CROSBY

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

TEST REPORT NO. 3977

QUALIFICATION TEST REPORT FOR THE
CROSBY IMF-2 SOLENOID PILOT VALVE

DATE OF TEST: FEBRUARY 5, 1982 - MARCH 17, 1982

GENERAL ELECTRIC
NUCLEAR ENERGY BUSINESS GROUP
APPROVED 6/3/82 DATE
VPF NO. 6114-70-2
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1. Summary/Conclusion

1.1 This report describes the testing and analysis performed to qualify the Crosby IMF-2 Solenoid Pilot Valve for Class 1E service in accordance with IEEE Standard 323-1974 and the reference documents of Paragraph 2 (below). The Crosby IMF-2 Solenoid Pilot Valve design, as exemplified by the test specimens, met all the qualification requirements of the test plan (T-16361, Revision No. 5).

1.2 Based upon the evaluation of the results and the pertinent specification requirements, Crosby concludes that the IMF-2 SPV is capable of performing its required safety functions of opening and closing or remaining in the open position upon electrical signal command:

1.2.1 In an abnormal environmental condition bounded by:

Area 1	Temperature	Pressure	R.H. Steam	Time
Phase 1	340°F	-2 to + 45 psig	100% R.H.	3 hours
Phase 2	320°	-2 to + 45 psig	100% R.H.	3-6 hours
Phase 3	250°	-0 to 25 psig	100% R.H.	6-24 hours
Phase 4	200°	-0 to 20 psig	100% R.H.	1-100 days

With a total integrated radiation dosage (normal plus LOCA) of 3×10^7 rads (gamma).

1.2.2 When:

1.2.2.1 The SPV is either intermittenly or continuously energized with an applied voltage that is at or between 105 Vdc (minimum) to 138 Vdc (maximum).

1.2.2.2 A minimum of 88 psid pneumatic (Air/N_2) supply pressure is concurrently applied at the solenoid pilot valve when it is energized.

1.2.3 After the SPV has been subject to:

1.2.3.1 500 cycles applied in a normal continuous environmental condition of 135° with a relative humidity ranging between 40 to 55 percent and a static ambient pressure that may range between minus (-) 0.5 to plus (+) 2.0 psig.

1.2.3.2 An operating base and/or safe shutdown earthquake yielding dynamic seismic coefficients at the safety relief valve inlet which is equal to or less than:

	Horizontal/Longitudinal	Vertical
OBE	4.5g	3.0g
SSE	6.5g	4.5g

1. Summary/Conclusion (Continued)

1.2 (Continued)

1.2.4 Providing the SPV has:

1.2.4.1 Been properly operated within its design parameters under the normal environmental conditions, properly installed and maintained and periodically tested.

1.2.4.2 Not exceeded a five (5) year actual in-service time frame under normal operating conditions.

1.3 The Crosby IMF-2 Solenoid Pilot Valve can be used as a replacement for the Crosby CVG-01 Solenoid Pilot Valve used on safety relief valves designated as G.E. MPL No's B21F013, B22F013, B21F041, B21F047 and B21F051.

2. Reference

2.1 Crosby Data Sheet DS-C-66181, Revision B, (Appendix 9).

2.2 Crosby Data Sheet DS-C-66274, Revision C, (Appendix 9).

2.3 Crosby Quality Assurance Plan QAP-3325, Revision 0, (Appendix 10).

2.4 Crosby Quality Assurance Plan QAP-3328, Revision 1, (Appendix 10).

2.5 Crosby Assembly and Test Procedure T-16362, Revision 4, (Appendix 11).

2.6 Crosby Qualification Test Procedure T-16361, Revision 5, (Appendix 12).

3. Specimen Identification

3.1 The two (2) Crosby IMF-2 Solenoid Pilot Valves (SPV's) were identified as units 66181-006 and 66181-007. Both units were assembled and tested to Crosby Procedure T-16362 (Assembly and Test Data are included in this report as Appendix 1).

4. Initial Reference Frame Test

Upon successful completion of all production tests, each test specimen (SPV) was subjected to the following reference frame test.

4.1 Electrical Characteristic Test

Each test specimen (SPV) was mounted to an air valve (slave) assembly then to a static stand test block to perform an electrical characteristic test (Paragraph 4.1 of Crosby Procedure T-16361).

4. Initifal Reference Frame Test (Continued)

4.1 Electrical Characteristic Test (Continued)

4.1.1 Electrical characteristic test results appear in Appendix 2. No anomalies or deviations from required procedures occurred.

4.2 Operability Test

Each test specimen (SPV) with an attached air valve (slave) assembly was mounted to a test SRV actuator and subjected to a five (5) cycle operability test (Paragraph 4.2 of Crosby Procedure T-16361).

4.2.1 Operability test results appear in Appendix 2. No anomalies or deviations from required procedures occurred.

4.3 System Leakage Test

Upon successful completion of the operability test with both test specimens (SPV's) still attached to the test SRV actuator a system leakage test was performed (Paragraph 4.3 of Crosby Procedure T-16361).

4.3.1 System Leakage Test Results

Both test specimens (66181-006 and 66181-007) showed no visible signs of leakage in both the fully opened and closed postiions for the test duration of ten (10) minutes. No anomalies or deviations from required procedures occurred.

5. Thermal Aging

Both test specimens (SPV's) with attached air valve (slave) assemblies were mounted to a standard production actuator manifold assembly and installed in a forced air circulation oven for the thermal aging test (Paragraph 5 of Crosby Procedure T-16361). The test specimens were aged at 329°F for 99.8 hours and at 344°F for 28.2 hours. (Equivalent to 100 hours at 343°F). (Aging record and justification appear in Appendix 4).

6. Post Thermal Aging Reference Frame Test

The reference frame test of Paragraph 4 was repeated for each of the test specimens (SPV's).

6.1 Electrical characteristic test results appear in Appendix 2. No anomalies or deviations from required procedures occurred.

6.2 Operability test results appear in Appendix 2. No anomalies or deviations from required procedures occurred.

6. Post Thermal Aging Reference Frame Test (Continued)

6.3 System Leakage Test Results

Test specimen (SPV) 66181-006 had slight visible leakage observed through the Sty-cast potting (fill-hole) in the open position but sealed off after approximately five (5) minutes. There was no visible leakage in the open position for the remaining duration of the test. In the closed position slight visible leakage was observed at the pilot vent hole which sealed off after approximately five (5) minutes. No visible leakage for the remaining duration of the test.

Test specimen (SPV) 66181-007 had slight visible leakage observed through the Sty-cast potting (fill-hole) for the test duration of ten (10) minutes. Zero (0) sccm was recorded on a thermal mass flow meter. In the closed position, slight visible leakage was observed at the pilot vent hole which sealed off after approximately five (5) minutes. No visible leakage for the remaining duration of the test.

Note: The leakage had no effect on the operation of the test specimens (SPV's).

7. Mechanical Aging

Each test specimen (SPV) and air valve (slave) assembly was mounted to a test SRV actuator on a test simulator providing the equivalent 250 psi SRV load of Paragraph 6.1 of Crosby Procedure T-16361 and subjected to a normal room ambient mechanical aging test. (Paragraph 6 of Crosby Procedure T-16361). (See Appendix 5 for Diagram of Mechanical Aging Test Fixture).

Note: The air valve (slave) units were changed after seventy (70) cycles due to air valve (slave) body vent hole leaks. The test was resumed with the test specimens (SPV's) functioning successfully.

8. Post Mechnical Aging Reference Frame Test

The reference frame test of Paragraph 4 was repeated for each of the test specimens (SPV's).

8.1 Electrical characteristic test results appear in Appendix 2. No anomalies or deviations from required procedures occurred.

8.2 Operability test results appear in Appendix 2. No anomalies or deviations from required procedures occurred.

8. Post Mechanical Aging Reference Frame Test (Continued)

8.3 System Leakage Test Results

Test specimen (SPV) 66181-006 had slight visible leakage observed through the pilot vent hole in the open position for the ten (10) minute duration of the test. Zero (0) sccm was recorded on a thermal mass flow meter. There was no visible leakage observed in the closed position for the duration of ten (10) minutes.

