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NUCLEAR ROCKET OPERATIONS

SACRAMENTO PLANT

MASTER

REPORT NO. RN-S-0425

TO

AEC-NASA SPACE NUCLEAR PROPULSION OFFICE

QUALIFICATION TEST PLAN

BENDIX MODEL NT-D1

TURBINE POWER CONTROL VALVE ACTUATOR

NERVA PROGRAM

CONTRACT SNP-1

SEPTEMBER 1967

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CLASSIFICATION CATEGORY

UNCLASSIFIED

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CLASSIFYING OFFICER

27 Sept 1967

DATE

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REPORT NO. RN-S-0425

QUALIFICATION TEST PLAN
BENDIX MODEL NT-D1
TURBINE POWER CONTROL VALVE ACTUATOR

H. O. Suttkus

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C. M. Rice
Program Manager
Nuclear Rocket Operations

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I. INTRODUCTION

This report documents the plan for qualification testing the Bendix turbine power control valve (TPCV) actuation system, Bendix P/L 2775030, Model NT-D1, hereinafter referred to as the actuator. The plan defines the general and detailed requirements that apply to all tests and test report documentation. The Actuator Qualification Test Plan includes proof pressure, vibration, mechanical shock, humidity, and life tests.

II. APPLICABLE DOCUMENTS

The Documents and Drawings listed below are sources of additional information related to all of the tests included in the Actuator Qualification Plan. Other documents that pertain to a specific test are listed in the detail plan of that test.

A. AEROJET-GENERAL CORPORATION

1. Drawings

094232	Actuator/TPCV Interface Control Drawing
1118758	Schematic Diagram-Electrical, TPCV Actuator Test Console
1118757	Schematic Diagram-Electrical, Modified TPCV Servo Amplifier

2. Design Criteria

NDC-51A	Actuator, Electro Pneumatic, Rotary for Turbopump Power Control Valve.
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3. Reports

RN-DR-0084 Electro-Pneumatic Servo Actuator Evaluation
Procedure

RN-S0348 Operating and Maintenance Instructions For
XE-1 Turbine Power Control Valve (TPCV)
Actuator Subsystem.

4. Other Documents

Actuator Logbook, NRO Controls Laboratory.

TPCV Actuator Model NT-D1 SN 17.

B. OTHER DOCUMENTS

1. Bendix Corporation

a. Drawings

2775030 - Actuator Assembly Turbine Power Control Valve

b. Specifications

CNPD-159 - Actuator, Electropneumatic Rotary for Turbine
Power Control Valve.

c. Reports

BPAD-863-16802 Turbine Power Control Valve Actuation
System Bendix Model NT-D1 P/L 2775030
S/N 15, 16, 17 and 18, Final Report
March 1966.

CNPI-121 Assembly and Test Record of Turbine Power
Control Valve Actuator Model NT-D1 P/N 2775030
S/N 17.

2. Burr-Brown

a. Reports

Instruction Manual, Model 9687 DC Servo Amplifier/Burr Brown

III. REQUIREMENTS

A. IDENTIFICATION

The actuator and its components shall be identified in accordance with the requirements of the Electro-Pneumatic servo actuator evaluation procedure, Report No. RN-DR-0084, Forms I and II.

B. ACCEPTANCE AND EVALUATION TESTS

The test actuator shall have been source-accepted in accordance with the requirements of Bendix Products Aerospace Division Report No. CNPI-121 and subjected to an engineering evaluation procedure per RN-DR-0084.

C. TIME AND CYCLE DATA

The actuator is a time and cycle sensitive assembly. All electrical and fluid power time "on" shall be recorded in the actuator log book and be included in the test report.

D. DEFINITION OF AXES

For the purpose of this test, the mutually perpendicular reference axes are defined as Z axis, the axis of rotation of the output shaft; Y axis, an axis parallel to the center line of the servo valve spool; and the X axis as an axis perpendicular to both the center line of the servo valve spool and the axis of rotation of the output shaft.

