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(NASA-CR-131401) VALVE, EXPLOSIVE
ACTUATED, NORMALLY OPEN, PYRONETICS MODEL
1399 Final Report (Pyronetics, Inc.)
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QC & R 6-045

PYRONETICS, INC.

A CORDON INTERNATIONAL COMPANY

REPORT NO. QC & R 6-045

EVALUATION TEST PROGRAM

FINAL REPORT

VALVE, EXPLOSIVE ACTUATED, NORMALLY OPEN

PYRONETICS MODEL 1399

JET PROPULSION LABORATORY

PURCHASE ORDER NO. ES-536829

PREPARED BY

Edward Avalos

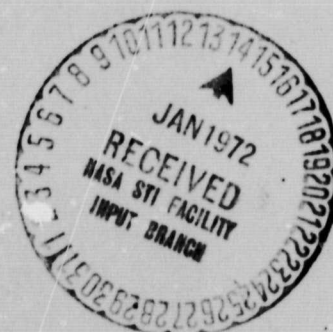
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CONTENTS

	<u>Page</u>
INTRODUCTION AND SUMMARY	1
DESCRIPTION OF EXPLOSIVE ACTUATED, NORMALLY OPEN, VALVE	2
1.0 TEST PROGRAM	3
2.0 REFERENCE DOCUMENTS	4
3.0 TEST DESCRIPTION AND RESULTS	5
3.1 Proof Pressure and External Leakage Test (Body Subassembly)	5
3.2 Proof Pressure and Leakage Test (Actuator Assembly)	6
3.3 Gross Leak Test (Actuator Assembly)	7
3.4 Examination of Product	8
3.5 Cleanliness Verification	9
3.6 Actuation Test	10
3.7 Post Actuation Proof Pressure & Internal Leakage	11
3.8 Disassembly Inspection	12
3.9 Post Actuation Leakage (Actuator Assembly)	13
3.10 Post Actuation Leakage Gross (Actuator Assembly)	14
3.11 External Leakage After Actuation (Valve Assembly Less Actuator Assembly)	15
3.12 Burst Pressure Test	16
4.0 TEST PROGRAM CONCLUSION	17
5.0 TEST EQUIPMENT AND SETUPS	18



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CONTENTS (continued)

Appendix 1	Proof Pressure & External Leakage Test Data Sheet	28
Appendix 2	Proof Pressure & Leakage (Act. Assy) Test Data Sheet	30
Appendix 3	Gross Leak Test Data Sheet	32
Appendix 4	Examination of Product Test Data Sheet	34
Appendix 5	Cleanliness Verification Test Data Sheet	37
Appendix 6	Actuation Test Data Sheet	40
Appendix 7	Post Actuation Proof Pressure & Internal Leakage Test Data Sheet	42
Appendix 8	Disassembly Inspection Test Data Sheet	44
Appendix 9	Post Actuation Leakage (Act. Assy) Test Data Sheet	46
Appendix 10	Post Actuation Gross Leakage (Act. Assy) Test Data Sheet	48
Appendix 11	External Leakage Test Data Sheet	50
Appendix 12	Burst Pressure Test Data Sheet	52



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LIST OF ILLUSTRATIONS

		<u>Page</u>
Figure 1	Proof Pressure & External Leakage Test Setup	21
Figure 2	Proof Pressure & Leak Test Setup (Actuator Assembly)	22
Figure 3	Leak Test (Gross Leak) Setup	23
Figure 4	Actuation Test Setup	24
Figure 5	Proof Pressure & Internal Leakage Test Setup	25
Figure 6	Post Actuation Leakage Test Setup (Less Actuator Assembly)	26
Figure 7	Burst Pressure Test Setup	27



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INTRODUCTION AND SUMMARY

The Evaluation Test Program for the Explosive Actuated, Normally Open Valve, Model 1399, was conducted in compliance with JPL Purchase Order Number ES-536829.

The objective of this Evaluation Test Program was to demonstrate compliance of this valve with the requirements of JPL P.O. ES-536829 by a series of operating tests applied to three (3) valves.

There were no failures.

Compliance of the Explosive Actuated, Normally Open Valve with all specification requirements was successfully demonstrated by this Test Program.

Additionally, within the testing parameters specified, the JPL cartridge, P/N 10028949, demonstrated successfully its capability to properly actuate the Model 1399 valves which underwent this testing program.



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DESCRIPTION OF CARTRIDGE ACTUATED, NORMALLY OPEN VALVE MODEL 1399

The Model 1399 is a normally open, cartridge actuated valve which will be utilized in the trajectory correction propulsion subsystem of the Thermoelectric Outer Planets Spacecraft. (TOPS).

The normally open valve will be used to control and isolate the flow of hydrazine to a 25 pound thrust monopropellant thruster.

The Model 1399 valves will be utilized in conjunction with the Pyronetics Model 1400, Cartridge Actuated, Normally Closed Valve in a manifold assembly to provide a multiple start-stop capability. Each assembly is normally closed in the TOPS vehicle at launch. The projected usage of the propulsion subsystem is for trajectory correction during mission durations as long as ten years in the interplanetary and outer space environments within the solar system.

Upon actuation, the normally open valves of each assembly will shut down the supply of fuel to the rocket engine assembly. Explosive valves are utilized in the propulsion subsystem to prevent leakage during long storage periods. Valve actuation is accomplished by explosive energy generated when the JPL cartridges, P/N 10028049, are ignited by the application of electrical power.

The valves are mounted in the propulsion subsystem by welding the inlet and outlet ports into a manifold tubular system. In the normally open position fluid flow is allowed by an unrestricted flow passage. Upon actuation, a tapered ram is driven through the flow passage, causing termination of flow and zero leakage.

EVALUATION TEST PROGRAM
EXPLOSIVE ACTUATED VALVE
MODEL 1399 NORMALLY OPEN

1.0 TEST PROGRAM

Three (3) normally open valves were submitted for evaluation testing in accordance with Pyronetics Test Procedure TS 1399. The objective of the test program was to verify design concept compatibility with the test requirements of JPL P.O. ES-536829 for a normally open explosive valve that will control the flow of hydrazine to a 25 pound thrust mono-propellant thruster. The cartridge utilized for actuation testing (JPL P/N 10028049) was supplied by Jet Propulsion Laboratory and underwent only the actuation test.

The three valves were subjected to the following test sequences:

1. Proof Pressure and External Leakage Test
(Body Subassembly)
2. Proof Pressure and Leakage Test (Actuator Assembly)
3. Gross Leak Test (Actuator Assembly)
4. Examination of Product
5. Cleanliness Verification
6. Actuation Test
7. Post Actuation Proof Pressure and Internal Leakage Test
8. Post Actuation Disassembly Inspection
9. Post Actuation Leakage (Actuator Assembly)
10. Post Actuation Leakage-Gross (Actuator Assembly)
11. External Leakage After Actuation
(Valve Assembly less Actuator Assembly)
12. Burst Pressure Test



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2.0 REFERENCE DOCUMENTS

The following documents comprise the criteria for this test program.

2.1 Military

MIL-C-45662 A	Calibration System Requirements 9 February 1962
MIL-P-27401 B	Propellant, Pressurizing Agent Nitrogen, 14 September 1971
MIL-P-27407	Propellant, Pressurizing Agent Helium, 8 June 1965

2.2 JPL

P. O. No. ES-536829	Requirements for Fabrication, Assembly and Test of Normally Open and Normally Closed Explosive Actuated Valve
FS 504574	General Cleanliness Required for Spacecraft Systems and Support Equipment, Detail Specification for
Drawing 10028049	Squib

2.3 Pyronetics, Inc.

Drawing 1399	Valve, Normally Open, Explosive Actuated
TS 1399	Acceptance and Evaluation Test Procedure

3.0 TEST DESCRIPTION AND RESULTS

The evaluation test requirements, descriptions and test results of the Normally Open Valves, Pyronetics Model 1399, employed in the evaluation test program (in accordance with Pyronetics Procedure TS 1399, Rev A), are described in the following paragraphs.

3.1 Proof Pressure and External Leakage (Body Subassembly) 3 Units

Requirement

(Reference JPL P.O. ES-536829)

Subject the body subassembly to an external leakage test by applying a pressure of 1000 ± 30 psig helium gas to the actuator cavity for a period of at least thirty (30) minutes. Measure the external leakage. The leakage shall not exceed 1×10^{-6} scc/sec.