Test specimen 66181-007 had slight visible leakage observed through the pilot vent hole and Sty-cast potting (fill-hole) in both the fully opened and closed positions for the test duration of ten (10) minutes. Zero (0) sccm was recorded on a thermal mass flow meter in both the open and closed positions.

Note: The leakage had no effect on the operation of the test specimens (SPV's).

9. Radiation Aging

Both test specimens, 66181-006 and 66181-007, were packaged and shipped to a subcontractor for the purpose of radiation aging. The test specimens (SPV's) were subjected to a cummulative total radiation does of 3.0×10^7 rads (air equivalent gamma). A copy of the letter of Certification is included in this report and appears in Appendix 8.

Visual inspection upon return of the test specimens (SPV's) indicated a slight discoloration of the Sty-cast potting which was the only apparent external change in the units due to the radiation.

10. Post Radiation Aging Reference Frame Test

The reference frame test of Paragraph 4 was repeated for each of the test specimens (SPV's).

10.1 Electrical characteristic test results appear in Appendix 2. No anomalies or deviations from required procedures occurred.

10.2 Operability test results appear in Appendix 2. No anomalies or deviations from required procedures occurred.

10.3 System Leakage Test Results

Test specimen (SPV) 66181-006 had no visible leakage in either the fully opened or closed positions for the test duration of ten (10) minutes.

10. Post Radiation Aging Reference Frame Test (Continued)

10.3 System Leakage Test Results (Continued)

Test specimen (SPV) 66181-007 had slight visible leakage observed through the pilot vent hole in the open position for the test duration of ten (10) minutes. Zero (0) sccm was recorded on a thermal mass flow meter. No visible leakage was observed in the closed position for the test duration of ten (10) minutes. Note: The leakage had no effect on the operation of the test specimen (SPV).

11. Negative Pressure Test

The negative pressure test required by the equipment specification was not performed. See Appendix 13 for justification.

12. Environmental Test (LOCA)

Each test specimen (SPV) was tested separately in a LOCA chamber in a controlled saturated steam environment to the test profile of Figure 1 of Crosby Procedure T-16361. (See Appendix 5 for diagram of LOCA test loop). Test specimen (SPV) 66181-006 was tested in the deenergized position with a 90 psi differential between the supply air (N2) and the test chamber and a supply voltage of 105 vdc for the periodic cycling except when a higher voltage was required. Test speciment 66181-007 was tested in the constantly energized position with a 90 psi differential and a supply voltage of 138 vdc. Except for the periodic cycling, the test specimen (SPV) remained energized throughout the test after completing the six (6) cycles of the first hour of the first 340°F peak.

Pilot valve operation and environmental conditions were monitored over the entire duration of the test (Paragraph 8.3 of Crosby Procedure T-16361).

The test specimens (SPV's) remained operable throughout all testing. The actual sequence of test events appear in the test LOCA curve plots of Appendix 3. Refer to Appendix 14 for a justification of the limited range of the LOCA test chamber relative to the required ramp rate.

Note: The testing of test specimen (SPV) 66181-007 was interrupted at the twenty-seven (27) hour mark due to failure of the power test cable female electrical connector (Cannon model number CVA6R145-25N, supplied by utility)*mated with the SPV connector. The failed connector was removed. In order to continue testing, the leadwires to the test specimen (SPV) were potted directly to the SPV male electrical connector with Sty-cast epoxy compound. The testing was resumed from the point of interruption after a twenty-two (22) hour delay. The test specimen (SPV) performed successfully for the duration of the test without any further problems.

*This four (4) pin female test connector was provided by LaSalle (utility) for test purposes only and did not necessarily represent the installed connector configuration. In any case, this four (4) pin connector is unique to the LaSalle Stations. The two (2) pin connector specified for other plants (G.E. MPL No's B21F013, B22F013, B21F041, B27F047, and B21F051) has a proven qualification history (e.g., Wyle Report No. 44220-2).

12. Environmental Test (LOCA) (Continued)

Test specimen 66181-006 was tested with the lead wires potted (Sty-cast) directly to the SPV male electrical connector to avoid a possible repeat failure of the female electrical connector. The test specimen (SPV) performed successfully for the entire duration of the test.

13. Post Environmental (LOCA) Reference Frame Test

The reference frame test of Paragraph 4 was repeated for each of the test specimens (SPV's).

13.1 Electrical characteristic test results appear in Appendix 2. No anomalies or deviations from required procedures occurred.

13.2 Operability test results appear in Appendix 2. No anomalies or deviations from required procedures occurred.

13.3 System Leakage Test Results

Test specimen (SPV) 66181-006 exhibited visible leakage in the SPV open position at the top-cover-to-pilot body interface, through the electrical connector potting (Sty-cast) and through the fill hole Sty-cast potting. There was a pressure drop of five (5) psi from a one (1) gallon accumulator over a period of ten (10) minutes. In the closed position there was no visible leakage observed for the ten (10) minute duration of the test.

Note: For volumetric equivalent of pneumatic leakage, see Appendix 15.

The leakage test was repeated on test specimen (SPV) 66181-006 with the leakage observed at the same locations in the open position. There was a pressure drop of thirteen (13) psi from a one (1) gallon accumulator over a period of ten (10) minutes. In the closed position there was no visible leakage observed for the ten (10) minute duration of the test.

Test specimen 66181-007 exhibited no visible leakage in either the fully opened or closed positions for the ten (10) minute duration of the test.

Note: The leakage of SPV 66181-006 had no effect on the ability of the test specimen (SPV) to open and close a SRV actuator. As there was no evidence of steam in-leakage at disassembly inspection (14.1.2, below) this post LOCA leakage is considered to be very minor pneumatic leakage past the sleeve gasket, which, even if assumed to exist at LOCA conditions, would not affect SPV performance, either electrically or mechanically. Even system supply air (N_2) pressurization of the solenoid coil chamber would cause only a tolerable positive differential relative to LOCA environmental pressure.

14. Disassembly Inspection

Upon completion of all testing, both test specimens (SPV's) were completely disassembled and photographed. The photographs appear in this report as Appendix 16.

14.1 Comments/Observations

14.1.1 Disassembly required prying up top cover and severing the coil lead wires at the internal joint to the top cover. The coil lead wires of both units were slightly pulled when removing the top cover.

14.1.2 Both units were completely dry inside indicating no in-leakage.

14.1.3 Residue from dried lubricant (Super-O-Lube) was found in both units on the top of the nut, the inside diameter of the top cover, and the pilot body raidal seal bore.

14.1.4 The nut was removed from the sleeve assembly in SPV 66181-006. The sleeve assembly threads and the mating nut threads were covered, as expected, with slivers of dried lubricant.

14.1.5 The nut and sleeve assembly removed as one (1) piece in pilot valve 66181-007.

14.1.6 The coil and yoke assembly of both units appeared unchanged except for slight discoloration. There was a small amount of residue under the yoke assembly of SPV 66181-006 which was either dried lubricant or the coil spacer RTV.

14.1.7 A small foreign particle was found on the plunger backseat of SPV 66181-006 and the seat had a convex appearance to it. The particle could have been the cause of pilot leakage. The plunger backseat of SPV 66181-007 had a concave appearance to it. Both plunger mainseats had concentric body seat impressions on them.