E. TEST EQUIPMENT

Verification that a valid calibration of all test equipment exists on the day of the tests shall be made prior to each of the tests required by this document. Record of these calibrations shall be made.

F. FAILURE

A failure shall be defined as the inability of the actuator to meet the specified performance requirements.

1. Failure Analysis

An engineering analysis shall be made of the failure and, as appropriate, shall include, but be not limited to, notations of visual observations of the disassembled actuator, stress, metallurgical, and dimensional analysis as well as recommended design changes.

2. Retesting

The actuation system or its components may be repaired and retested as required to properly evaluate the actuator.

G. DATA REQUIREMENTS

All qualification test operating time, inspection and calibration test data resulting from the requirements of this test plan shall be recorded. Data which is produced on machine formats (strip charts, etc.) or recorded on prepared formats shall be completely identified with test name, run number, date, time and test conductor's initials and such other information which may be appropriate to enhance the value of the data. The actuator log book shall be used to document all data for which a prepared format does not exist.

Identification of data in the log book shall be complete and correspond to the appropriate qualification test plan paragraph. Notes as required shall be kept in the actuator log book for use in completing the summary report.

H. QUALIFICATION TEST REPORTS

1. Qualification Testing

Each qualification test will have an individual test report prepared in accordance with the requirements of Appendix B.

2. Summary Report

A summary report will be written to cover the results of the Qualification Test Program in its entirety, arrive at conclusions, and make recommendations.

IV. QUALIFICATION TESTS

A. ACTUATOR PROOF PRESSURE TEST

1. Scope

The proof pressure test portion of the actuator qualification test plan is defined in this section.

2. Objective

The objective of the actuator proof pressure test is to establish the adequacy of the actuator housing structure to resist internal pressure loads.

3. Applicable Bendix Corporation Documents

The applicable Bendix Corporation drawings include:
2775745 - Cover Assembly; 2775746 - Cover; 2775748 - Screw, Captive Drilled
Socket Head; and 2775801 - Schematic-Wiring Turbine Power Control Valve
Actuator.

4. Requirement

a. Actuator/Fixture Installation

(1) The actuator shall be installed on the test fixture with the clamp torqued to the values specified in RN-DR-0084.

(2) The pressure inlet port, the exhaust port and the valve (TPCV) side of the dynamic seal shall be connected to a common pressurant source. The pressurant shall be clean dry gaseous nitrogen.

b. Test Setup, Instrumentation

(1) The potentiometer base thermocouple (I-C) shall be connected to an appropriate readout system (receptacle pins 14 and 15) as identified by Bendix Drawing 2775801.

(2) A pressure transducer or gage shall be used to measure and record the actuator's internal pressure continuously throughout the test.

c. Test conditions

(1) The proof pressure test shall be conducted under the ambient laboratory conditions of temperature, pressure, and humidity.

(2) The actuator shall be unloaded and inoperative during the proof pressure test.

(4) Time

Temperature/Pressure Stabilization
Duration of Proof Test Pressurization

(5) Performance Reference Data

- (a) Actuator Stall Torque
- (b) Frequency Response
- (c) Step Response

- 1 Saturation Velocity
- 2 Rise Time
- 3 Settling Time
- 4 Overshoot

(d) Threshold

ACTUATOR COMMAND, POSITION FEEDBACK,
AND TORQUE MOTOR CURRENT SIGNALS
SHALL BE ZERO SUPPRESSED.

5. The actuator proof pressure test report shall be prepared in accordance with the requirements defined in Appendix B.

6. Safety

THE ACTUATOR PROOF PRESSURE TEST USES COMPRESSED GAS AT HIGH PRESSURES AND PLACES THIS TEST IN THE HAZARDOUS CATEGORY. STRICT ADHERENCE TO SAFETY PROCEDURES IS MANDATORY.

d. Proof Pressure Test Sequence

(1) The actuator cover and transmission housing screws shall be identified and torque checked before and after the actuator housing proof pressure tests (2775745 cover assembly, 2775746 cover, and 2775748 screw).

