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REPORT NO. QC & R 6-051

EVALUATION TEST PROGRAM

FINAL REPORT

VALVE, NORMALLY CLOSED, TITANIUM

PYRONETICS MODEL 1426

JET PROPULSION LABORATORY

PURCHASE ORDER NO. ES-565923

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INTRODUCTION AND SUMMARY

The Evaluation Test Program for the Explosive Actuated, Normally Closed, Titanium Valve, Model 1426, was conducted in compliance with JPL Purchase Order Number ES-565923.

The objective of this Evaluation Test Program was to demonstrate compliance of this valve with the requirements of JPL P.O. ES-565923 by a series of operating tests applied to two (2) valves.

There were no failures.

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

Additionally, within the testing parameters specified, the JPL cartridge P/N 10000029-1, demonstrated successfully its capability to properly actuate the Model 1426 valves which underwent this testing program.



DESCRIPTION OF CARTRIDGE ACTUATED, NORMALLY CLOSED,
TITANIUM VALVE MODEL 1426

The Model 1426 is a normally closed, cartridge actuated, titanium valve which will be utilized in the trajectory correction propulsion subsystem of the Thermoelectric Outer Planets Spacecraft (TOPS).

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

The Model 1426 valves will be utilized in conjunction with the Pyronetics Model 1425, Cartridge Actuated, Normally Open titanium valve in a manifolded 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 duration as long as ten years in the interplanetary and outer space environments within the solar system.

Upon actuation, the normally closed valves of each assembly will supply the fuel to the rocket engine assembly. Prior to actuation, the propellant and pressurization fluids are isolated by the valves until engine ignition is desired. Valve actuation is accomplished by explosive energy generated when the JPL cartridges, P/N 10000029-1, 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 closed position internal leakage is prevented by two integral nipples. Upon actuation, the nipples are sheared and retained within the valve body by a ram propelled by the pressure cartridge. A flow passage is opened through the valve by the shearing of the nipples.



EVALUATION TEST PROGRAM

EXPLOSIVE ACTUATED, TITANIUM VALVE

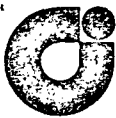
MODEL 1426 NORMALLY CLOSED

1.0 TEST PROGRAM

Two (2) normally closed valves were submitted for evaluation testing in accordance with Pyronetics Test Procedure TS 1426. The objective of the test program was to verify design concept compatibility with the test requirements of JPL P.O. ES 565923 for a normally closed explosive valve that will control the flow of hydrazine to a 25 pound thrust monopropellant thruster. The cartridge utilized for actuation testing (JPL P/N 10000029-1) was supplied by Jet Propulsion Laboratory and underwent only the actuation test.

The two valves were subjected to the following test sequences:

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



2.0 REFERENCE DOCUMENTS

The following documents comprise the criteria for this test program.

2.1 Military

MIL-C-45662A	Calibration System Requirements 9 February 1962
MIL-P-27401B	Propellant, Pressurizing Agent Nitrogen, 19 September, 1962
MIL-P-27407	Propellant, Pressurizing Agent Helium, 8 June 1965

2.2 JPL

P.O. No. ES 565923	Requirements for Fabrication, Assembly, and Test of Normally Open and Normally Closed, Explosive Actuated Valve
Drawing 10000029-1	Squib

2.3 Pyronetics

Drawing 1426	Valve, Normally Closed, Titanium
TS 1426	Acceptance and Evaluation Test Procedure 7 December 1971



3.0 TEST DESCRIPTION AND RESULTS

The evaluation test requirements, descriptions, and test results of the Normally Closed Valves, Pyronetics Model 1426, employed in the evaluation test program (in accordance with Pyronetics Procedure TS 1426) are described in the following paragraphs.

3.1 Proof Pressure and Internal Leakage (Body Subassembly) 2 Units

Requirement

(Reference JPL P. O. ES-565923)

Each body subassembly shall be internally pressurized simultaneously through both nipple tubes to $1000 + 30/-0$ psig with gaseous helium for thirty (30) minutes minimum. There shall be no evidence of leakage in excess of 1×10^{-6} scc/sec of helium. The leakage shall be measured through the cartridge port. There shall be no evidence of deformation or failure as a result of this test.

Test Description

The proof and internal leakage test was performed on the valve body subassembly during inprocess testing per TS 1426, prior to submitting the assembled valves to the functional evaluation tests. The normally closed valves were subjected to a combined proof pressure and internally leakage test. (See Figure 1). Each valve was simultaneously pressurized through both nipple tubes to $1,000 +30/-0$ psig with gaseous helium. A test adaptor was connected to the cartridge port which in turn was connected to a helium mass spectrometer and subsequently evacuated to 10^{-4} torr. The internal 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 nipple tubes were blown off with gaseous nitrogen to prevent any residual helium potentially entrapped in the tubes from yielding erroneous leakage rates during subsequent tests.

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 internal leakage recorded was 5.6×10^{-9} sccs. Reference test results in Appendix 1.



3.0 TEST DESCRIPTION AND RESULTS (Continued)

3.2 Proof Pressure and External Leakage (Body Subassembly) 2 Units

Requirement

(Reference JPL P.O. ES-565923)

Subject the body subassembly to an external leakage test by applying a pressure of 1000 +30/-0 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 1426 prior to submitting the assembled valves to the functional evaluation tests. The normally closed valves were subjected to a combined proof pressure and external test (see Figure 2). Each valve was individually pressurized through the cartridge port, while installed in a bell jar, to 1000 +30/-0 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 5.0×10^{-9} sccs. Reference test results in Appendix 1.



3.0 TEST DESCRIPTION AND RESULTS (Continued)

3.3 Proof Pressure and Leakage Test (Actuator Assembly) 2 Units

Requirement

(Reference JPL P.O. ES-565923)

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 1426. Each actuator sub-assembly was installed in a holding fixture as shown in Figure 3 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 1.5×10^{-8} sccs. Reference test results in Appendix 2.



3.0 TEST DESCRIPTION AND RESULTS (Continued)

3.4 Gross Leak Test (Actuator Assembly) 2 Units

(Reference JPL P.O. ES-565923)

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 1426. 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 4. 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 2.



3.0 TEST DESCRIPTION AND RESULTS (Continued)

3.5 Examination of Product (2 Units)

Requirement

(Reference JPL P. O. ES-565923)

Each valve body and component 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 dimensions 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 1426. 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 inprocess tests and prior to assembling the valve. Each valve body and components were visually examined for freedom from blemishes, tool marks, and 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 3 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.



