier	Burr-Brown	2775842 (Modified) Dwg. 1118757	
Load Stand	AGC		

3.3 TEST OBJECTIVES

The primary test objective is to demonstrate satisfactory operation of the TPCV actuator prior to use in the NERVA program.

- 3.3.1 Physical Examination - Prior to testing, the actuator will be examined for the following: (1) bent electrical pins on the actuator connector and amplifier connectors; and (2) dents or bends in the actuator or amplifier housing which would indicate impact damage.
- 3.3.2 Performance Tests - The following tests will be conducted to demonstrate the ability of the actuator (with the servo amplifier) to satisfy the dynamic and static performance requirements of the NERVA TPCV subsystem. Data shall be recorded on Forms I, II, and III (Appendix B). The tests shall consist of the following:

- a. Potentiometer alignment (see Section 4.4.1)
- b. Amplifier gain and step response (no load) (4.4.2)
- c. Potentiometer linearity and noise (no load) (4.4.3)
- d. System error (under load) (4.6.1)
- e. Closed-loop frequency response (under load) (4.6.2)
- f. Step response (under load) (4.6.3)
- g. Threshold (under load) (4.6.4)
- h. Stall torque (4.6.5)

The above tests shall normally be conducted with GHe. A GN₂ test may be performed, however, if needed for comparison with Bendix acceptance test data at ambient temperature.

4.0 PROCEDURES

4.1 FACILITY PROCEDURE

The facility must be checked out and its operational capability established prior to the start of actuator testing. Prior to the no-load actuator test described in Section 4.4, adjust the load stand to remove the friction and spring load from the load stand shaft.

4.2 ACTUATOR/TEST LOAD STAND INSTALLATION

- a. Inspect actuator interface surfaces for seal-surface damage and cleanliness.
- b. Install the Conoseal, Marman P/N 50887-450S, into the actuator.
- c. The index pin (Bendix P/N 2775796) shall be visually checked.
- d. Examine interface surface of the test fixture for cleanliness and seal-surface damage.

- e. Install actuator into stand and torque Marman clamp P/N AE 59158 to 180 to 200 lb in.

4.3 SYSTEM SET-UP

4.3.1 Actuator/Gas Line Installation (No Load)

- a. Examine the interface surface of the actuator and mating facility gas line fittings for cleanliness and damage.
- b. Connect the actuator gas supply-line to the 2-micron filter outlet. Flush the helium supply line with clean, dry helium from the supply system.
- c. Install a Marman Conoseal (P/N 54973-4S) and connect the actuator gas supply-line to the actuator gas-inlet port. Torque the Marman fitting to 160 lb in.

NOTE: DO NOT APPLY ACTUATING PRESSURE TO
THE ACTUATOR AT THIS TIME. DO NOT
AT ANY TIME TURN ELECTRICAL POWER
OFF WHEN GAS PRESSURE IS ON.

4.3.2 Actuator/Amplifier/Instrumentation - Facility Power Installation

- a. Set all power switches to OFF position. Set command switch to ON.
- b. Connect the vacuum-tube voltmeter (VTVM) to the console external meter terminations (TP-7). Set meter switch (S-3) to EXTERNAL.
- c. Connect the test console to the 115 v, 60 cps, 1Ø power source.

- d. Set the 8-channel recorder power switch to the OFF position and connect recorder and preamplifier to the 115 v, 60 cps, 1 $\emptyset$ power source.
- e. Connect the function generator to TP-4 with power ON and amplitude at ZERO.
- f. Connect the actuator and servo-amplifier to the test console with test cable and connectors (see AGC drawing 1118758).
- g. Connect the command, torque-motor (TM) current monitor, and average TPCV position cables to the recorder. The recorder can be connected to the following test points:

TM current connected to TP-1

Average TPCV position connected to TP-2

Command connected to TP-3

Load-stand position connected to TP-5

System-error connected to TP-6

Potentiometer-error connected to TP-8

- h. Recorder scale factors for each test shall be chosen to produce the most meaningful and accurate data. (i.e., they must be set to provide traces covering from 1/3 to 9/10 of recorder full scale.)

4.3.3 Actuator/Test Stand/Instrumentation (Set-up and circuit verification)

- a. Turn the power switches to the ON position. Verify the ± 15 vdc levels by reading the power-supply voltage on test switch positions 11 and 12.