(2) A performance reference test shall be accomplished in accordance with the requirements defined in Appendix A before and after the proof pressure test.

(3) The actuator shall be pressurized to 245 ± 10 psia at a rate not to exceed 20 psi per minute. After temperature and pressure have stabilized, measurements shall be recorded for a 10-minute period.

(4) The actuator housing shall be depressurized at a maximum rate of 20 psi per minute.

e. Data

The following data shall be obtained during the actuator proof pressure test:

(1) Temperature

Potentiometer Base

(2) Pressure

Actuator Housing

Dynamic Seal Cavity

(3) Torque

	<u>Before Test</u>	<u>After Test</u>
Actuator Cover Screws	x	x

B. ACTUATOR VIBRATION TEST

1. Scope

The random and sinusoidal vibration test portion of the actuator qualification test plan is defined in this section.

2. Objectives

The objectives of the vibration tests are:

a. To assure that the actuator design has achieved structural integrity and functional capability in a mechanical vibration environment.

b. To determine the resonant frequencies along each of the three mutually perpendicular axes and the actuators performance at resonant frequencies in a random vibration environment.

c. To determine if the actuator will continue to function after being subjected to a mechanical vibration environment.

3. Applicable Documents

a. Bendix Corporation

(1) Drawings

2775743 - Plate Seal Retainer

2775745 - Cover Assembly

2775748 - Screw, Captive Drilled Socket Head

2775517 - Seal Spring

b. Government

(1) Standards

MIL-STD-810A Military Standard, Environmental Test
Methods for Aerospace and Ground
Equipment

4. Requirements

a. Actuator/Test Fixture Installation

(1) The actuator shall be installed on the test fixture with the x and y axes parallel to the base of the fixture. Installation shall be in accordance with the requirements of RN-DR-0084.

b. Test Setup, Instrumentation

(1) Accelerometers shall be mounted as shown in Figure 1. The following actuator parts may be removed to facilitate installation of accelerometers, Bendix P/N's 2775745, 2775748 (10 pcs.), 2775743 and 2775517-6. All accelerometers shall be insulated electrically from the actuator hardware and mounted by use of adhesives (except where a standard insulated mounting stud can be used in an existing threaded hole). Acceleration data shall be recorded continuously on FM magnetic tape during the test. Data shall also be recorded on an oscillograph or visocorder for Quick-Look use.

(2) A triaxial accelerometer shall be installed on the actuator test fixture to record input accelerations continuously throughout the test.

Figure 1 - Accelerometer Mounting Positions

(3) A pressure transducer shall be used to measure the dynamic seal cavity pressure continuously throughout the test.

c. Test conditions

(1) The actuator vibration test shall be performed under ambient laboratory conditions.

(2) The TPCV side of the dynamic seal cavity shall be pressurized to 525 ± 20 psia with gaseous nitrogen.

(3) The actuator shall be operative during all vibration testing. The modes of operation and duration shall be as defined in Table 1 and Figure 2.

d. Vibration test sequence

(1) Performance reference tests in accordance with the requirements defined in Appendix A shall be run on the actuator before and after the vibration tests.

(2) The actuator shall be subjected to the sinusoidal vibration tests defined in Table 1 and are performed in the order in which they are numbered. Random vibration testing shall be as defined by Figure 2 along the x, y, and z axis for 15 minutes (minimum) or the time required to complete the Table 1, Mode B tests.

e. Data

The following data shall be obtained during all vibration testing for the modes of operation and duration defined in Table 1 and Figure 2.