Test Description

The proof and external leakage test was performed on the valve body subassembly during inprocess testing per TS 1399 prior to submitting the assembled valves to the functional evaluation tests. The normally open valves were subjected to a combined proof pressure and external leakage test (see Figure 1). Each valve was individually pressurized through the cartridge port, while installed in a bell jar, to 1000 ± 30 psig with gaseous helium. The bell jar was connected to a helium mass spectrometer and subsequently evacuated to 10^{-4} torr. The external leakage was then monitored on the mass spectrometer for 30 minutes minimum for evidence of leakage in excess of 1×10^{-6} sccs of helium. Upon completion of test, the valves were removed from the test system and the cartridge port was blown off with gaseous nitrogen.

Test Results

None of the units tested sustained any evidence of yielding, permanent deformation or other visible damage. Additionally, the valves did not exhibit any detectable leakage in excess of 1×10^{-6} sccs. Maximum external leakage recorded was 8.0×10^{-8} sccs. Reference test results in Appendix 1.



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3.2 Proof Pressure and Leakage Test (Actuator Assembly) 3 Units

Requirement

(Reference JPL P.O. ES-536829)

Each actuator assembly shall be installed in a suitable holding fixture and subjected to an external pressure of $500 \pm 10/-0$ psig with gaseous helium for thirty (30) minutes minimum. Following pressurization period, actuator assembly shall be removed from the helium pressurization and subjected to a helium mass spectrometer leak test. There shall be no evidence of leakage in excess of 1×10^{-6} scc/sec helium. There shall be no evidence of deformation or damage as a result of these tests.

Test Description

The combined proof pressure and leakage test was performed on each actuator assembly prior to assembling into valve body as an inprocess test per TS 1399. Each actuator sub-assembly was installed in a holding fixture as shown in Figure 2 and subjected to an external pressure of $500 \pm 10/-0$ psig with gaseous helium for thirty minutes. The actuator assembly was then removed from the pressure fixture and blown off with gaseous nitrogen and within sixty seconds after removal from fixture was installed in the leakage test fixture. The test fixture was evacuated to 10^{-4} torr and the leakage rate from the actuator assembly was checked with a mass spectrometer for evidence of leakage in excess of 1×10^{-6} sccs, the initial value indicated by the mass spectrometer was recorded. The bellows assembly was then visually examined for evidence of damage or deformation as a result of the proof pressure test.

Test Results

None of the units tested exhibited any evidence of yielding, permanent deformation or other visible damage. There was no evidence of leakage in excess of 1×10^{-6} sccs. Maximum leak rate recorded was 5.5×10^{-9} sccs, reference test results in Appendix 2.



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3.3 Gross Leak Test (Actuator Assembly) 3 Units

Requirement

(Reference JPL P.O. ES-536829)

The actuator assembly shall be tested for gross leakage by submerging in hot deionized water at $+180 \pm 15^\circ\text{F}$ and checked for evidence of bubbles.

Test Description

The gross leak test on the actuator assembly was performed prior to assembling into valve body as an in process test per TS 1399. Each actuator assembly was immersed in hot water ($+180 \pm 15^\circ\text{F}$) with axis in a horizontal position and the entrapped air in the bellows was removed by slightly agitating the assembly, reference Figure 3. Actuator assembly was maintained immersed in the hot water for one minute minimum while visually observing for bubble emission from the bellows of the actuator assembly as an indication of gross leakage.

Test Results

No evidence of bubble emission was detected from any of the actuator assemblies during the test. Hence, no gross leaks were found in the bellows area of the actuator assembly as recorded on the data sheet of Appendix 3.



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3.4 Examination of Product (3 Units)

Requirement

(Reference JPL P.O. ES-536829)

Each valve body and components shall be visually examined for freedom from blemishes, tool marks, burrs, legibility and correctness of markings and any other characteristics which reflect the general quality of workmanship. The size, configuration and mounting dimension shall be in accordance with the dimensions noted on the appropriate drawings. These units shall be inspected with suitable gauges and/or instruments for conformance to the dimensions noted on the appropriate drawings, reference drawing 1399. The specimens shall be deemed acceptable for testing if they conform to the drawing requirements and are free from damage.

Test Description

The examination of product was performed upon completion of all the in process tests and prior to assembling the valve. Each valve body and components were visually examined for freedom from blemishes, tool marks, burrs, legibility and correctness of markings and other characteristics which reflected the general quality of workmanship. The size, configuration and mounting dimensions were inspected for conformance to the appropriate drawing.

Test Results

All of the major dimensions and characteristics were one hundred percent inspected and were per print. The requirements, results and verification of special processes are on file at Pyronetics. Appendix 4 includes the Configuration Identification Index indicating the as built configuration of the valves, and inspection/buy-off records. The index indicates all documents, by revision letter, necessary for the manufacture of the parts.

3.5 Cleanliness Verification (3 Units)

Requirement

(Reference JPL P.O. ES-536829)

Units shall be cleaned and assembled in accordance with applicable drawing requirements. (Reference level D.2 of JPL Spec. FS 504574.) Units selected for Evaluation Tests shall have JPL 10028049 squib installed in the actuator assembly prior to cleaning. Installation torque shall be 300 ± 20 in-lbs.

Verify cleanliness level of completed assembly and sign off on data sheet.

Test Description

The cleaning operation was performed by Garwood Laboratories in accordance with JPL Specification FS 504574 (Level D.2). The JPL 10028049 cartridge was installed in the actuator assembly prior to cleaning with 300 ± 20 in-lbs. Upon completion of cleaning operation Pyronetics personnel assembled the valves in the clean room. After the units were assembled, a final partical count was performed and the cleanliness level of FS 504574 D.2 was verified. The units were again vacuum oven dried and the tube ports were sealed with nylon film and tape cleaned to the same level as the valves. Each valve was placed in a polyethylene bag; purged with gaseous nitrogen, vacuum evacuated and heat sealed.

Test Results

All applicable surfaces of the components were cleaned as specified in FS 504574 and certified to a cleaning level of D.2. Reference test results in Appendix 5.

3.6 Actuation Test (3 Units)

Requirement

(Reference JPL P.O. ES-536829)

The actuation test shall be performed on a sample selected at random from the production lot. The valve shall be actuated while a water pressure of 500 psig is flowing through the valve. The response time shall be measured from bridgewire burnout to first indication of pressure decay on the downstream side of the valve. Response time shall not exceed 10 milliseconds.

Test Description

The valves were mounted in a holding fixture as indicated in Figure 4. A pressure transducer was connected on the downstream side of the valves to detect response time. The bridgewire resistance of each bridgewire on the 10028049 JPL cartridge was measured and recorded with an Alinco Ohmmeter. The normally open tube ports were pressurized to 500 ± 10 psig with water. The valves were actuated individually upon application of 5.0 amperes from a constant current power supply to one bridgewire of the cartridge while flowing 500 psig of water through the normally open tubes. The response time was measured by the transducer installed on the downstream side of the valve with an oscilloscope and camera. Upon actuation of the valve, transfer of the valve to the closed mode caused the pressure to decay on the downstream side as the water flow was shut off. Hence, response time was measured from bridgewire burnout to first indication of pressure drop on the downstream side of the valve.

Test Results

The valves actuated to the closed mode satisfactorily without any detectable evidence of damage to the structural integrity of the valves. The bridgewire burnout time was 0.95 milliseconds for all the valves; response times occurred between 0.95 to 1.00 milliseconds. Hence all of the valves complied with the 10.0 millisecond maximum response time requirement. Since all three units met the actuation test requirements, and they all passed the subsequent post actuation leakage test, the test was deemed successful. Reference test results in Appendix 6.

3.7 Post Actuation Proof Pressure and Internal Leakage (3 Units)

Requirement

(Reference JPL P. O. ES-536829)

Each valve shall be internally pressurized through one nipple tube to $1000 +30/-0$ psig with gaseous helium for thirty (30) minutes minimum. There shall be no evidence of internal leakage in excess of 1×10^{-6} scc/sec of helium measured at the opposite port.