IMF-2 SOLENOID PILOT VALVE PRODUCTION TEST RESULTS

Electrical Characteristic Test	Serial Number 66181-006		Serial Number 66181-007	
	Pre Potting	Post Potting	Pre Potting	Post Potting
Temperature	72°F	70°F	72°F	70°F
Coil Resistance	720 ohms	742 ohms	720 ohms	720 ohms
No Applied Pressure				
Pick Up Voltage	61.4 vdc	64.1 vdc	66.1 vdc	60.8 vdc
Pick Up Current	84.0 ma	84.7 ma	84.1 ma	83.2 ma
Drop Out Voltage	7.5 vdc	8.7 vdc	7.9 vdc	6.8 vdc
Drop Out Current	10.3 ma	11.6 ma	10.9 ma	9.5 ma
With Applied Pressure				
Pick Up Voltage	56.4 vdc	57.5 vdc	54.8 vdc	55.0 vdc
Pick Up Current	77.0 ma	76.2 ma	74.6 ma	75.0 ma
Drop Out Voltage	7.5 vdc	8.0 vdc	8.4 vdc	6.4 vdc
Drop Out Current	10.3 ma	10.8 ma	11.6 ma	8.8 ma

Operability Test	Serial Number 66181-006	Serial Number 66181-007	Both Pilots Together
Minimum Opening Response Time	0.068 sec.	0.060 sec.	0.058 sec.
Maximum Opening Response Time	0.070 sec.	0.061 sec.	0.058 sec.
Minimum Closing Repsonse Time	0.332 sec.	0.350 sec.	0.348 sec.
Maximum Closing Repsonse Time	0.352 sec.	0.351 sec.	0.359 sec.

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

TABLE 4

Pilot Valve Assembly and Test Data Sheet

Pilot Assembly Serial Number: 66181-006

Part	Dimension	Inspector Date and Stamp
Body Seat I.D.	.091/.095	ACCEPTED 30 CROSBY 2-5-82
Seat Height	.466	ACCEPTED 30 CROSBY 2-5-82
Plunger Travel	.030/.035	ACCEPTED 30 CROSBY 2-5-82

Plunger and Spring Assembly Non-binding Verification

CROSBY: Bernard Mullaney 2/5/82
Signed Date

Coil Resistance: 722 ohms. Temperature: 72 °F

Sleeve Assembly to Pilot Body Seal Leakage Test

Test Pressure (200 ± 2 psig): 200-PSIG

Test Duration (5 Minutes): 5-MIN.

ACCEPTED 30 CROSBY 2-5-82

Results: N.U.L.

CROSBY: Bernard Mullaney 2/5/82
Signed Date

ASSEMBLED BY: Mike Burnelli 2/5/82
Signed Date

TABLE 4 (Continued)

Pilot Assembly Serial Number: 66181-006

Top Cover to Nut "O"-Ring Leakage Test

Test Pressure (10 psig): 10-PSIG

Test Duration (5 Minutes): 5-MIN

Results: N.V.L.

ACCEPTED PO CROSBY (N) 2-5-82

CROSBY: (Signature) Mullaney 2/5/82
Signed Date

Prepotting Tests

System Leakage Test

	Fully Closed	Fully Open
Test Pressure (200 ± 2 psig):	200 psig	200 psig
Test Duration (10 Minutes):	10 min	10 min
Results:	NVL	NVL

CROSBY: Mike Brunelli 2-5-82
Signed Date

ACCEPTED PO CROSBY (N) 2-5-82

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

TABLE 4 (Continued)

Pilot Assembly Serial Number: 66181-006

Electrical Characteristic Test

Coil Resistance: 720 ohms. Temperature: 72 °F

Minimum Pick Up Voltage (No Pressure Applied):	61.4	vdc
Minimum Pick Up Current (No Pressure Applied):	84.0	ma
Maximum Drop Out Voltage (No Pressure Applied):	7.5	vdc
Maximum Drop Out Current (No Pressure Applied):	10.3	ma
Minimum Pick Up Voltage (90 psig Applied):	56.4	vdc
Minimum Pick Up Current (90 psig Applied):	77.0	ma
Maximum Drop Out Voltage (90 psig Applied):	7.5	vdc
Maximum Drop Out Current (90 psig Applied):	10.3	ma

CROSBY: Mike Brunelli 2-5-82
Signed Date

ACCEPTED 30 CROSBY 2-5-82

Post Potting Coil Resistance 715 ohms. Temperature: 70 °F

Production Tests

System Leakage Test

	Fully Closed	Fully Open
Test Pressure (200 ± 2 psig):	200 psig	200 psig
Test Duration (10 Minutes):	10 min	10 min
Results:	NVL	NVL

CROSBY: Mike Brunelli 2-6-82
Signed Date

TABLE 4 (Continued)

Pilot Assembly Serial Number: 66181-006

Electrical Characteristic Test

Coil Resistance: 742 ohms. Temperature: 70 °F

Minimum Pick Up Voltage (No Pressure Applied):	64.1	vdc
Minimum Pick Up Current (No Pressure Applied):	84.7	ma
Maximum Drop Out Voltage (No Pressure Applied):	8.7	vdc
Maximum Drop Out Current (No Pressure Applied):	11.6	ma
Minimum Pick Up Voltage (90 psig Applied):	57.5	vdc
Minimum Pick Up Current (90 psig Applied):	76.2	ma
Maximum Drop Out Voltage (90 psig Applied):	8.0	vdc
Maximum Drop Out Current (90 psig Applied):	10.8	ma

CROSBY: Mike Brunelli 2-6-82
Signed Date

Operability Test

No. of Cycles: 20

Opening Response Time (≥0.100 Second)
(Switch-in to Start of Motion): Minimum: .068 sec. Maximum: .070 sec.

Closing Response Time (≥0.900 Second)
(Switch-out to Start of Motion): Minimum: .332 sec. Maximum: .352 sec.

~~All Three (3)~~ BOTH Pilots

No. of Cycles: 5 10

Opening Response Time (≥0.100 Second)
(Switch-in to Start of Motion): Minimum: .058 sec. Maximum: .058 sec.

Closing Response Time (≥0.900 Second)
(Switch-out to Start of Motion): Minimum: .348 sec. Maximum: .359 sec.

CROSBY: Mike Brunelli 2-6-82
Signed Date

Pilot VALVE 66181-006

TABLE 4 (Continued)

System Leakage Test

	Fully Closed	Fully Open
Test Pressure (200 ± 2 psig):	200 PSIG	200 PSIG
Test Duration (10 Minutes):	10 min	10 min
Results:	NVL	NVL

CROSBY: Mike Brunelli 2-6-81
Signed Date

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

Q.C.-278

TABLE 4

Pilot Valve Assembly and Test Data Sheet

Pilot Assembly Serial Number: 66181-007

Part	Dimension	Inspector Date and Stamp
Body Seat I.D.	.091/.095	ACCEPTED BO CROSBY 2-5-82
Seat Height	.468	ACCEPTED BO CROSBY 2-5-82
Plunger Travel	.030/.035	ACCEPTED BO CROSBY 2-5-82

Plunger and Spring Assembly Non-binding Verification

CROSBY: Bernard Mullaney 2/5/82
Signed Date

Coil Resistance: 721 ohms. Temperature: 72 °F

Sleeve Assembly to Pilot Body Seal Leakage Test

Test Pressure (200 ± 2 psig): 200-PSIG

Test Duration (5 Minutes): 5-MIN

ACCEPTED BO CROSBY 2-5-82

Results: N.V.L.

CROSBY: Bernard Mullaney 2/5/82
Signed Date

ASSEMBLED BY: Vito Buccelli 2/5/82
Signed Date

TABLE 4 (Continued)

Pilot Assembly Serial Number: 66181-007

Top Cover to Nut "O"-Ring Leakage Test

Test Pressure (10 psig): 10-PSIG

Test Duration (5 Minutes): 5-MIN

Results: N.V.C.