- b. Turn ON the recorder and recorder preamplifier. Check the recorder stylus ZERO positions and calibration.
- c. Set console selector switch to POSITION #9 (Command). Rotate command potentiometer fully counter-clockwise. The VTVM or meter and recorder should indicate approximately 0.0 vdc. Rotate command potentiometer fully clockwise. VTVM and recorder should indicate approximately 10.0 vdc.
- d. Turn the selector switch to POSITION #8 (average TPCV position) and read voltage. It should be approximately 5 v (actuator at 45°). Turn the selector switch back to POSITION #9 and turn the command potentiometer (about 5 turns) to set the VTVM voltage to equal the voltage previously read at POSITION #8.
- e. Switch the console test switch to POSITION #7 (TM current) and observe the current vary from +200+ to -200+ ma as the command voltage is varied to each side of the null voltage (~5 volts). (A more positive command signal should generate a positive torque-motor current). Leave command set for ZERO TM current.
- f. Set the actuator GHe supply pressure at 215 ± 10 psia (ambient temperature). Record the elapsed-time meter reading in the START space on the data sheet.
- g. Check that the command, TM current, and position signals are stable and of the same magnitude (about 5 v) by observing the recorder traces.
- h. Using the command potentiometer, manually advance the actuator position to its 90° position and then return it to the 0° position. The position signals should follow the command. Record the average position voltages (maximum 90° ; minimum 0°) on the recorder.

4.4 TEST PROCEDURE - ACTUATOR SYSTEM (NO LOAD)

4.4.1 Potentiometer Alignment

- a. Position the actuator shaft to the ZERO OUTPUT SHAFT position (command at 0 turns). Record the voltages on selector switch positions 4, 5 and 6. The voltages should be 5.5 v, ± 0.1 v, and be within ± 50 mv of each other. Record the average position on selector position 8 (0 v).
- b. Position the actuator output shaft to approximately 90° . (Command at 10 turns). Compare the voltage on selector switch POSITIONS 4, 5, and 6. The voltages should be 9.5 v, ± 0.05 v. Average position should be 10v.
- c. Position the actuator output shaft to 45° and repeat 4.4.1 b. Potentiometer voltages should read 7.5 v, ± 0.05 v and average position should be 5 v.

4.4.2 Amplifier Gain Test (No Load)

- a. Set the command potentiometer to position the actuator at 45° (5 v on the recorder average-position trace).
- b. Set the function generator to 0.33 cps, square wave and increase the amplitude control to effect about $\pm 1^\circ$ actuator motion (44° to 46° , equivalent to 4.9 to 5.1 v on the recorder average-position trace).
- c. Set the recorder at 200 mm/sec and record at least two cycles. Then place the recorder paper speed in the OFF position and the function generator at ZERO amplitude.

- d. Check the recorder trace for fast response (one to three overshoots of the actuator at each command step).

The rise time (time of output to reach 62% of the command) shall be less than 0.12 sec. The maximum output overshoot shall be 10% to 20% of the command step. The settling time (time for the output to come within $\pm 5\%$ of the command step) shall be less than 0.3 sec.

- e. Repeat Section 4.4.2 b, and c with step amplitudes of $\pm 22.5^\circ$ (45° pp step).

The saturation velocity of the actuator shall be greater than 360 degrees/sec. The peak output overshoot shall not exceed 30% of the command step.

4.4.3 Actuator Potentiometer Linearity and Noise Test

- a. Set the function generator to a 0.01 cps triangular wave and increase the amplitude of the command to the actuator from about 0° to about 90° (0 to 10 v on the recorder).
- b. Disconnect the leads from TB1 pins 9 and 12 on the test console.
- c. Record potentiometer #1 error (linearity and noise) on TP-8 as the actuator moves from 0 to 90° and the load stand position (TP-5).
- d. Repeat section 4.4.3 b and c, except reconnect the wire to TB1 pin 12 and disconnect the wire to TB1 pin 2. This will provide potentiometer #2 error.

- e. Repeat section 4.4.3 b and c except reconnect the wire to TB1 pin 9 and disconnect the wire to TB1 pin 12. This will provide potentiometer #3 error.
- f. Potentiometer error measured in Section 4.4.3 c, d, and e shall not exceed ± 0.05 v.
- g. Reconnect TB1 leads to their normal condition.

4.4.4 Decrease Actuating Gas Pressure to 0 psig

4.5 LOAD STAND TORQUE ADJUSTMENT

4.5.1 Prior to actuator load tests (see Section 4.6) adjust the load-stand friction to 50 lb.in. and the spring force to 1.5 lb.in./degree. (Zero spring force at zero shaft degrees.)