Test Description

The actuated valves were installed in a pressure fixture (reference Figure 5) and only one of the tube ports was pressurized to $1000 +30/-0$ psig with helium, the other tube port was connected to a mass spectrometer and then evacuated to 10^{-4} torr. The leakage rate was monitored for 30 minutes for evidence of leakage in excess of 1×10^{-6} sccs.

Test Results

No internal leakage in excess of 1×10^{-6} sccs of helium was detected during the 30 minute test period. The post actuation internal leakage ranged from 2.4×10^{-9} to 1.2×10^{-8} sccs. Reference test results in Appendix 7.

3.8 Disassembly Inspection (3 Units)

Requirement

(Reference JPL P.O. ES-536829)

The JPL 10028049 squib shall be removed from the actuator assembly and the actuator assembly shall be removed from the valve body. Valve and actuator assembly shall be examined for proper actuation and there shall be no evidence of abnormal deformities, cracks, etc. on the actuator assembly bellows.

Test Description

The fired JPL 10028049 cartridge was removed from the actuator assembly first, then the actuator assembly was removed from the valve body. Examination of the actuator assembly was then performed under a 40X microscope for evidence of abnormal deformities, cracks, etc on the bellows and all observations were recorded, the valve body was also visually examined for proper actuation.

Test Results

No cracks or other anomalies were detected on the actuator assembly bellows exterior. There was no evidence of cartridge gas blowby. No visual evidence of abnormal deformation was found in the valve bodies. The structural integrity of the actuated valves appeared sound. Reference test results in Appendix 8.

3.9 Post Actuation Leakage (Actuator Assembly) 3 Units

Requirement

(Reference JPL P.O. ES-536829)

Each actuator assembly shall be installed in a suitable holding fixture and subjected to an external pressure of 500 +10/-0 psig with gaseous helium for thirty (30) minutes minimum. Following pressurization period, actuator assembly shall be removed from the helium pressurization and subjected to a helium mass spectrometer leak test. There shall be no evidence of leakage in excess of 1×10^{-6} scc/sec helium. There shall be no evidence of deformation or damage as a result of these tests.

Test Description

The actuator assembly from each actuated valve was installed in a holding fixture as shown in Figure 2 and externally pressurized with helium to 500 +10/-0 psig for 30 minutes. Upon completion of the pressurization period the actuator assembly was removed from the test fixture and within 60 seconds was blown off externally with gaseous nitrogen and subjected to a leak check. A mass spectrometer was utilized to check for evidence of leakage in excess of 1×10^{-6} sccs.

Test Results

No evidence of leakage in excess of 1×10^{-6} sccs of helium was detected on any of the actuator assemblies. Maximum leakage rate detected was 5.0×10^{-8} sccs. Reference actual test results in Appendix 9.



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3.10 Post Actuation Gross Leakage (Actuator Assembly) 3 Units

Requirement

(Reference JPL P. O. ES-536829)

The actuator assemblies from the actuated valves shall be tested for gross leakage by submerging in hot deionized water at $+180 \pm 15^{\circ}\text{F}$ and checking for evidence of bubbles.

Test Description

Each actuator assembly that had been removed from the actuated valve was immersed in hot water ($+180 \pm 15^{\circ}\text{F}$) with axis in a horizontal position and the entrapped air in the bellows was removed by slightly agitating the assembly, reference Figure 3, and checked for gross leakage. Actuator assembly was maintained immersed in hot water for one minute minimum while visually observing for bubble emission from the bellows in the actuator assembly as an indication of gross leakage.

Test Results

No evidence of bubble emission was detected in the bellows area during the time the actuator assembly was immersed in the hot water. Reference test results in Appendix 10.

**3.11 External Leakage After Actuation (Valve Assembly Less
Actuator Assembly (3 Units)**

Requirement

(Reference JPL ES-536829)

The external leakage after actuation of each valve shall be determined. The tube ports shall be pressurized to 1000 +30/-0 psig with helium gas for a minimum duration of thirty (30) minutes. The external leakage shall not exceed 1×10^{-6} scc/sec of helium. The actuator assembly shall be removed for this test.

Test Description

Following the actuation test, the actuator assembly was removed from the valve body. The actuated valves were then secured in a pressure fixture, reference Figure 6, placed in a bell jar and both tube ports were simultaneously pressurized to 1000^{+10}_{-0} psig with helium gas. The bell jar was connected to a helium mass spectrometer and then evacuated to 10^{-4} torr. The valves were leak checked for evidence of external leakage by monitoring a mass spectrometer for leakage in excess of 1×10^{-6} sccs of helium for 30 minutes.

Test Results

None of the valves tested exhibited any detectable external leakage in excess of 1×10^{-6} sccs during the 30 minute test period. The post actuation leakage rate recorded ranged from 7.0×10^{-8} to 8.8×10^{-8} sccs. Therefore, test was considered acceptable since no leakage in excess of 1×10^{-6} sccs was detected. Reference test results in Appendix 11.



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3.12 Post Actuation Burst Pressure Test (3 Units)

Requirement

(Reference JPL ES-536829)

The valve assembly (actuator assembly removed) shall be subjected to a burst pressure test and burst pressure determined. One tube port shall be pressurized with hydrostatic pressure from 0 to 10,000 psig in increments of 1000 psig. Minimum burst pressure shall be 2000 psig. If unit fails to burst at 10,000 psig pressure, discontinue test.

Test Description

The actuated valves were firmly secured in a burst test holding fixture (reference Figure 7) and one tube port was connected to a hydrostatic pressure source. The valves were placed behind a safety barricade and the tube port was slowly pressurized in increments of 1,000 psig and maintained for 15 seconds minimum at each level up to 10,000 psig and held for 60 ± 10 seconds. During the test valves were visually examined for evidence of leakage with the aid of a mirror.

Test Results

None of the actuated valves burst tested exhibited any visual evidence of external leakage. The test was considered successful since the valves did not burst and no evidence of structural damage was observed as a result of the burst pressure. Reference test results in Appendix 12.



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4.0 TEST PROGRAM CONCLUSIONS

Accomplishment of the evaluation tests in accordance with Pyronetics Test Procedure TS 1399 Rev A, dated 22 March 1971 signify the acceptance of the Normally Open Explosive Actuated Valve, Pyronetics Model 1399, as having fulfilled the test requirements of JPL Purchase Order No ES-536829. The evaluation test program was conducted by Pyronetics, Inc. and witnessed and acknowledged by JPL Engineering.

Examination of the data included herein indicates excellent repeatability of all functional characteristics, i.e., ignition time and response time. Additionally, post actuation proof and leakage test of the actuator assembly and valve body revealed adequacy of the taper lock (metal-to-metal seal) between the ram and valve body after actuation. It should also be noted that the internal proof pressure had no effect on the integrity of the shear section of the normally open tubes.

The structural integrity of the valve assemblies was successfully demonstrated by the post actuation 10,000 psig burst test and in the fact that the pre-actuation and post-actuation leak rates detected far surpassed the 1×10^{-6} sccs requirements. The fact that no anomalies or degradation in performance was experienced further testifies to the soundness of the design.

Finally, it should be noted, that the Bellows which is incorporated into the valve design to positively prevent any cartridge products of combustion from entering the flow stream, performed exactly as required. Positive retention of all contamination was achieved.

Therefore, based on the data described herein, no changes to valve design are recommended.

5.0 TEST EQUIPMENT AND SETUPS

The test equipment and environmental apparatus employed in the performance of the various tests described herein are listed below. All equipment was checked for reliable performance prior to initiation of specific tests. Accuracy and capability is as specified and all calibrations are traceable to the National Bureau of Standards.