ACCEPTED BY CROSBY 2-5-82

CROSBY: Bernard M Mullaney 2/5/82
Signed Date

Prepotting Tests

System Leakage Test

	Fully Closed	Fully Open
Test Pressure (200 ± 2 psig):	200 PSIG	200 PSIG
Test Duration (10 Minutes):	10 MIN	10 MIN
Results:	NVL	NVL

CROSBY: Mike Brunelli 2-5-82
Signed Date

ACCEPTED BY CROSBY 2-5-82

TABLE 4 (Continued)

Pilot Assembly Serial Number: 66181-007

Electrical Characteristic Test

Coil Resistance: 720 ohms. Temperature: 72 °F

Minimum Pick Up Voltage (No Pressure Applied):	61.6	vdc
Minimum Pick Up Current (No Pressure Applied):	84.1	ma
Maximum Drop Out Voltage (No Pressure Applied):	7.9	vdc
Maximum Drop Out Current (No Pressure Applied):	10.9	ma
Minimum Pick Up Voltage (90 psig Applied):	54.8	vdc
Minimum Pick Up Current (90 psig Applied):	74.6	ma
Maximum Drop Out Voltage (90 psig Applied):	8.4	vdc
Maximum Drop Out Current (90 psig Applied):	11.6	ma

CROSBY: Mike Brunelli 2-5-82
Signed Date

ACCEPTED BY CROSBY 2-5-82

Post Potting Coil Resistance 715 ohms. Temperature: 70 °F

Production Tests

System Leakage Test

	Fully Closed	Fully Open
Test Pressure (200 ± 2 psig):	200 PSIG	200 PSIG
Test Duration (10 Minutes):	10 min	10 min
Results:	NVL	NVL

CROSBY: Mike Brunelli 2-6-82
Signed Date

TABLE 4 (Continued)

Pilot Assembly Serial Number: 66181-007

Electrical Characteristic Test

Coil Resistance: 720 ohms. Temperature: 70 °F

Minimum Pick Up Voltage (No Pressure Applied):	60.8 vdc
Minimum Pick Up Current (No Pressure Applied):	83.2 ma
Maximum Drop Out Voltage (No Pressure Applied):	6.8 vdc
Maximum Drop Out Current (No Pressure Applied):	9.5 ma
Minimum Pick Up Voltage (90 psig Applied):	55.0 vdc
Minimum Pick Up Current (90 psig Applied):	75.0 ma
Maximum Drop Out Voltage (90 psig Applied):	6.4 vdc
Maximum Drop Out Current (90 psig Applied):	8.8 ma

CROSBY: Mike Brunelli 2-6-82
Signed Date

Operability Test

No. of Cycles: 20

Opening Response Time (>0.100 Second)
(Switch-in to Start of Motion): Minimum: .060 sec. Maximum: .061 sec.

Closing Response Time (>0.900 Second)
(Switch-out to Start of Motion): Minimum: .350 sec. Maximum: .357 sec.

~~All Three (3)~~ BOTH Pilots

No. of Cycles: 10

Opening Response Time (>0.100 Second)
(Switch-in to Start of Motion): Minimum: .058 sec. Maximum: .058 sec.

Closing Response Time (>0.900 Second)
(Switch-out to Start of Motion): Minimum: .348 sec. Maximum: .359 sec.

CROSBY: Mike Brunelli 2/6/82
Signed Date

Pilot VALVE 66181-007

TABLE 4 (Continued)

System Leakage Test

	Fully Closed	Fully Open
Test Pressure (200 ± 2 psig):	200 PSIG	200 PSIG
Test Duration (10 Minutes):	10 min	10 min
Results:	NVL	NVL

CROSBY: Mike Buonelli 8-6-82
Signed Date

IMF-2 Solenoid Pilot Valve Reference Frame Test Results - Serial Number 66181-006

Electrical Characteristic Test	Reference Frame	Post Thermal Aging Baseline	Post Mechanical Aging Baseline	Post Radiation Aging Baseline	Post LOCA Baseline
Temperature	70°F	72°F	73°F	72°F	73°F
Coil Resistance	717 ohms	722 ohms	687 ohms	725 ohms	744 ohms
No Applied Pressure					
Pick Up Voltage	63.6 vdc	62.1 vdc	59.3 vdc	63.6 vdc	66.0 vdc
Pick Up Current	86.7 ma	86.2 ma	86.6 ma	88.3 ma	86.0 ma
Drop Out Voltage	8.1 vdc	7.3 vdc	6.9 vdc	6.5 vdc	6.0 vdc
Drop Out Current	11.1 ma	10.1 ma	10.0 ma	9.0 ma	10.0 ma
With Applied Pressure					
Pick Up Voltage	57.2 vdc	57.1 vdc	54.8 vdc	58.4 vdc	57.0 vdc
Pick Up Current	78.1 ma	79.0 ma	78.8 ma	81.0 ma	72.0 ma
Drop Out Voltage	7.5 vdc	7.7 vdc	5.9 vdc	6.5 vdc	6.0 vdc
Drop Out Current	10.4 ma	10.6 ma	8.6 ma	9.0 ma	9.0 ma
Operability Test					
Minimum Opening Response Time	0.078 sec.	0.075 sec.	0.082 sec.	0.075 sec.	0.073 sec.
Maximum Opening Response Time	0.078 sec.	0.085 sec.	0.084 sec.	0.078 sec.	0.075 sec.
Minimum Closing Response Time	0.255 sec.	0.280 sec.	0.310 sec.	0.287 sec.	0.220 sec.
Maximum Closing Response Time	0.255 sec.	0.285 sec.	0.312 sec.	0.290 sec.	0.230 sec.