3.0 TEST DESCRIPTION AND RESULTS (Continued)

3.6 Actuation Test (2 Units)

(Reference JPL P.O. ES-565923)

The actuation test shall be performed on samples selected at random from the production lot. The valve shall be actuated while a water pressure of 500 psig is applied to one of the normally closed nipples. The response time shall be measured from bridgewire burnout to first indication of pressure rise 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 5. A pressure transducer was connected on the downstream side of the valves to detect response time. The bridgewire resistance of each bridgewire on the 10000029-1 JPL cartridge was measured and recorded with an Alinco Ohmmeter. The normally closed inlet tubes were pressurized to 500^{+10}_{-0} 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 one nipple tube was pressurized to 500 psig. 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 open mode caused the pressure to rise on the downstream side as the water flowed through the valve. Hence, response time was measured from bridgewire burnout to first indication of pressure rise on the downstream side of the valve.

Test Results

The valves tested actuated to the open mode satisfactorily without any detectable evidence of damage to the structural integrity of the valves. Response time ranged 1.95 to 2.25 milliseconds for all valves. Hence all valves complied with the 10 milliseconds (maximum) response time requirement. Since both units passed the subsequent post actuation leakage and burst test, the test was deemed successful. See test data sheets in Appendix 4.



3.0 TEST DESCRIPTION AND RESULTS (Continued)

3.7 Post Actuation Proof Pressure (2 Units)

Requirement

(Reference JPL P.O. ES-565923)

Each valve assembly shall be subjected to a hydrostatic pressure of 1000 +30/-0 psig. One (1) port shall be capped and the other pressurized from 0 to 1000 psig for two (2) minutes minimum. There shall be no evidence of deformation or failure as a result of this test, nor shall the ram retract.

Test Description

The actuated valves were firmly secured in a proof test holding fixture (reference Figure 6) 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 to 1,000 psig with water for two minutes.

Test Results

None of the actuated valves tested, exhibited any visual evidence of external leakage. The test was considered successful since the valves did not reveal evidence of structural damage, nor did the ram retract. Reference test results in Appendix 5.



3.0 TEST DESCRIPTION AND RESULTS (Continued)

3.8 Flow vs Pressure Drop Test (2 Units)

Requirements

(Reference JPL ES-565923)

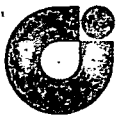
The flow rate versus the pressure drop shall be determined across the open flowpath of each normally closed valve. The pressure drop across the unit shall not exceed 5.0 psid when a water pressure of 500 psig is applied at the inlet port and a flow of 0.15 lbs/sec of H₂O is established.

Test Description

Each valve was installed in a holding fixture (Ref. Figure 7), and the tube ports were pressurized to 500 psig with water while a regulated flow rate through the open flow path was maintained at 0.15 lbs/sec. The pressure drop through the entire system was determined with a differential pressure gauge and recorded. The net pressure drop across the valve was determined by subtracting the tare pressure drop from the gross pressure drop. The tare pressure drop was determined by removing the valve from the system and replacing it with a tare tube and repeating the flow test. The tare tube is a straight section one half inch long and has the same I.D. and O.D. as the valve under test.

Test Results

The flow test was performed on both of the actuated valves. Neither of the two units exceeded the maximum pressure drop requirements of 5.0 psid. The test was considered successfully passed since the net pressure drop was <0.90 psi. Actual test results are found in Appendix 5.



3.0 TEST DESCRIPTION AND RESULTS (Continued)

3.90 Disassembly Inspection (2 Units)

Requirement

(Reference JPL P. O. ES-565923)

The JPL 10000029-1 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 deformation, cracks, etc. on the actuator assembly bellows.

Test Description

The fired JPL 10000029-1 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 deformation, 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 5.



3.0 TEST DESCRIPTION AND RESULTS (Continued)

3.10 Post Actuation Leakage (Actuator Assembly) 2 Units

Requirement

(Reference JPL P. O. ES-565923)

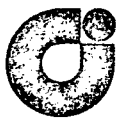
Each actuator assembly shall be installed in a suitable holding fixture and subjected to an external pressure of $500 +10/-0$ psig with gaseous helium for thirty (30) minutes minimum. Following pressurization period, actuator assembly shall be removed from the helium pressurization and subjected to a 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 3 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 1.7×10^{-8} sccs. Reference actual test results in Appendix 6.



3.0 TEST DESCRIPTION AND RESULTS (Continued)

3.11 Post Actuation Gross Leakage (Actuator Assembly) 2 Units

Requirement

(Reference JPL P.O. ES-565923)

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 4, 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 6.



3.0 TEST DESCRIPTION AND RESULTS (Continued)

3.12 External Leakage After Actuation (Valve Assembly Less Actuator Assembly (2 Units)

Requirement

(Reference JPL P.O. ES-565923)

The external leakage after actuation of each valve shall be determined. The tube ports shall be pressurized to 1000 $\pm 30/-0$ 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 8, placed in a bell jar and both tube ports were simultaneously pressurized to 1000 $\pm 10/-0$ 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 5.0×10^{-8} to 9.5×10^{-8} sccs. Therefore, test was considered acceptable since no leakage in excess of 1×10^{-6} sccs was detected. Reference test results in Appendix 7.



3.0 TEST DESCRIPTION AND RESULTS (Continued)

3.13 Post Actuation Burst Pressure Test (2 Units)

Requirement

(Reference JPL P. O. ES-565923)

The valve assembly (actuator assembly removed) shall be subjected to a burst pressure test and burst pressure determined. One nipple tube shall be capped and the other 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 6) and one nipple tube was capped and the other was connected to a hydrostatic pressure source. The valves were placed behind a safety barricade and the nipple tube was slowly pressurized in increments of 1000 psig and maintained for 15 seconds at each level up to 10,000 psig with water. 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 7.



4.0 TEST PROGRAM CONCLUSIONS

Accomplishment of the evaluation tests in accordance with Pyronetics Test Procedure TS 1426, dated 7 December 1971, signify the acceptance of the Normally-Closed, Explosive Actuated, Titanium Valve, Pyronetics Model 1426, as having fulfilled the test requirements of JPL Purchase Order No. ES-565923. The evaluation test program was conducted by Pyronetics and witnessed and acknowledged by JPL Engineering.