5.1 Test Equipment - Proof Pressure and Leakage

Instrument	Mass Spectrometer
Manufacturer	Consolidated Electrodynamics
Model No.	24-120B S/N 9593
Range	5×10^{-11} scc/sec
Type	Helium Detector
Calib. Frequency	Prior to use
Instrument	Sensitivity Calibrator
Manufacturer	Consolidated Electrodynamics
Model No.	25643 S/N 122G6
Range	Helium Leak Rate 8.8×10^{-7} scc/sec
Accuracy	$\pm 10\%$ of indicated leak rate
Instrument	Pressure Gauge
Manufacturer	Marsh Instrument Co.
Model No.	100 S/N 535
Range	0-1500 psi
Accuracy	$\pm 0.5\%$
Calib. Frequency	90 days
Calib. Due	10-28-71
Instrument	Stop Watch
Manufacturer	Minerva
Model No.	136-L S/N 1355
Range	0-15 Min x .01 sec
Accuracy	± 0.05 min/hr
Calib. Frequency	6 months
Calib. Due	2-5-72



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5.2 Test Equipment - Gross Leakage

Instrument	Hot Plate
Manufacturer	Thermolyne Corp.
Model No.	HP-A1915B
Range	100-500°F
Accuracy	N/A
Calib. Frequency	N/A

Instrument	Thermometer
Manufacturer	Van Waters Rodgers
Model No.	-- 1211
Range	0-230°F
Accuracy	±1%

5.3 Test Equipment - Examination of Product

As examination of products consists of visual inspections, dimensional measurements, surface finish inspection measurements, all of the equipment necessary to perform these inspections will not be listed below. However, all inspection tools utilized in the accomplishment of this task were verified to be within calibration prior to use.

5.4 Test Equipment - Actuation Test

Instrument	Ignition Circuit Tester
Manufacturer	Alinco
Model No.	1015 AF S/N 501
Range	0-10, 0-20 ohms
Accuracy	±0.02 ohms
Calib. Frequency	90 days
Calib. Due	12-18-71

Instrument	Constant Current Pulse Generator
Manufacturer	E&R Development Co.
Model No.	PS-4A S/N 653
Range	0-to 10 amp; 0 to 100m' sec
Accuracy	±0.5%
Calib. Frequency	6 months
Calib. Due	9-29-71



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5.4 Test Equipment - Actuation Test (continued)

Instrument	Charge Amplifier
Manufacturer	Kistler Corp.
Model No.	503 S/N 746
Type	Dial Calibration
Range	0-10 volts
Calib. Frequency	Prior to use
Instrument	Oscilloscope Camera
Manufacturer	Tektronix
Model No.	C12 S/N 003939
Instrument	Oscilloscope
Manufacturer	Tektronix
Model No.	502 S/N 002367
Type	Dual Beam
Range	100 μ to 20 v/centimeter
Accuracy	$\pm 3\%$
Calib. Frequency	90 days
Calib. Due	12-12-71
Instrument	Pressure Transducer
Manufacturer	Kistler Corp.
Model No.	603H S/N 2773
Range	0-15,000 psi
Accuracy	$\pm 1\%$
Calib. Frequency	Prior to use

5.5 Test Equipment - Burst Pressure

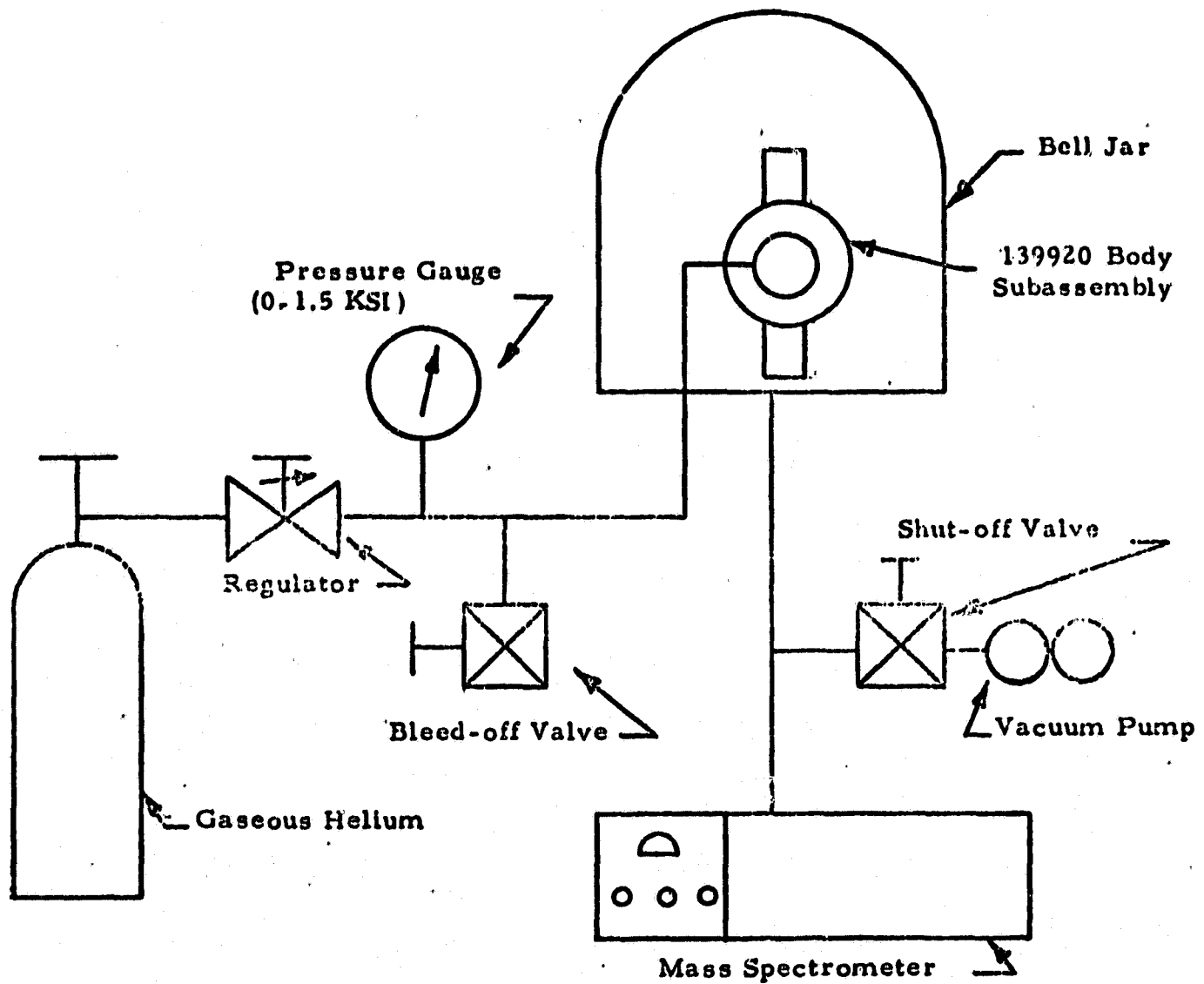
Instrument	Pressure Gauge
Manufacturer	U.S. Gauge
Model	19035, Serial No. 669
Range	0-20,000 psig
Accuracy	$\pm 0.5\%$
Calib. Frequency	90 days
Last Calibration	11-2-71
Instrument	Hydrostatic Test Console
Manufacturer	Pyronetics, Inc.
Model No.	N/A
Range	0-20,000 psig
Calib. Frequency	N/A