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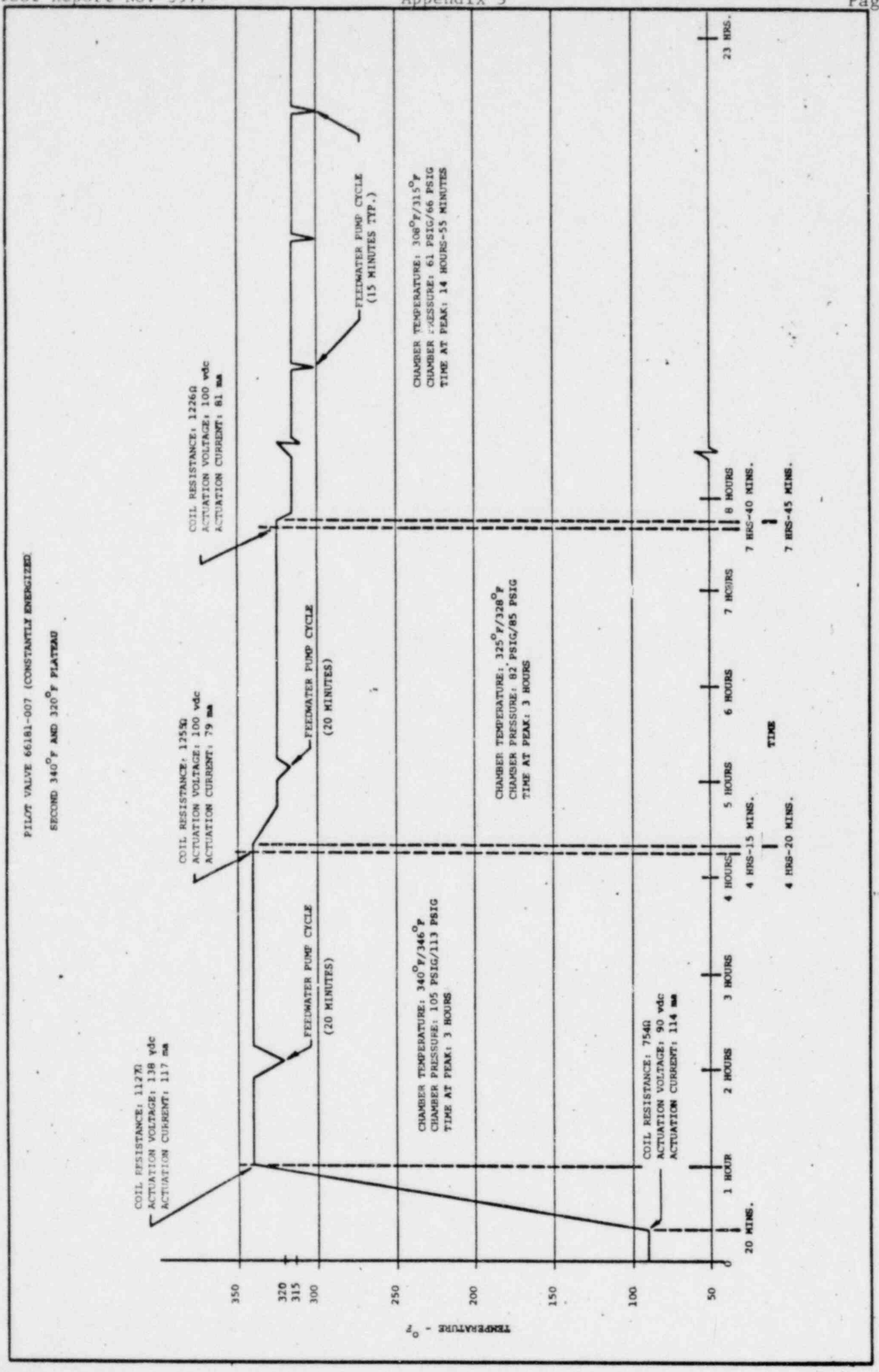
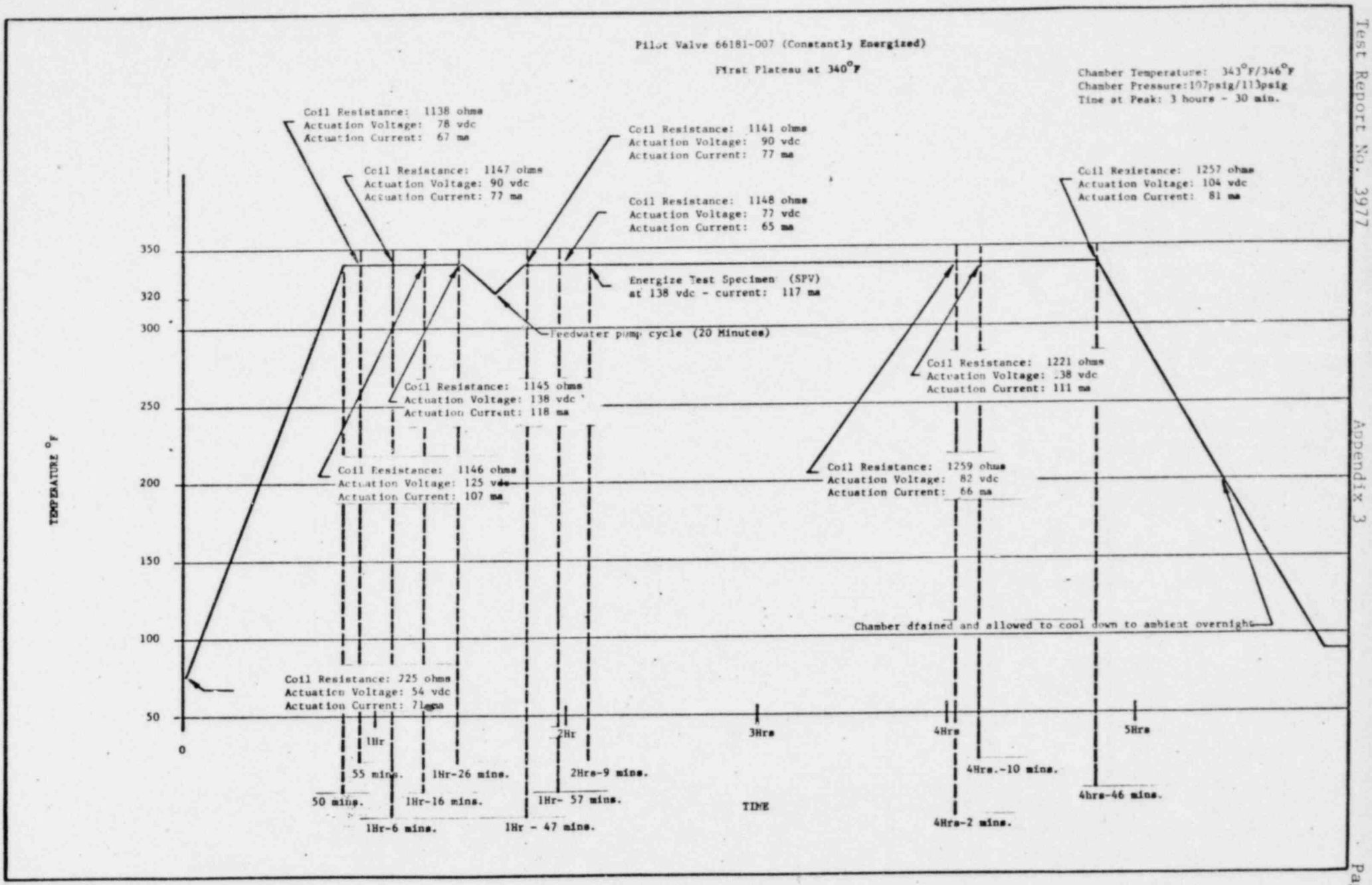
IMF-2 Solenoid Pilot Valve Reference Frame Test Results - Serial Number 66181-007

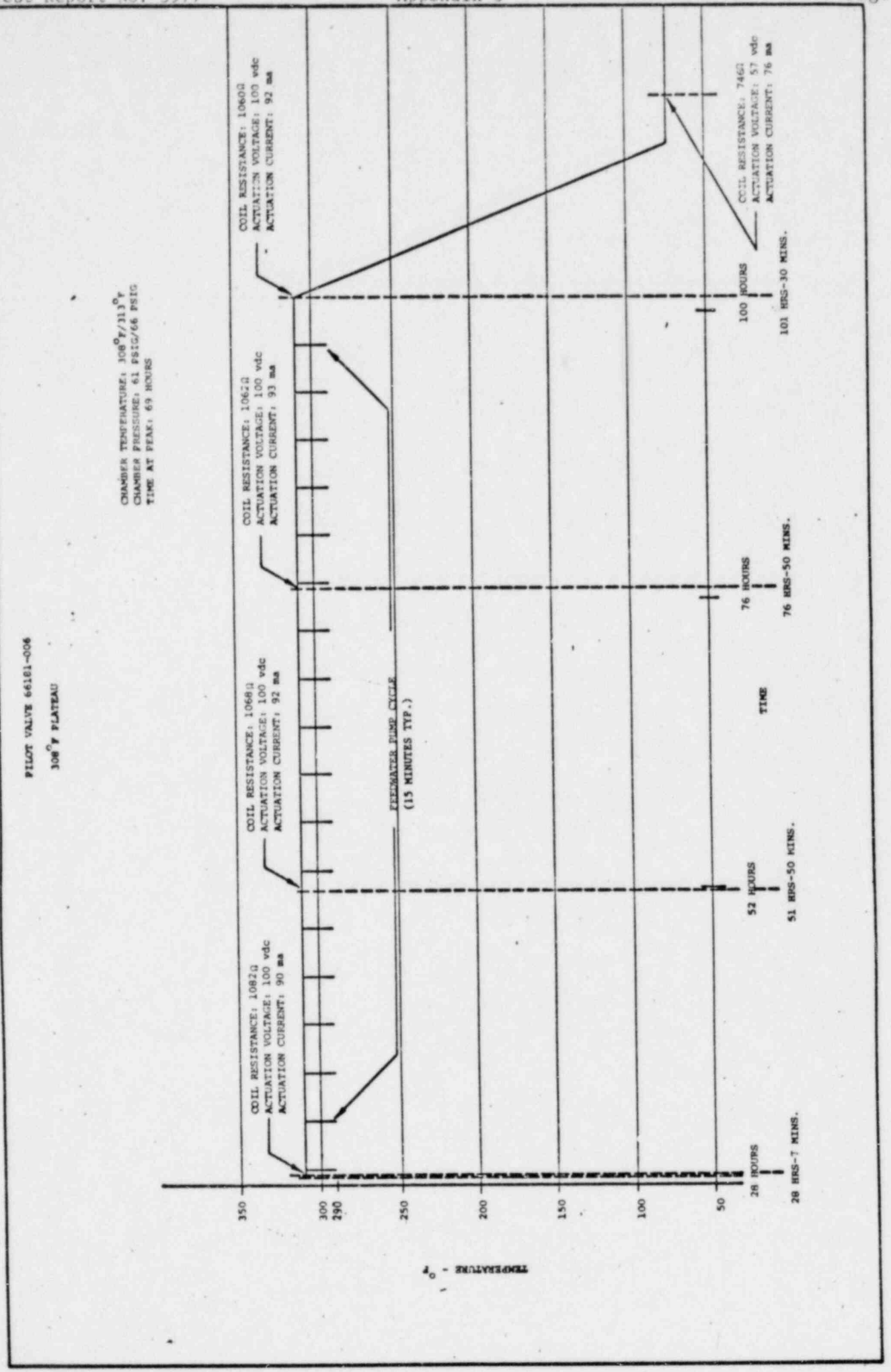
Electrical Characteristic Test	Reference Frame	Post Thermal Aging Baseline	Post Mechanical Aging Baseline	Post Radiation Aging Baseline	Post LOCA Baseline
Temperature	70°F	72°F	73°F	72°F	73°F
Coil Resistance	724 ohms	726 ohms	700 ohms	726 ohms	736 ohms
No Applied Pressure					
Pick Up Voltage	61.4 vdc	62.6 vdc	57.8 vdc	62.5 vdc	62.0 vdc
Pick Up Current	83.4 ma	87.2 ma	83.6 ma	87.1 ma	81.0 ma
Drop Out Voltage	8.1 vdc	7.1 vdc	6.4 vdc	6.5 vdc	5.7 vdc
Drop Out Current	11.1 ma	9.8 ma	9.2 ma	9.0 ma	7.0 ma
With Applied Pressure					
Pick Up Voltage	56.1 vdc	54.2 vdc	52.8 vdc	57.0 vdc	54.0 vdc
Pick Up Current	76.2 ma	75.2 ma	76.1 ma	79.3 ma	71.0 ma
Drop Out Voltage	6.9 vdc	7.3 vdc	6.4 vdc	6.6 vdc	6.0 vdc
Drop Out Current	9.4 ma	10.0 ma	9.2 ma	9.2 ma	7.0 ma
Operability Test					
Minimum Opening Response Time	0.060 sec.	0.076 sec.	0.067 sec.	0.070 sec.	0.072 sec.
Maximum Opening Response Time	0.070 sec.	0.080 sec.	0.072 sec.	0.072 sec.	0.077 sec.
Minimum Closing Response Time	0.260 sec.	0.255 sec.	0.305 sec.	0.270 sec.	0.209 sec.
Maximum Closing Response Time	0.275 sec.	0.260 sec.	0.312 sec.	0.278 sec.	0.210 sec.