Examination of the data included herein indicates excellent repeatability of all functional characteristics, i. e., ignition time, response time, and flow vs pressure drop. 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 closed nipple 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 were much smaller than the 1×10^{-6} sccs requirements.

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 the 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} sccs
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} sccs
Accuracy	$\pm 10\%$ of indicated leak rate
Instrument	Pressure Gauge
Manufacturer	Marsh Instrument Co.
Model No.	100 S/N 507
Range	0-1500 psi
Accuracy	$\pm 0.5\%$
Calib. Due	4-29-72
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. Due	2-5-72



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
Manufactuere	Van Waters Rodgers
Model No.	N/A
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. Due	6-13-72

Instrument	Constant Current Pulse Generator
Manufacturer	E & R Development Co.
Model No.	PS-4A S/N 653
Range	0 to 10 amp; 0 to 100 m'sec
Accuracy	± 0.5 %
Calib. Due	4-4-72



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. Due	2-12-72
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 %
Last Calibration	4-18-72
Instrument	Hydrostatic Test Console
Manufacturer	Pyronetics, Inc.
Model No.	N/A
Range	0-20,000 psig
Calib. Frequency	N/A

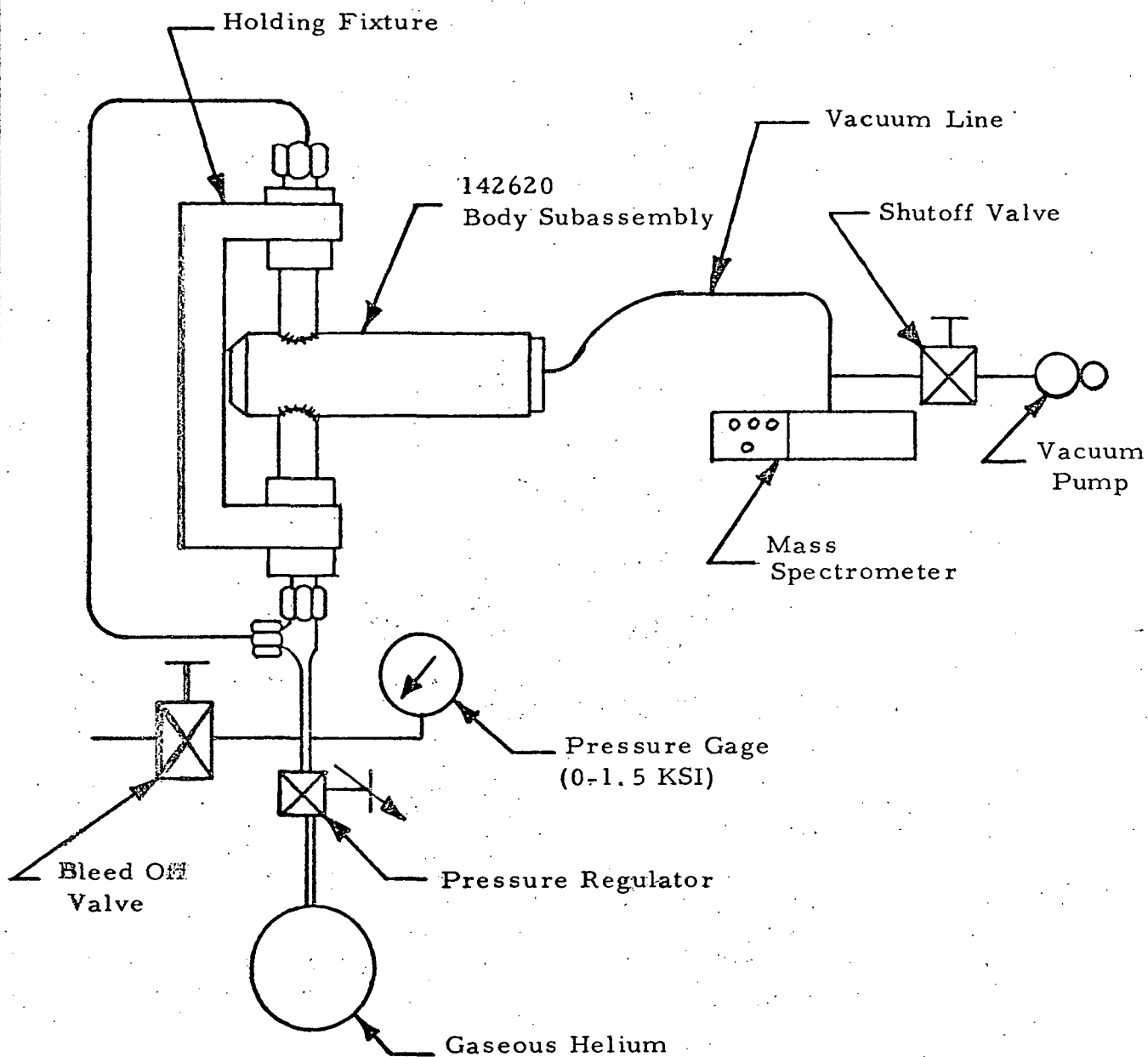


FIGURE 1 PROOF PRESSURE & INTERNAL LEAKAGE TEST SETUP

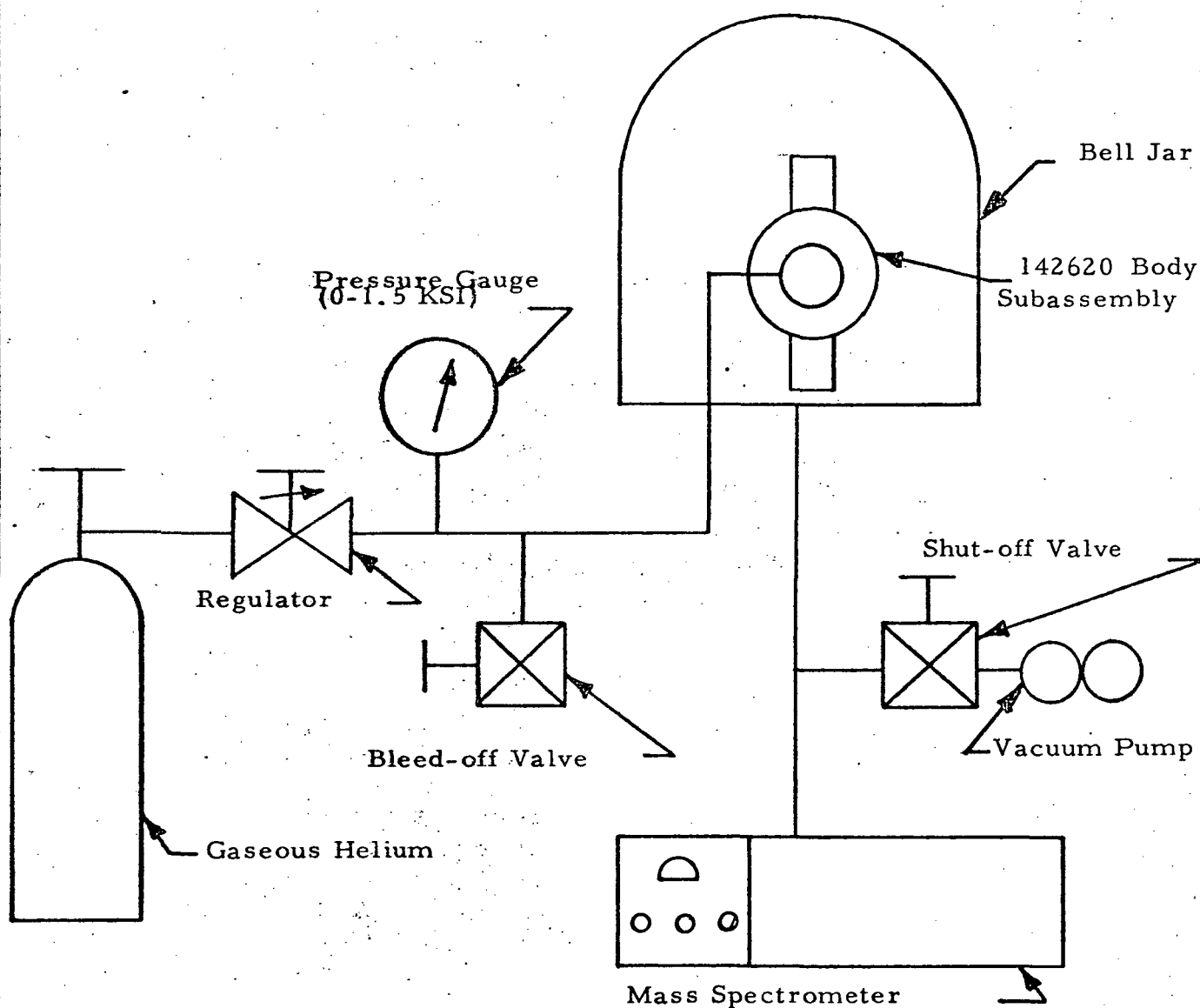
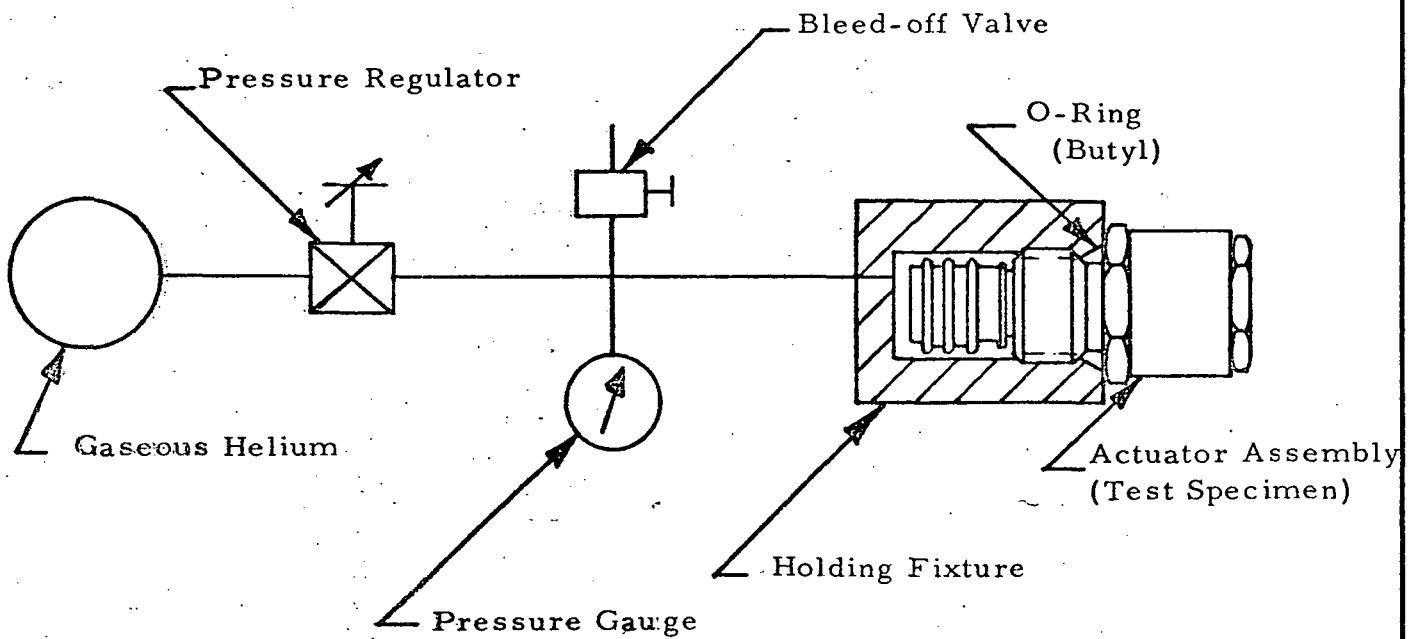
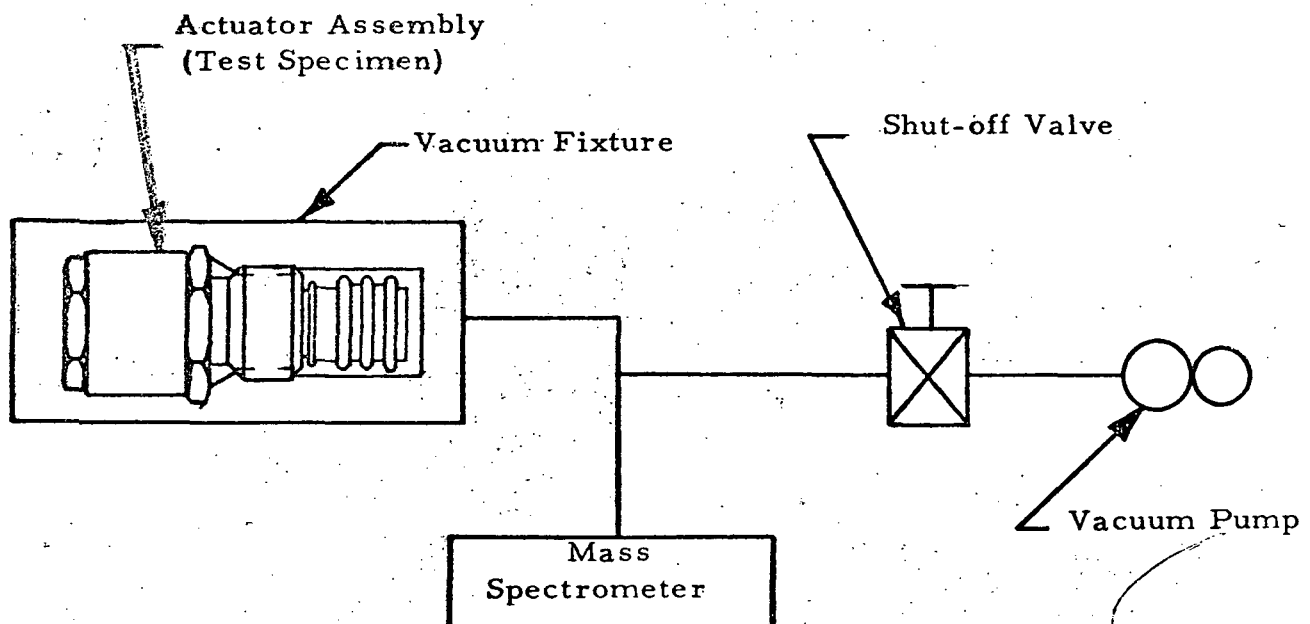