4.5.2 Pressurize load stand actuator dynamic-seal cavity to 525 ± 25 psig.

4.6 TEST PROCEDURE - ACTUATOR SYSTEM (LOADED)

4.6.1 System Error Test

- a. Set the actuator output to the 45° position by using the command potentiometer. (5 v on the recorder command trace.)
- b. Adjust the function generator in the test console to generate a command 0.01 cps triangular-wave and an amplitude of $\pm 45^\circ$ (0 to 10 v). The deviation of the load-stand precision potentiometer from the straight-line triangular-wave command should not exceed $\pm 0.5^\circ$ (approximately ± 0.056 v).

4.6.2 Frequency Response Test (Closed Loop)

- a. Use the manual command potentiometer in the test console to position the actuator at 45° (5 v on the recorder command trace).
- b. Record the system frequency response at 0.025, 0.1, 0.5, 1, 2, 4, 6, 8, 10, 12, 16 and 20 cps and at an amplitude of $\pm 2^\circ$ (± 0.22 volts).

NOTE: RECORDER EXPANDED SCALES ARE REQUIRED
FOR THIS TEST.

- c. Calculate the recorded phase-angle and amplitude ratio at each frequency (it should be 90° or less at 8 cps).

4.6.3 Step Response Test

- a. Use the command potentiometer to position the actuator at 45° (5 v on the recorder command trace).
- b. Adjust the function generator to generate a square-wave output at a frequency of 0.33 cps and an amplitude of $\pm 1^\circ$ (4.9 to 5.1 v, peak-to-peak). Use a recorder paper speed of 200 mm/sec or faster. Record at least two cycles. Turn the function generator amplitude to ZERO and stop the recorder.
- c. Check the recorder for fast response (one to three overshoots of the actuator at each command step). The rise time (time of output to reach 62% of the command) shall be less than 0.12 sec. The maximum output overshoot shall be from 10% to 20% of the command step. The settling time (time for the output to come within $\pm 5\%$ of the command step) shall be less than 0.3 sec.

- d. Repeat Section 4.6.3 b, except at an amplitude of 45° peak-to-peak step.
- e. Calculate the maximum velocity of the actuator in the increasing and decreasing valve directions from the recorded position trace. (It should be a minimum of 360° per second when using GHe.)

NOTE: THE PEAK OUTPUT OVERSHOOT SHALL
NOT EXCEED 30% OF THE COMMAND STEP.

4.6.4 Threshold Test

- a. Set the actuator at the 45° position with the command potentiometer.
- b. Adjust the function generator to generate a sine wave at a frequency of 0.1 cps.
- c. Increase and decrease the amplitude of the function generator voltage until the actuator feedback indicates the presence of, or lack of response to, the command.

NOTE: THE AMPLITUDE OF THE COMMAND SIGNAL SHOULD NOT EXCEED ± 0.10 DEGREES (± 0.0112 v) BEFORE THE ACTUATOR INDICATES WHETHER IT IS OR IS NOT FOLLOWING THE COMMAND.

4.6.5 Stall Torque Test

- a. Turn the actuating gas pressure OFF.
- b. Turn test-console power switch S1 to the OFF position.

- c. Remove actuator from the load stand in this manner:
 - (1) Depressurize load stand actuator dynamic seal-cavity to 0 psig.
 - (2) Loosen Marman clamp and lift actuator from the stand.
- d. Install actuator on torque measuring device with the output shaft locked at about 45° .
- e. Turn test-console power switch S1 to the ON position.
- f. Turn actuating gas pressure ON.

NOTE: PRESSURE SHOULD BE 215 ± 10 PSIA

- g. Set the selector switch to POSITION 7. (TM current.)
- h. Set the command potentiometer to provide zero output torque (about 5 turns).
- i. Vary the command signal to obtain approximately 14 evenly spaced torque levels between the maximum clockwise and counterclockwise torque levels. At each torque level, record both the TM current (test switch POSITION 7) and the output torque.

4.6.6 GN₂ Testing

When GN₂ testing is required, remove the GHe supply and replace with a 215 ± 10 psia GN₂ supply at ambient temperature. Repeat sections 4.6.1 through 4.6.4.