TABLE 1

VIBRATION TEST REQUIREMENTS

Test No.	Axis	Resonance Dwell			Frequency Spectrum, Hz	Number of Sweeps	Frequency Sweep			Operating Mode	Notes
		Time, min	Acceleration g's	Operating Mode			Sweep Rate	Force Parameter g's or D.A. (inch)			
1	X				5-2000-5	2	1.5 min/Octave	5-17 17-2000	0.135 2 g 0-peak	A	(1)
2	X	10	1	B							(2)
											(3)
3	Y				5-2000-5	2	1.5 min/Octave	5-17 17-2000	0.135 D.A. 2 g 0-peak	A	(1)
4	Y	10	1	B							(2)
											(3)
5	Z				16-2000-16	2	1.5 min/Octave	16-45 45-87 87-2000	1.33 g 0-peak 0.013 D.A. 5.0 g 0-peak	A	(1)
6	Z	10	5	B							(2)
											(3)

(1) Determine resonant frequencies during sweep

(2) Operating Mode: (A) Command: $45^\circ + 35^\circ$ triangular wave at 0.025 Hz (No Load)
(B) Performance Reference Test, Appendix A

(3) Duration: 10 minutes minimum or time required to complete Mode B testing

Figure 2 - Random Vibration Test Curve Envelope

(1) Acceleration

- (a) Table Acceleration (x, y and z axes)
- (b) Actuator acceleration (x, y, and z axes)

(2) Pressure

- (a) Actuator, operating fluid
- (b) Dynamic seal cavity pressurant

(3) Time

- (a) Fluid power on
- (b) Electrical power on

(4) Performance reference data

- (a) Actuator stall torque
- (b) Frequency response
- (c) Step response

- 1 Saturation velocity
- 2 Rise Time
- 3 Settling time
- 4 Overshoot

- (d) Threshold

ACTUATOR COMMAND, POSITION FEEDBACK,
AND TORQUE MOTOR CURRENT SIGNALS
SHALL BE ZERO SUPPRESSED.

(5) Random Vibration

- (a) Filter band widths
- (b) Integrate time constant
- (c) Amplitude accuracy

5. Reports

The actuator vibration test report shall be prepared in accordance with the requirements defined in Appendix B.

6. Safety

THE ACTUATOR VIBRATION TEST IS ACCOMPLISHED WITH THE COMBINED CONDITIONS OF HIGH PRESSURE GAS AND VIBRATION, WHICH PLACES THIS TEST IN THE HAZARDOUS CATEGORY. STRICT ADHERENCE TO SAFETY PROCEDURES IS MANDATORY.

C. ACTUATOR MECHANICAL SHOCK TEST

1. Scope

The mechanical shock test portion of the actuator qualification test plan is defined in this section.

2. Objectives

The objectives of the mechanical shock test are to determine that the actuator design is:

- a. Structurally capable of accommodating mechanical shock
- b. Capable of operating when subjected to mechanical shock
- c. Capable of operating after having been subjected to mechanical shock along the x, y, and z axes.

3. Applicable Documents

a. Bendix Corporation

(1) Drawings

2775743 - Plate Seal Retainer

2775745 - Cover Assembly

2775748 - Screw, Captive Drilled Socket Head

2775517 - Seal Spring,

b. Government

(1) Standards

MIL-STD-810A Military Standard, Environmental Test
Methods for Aerospace and Ground Equipment.

4. Requirements

a. Actuator/test fixture installation

(1) The actuator shall be installed on the test fixture with the x and y axes parallel to the base of the fixture. Installation shall be in accordance with the requirements of RN-DR-0084.

b. Test Setup, Instrumentation

(1) Accelerometers shall be mounted as shown in Figure 1. The following actuator parts may be removed to facilitate installation of accelerometers, Bendix P/N's 2775745, 2775748 (10 pcs.), 2775743 and 2775517-6. All accelerometers shall be insulated electrically from the actuator hardware and mounted by use of adhesives (except where a standard insulated mounting stud can be used in an existing threaded hole).

(2) Accelerometers shall be mounted on the shock machine specimen table to record the input shock pulse.

(3) Oscillograph records shall be made of all shock data.

(4) A pressure transducer shall be mounted in the dynamic seal cavity pressurant line.

c. Test conditions

(1) The actuator shock test shall be performed under ambient laboratory conditions.

(2) The TPCV side of the dynamic seal cavity shall be pressurized to 525 ± 20 psia with gaseous nitrogen.