Tyronetics Inc.
SUNSHINE OF CALIFORNIA

10025 SHOEMAKER AVE.
SANTA FE SPRING, CALIF.

QC & R 6-045



PROOF PRESSURE & EXTERNAL LEAKAGE TEST SETUP

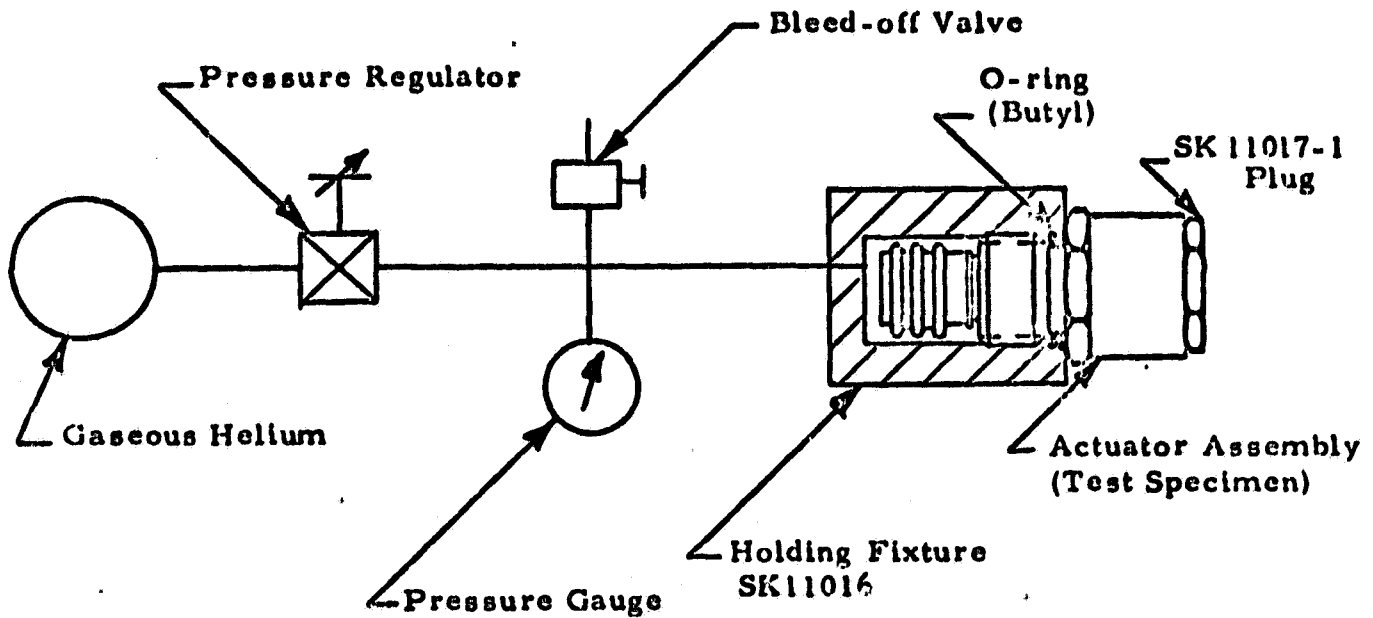
FIGURE 1



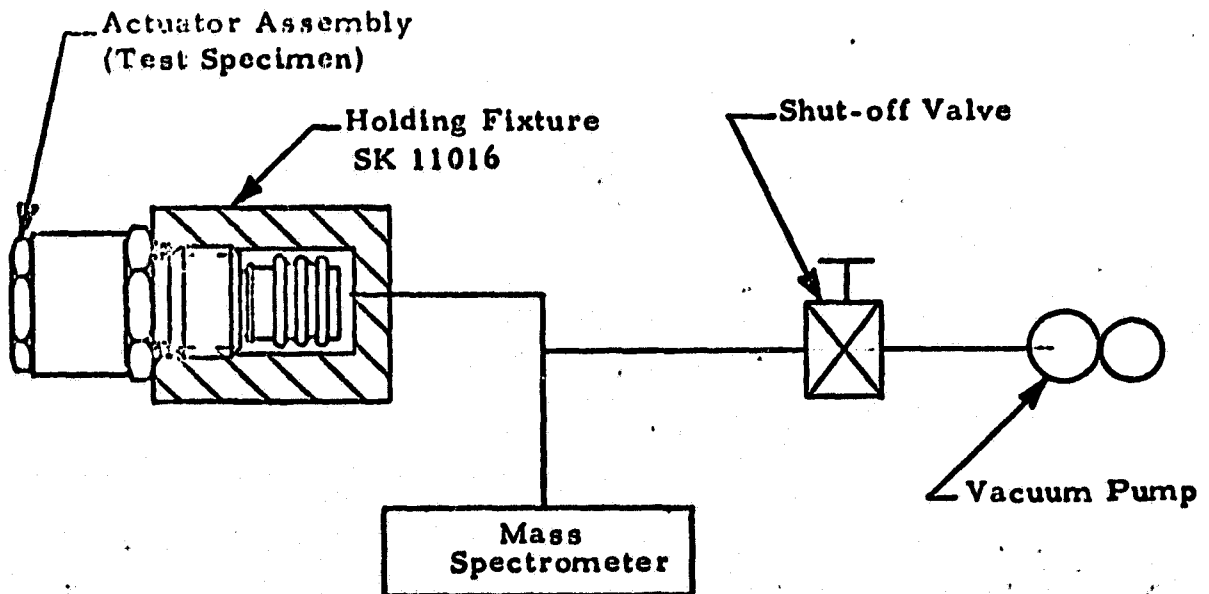
Pyrotech Inc.
SUBSIDIARY OF CHROMODYNE

10025 SHOEMAKER AVE.
SANTA FE SPRING, CALIF.

QC & R 6-C45



(A) PROOF PRESSURE



(B) LEAK TEST

PROOF PRESSURE & LEAK TEST SETUP
(ACTUATOR ASSEMBLY)