FIGURE 2 PROOF PRESSURE & EXTERNAL LEAKAGE TEST SETUP



(A) PROOF PRESSURE



(B) LEAK TEST

FIGURE 3 PROOF PRESSURE & LEAK TEST SETUP (ACTUATOR ASSEMBLY)

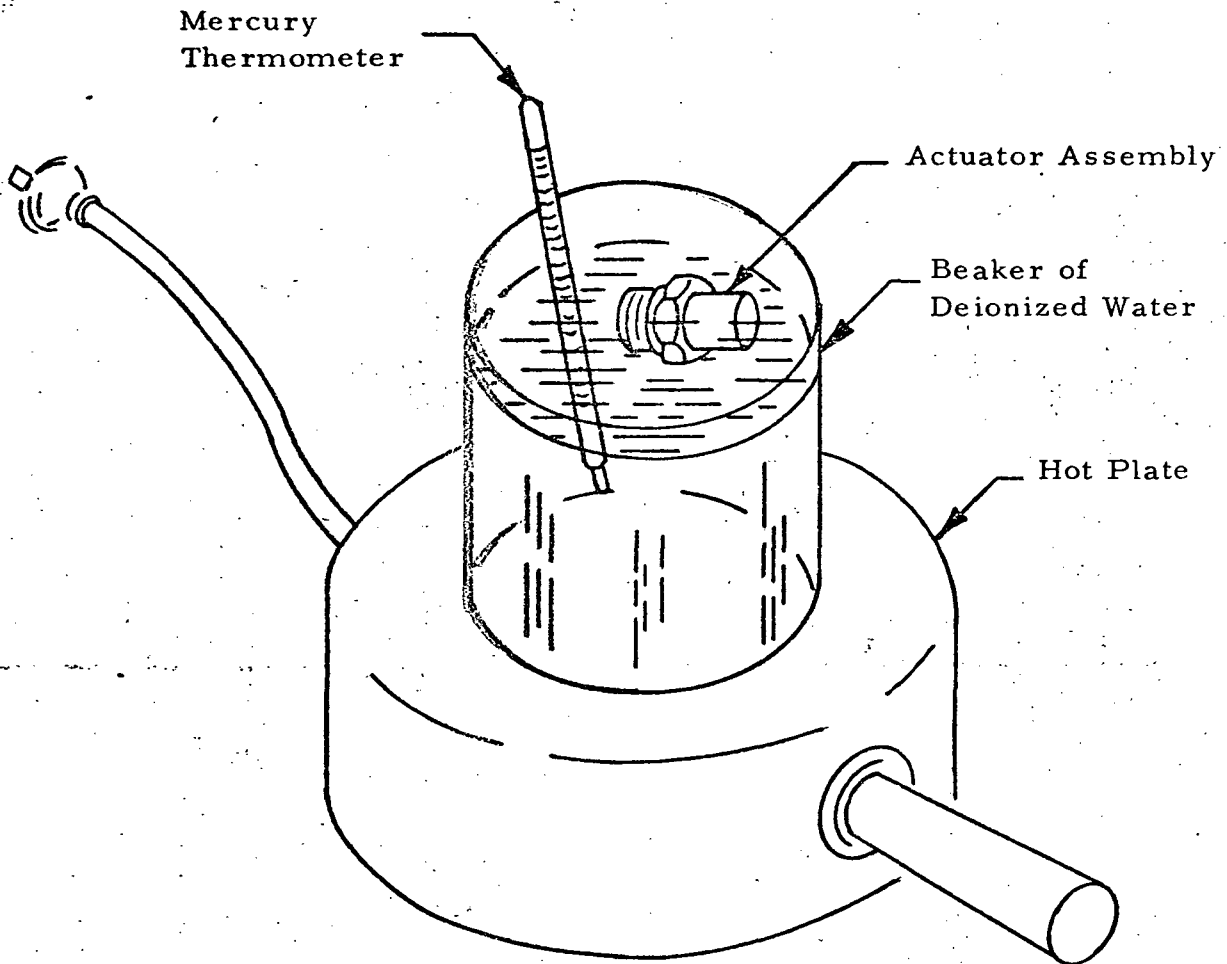


FIGURE 4 LEAK TEST (HOT WATER) SETUP

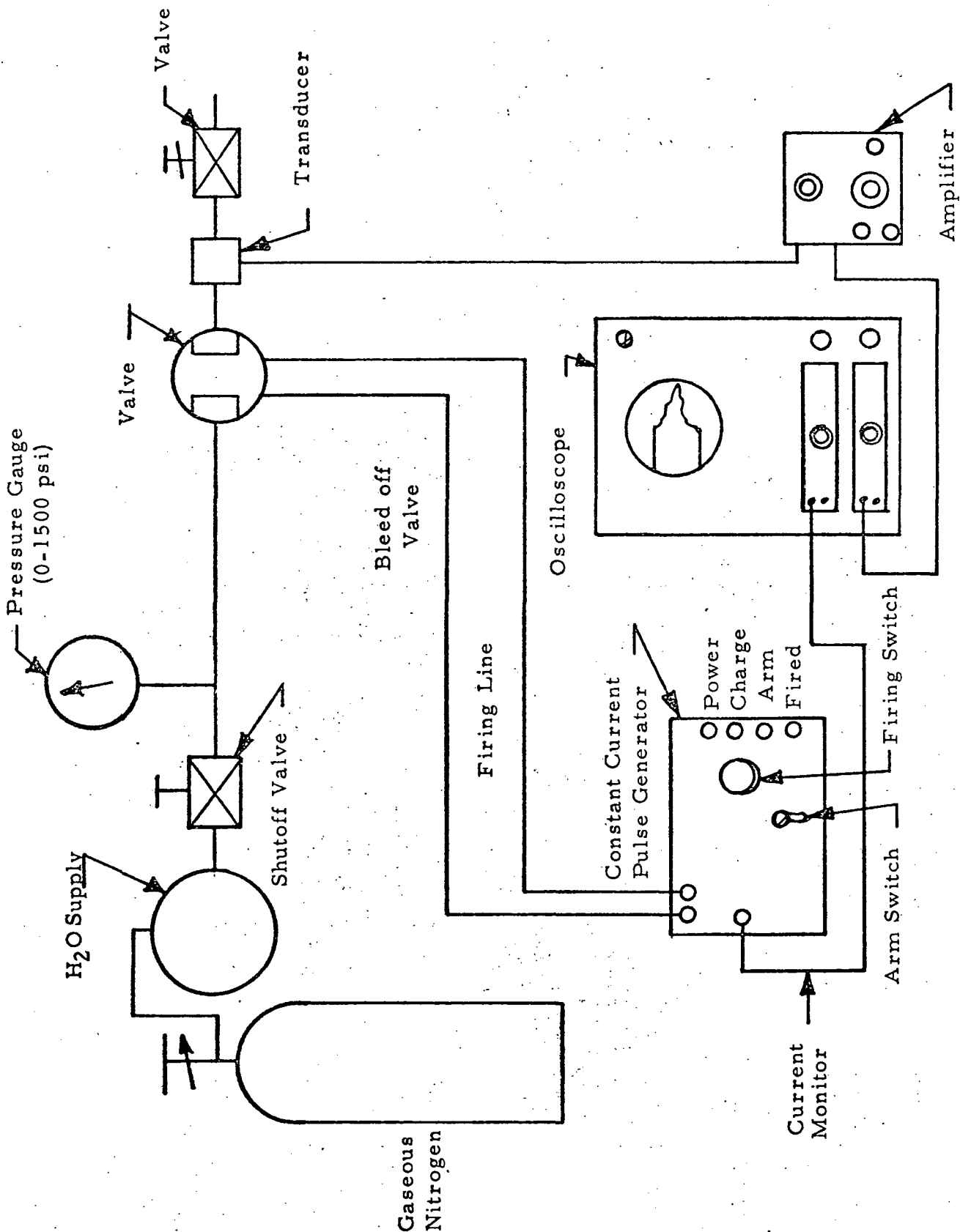


FIGURE 5 ACTUATION TEST SETUP

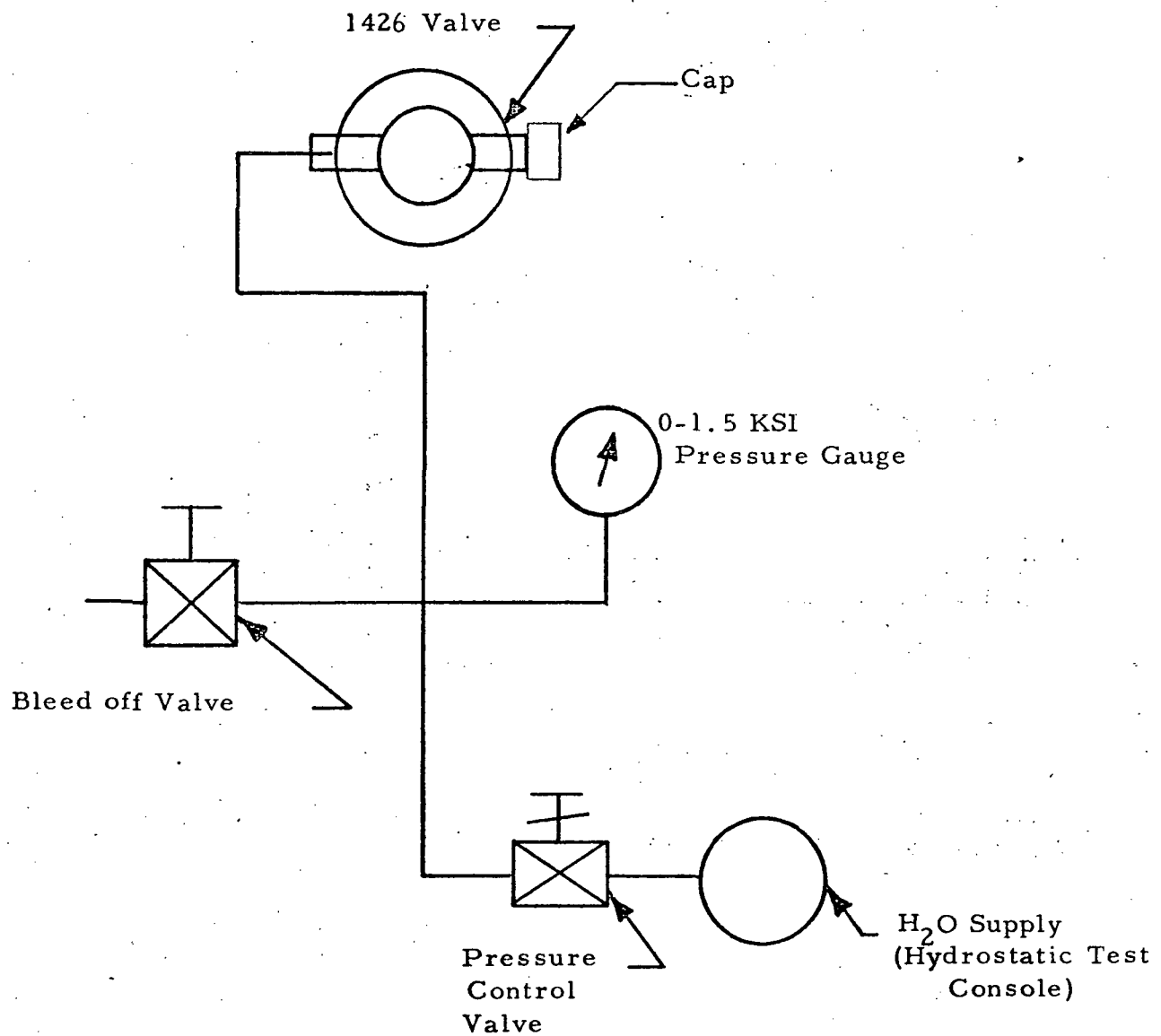


FIGURE 6 PROOF PRESSURE TEST SETUP

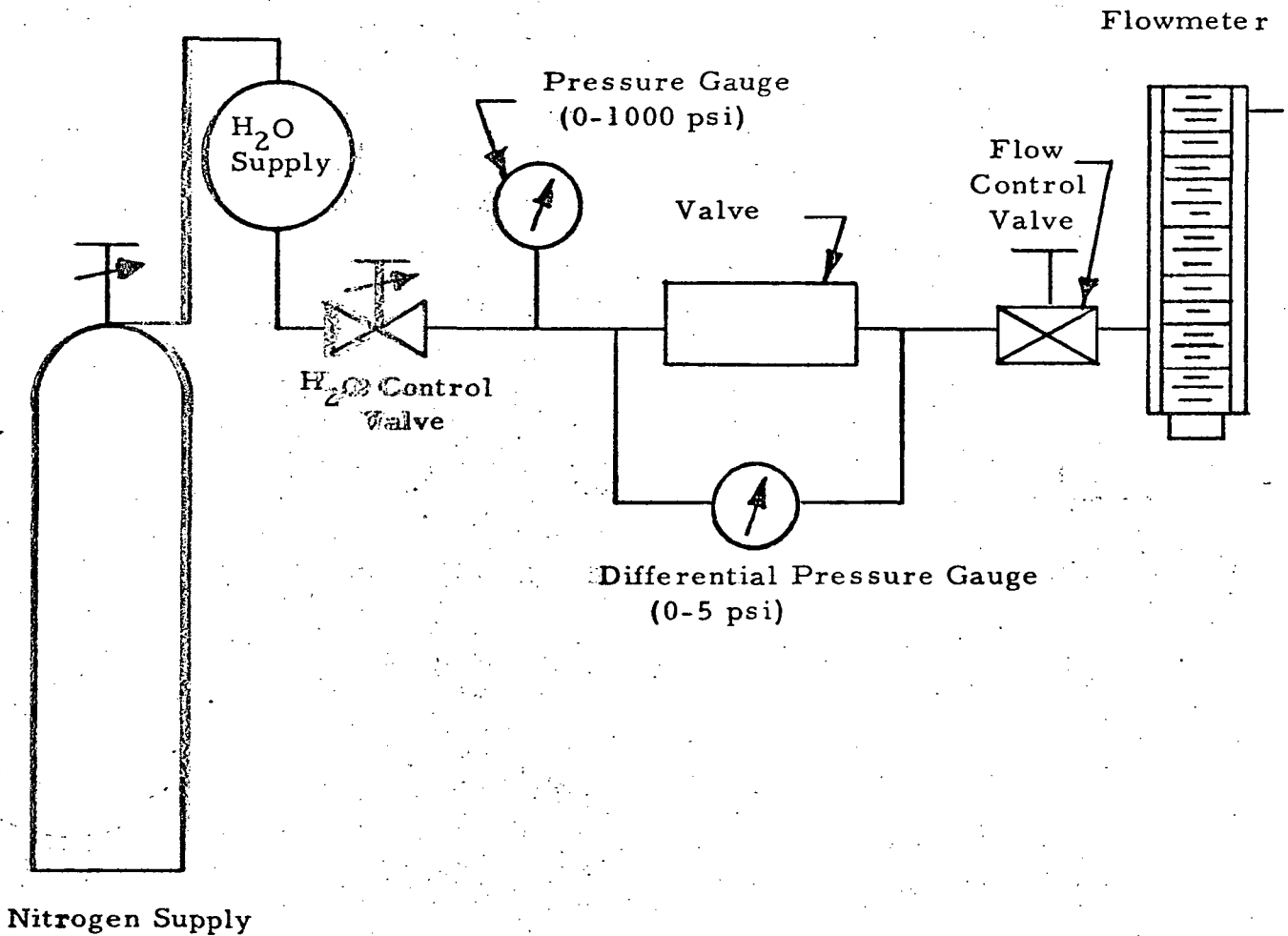


FIGURE 7 FLOW VS PRESSURE DROP SETUP

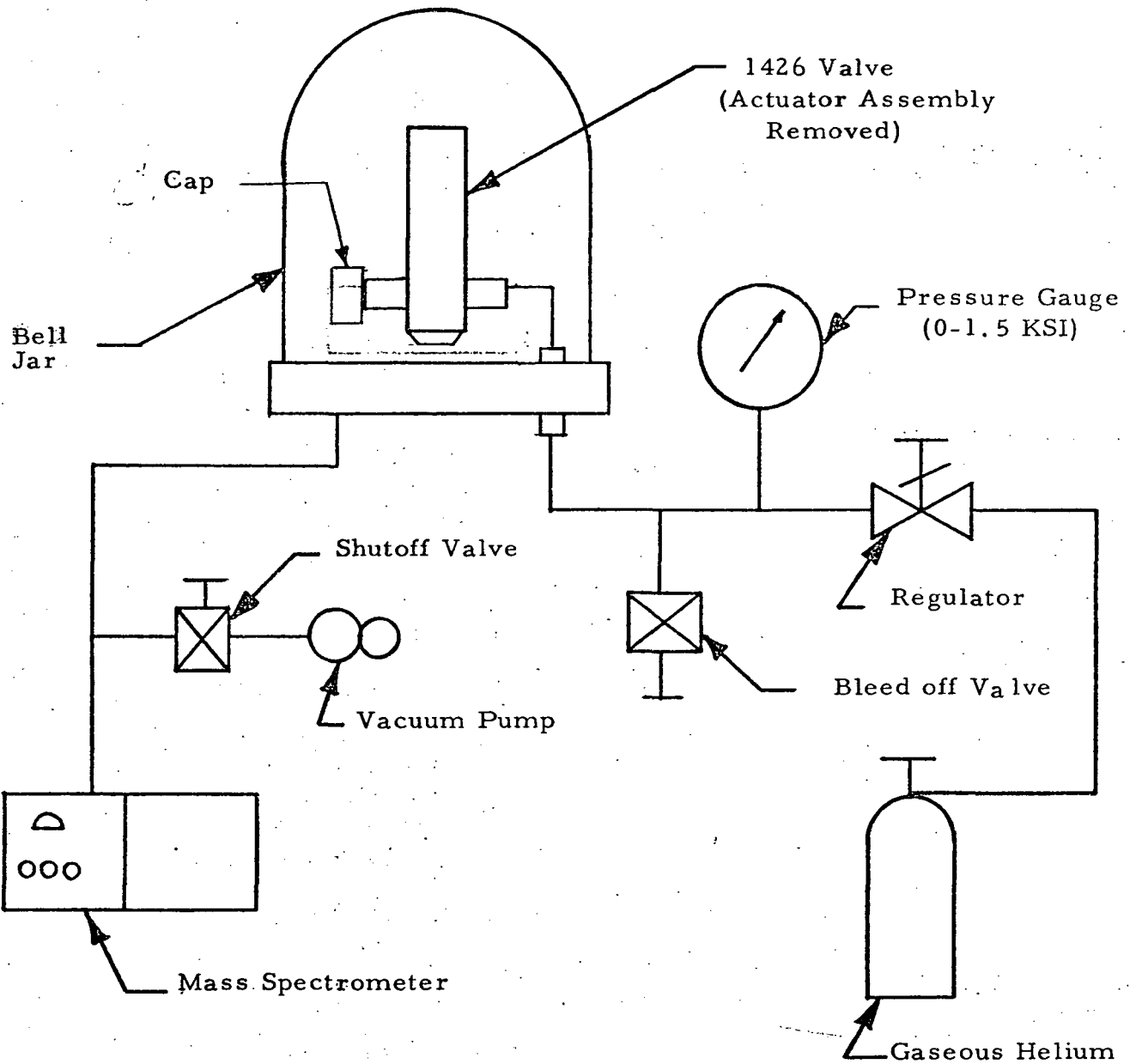


FIGURE 8 POST ACTUATION LEAKAGE TEST SETUP (LESS ACTUATOR ASSY)



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APPENDIX 1

PROOF PRESSURE, INTERNAL AND EXTERNAL LEAKAGE



SANTA FE SPRINGS, CALIF.

LOG S/N 1441

LABORATORY TEST REPORT

JOB NO. 1081 MODEL 7300W

14.26