(3) The actuator shall be operated with a command signal of $45^\circ \pm 35^\circ$ amplitude at 0.025 Hz but without applied load.

d. Shock Test Sequence

(1) A performance reference test accomplished in accordance with the requirements defined in Appendix A shall precede and follow the shock tests.

(2) Two shock pulses from opposite directions shall be applied parallel to each of the x, y, and z axes and through the actuators center of gravity. (Total number of six shock pulses). The shock pulse peak shall be achieved within 6 millisec from start of application and be between 10 g's and 25 g's in amplitude.

e. Data

The following data shall be obtained during the actuator shock tests:

(1) Accelerations

- (a) Specimen Table Acceleration (x, y and z axes)
- (b) Actuator Acceleration (x, y and z axes)

(2) Pressures

- (a) Actuating, operating fluid
- (b) Dynamic seal pressurant

(3) Time

- (a) Fluid power on
- (b) Electrical power on

(4) Performance reference data

- (a) Actuator stall torque
- (b) Frequency response
- (c) Step response

- 1 Saturation velocity
- 2 Rise time
- 3 Settling time
- 4 Overshoot

(d) Threshold

ACTUATOR COMMAND, POSITION FEEDBACK
AND TORQUE MOTOR CURRENT SIGNALS
SHALL BE ZERO SUPPRESSED

5. Reports

The actuator shock test report shall be prepared in accordance with the requirements defined in Appendix B.

6. Safety

THE ACTUATOR SHOCK TEST IS ACCOMPLISHED UNDER COMBINED CONDITIONS OF GAS AT HIGH PRESSURE AND SHOCK, WHICH PLACES THIS TEST IN THE HAZARDOUS CATEGORY. ADHERENCE TO SAFETY PROCEDURES IS MANDATORY.

D. ACTUATOR HUMIDITY TEST

1. Scope

The humidity test portion of the actuator qualification test plan is defined in this section.

2. Objectives

The objectives of the humidity test are to:

a. Determine the resistance change of the cabling, connector, and receptacle when subjected to 95% + humidity at temperatures up to 165°F.

b. Determine if the actuator will remain operable in humidities up to 100%.

c. Determine if the insulation resistance will return to initial values when the humidity returns to ambient.

3. Applicable Government Documents

MIL-STD-810A Military Standard, Environmental Test
Methods for Aerospace and Ground Equipment.

4. Requirements

a. Actuator/Test Fixture Installation

The actuator shall be subjected to the humidity test when positioned with the Z axis vertical and the output shaft downward. Installation in the test fixture shall be in accordance with the requirements of RN-DR-0084.

b. Test Setup, Instrumentation

(1) The actuator thermocouple located at the electrical connector shall be used to monitor the temperature at the electrical connector (Bendix Drawing 2775801).

(2) An insulation resistance checker shall be used to measure required pin to pin resistances.

(3) The seal cavity pressure shall be monitored continuously with either a pressure gage or transducer.

(4) The test chamber, accessories, and capacity shall be similar to that defined by MIL-STD-810A, method 507.1, Paragraph 2.

c. Test Conditions

(1) The humidity test shall be conducted at ambient pressure.

(2) The TPCV side of the dynamic seal cavity shall be pressurized to 525 ± 20 psia with gaseous nitrogen.

d. Humidity Test, Sequence and Cycle

(1) The actuator shall be subjected to a performance reference test before, during each humidity cycle (one), and after completion of the cycle (one). The performance reference test at the end of each humidity cycle shall be run at ambient laboratory temperature but at a minimum humidity of 95%.

(2) The pin-to-pin resistance shall be measured before, during, and after each humidity cycle. Pins 15 to 8, 15 to 10 and 15 to 12 shall have the thermocouple junctions removed from the actuator structure, insulated, and stowed for this test.

(3) The actuator shall be driven by a triangular wave command signal of $45^\circ \pm 30^\circ$ at 0.025 HZ throughout the duration of the test except when a performance reference test is being made.