4.7 ACTUATOR/INSTRUMENTATION/TEST STAND SHUTDOWN

- a. Set selector switch to POSITION 1 (spare).
- b. Set function generator to 0 output and turn generator OFF.
- c. Set command potentiometer for 0° position.
- d. Decrease actuating pressure to 0 psig.
- e. Turn the servo-amplifier power switch to the OFF position.
- f. Turn switch S1 to the OFF position.
- g. Turn OFF the recorder and pre-amplifier.
- h. Record the elapsed-time meter reading.
- i. Disconnect the actuator from the test console.
- j. Disconnect the actuator from the actuating supply-pressure line and the torque-measuring device or load stand.

5.0 TEST REPORT

The test report shall include, but not be limited to, data Forms I, II, and III, (Appendix B) copies of the machine-produced data (e.g., sections of Brush recorder tapes as required), Bode plots, appropriate test setup schematics, and pictures as may be desirable. Samples of test data, as recorded on machine formats, shall be mounted as illustrated in Appendix C.

6.0

LABORATORY STORAGE

Remove Conoseal gaskets used during testing. Place protective covers over ports, connectors and interface surfaces. Replace actuator in the same (or equivalent) packaging in which it was received. Place the following with the actuator:

a.	P/N 58501-450S	Marman Seal
b.	P/N 54973-12S	Marman Seal
c.	P/N 54973-4S	Marman Seal
d.	P/N 13002-19S	Connector, Deutsch

APPENDIX A

APPLICABLE AEROJET-GENERAL CORPORATION DRAWINGS

APPENDIX B

TPCV ACTUATOR DATA FORMS

- Form I - Configuration Control
- Form II - Component Configuration, Application
and Performance History
- Form III - TPCV Actuator Evaluation Test Report

FORM I

DATE _____
PAGE A OF _____

[illegible]

DATE _____

PAGE _____ OF _____

[illegible]

FORM III

TPCV ACTUATOR EVALUATION TEST REPORT

Test Date: _____

Test Conductor: _____

Test Specimen Identification:

Actuator

Part Number _____

Model Number _____

Serial Number _____

3.2.3* Test Equipment

Component	Manufacturer	Part/Model Number	Serial No.	Calibration Date	Test Conductor (Initials)
Function Generator	Hewlett/ Packard	202A	325-13248	_____	_____
Recorder	Brush	Mark 200 RF 1783	528	_____	_____
Amplifier	Burr/Brown	_____	_____	_____	_____
Recorder Preamp	_____	_____	_____	_____	_____
Test Console	AGC	1116842	_____	_____	_____
VTVM	Fluke	825A	835	_____	_____
Oscilloscope	_____	_____	_____	_____	_____
Torque Wrench	_____	_____	_____	_____	_____
Torque Meter	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

*Numbers correspond to paragraph numbers of evaluation procedure.

Test Conductor
(Initials)

3.3.1 Condition of Hardware

Actuator: _____

TEST CONDUCTOR
(INITIALS)

4.0 PROCEDURES

4.1 Facility in working condition

Load stand adjusted to zero torque

4.2 Actuator/Load Stand Installation

a. Visual Examination Actuator Interface

b. Install conoseal, P/N 50887-450S

c. Index Pin Checked

d. Visual Examination of Test Fixture

e. Assemble Actuator to Load Stand

Install P/N AE 59158 Clamp _____lb.in.

4.3.1 Actuator/Gas Line Installation (no load)

a. Visual examination (actuator/test fixture interface)

b. Connect gas line to filter supply

Gas line flushed with dry GHe

c. Gas line connected to actuator

_____lb in.

TEST CONDUCTOR
(INITIALS) _____

4.3.2 Actuator/Amplifier/Instrumentation Installation

- a. Console power switch OFF (S-1)
Command switch ON _____
- b. VTVM connected to console VTVM terminals _____
Selector switch to position 11. _____
- c. Connect the console test rack to 115 v
60 cycle power _____
- d. Eight-channel recorder power OFF _____
Eight-channel recorder and preamplifier
connected to 115 v, 60 cycle power _____
- e. Function generator connected and ON _____
- f. Amplifier and actuator connected to test console _____
- g. Recorder connected to test console _____

4.3.3 System Setup and Verification

- a. Amplifier and console power ON.
Voltage selector position 11 _____ volts _____
Voltage selector position 12 _____ volts _____
- b. Recorder and preamplifier ON; zeroed and
calibrated _____
- c. Console selector switch to POSITION 9
Voltage reading _____ volts command CCW _____
Voltage reading _____ volts command CW _____
- d. Console selector switch to POSITION 8 _____
Voltage reading _____ volts _____