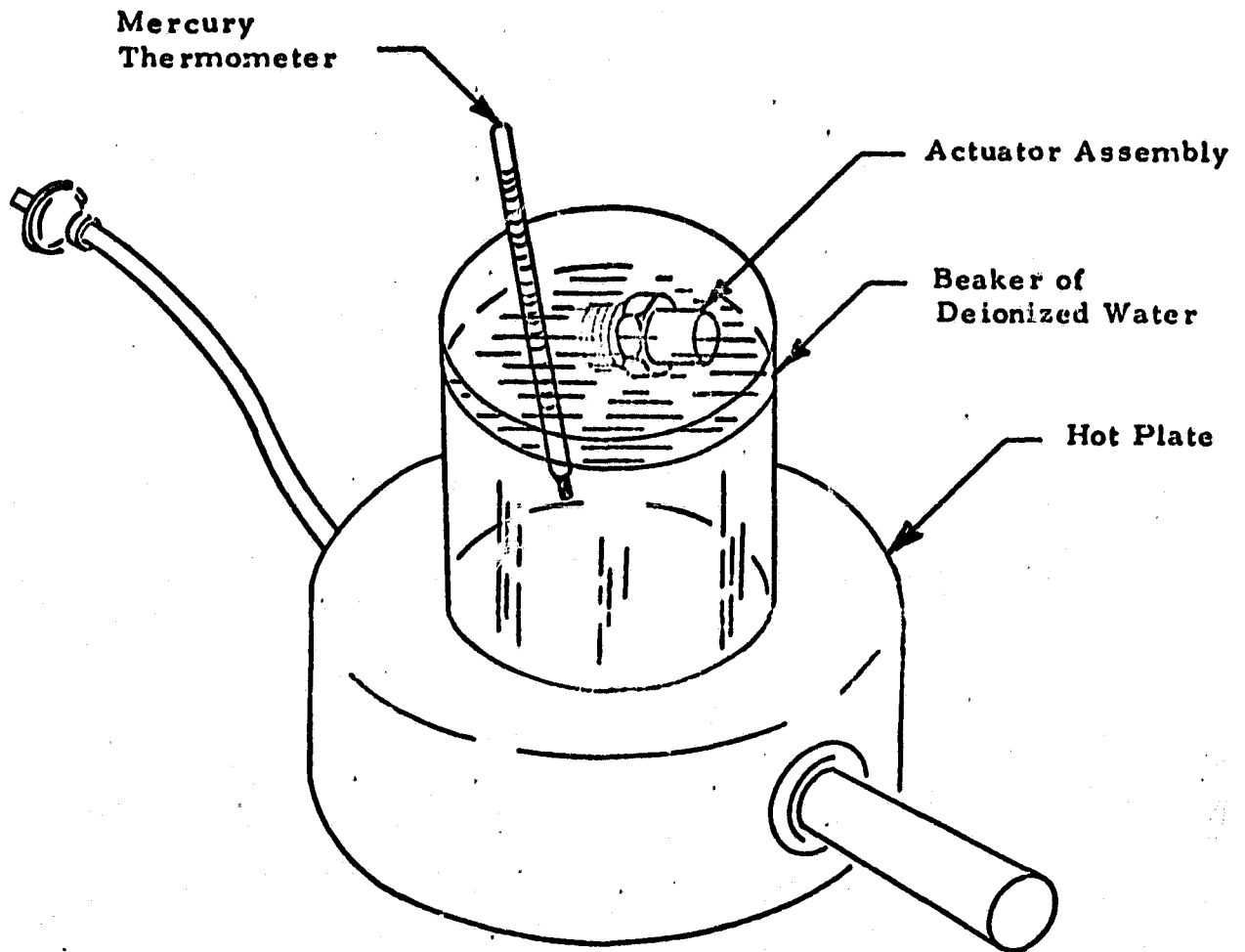
FIGURE 2



Pyrotechnics Inc.
SUBSIDIARY OF CHROMATICS

10025 SHOEMAKER AVE.
SANTA FE SPRING, CALIF.

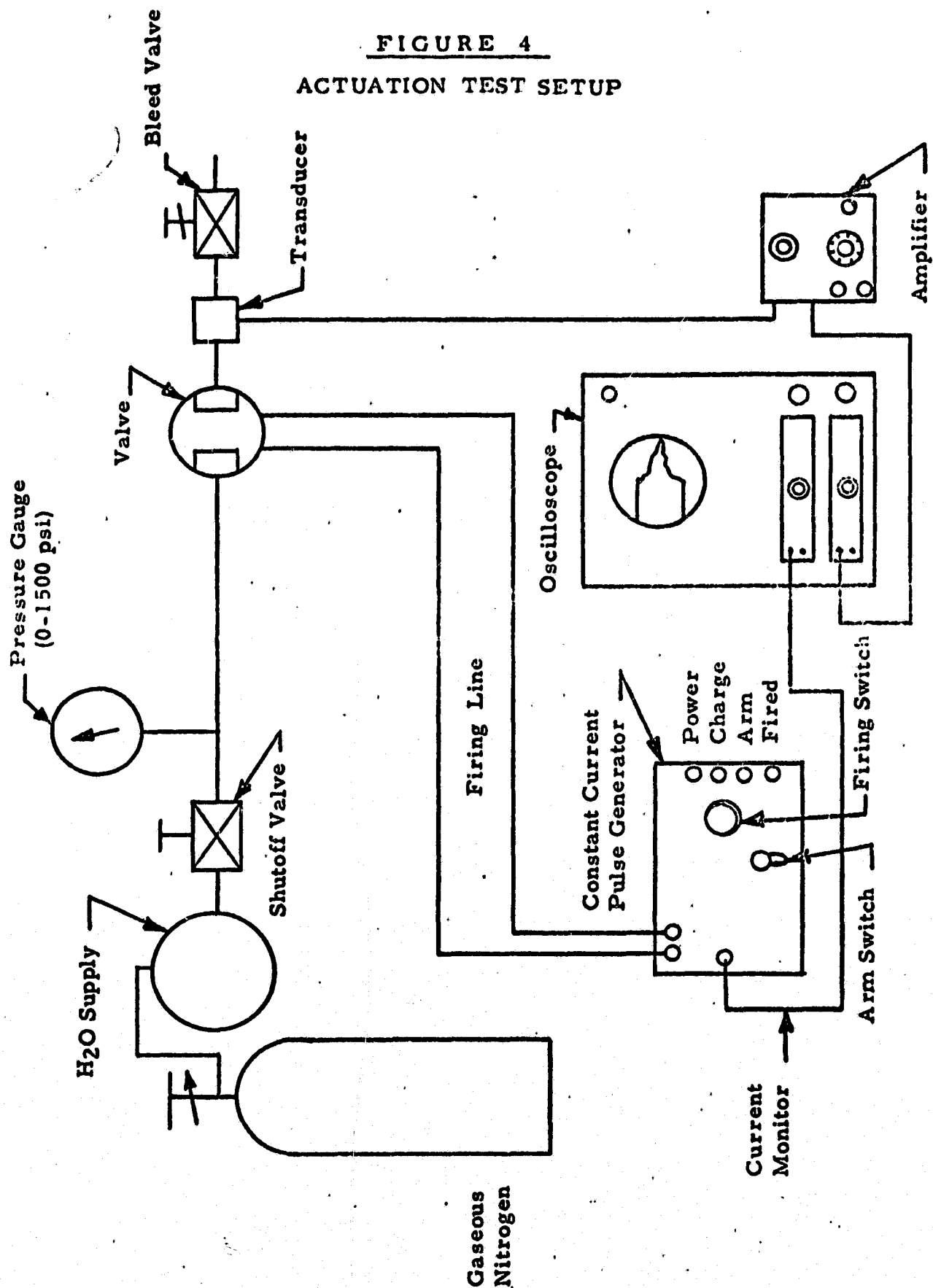
QC & R 6-045

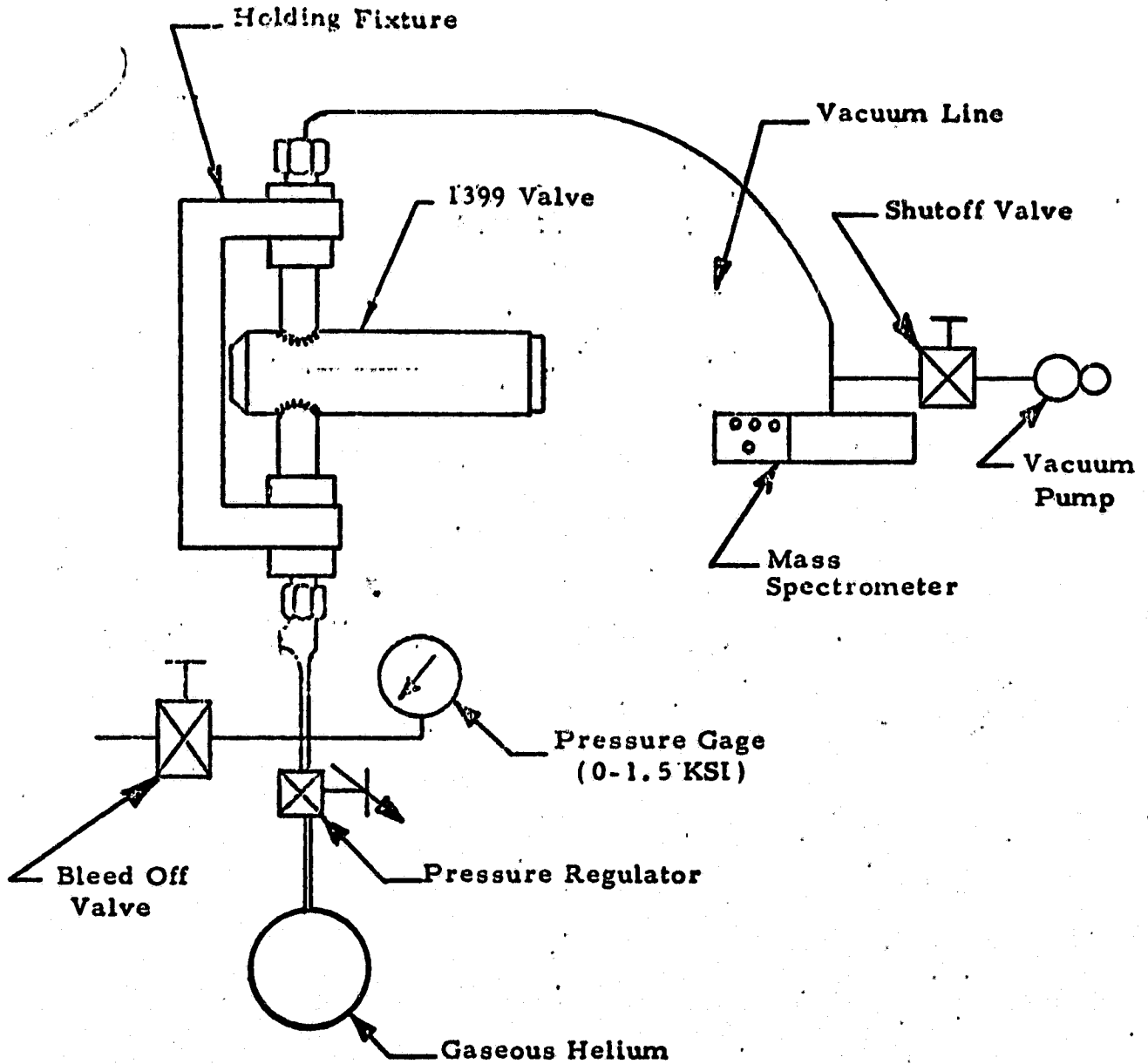


LEAK TEST (HOT WATER) SETUP

FIGURE 3

FIGURE 4
ACTUATION TEST SETUP





PROOF PRESSURE & INTERNAL LEAKAGE TEST SETUP

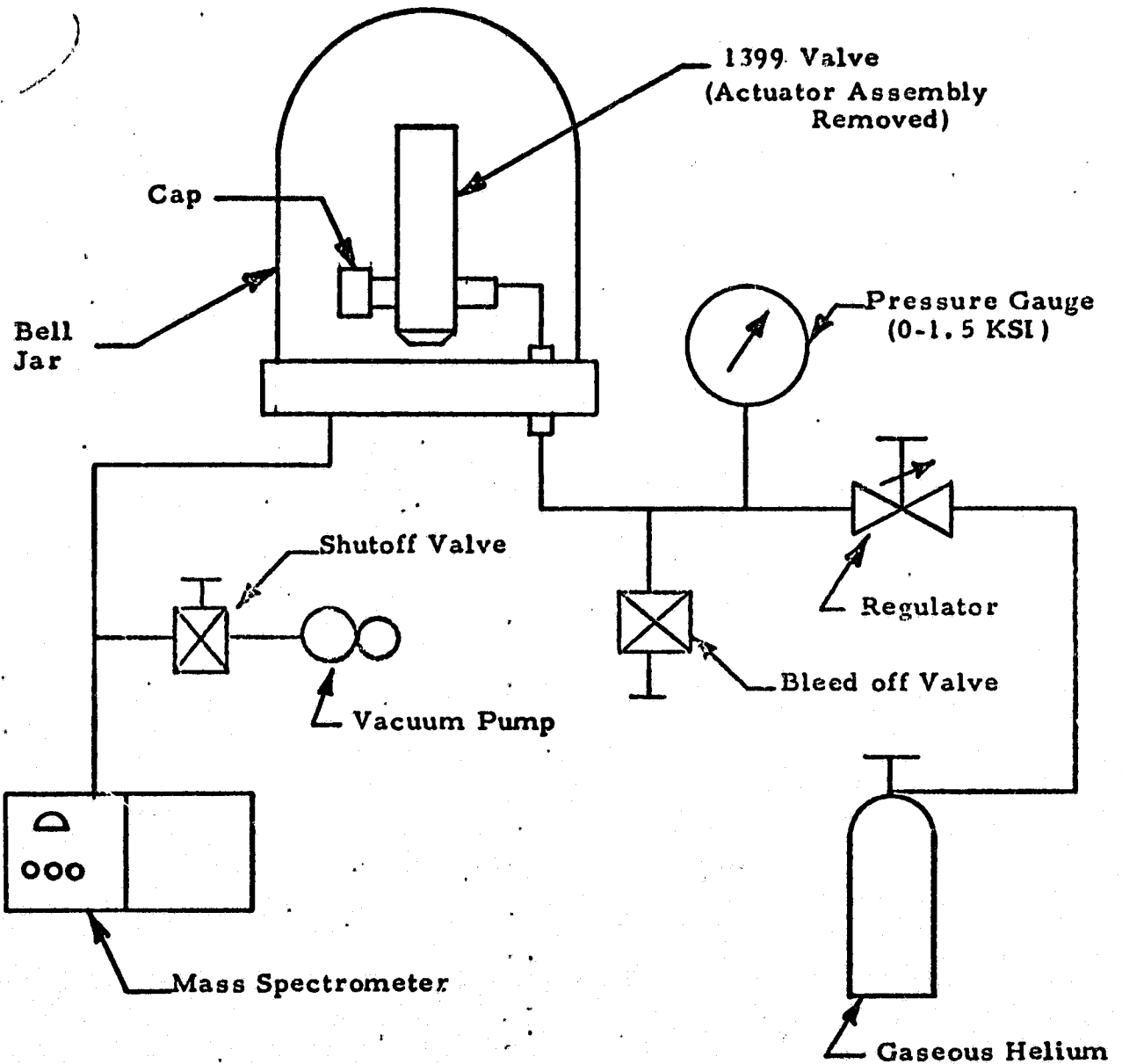
FIGURE 5.



Aerometrics Inc.
DIVISION OF COMPOSING

10025 SHOEMAKER AVE.
SANTA FE SPRING, CALIF.

QC. & R 6-045



POST ACTUATION LEAKAGE TEST SETUP
(LESS ACTUATOR ASSEMBLY)