(4) The actuator shall be subjected to the humidity test profile defined by Figure 3.

e. Data

The following data shall be obtained during the actuator humidity test:

Figure 3 - Humidity Test Cycle

(1) Performance reference data

- (a) Stall torque
- (b) Frequency response
- (c) Step response

- 1 Saturation velocity
- 2 Rise time
- 3 Settling time
- 4 Overshoot

- (d) Threshold

ACTUATOR COMMAND, POSITION FEEDBACK
AND TORQUE MOTOR CURRENT SIGNALS
SHALL BE ZERO SUPPRESSED.

(2) Humidity Cycle Data (Actuator)

- (a) Command signal
- (b) Torque motor current
- (c) Actuator position signal
- (d) Temperature

ACTUATOR COMMAND, POSITION FEEDBACK
AND TORQUE MOTOR CURRENT SIGNALS
SHALL BE ZERO SUPPRESSED.

- 1 Electrical connector
- 2 Fluid power

(3) Humidity Cycle Data (Chamber)

(a) Chamber temperature

1 Wet bulb

2 Dry bulb

(b) Air velocity

(c) Water pH

5. Reports

The actuator humidity test report shall be prepared in accordance with the requirements defined in Appendix B.

6. Safety

THE USE OF GAS AT HIGH PRESSURE AND TEMPERATURE IN THE ACTUATOR HUMIDITY TEST PLACES THIS TEST IN THE HAZARDOUS CATEGORY. STRICT ADHERENCE TO SAFETY PROCEDURES IS MANDATORY.

E. ACTUATOR LIFE TEST

1. Scope

The life test portion of the actuator qualification test plan is defined in this section.

2. Objectives

The objectives of the actuator life tests are to determine:

a. The life of the actuator when subjected to simulated engine operating conditions.

b. The rate of deterioration of the actuator's performance

3. Applicable Documents

a. Aerojet-General Corporation

Drawings

11174000 Test Fixture - Turbine Control Valve Actuator

1118325 Installation - Actuator Test Fixture

b. Inland Motor Corporation

IM-3000B-1 Instruction Manual Model 3000B ES 10328
DC Amplifier

4. Requirements

The requirements specified herein are intended to simulate engine operation cycle conditions except for radiation.

a. Actuator/Life Test Fixture Installation

The actuator shall be installed in the life test fixture in accordance with the requirements of RN-DR-0084

b. Test Setup, Instrumentation

(1) Instrumentation to produce a continuous recording of the actuator torque is required.

(2) Pressure gages or transducers shall be provided in the actuator fluid power and in the dynamic seal cavity pressurant inlets.

(3) Temperature sensors shall be provided in the dynamic seal cavity, at the actuator fluid power inlet, at the actuator exhaust gas outlet, at the potentiometer base, at the gearmotor base, at the servovalve base, at the torque motor base, and at the transmission case and for ambient temperature.

c. Test Conditions

(1) The actuator life test temperature cycle shall be in accordance with Figures 4 and 5.

(2) The dynamic seal cavity shall be pressurized to 100 ± 20 psia through the ambient and cryogenic cycle, to 200 ± 20 psia during temperature increase, and to 300 ± 20 psia at the elevated temperature. The pressurant shall be gaseous helium.

(3) A simulated TPCV torque of 400 lb-in. in the opening direction and 80 lb-in. in the closing direction, which approximates the extreme torque values shown in Figure 6 for the TPCV operating between the 20- and 60-degree positions, shall be applied to the actuator.

d. Life Test, Sequence, and Cycle

The actuator life test sequence shall be as follows:

Figure 4 - TPCV Qualification Life Test Operating Cycle

Figure 5 - TPCV Actuator Base Temperature Cycle

Figure 6 - TPCV Torque vs Position

(1) A performance reference test in accordance with the requirements defined in Appendix A shall precede and follow each life test cycle.

(2) The actuator shall be operated on gaseous helium during the entire test. The life cycle is defined in Figures 4 and 5 and has a duration of approximately 3-1/2 hours.