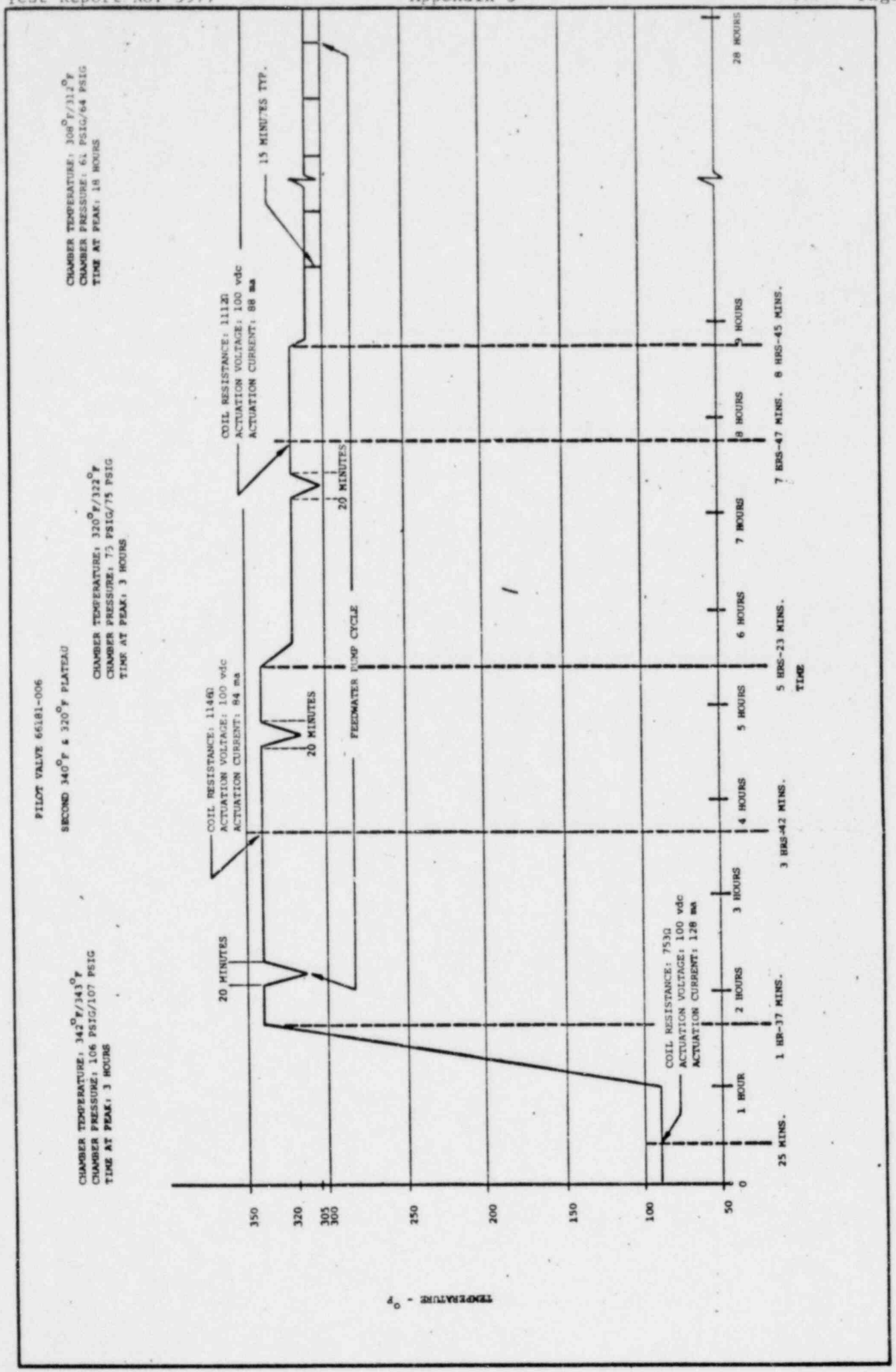
CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