Tests Conducted By

Instrumentis und Procedure Peri:

9757

DATE 7-1-77

Witnessed By _____ Source Insp.

Source Insp.

Traveler S/N 4986

10996

Traveler S/N

PARAGRAPH NO. 41

[illegible]



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a Cordon International
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APPENDIX 2

PROOF PRESSURE AND LEAKAGE; ACTUATOR ASSEMBLY



SANTA FE SPRINGS, CALIF.

LOG S/N 1439-2

LABORATORY TEST REPORT

JOB NO. 1426 MODEL 1426

12/14/26
Institution and Purpose Box

Witnessed By _____ Source Insp.

Belows Assy

Traveler 5/A

PARAGRAPH NO. 43

33



Pyronetics
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Company 10025 SHOEMAKER AVENUE
SANTA FE SPRINGS, CA. 90670

QC & R 6-051

APPENDIX 3

EXAMINATION OF PRODUCT



**10025 SHOEMAKER AVE.
SANTA FE SPRINGS, CALIF.**

LOG S/N 1443

JOB NO. 1081

1426

Tests Conducted By F. V.

Instruments and Procedure Per: TS 1426DATE 1-31-72

Witnessed By _____ Source Insp.

Traveler S/N 5051

PARAGRAPH NO. 4.5 Examination of Product

[illegible]



Pyronetics
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Company 10025 SHOEMAKER AVENUE
SANTA FE SPRINGS, CA. 90670

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APPENDIX 4
ACTUATION TEST



Pyronetics
a Cordon International
Company 10025 SHOEMAKER AVENUE
SANTA FE SPRINGS, CA. 90670

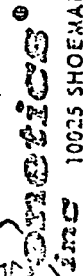
QC & R 6-051

APPENDIX 5

POST ACTUATION PROOF PRESSURE

FLOW VS PRESSURE DROP

DISASSEMBLY INSPECTION



SANTA FE SPRINGS, CALIF.

2471 N/S 207

1426 Tests Conducted By E.A. [Signature]

DATE 1-31-72

Witnessed By _____ Source Insp.

Traveler S/N 5051

PARAGRAPH NO. 48

11

4.10

[illegible]



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SANTA FE SPRINGS, CA. 90670

QC & R-051

APPENDIX 6

POST ACTUATION LEAKAGE; ACTUATOR ASSEMBLY



SANTA FE SPRING, CALIF.

LOG S/N 2771 1442

1426

1575

[illegible]

Traveler SA 5051

PARAGRAPH NO. 411

42

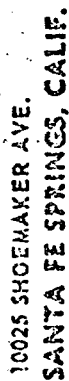


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APPENDIX 7

EXTERNAL LEAKAGE AND BURST PRESSURE



LABORATORY TEST REPORT

LOG S/N 1442

WITNESSES:

10025 SHOEMAKER AVE.

SANTA FE SPRINGS, CALIF.

LABORATORY TEST REPORT

JOB NO. 1281 MODEL 7300

Instrumente und Procedure Per: LS 1426

Witnessed By: _____ Source Insp. _____

Traveler S/H 5051

PARAGRAPH NO. 413

44

[illegible]