TEST CONDUCTOR
(INITIALS) _____

Console selector switch to POSITION 9 _____

Voltage reading _____ volts _____

e. Console selector switch to POSITION 7 _____

Voltage reading + _____ volts (Command 7 turns) _____

Voltage reading - _____ volts (Command 3 turns) _____

f. Actuator elapsed time meter _____ hours _____

GHe pressure ON _____ psia _____

g. Recorder traces stable _____

Recorder traces read _____ volts _____

h. Command moves actuator properly _____

4.4 Test Procedure - Actuator System (No Load)

4.4.1 Potentiometer Alignment Check:

a. Actuator output shaft, zero position _____

Voltage selector POSITION 4 _____ volts _____

Voltage selector POSITION 5 _____ volts _____

Voltage selector POSITION 6 _____ volts _____

Voltage selector POSITION 8 _____ volts _____

b. Actuator output shaft, 90° position _____

Voltage selector POSITION 4 _____ volts _____

Voltage selector POSITION 5 _____ volts _____

TEST CONDUCTOR
(INITIALS)

Voltage selector POSITION 6 _____ volts
Voltage selector POSITION 8 _____ volts

c. Actuator output shaft at 45° position

Voltage selector POSITION 4 _____ volts
Voltage selector POSITION 5 _____ volts
Voltage selector POSITION 6 _____ volts
Voltage selector POSITION 8 _____ volts

4.4.2 Amplifier Gain Test (No Load)

a. Actuator at 45° _____ volts _____ degree _____

b. Function Generator set at 0.33 cps square wave _____
Actuator motion _____ to _____ volts _____
_____ to _____ degrees _____

c. Step data taken

d. Step data satisfactory _____
Rise time _____ sec
% Overshoot _____
Settling time _____ sec

e. Actuator motion _____ to _____ volts _____
_____ to _____ degrees _____
Data taken _____
Saturation velocity _____ opening _____
_____ closing _____
% Overshoot _____

TEST CONDUCTOR
(INITIALS)

4.4.3 Potentiometer Linearity and Noise

- a. Function set to 0.01 cps triangle wave _____
Actuator motion _____ to _____ volts _____
_____ to _____ degrees _____
- b. TB-1 pin 9 and 12 leads disconnected _____
- c. Potentiometer #1 error taken _____
- d. TB1 pin 12 wire reconnected to console _____
TB1 pin 2 wire disconnected _____
Potentiometer #2 error taken _____
- e. TB1 pin 9 wire reconnected to console _____
TB1 pin 12 wire removed from console _____
Potentiometer #3 error taken _____
- f. Traces acceptable _____
- g. Reconnect TB1 pins 2, 9, and 12 to their
normal condition _____

4.4.4 Actuating Pressure Zero

4.5 Test Load Stand Torque Adjustment

- 4.5.1 Set _____ lb.in. friction load _____
_____ lb.in./degree spring load _____

TEST CONDUCTOR
(INITIALS) _____

4.5.2 Dynamic seal cavity pressure _____ psia _____

4.6 Test Procedure-Actuator System (Loaded)

4.6.1 System Error Test

a. Actuator at 45° _____ volts _____ degrees _____

b. Function generator set to 0.01 cps and triangular wave

Actuator motion _____ to _____ volts _____

_____ to _____ degrees _____

Error within limits _____

4.6.2 Frequency Response

a. Actuator at 45° _____ volts _____ degrees _____

b. Frequency Response taken _____

c. Phase at 8 cps _____ degrees _____

4.6.3 Step Response Test

a. Actuator at 45° _____ volts _____ degrees _____

b. Function generator set to 0.33 cps and a square wave.

2-degree step data taken _____

TEST CONDUCTOR
(INITIALS) _____

- c. Step data satisfactory _____
Rise Time _____ sec
% Overshoot _____
Settling time _____ sec
- d. 45 degree step data taken
- e. Angular velocity increase _____ V/Sec _____ Deg./Sec _____
Angular velocity decrease _____ V/Sec _____ Deg./Sec _____
% Overshoot _____

4.6.4 Threshold Test

- a. Actuator at 45° _____ volts _____ degrees _____
- b. Function generator set at 0.1 cps and sine wave _____
- c. Input (starts following) _____ volts _____ degrees _____
Input (stops following) _____ volts _____ degrees _____

4.6.5 Stall torque test

- a. Actuating gas pressure _____ psig _____
- b. Console power switches S-1 OFF _____
- c.1 Load-stand pressure _____ psig _____
- c.2 Actuator removed from load stand _____
- d. Actuator installed on torque device _____