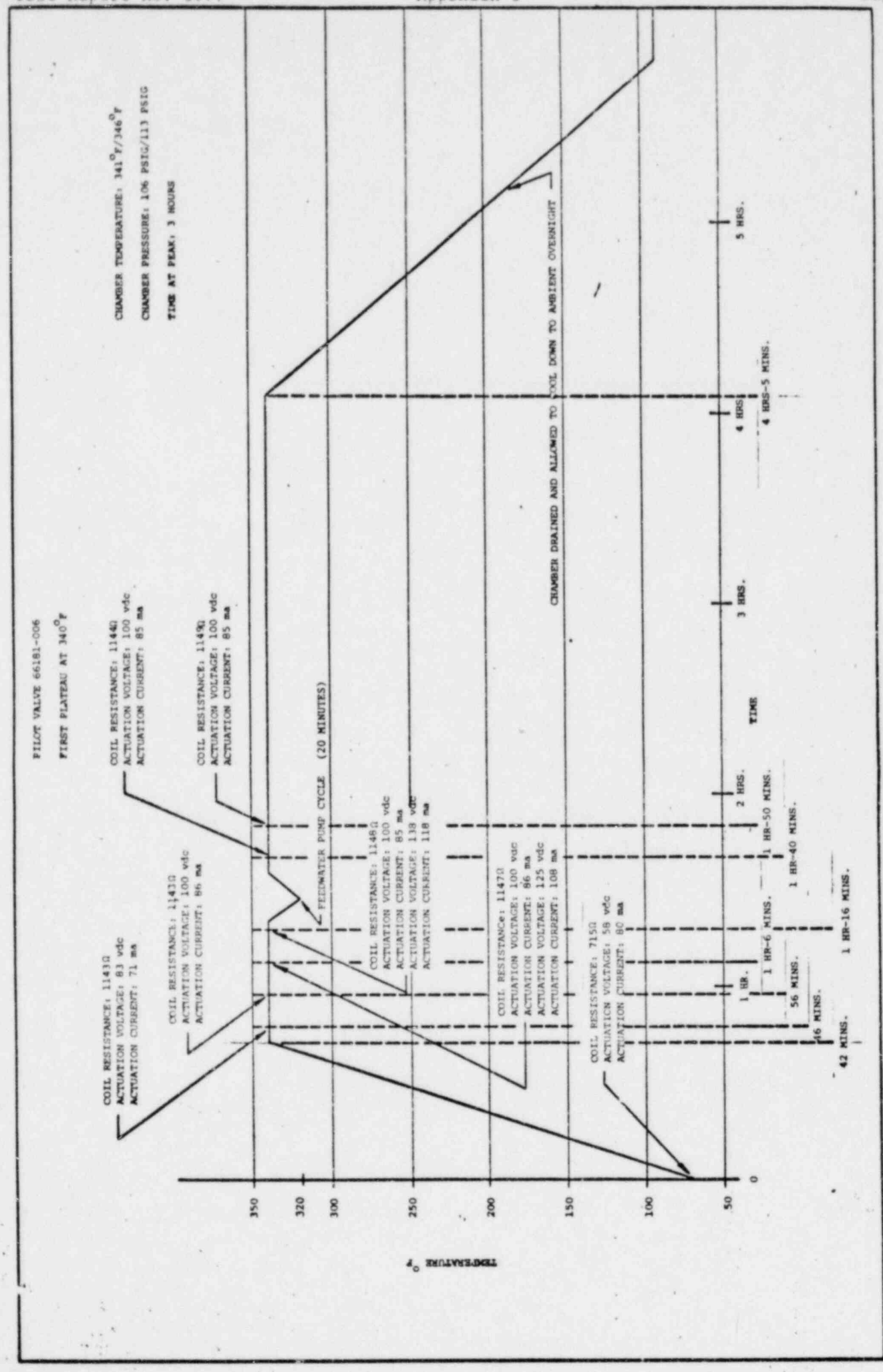
Test Report No. 3977 Appendix 2 Page 24

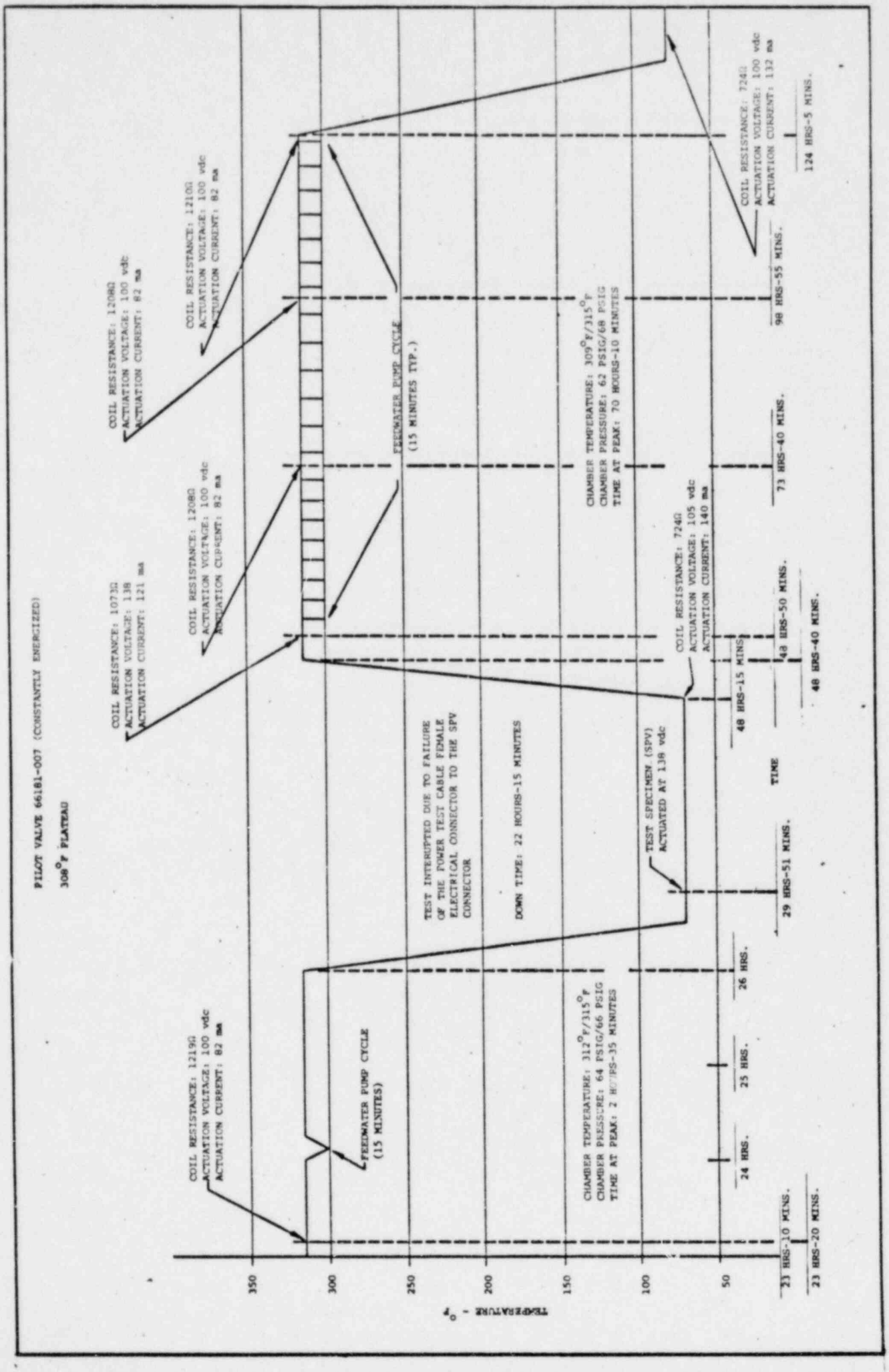

PILOT VALVE 66181-007 (CONSTANTLY ENERGIZED
SECOND 340°F AND 320°F PLATEAU
COIL RESISTANCE: 1127Ω
ACTUATION VOLTAGE: 138 vdc
ACTUATION CURRENT: 117 ma
COIL RESISTANCE: 1255Ω
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 79 ma
COIL RESISTANCE: 1226Ω
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 81 ma
COIL RESISTANCE: 754Ω
ACTUATION VOLTAGE: 90 vdc
ACTUATION CURRENT: 114 ma
FEEDWATER PUMP CYCLE
(20 MINUTES)
FEEDWATER PUMP CYCLE
(20 MINUTES)
FEEDWATER PUMP CYCLE
(15 MINUTES TYP.)
CHAMBER TEMPERATURE: 340°F/346°F
CHAMBER PRESSURE: 105 PSIG/113 PSIG
TIME AT PEAK: 3 HOURS
CHAMBER TEMPERATURE: 325°F/328°F
CHAMBER PRESSURE: 82 PSIG/85 PSIG
TIME AT PEAK: 3 HOURS
CHAMBER TEMPERATURE: 308°F/315°F
CHAMBER PRESSURE: 61 PSIG/66 PSIG
TIME AT PEAK: 14 HOURS-55 MINUTES
TEMPERATURE - °F
350
320
315
300
250
200
150
100
50
0
20 MINS.
1 HOUR
2 HOURS
3 HOURS
4 HOURS
4 HRS-15 MINS.
4 HRS-20 MINS.
5 HOURS
6 HOURS
7 HOURS
7 HRS-40 MINS.
7 HRS-45 MINS.
8 HOURS
23 HRS.
TIME