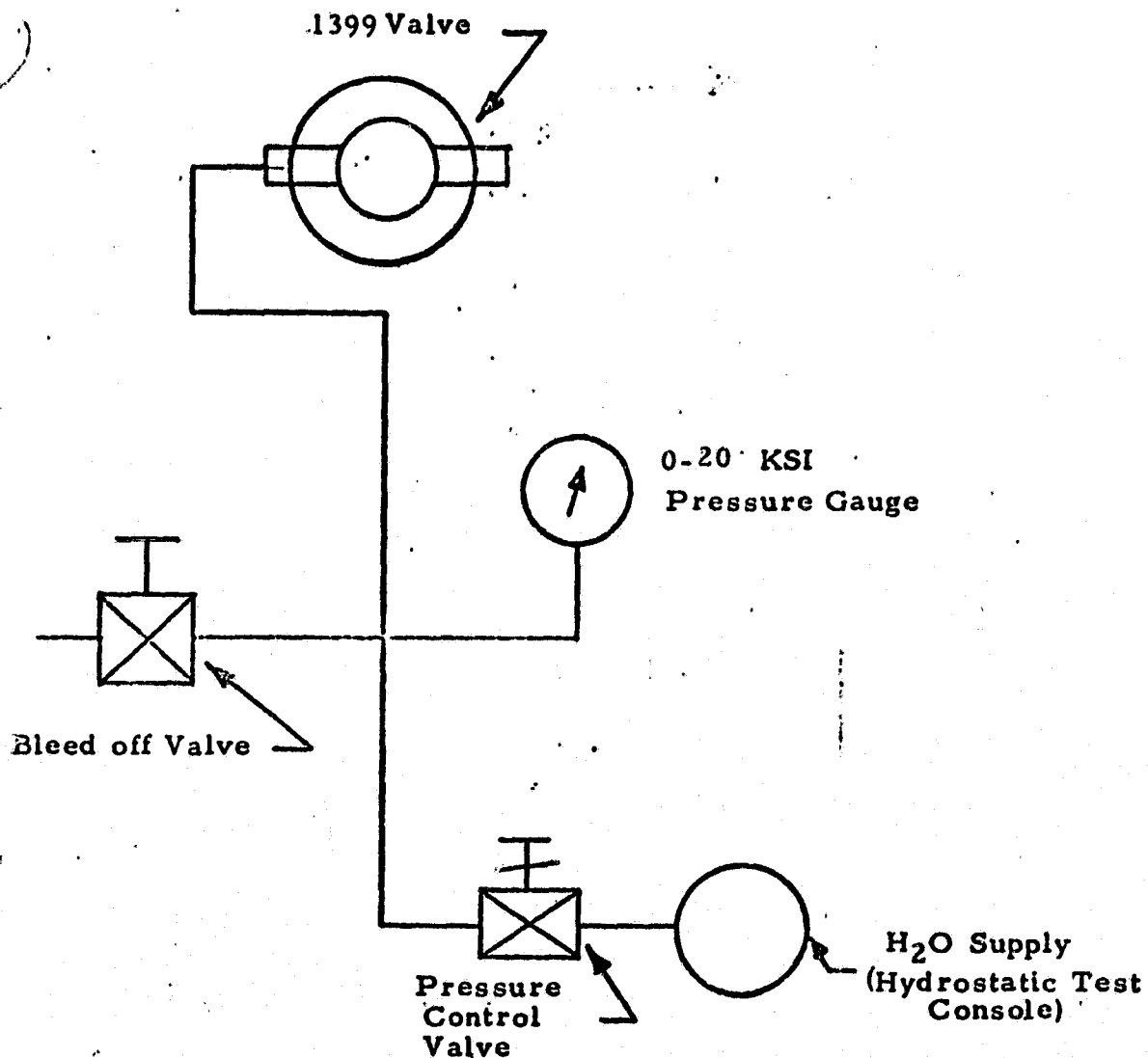
FIGURE 16



Tyronetics Inc.
SUBSIDIARY OF COSMOGONE

10025 SHOEMAKER AVE.
SANTA FE SPRINGS, CALIF.

QC & R 6-045



BURST PRESSURE TEST SETUP

FIGURE 7



Pyrotechnics Inc.
SUBSIDIARY OF COSMOBYNE

10025 SHOEMAKER AVE.,
SANTA FE SPRINGS, CA 90670

QC & R 6-045

APPENDIX 1

[illegible]



Eyratronics Inc.
SUBSIDIARY OF COSMOGYNE

10025 SHOEMAKER AVE.,
SANTA FE SPRINGS, CA 90670

QC & R 6-045

APPENDIX 2



Eyrannetics Inc.
SUBSIDIARY OF COMPOSITE

10025 SHOEMAKER AVE.,
SANTA FE SPRING, CA 90670

QC & R 6-045

APPENDIX 3



SANTA FE SPRINGS, CALIF.