TEST CONDUCTOR
(INITIALS)

e. Console power switches S-1 ON _____

f. Actuating gas pressure _____ psia _____

g. Console selector to POSITION 7 _____

h. VTVM reading _____ volts _____

i. Torque data

<u>Input Error mv</u>	<u>VTVM mv</u>	<u>Torque lb in.</u>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

4.6.6 GN₂ Testing

a. GN₂ actuating gas fitting torque _____ lb in. _____

b. Actuating gas pressure _____ psig _____

TEST CONDUCTOR
(INITIALS)

4.6.6.1 System Error Test

- a. Actuator at 45° _____ volts _____ degrees _____
- b. Function generator set to 0.01 cps and triangular wave
Actuator motion _____ to _____ volts _____
_____ to _____ degrees _____
Error within limits _____

4.6.6.2 Frequency Response Test

- a. Actuator at 45° _____ volts _____ degrees _____
- b. Frequency Response taken _____
- c. Phase at 8 cps _____ degrees _____

4.6.6.3 Step Response Test

- a. Actuator at 45° _____ volts _____ degrees _____
- b. Function generator set to 0.33 cps and a square wave.
2-degree step data taken _____
- c. Step data satisfactory _____
Rise time _____ sec
% overshoot _____
Settling time _____ sec

TEST CONDUCTOR
(INITIALS)

d. 45-degree step data taken

e. Angular velocity Inc. _____ v/Sec _____ Deg./Sec

Angular velocity Dec. _____ v/Sec _____ Deg./Sec

% Overshoot _____

4.6.6.4 Threshold Test

a. Actuator at 45° _____ volts _____ degrees

b. Function generator set at 0.1 cps and sine wave

c. Input (starts following) _____ volts _____ degrees

Input (stops following) _____ volts _____ degrees

4.6.6.5 Stall Torque Test

a. Actuating gas pressure _____ psig

b. Console power switches S-1 OFF

c.1 Load stand pressure _____ psig

c.2 Actuator removed from load stand

d. Actuator installed on torque device

e. Console power switches S-1 ON

f. Actuating gas pressure _____ psia

TEST CONDUCTOR
(INITIALS)

g. Console selector to POSITION 7

h. VTVM reading _____ volts

i. Torque data

<u>Input Error mv</u>	<u>VTVM mv</u>	<u>Torque lb in.</u>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

4.6.7 System Shutdown

a. Console selector to position 1

b. Function generator OFF

c. Command potentiometer full CCW

TEST CONDUCTOR
(INITIALS)

- d. Actuating gas pressure _____ psig _____
- e. Servo amplifier power OFF _____
- f. Console power switch S-1 OFF _____
- g. Recorder and preamplifier OFF _____
- h. Actuator elapsed time _____ hours _____
- i. Disconnect actuator from console _____
- j. Disconnect actuator gas line _____
Remove actuator from load stand or torque device _____

APPENDIX C
TEST DATA SAMPLES

MOUNT SYSTEM

MOUNT THRESHOLD

ERROR TEST DATA

TEST DATA

SAMPLE HERE

SAMPLES HERE

SYSTEM ERROR TEST

THRESHOLD TEST

SERVO MEDIUM

SHAFT SEAL PRESSURE

SUPPLY PRESSURE

EXHAUST PRESSURE

LOAD SPRING RATE

STEADY STATE SHAFT POS.

LOAD FRICTION

TPCV ACTUATOR MOD. _____ S/N _____ CLOSED LOOP PERFORMANCE

MOUNT STEP

MOUNT SATURATION VELOCITY

RESPONSE DATA

DATA SAMPLE HERE

SAMPLE HERE

STEP RESPONSE

SATURATION VELOCITY

SERVO MEDIUM

SHAFT SEAL PRESSURE

SUPPLY PRESSURE

EXHAUST PRESSURE

LOAD SPRING RATE

LOAD FRICTION

STEADY STATE SHAFT POS.

TPCV ACTUATOR MOD _____ S/N _____ CLOSED LOOP PERFORMANCE

MOUNT FREQUENCY RESPONSE

DATA SAMPLES HERE

FREQUENCY RESPONSE TEST

SERVO MEDIUM

SHAFT SEAL PRESSURE

SUPPLY PRESSURE

EXHAUST PRESSURE

LOAD SPRING RATE

LOAD FRICTION

STEADY STATE SHAFT POS.

TPCV ACTUATOR MOD _____ S/N _____ CLOSED LOOP PERFORMANCE