(3) The actuator command signal shall be a nominal 45° position signal on which is superimposed a 0.3 HZ sine wave of sufficient amplitude to generate torque values defined above by driving the test fixture servo torque motor (Inland) away from its set point approximately 4 degrees in the opening direction and 2 degrees in the closing direction.

(4) The actuator/TPCV interface temperature excursion from laboratory ambient temperature shall be to LN₂ temperature, 140°R or until a minimum has been reached and stabilized. The minimum temperature shall be maintained for approximately 7 minutes. The actuator interface temperature shall be increased from 140°R (or the minimum) to 1200°R (approximate) and stabilized at that temperature for 15 minutes. The actuator shall then be permitted to decay from 1200°R to ambient.

(5) The actuator shall be subjected to the post-life cycle performance reference test after its temperature has stabilized at ambient.

(6) The actuator shall be removed from the life test stand and the output shaft dynamic seal shall be disassembled from the actuator housing. A Talysurf inspection and photo-micrographs shall be made of the sealing surfaces of the dynamic seal.

(7) The life-cycle tests shall be repeated until a determination has been made of its design performance life and its operable life. The design performance life is defined to have been reached when performance data is no longer within specification requirements. Operable life is that operating time beyond the design performance life in which useable data on components can still be obtained. The output shaft dynamic seal and the potentiometer may be replaced to enable a determination of the life of the balance of the actuator mechanism.

e. Data

The following data shall be obtained during the actuator life cycle tests:

(1) Actuator Data

(a) Performance reference data

- 1 Actuator stall torque
- 2 Frequency response
- 3 Step response
 - a Saturation velocity
 - b Rise time
 - c Settling time
 - d Overshoot
- 4 Threshold

ACTUATOR COMMAND, POSITION FEEDBACK,
AND TORQUE MOTOR CURRENT SIGNALS ARE
ZERO SUPPRESSED

(b) Life Cycle

1 Loads

a Actuator output torque

2 Pressures

a GH_e , actuating fluid

b GH_e , seal cavity pressurant

3 Flow

a GH_e , actuating fluid

b GH_e , seal cavity pressurant

4 Temperature

a GH_e , actuator fluid

b GH_e , seal cavity pressurant

c GH_e , actuator exhaust gas

d Potentiometer base

e Gearmotor base

f Servovalve base

g Torque motor base

h Transmission case, internal at output shaft dynamic seal

5. Reports

The actuator life test report shall be prepared in accordance with the requirements defined in Appendix B.

6. Safety

THE USE OF COMPRESSED GAS AT HIGH PRESSURES, CRYOGENIC FLUID AND ELECTRICAL POWER AT MODERATELY HIGH VOLTAGES WHILE PERFORMING THE LIFE CYCLE TEST PLACES THIS TEST IN THE HAZARDOUS CATEGORY. STRICT ADHERENCE TO SAFETY PROCEDURES IS MANDATORY.

APPENDIX A

ACTUATOR PERFORMANCE REFERENCE TEST

Appendix A

A. SCOPE

This appendix presents the requirements of the actuator performance reference test.

B. OBJECTIVES

The objectives of the performance reference test are:

1. To establish the performance capability of the actuator prior to the qualification testing.

2. To establish performance capability during the qualification testing for evaluating the change in performance that results from the individual tests of the qualification program.

3. To determine the life of the actuator under test conditions simulating the expected engine environment and interface conditions, with the exception of nuclear radiation.

C. APPLICABLE DOCUMENTS

1. Aerojet Documents

Aerojet-General Corporation Drawings

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

Appendix A

2. Other Documents

Bendix Report CNPI-121: Assembly and Test Record
Instruction Manual Model 9687 DC Servo Amplifier/Burr Brown
Actuator Log Book

D. REQUIREMENTS

The actuator/test fixture installation, test setup and instrumentation shall be in accordance with RN-DR-0084.

1. Test Conditions

a. The actuator reference test shall be performed under ambient conditions existing in the laboratory except as otherwise required by the individual test plans.

b. The actuator shall be unloaded during the performance reference test.

c. The performance reference tests shall be conducted in accordance with the test equipment and procedures defined in RN-DR-0084.