LABORATORY TEST REPORT

JOB NO. 1068 MODEL 1399

Instruments and Procedure Per: TS-1399

Witnessed by _____ Source Insp. _____

Traveler S/N 4196

4.3 Gross Weak Test (Actuator Assembly)

[illegible]



Franchise Inc.
SUCROARY OF COSMOBYNE

10025 SHOEMAKER AVE.,
SANTA FE SPRINGS, CA 90670

QC & R 6-045

APPENDIX 4

[illegible]

Date 15 July 1971

CUSTOMER INFORMATION

CUSTOMER Jet Propulsion Lab. P. O. NO. ES-536829 CONTRACT NO. NAS 7-100

1399
MODEL NO. 1399
SERIAL NO. [S] 1068-

[illegible]

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR.

B

S/N 1068-001,002,003

DATE	6-15-71	INSP. BY	Kr
AMT. INSP.	3		
AMT. ACC.	3		
DMR. NO.	8	JOB NO.	1068

JUL 12 1971

139900 A

A/R	MS20995C32	LOCKWIRE	
I	3-909,E515-8	O-RING	
I	140024	ACTUATOR ASSY	
I	139923	RAM	
I	139920	BODY SUBASSEMBLY	

QTY REQD	PART NUMBER	DESCRIPTION	
-------------	-------------	-------------	--

CT NO.	Pyronetics, inc. SUBSIDIARY OF COSMODYNE	10026 SHOEMAKER AVENUE SANTA FE SPRINGS, CALIF. 90370
--------	---	--

Bar	4-14-71	VALVE ASSEMBLY
Mazengart	4-12-71	
Con		
Heckert	3-30-71	

SIZE	CODE IDENT. NO.	DWG NO.	REV LTR
D	19689	139900	A
SCALE 2/1	UNIT WT.	SHEET	

A



Pyrotech Inc.
SUBSIDIARY OF COMBUSTEC

10025 SHOUMAKER AVE.
SANTA FE SPRINGS, CA 90670

APPENDIX 5

GARWOOD LABORATORIES, INC.

708 SO. VAIL AVENUE
MONTEBELLO, CALIF.
90640
(213) 723-0011

Pyronetics Inc.
10025 Shoemaker Ave.
Santa Fe Springs, Calif. 90670

Attention:

CERTIFICATION**PYRONETICS**Number C3L24-5Date 7-13-71Your Order 12170
1230-1068

Delivered To _____ Pickup

Date _____ Via _____

Eng'r. VLW

QUAN

Description

- 3 Pyronetics P/N 1400-D, Valve Normally Closed
S/N 1063-001 thru 1068-003
- 3 Pyronetics P/N 1399-B, Valve Normally Open
S/N 1068-001 thru 1068-003
JPL P.O. ES-536829
Cont. NAS 7-100

This will certify that the above items were processed according to the following methods and that the specification requirements were complied with:

~~XXXXXX~~ Tested Per Assy by Pyronetics per Applicable Dwg.

Cleaned Per JPL Spec. FS504574, Level D2

Packaged Per JPL Spec. FS 504574

Delores L. Wilkerson
Quality Assurance Supervisor

**708 SOUTH VAIL AVE.
MONTEBELLO, CALIF. 90640
TELEPHONE: RAYmond 3-0011**

GLI Job No. C3824-5

Date 7/14/71

MICRON COUNT (100/ml.)

[illegible]

Form G121 3M 4-66

OLT
3
INSP

W.C. Dahlberson 7/14/7-
INSPECTOR - GLI

INSPECTOR - CUSTOMER



Pyrotechnics Inc.
SUBSIDIARY OF COSMOBYNE

10025 SHOEMAKER AVE.,
SANTA FE SPRINGS, CA 90870

QC & R 6-045

APPENDIX 6



Prime Contr. No.: _____

TEST DESCRIPTION: Actuation Test

[illegible]

REMARKS:

APPROVALS:

Tested by

Test Engineer

Customer Witness

Customer Witness

DCAS



Pyrotechnics Inc.
SUBSIDIARY OF COSMOSYS

10025 SHOEMAKER AVE.,
SANTA FE SPRINGS, CA 90670

QC & R 6-045

APPENDIX 7



TEST DATA SHEET

Test Title: Acceptance Test

Customer: SpL

Customer P/N: _____

Cust. Spec. No.: _____

Cust. Spec. Para. No. : _____

Customer P. O.: ES-536829

Prime Contr. No. : _____

TEST DESCRIPTION: Proof Pressure and Internal Leakage
(Post Activation)

[illegible]

REMARKS:

APPROVALS:

Archie

Test Engineer

Customer Witness

PAGE 43



Eyrannetics Inc.
SUBSIDIARY OF COSMOSTRE

10025 SHOEMAKER AVE.,
SANTA FE SPRINGS, CA 90670

QC & R 6-045

APPENDIX 8





Eyrone Inc.
SUBSIDIARY OF COSMOSYS

10025 SHOEMAKER AVE.,
SANTA FE SPRINGS, CA 90670

QC & R 6-045

APPENDIX 9

16025 SHOEMAKER AVE.
SANTA FE SPRINGS, CALIF.

TEST DATA SHEET

Test Title: LOT ACCEPTANCE
Customer: JPL
Customer P/N: _____
Cust. Spec. No.: _____
Cust. Spec. Para. No.: _____
Customer P. O.: ES-536829
Prime Contr. No.: _____

TEST DESCRIPTION: *POST ACTUATION LEAKAGE (ACTUATOR ASSY.)*

[illegible]

REMARKS:

APPROVALS:

R. DeFrisco *E. Amos*
Tested by Test Engineer

Customer Witness

Customer Witness

DCAS



Dynamics Inc.
SUGGESTED BY COLLECTING

10026 SHOEMAKER AVE.,
SANTA FE SPRINGS, CA 90670

QC & R 6-045

APPENDIX 10



TEST DATA SHEET

Test Title: LOT ACCEPTANCE
Customer: JPL
Customer P/N: _____
Cust. Spec. No. : _____
Cust. Spec. Para. No. : _____
Customer P. O. : ES-576829
Prime Contr. No. : _____

TEST DESCRIPTION: *POST ACTUATION LEAKAGE - GROSS (ACTUATOR ASSY.)*

[illegible]

REMARKS:

APPROVALS:

DCAS



Synetics Inc.
SUBSIDIARY OF COMBUSTION

10025 SHOEMAKER AVE.,
SANTA FE SPRINGS, CA 90670

QC & R 6-045

APPENDIX 11



Test Title: LOT ACCEPTANCE
Customer: JPL
Customer P/N: _____
Cust. Spec. No.: _____
Cust. Spec. Para. No.: _____
Customer P. O.: ES-536829
Prime Contr. No.: _____

TEST DESCRIPTION: EXTERNAL LEAKAGE AFTER ACTUATION
(VALVE ASSEMBLY LESS ACTUATOR ASSY.)

[illegible]

REMARKS:

APPROVALS:

Tested by



Test Engineer

Customer Witness

Customer Witness

DCAS

F

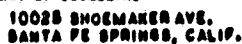


E-Systems Inc.
SUBSIDIARY OF COSMOSYS

10025 SHOEMAKER AVE.,
SANTA FE SPRINGS, CA 90670

QC & R 6-045

APPENDIX 12



TEST DATA SHEET

Part Name: VALVE N.O.
Pyronetics P/N: 1399
Pyronetics Spec: TS 1399
Test Para. No.: 4.12
Test Sequence No.: 12
Date Started: 7-20-71
Date Completed: 7-20-71

Test Title: LPT ACCEPTANCE
Customer: JPL
Customer P/N: _____
Cust. Spec. No.: _____
Cust. Spec. Para. No.: _____
Customer P. O.: ES-536829
Prime Contr. No.: _____

TEST DESCRIPTION: *BURST PRESSURE TEST*

[illegible]

REMARKS:

APPROVALS:

R. DeTresca E. Avalos
Tested by Test Engineer

Customer Witness

Customer Witness

DCAS