2. The performance test shall consist of the following:

a. Actuator Stall Torque Test

- (1) 600 lb-in. (min) clockwise
- (2) 600 lb-in. (min) counterclockwise

Appendix A

b. Frequency Resonse

- (1) Phase lag 90° or less at 8 HZ

c. Step Response

- (1) Driving function, $45^\circ \pm 22.5^\circ$ @ 0.33 HZ
 - (2) Saturation velocity, $360^\circ/\text{sec}$ minimum
 - (3) Rise time, 0.12 sec (to 62% of commanded change of position.
 - (4) Settling time, 0.3 sec to within $\pm 5\%$ of commanded change of position.
 - (5) Overshoot, 15% of commanded change of position
- d. Threshold: ± 0.1 degrees maximum
- e. Data shall be recorded as required by RN-DR-0084.

E. REPORTS

The results and evaluation of the performance reference tests shall be incorporated as a part of individual qualification test reports.

APPENDIX B

DOCUMENTATION

Appendix B

I. DOCUMENTATION

A. SCOPE

This appendix defines the documentation requirements of the actuator qualification test program.

B. OBJECTIVES

The objectives of the actuator qualification test program documentation requirements are:

1. To record all original test data, instrumentation calibrations, and notes on observations related to the performance of each test defined in the qualification test plan.

2. To document and publish detailed engineering reports for the individual tests defined in the qualification test plan.

3. To document and publish an engineering summary report to summarize results, arrive at conclusions, and make recommendations.

C. APPLICABLE DOCUMENTS

Aerojet-General Corporation Style Manual and Technical Writers
Guide

Appendix B

D. REQUIREMENTS

1. Reports, Individual Tests

The format of the test reports shall consist of an abstract, table of contents, text and appendixes. The major sections of the text shall be as follows:

a. Text Outline

- I Introduction
- II Summary
- III Technical Discussion
 - A. Objective
 - B. Procedure
 - C. Results
- IV Conclusions

b. Text Detail

Individual test reports shall include but are not limited to the following detail information.

- (1) Identification of test item
- (2) Identification of test instrumentation and verification of calibration.
- (3) Reference to test plan
- (4) Procedures, referenced or included as an appendix
- (5) Statement of test objectives
- (6) Performance data
- (7) Environmental data
- (8) Copies of machine-produced data formats, (e.g. section of Brush recorder tapes) included as figures or appendixes

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- (9) Test setup data (bolt or clamp torque values, etc.)
- (10) Derived data (e.g. Bode plots)
- (11) Test setup schematics
- (12) Pictures of test item, test setup, failed parts, etc.
- (13) Analyses in support of test or in the evaluation of failures
- (14) Drawings, schematics of test article, test equipment and test setup
- (15) Results of physical test, measurements and material analyses
- (16) Data from actuator log book

2. Summary Report

An actuator summary report shall be prepared to evaluate the composite results of the individual tests, document conclusions and make recommendations.

a. Format

The format and test outline of the summary report shall be the same as that of the individual test report: abstract, table of contents, introduction, summary, technical discussion, conclusions and recommendations.

b. Test, Detail

(1) Technical Discussion

The technical discussion shall include a brief restatement of the overall objectives of the qualification test program. A technical evaluation of the overall effect of the individual tests, their degree of success or failure, component or detail parts failure, the effect

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of the repair relative to the actuator life, desired versus actual test environments, and a review of the performance history up to and including the qualification program will be included.

(2) Conclusions and Recommendations

Each conclusion shall be covered specifically, with complete details and the logic leading to the conclusion. Recommendations are to be supported in detail with analyses, test data and other justifications which apply.

(3) Appendixes

The individual test reports covering the proof pressure test, vibration test, mechanical shock test, humidity test, and life test shall be included in the summary report as appendixes. Other appendixes as necessary to support the summary report technical discussion, conclusions and recommendations shall also be included in the reports.