Pilot Valve 66181-007 (Constantly Energized)
First Plateau at 340°F
Chamber Temperature: 343°F/346°F
Chamber Pressure:107psig/113psig
Time at Peak: 3 hours - 30 min.
Coil Resistance: 1138 ohms
Actuation Voltage: 78 vdc
Actuation Current: 67 ma
Coil Resistance: 1147 ohms
Actuation Voltage: 90 vdc
Actuation Current: 77 ma
Coil Resistance: 1141 ohms
Actuation Voltage: 90 vdc
Actuation Current: 77 ma
Coil Resistance: 1148 ohms
Actuation Voltage: 77 vdc
Actuation Current: 65 ma
Coil Resistance: 1257 ohms
Actuation Voltage: 104 vdc
Actuation Current: 81 ma
Energize Test Specimen (SPV)
at 138 vdc - current: 117 ma
Feedwater pump cycle (20 Minutes)
Coil Resistance: 1145 ohms
Actuation Voltage: 138 vdc
Actuation Current: 118 ma
Coil Resistance: 1221 ohms
Actuation Voltage: 138 vdc
Actuation Current: 111 ma
Coil Resistance: 1146 ohms
Actuation Voltage: 125 vdc
Actuation Current: 107 ma
Coil Resistance: 1259 ohms
Actuation Voltage: 82 vdc
Actuation Current: 66 ma
Chamber drained and allowed to cool down to ambient overnight
Coil Resistance: 725 ohms
Actuation Voltage: 54 vdc
Actuation Current: 71 ma
TEMPERATURE °F
350
320
300
250
200
150
100
50
0
1Hr
2Hr
3Hrs
4Hrs
5Hrs
55 mins.
1Hr-26 mins.
2Hrs-9 mins.
4Hrs.-10 mins.
50 mins.
1Hr-16 mins.
1Hr- 57 mins.
4hrs-46 mins.
1Hr-6 mins.
1Hr - 47 mins.
4Hrs-2 mins.
TIME


PILOT VALVE 66161-006
308°F PLATEAU
CHAMBER TEMPERATURE: 308°F/313°F
CHAMBER PRESSURE: 61 PSIG/66 PSIG
TIME AT PEAK: 69 HOURS
COIL RESISTANCE: 1082Ω
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 90 ma
COIL RESISTANCE: 1068Ω
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 92 ma
COIL RESISTANCE: 1062Ω
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 93 ma
COIL RESISTANCE: 1060Ω
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 92 ma
COIL RESISTANCE: 746Ω
ACTUATION VOLTAGE: 57 vdc
ACTUATION CURRENT: 76 ma
FEEDWATER PUMP CYCLE
(15 MINUTES TYP.)
28 HOURS
28 HRS-7 MINS.
52 HOURS
51 HRS-50 MINS.
76 HOURS
76 HRS-50 MINS.
100 HOURS
101 HRS-30 MINS.
TIME
TEMPERATURE - °F
350
300
290
250
200
150
100
50


PILOT VALVE 66181-006
SECOND 340°F & 320°F PLATEAU
CHAMBER TEMPERATURE: 342°F/343°F
CHAMBER PRESSURE: 106 PSIG/107 PSIG
TIME AT PEAK: 3 HOURS
CHAMBER TEMPERATURE: 320°F/322°F
CHAMBER PRESSURE: 73 PSIG/75 PSIG
TIME AT PEAK: 3 HOURS
CHAMBER TEMPERATURE: 308°F/312°F
CHAMBER PRESSURE: 64 PSIG/64 PSIG
TIME AT PEAK: 18 HOURS
COIL RESISTANCE: 1140
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 84 ma
COIL RESISTANCE: 1112Ω
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 88 ma
COIL RESISTANCE: 753Ω
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 128 ma
20 MINUTES
20 MINUTES
20 MINUTES
15 MINUTES TYP.
FEEDWATER DUMP CYCLE
25 MINS.
1 HOUR
1 HR-37 MINS.
2 HOURS
3 HOURS
3 HRS-42 MINS.
4 HOURS
5 HOURS
5 HRS-23 MINS.
6 HOURS
7 HOURS
7 HRS-47 MINS.
8 HOURS
8 HRS-45 MINS.
9 HOURS
28 HOURS
TIME
TEMPERATURE - °F
350
320
305
300
250
200
150
100
50
0


PILOT VALVE 66181-006
FIRST PLATEAU AT 340°F
CHAMBER TEMPERATURE: 341°F/346°F
CHAMBER PRESSURE: 106 PSIG/113 PSIG
TIME AT PEAK: 3 HOURS
COIL RESISTANCE: 11430
ACTUATION VOLTAGE: 83 vdc
ACTUATION CURRENT: 71 ma
COIL RESISTANCE: 11440
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 85 ma
COIL RESISTANCE: 11430
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 86 ma
COIL RESISTANCE: 11490
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 85 ma
FEEDWATER PUMP CYCLE (20 MINUTES)
COIL RESISTANCE: 11480
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 85 ma
ACTUATION VOLTAGE: 138 vdc
ACTUATION CURRENT: 110 ma
COIL RESISTANCE: 11470
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 86 ma
ACTUATION VOLTAGE: 125 vdc
ACTUATION CURRENT: 108 ma
COIL RESISTANCE: 7150
ACTUATION VOLTAGE: 58 vdc
ACTUATION CURRENT: 80 ma
CHAMBER DRAINED AND ALLOWED TO COOL DOWN TO AMBIENT OVERNIGHT
TEMPERATURE °F
350
320
300
250
200
150
100
50
0
1 HR.
56 MINS.
46 MINS.
42 MINS.
1 HR-6 MINS.
1 HR-16 MINS.
1 HR-40 MINS.
1 HR-50 MINS.
2 HRS.
3 HRS.
4 HRS.
4 HRS-5 MINS.
5 HRS.
TIME


PILOT VALVE 66181-007 (CONSTANTLY ENERGIZED)
308°F PLATEAU
TEMPERATURE - °F
350
300
250
200
150
100
50
TIME
COIL RESISTANCE: 12196
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 82 ma
FEEDWATER PUMP CYCLE
(15 MINUTES)
CHAMBER TEMPERATURE: 312°F/315°F
CHAMBER PRESSURE: 64 PSIG/66 PSIG
TIME AT PEAK: 2 HOURS-35 MINUTES
24 HRS.
25 HRS.
26 HRS.
23 HRS-10 MINS.
23 HRS-20 MINS.
COIL RESISTANCE: 10736
ACTUATION VOLTAGE: 138
ACTUATION CURRENT: 121 ma
COIL RESISTANCE: 12080
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 82 ma
COIL RESISTANCE: 12080
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 82 ma
COIL RESISTANCE: 12100
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 82 ma
TEST INTERRUPTED DUE TO FAILURE OF THE POWER TEST CABLE FEMALE ELECTRICAL CONNECTOR TO THE SPV CONNECTOR
DOWN TIME: 22 HOURS-15 MINUTES
TEST SPECIMEN (SPV) ACTUATED AT 138 vdc
29 HRS-51 MINS.
48 HRS-15 MINS.
COIL RESISTANCE: 7240
ACTUATION VOLTAGE: 105 vdc
ACTUATION CURRENT: 140 ma
48 HRS-50 MINS.
48 HRS-40 MINS.
FEEDWATER PUMP CYCLE
(15 MINUTES TYP.)
CHAMBER TEMPERATURE: 309°F/315°F
CHAMBER PRESSURE: 62 PSIG/68 PSIG
TIME AT PEAK: 70 HOURS-10 MINUTES
73 HRS-40 MINS.
90 HRS-55 MINS.
COIL RESISTANCE: 7240
ACTUATION VOLTAGE: 100 vdc
ACTUATION CURRENT: 132 ma
124 HRS-5 MINS.

JUSTIFICATION OF THERMAL AGING

Thermal aging was performed using two (2) different accelerated aging times (t_1'; t_1'') and accelerated aging temperatures (T_1';T_1''). Each aging plateau establishes a partial service life (t_2';t_2'') and the sum of the two (2) is then shown to be equivalent to 100 hours at 343°F.

$$t_2 = t_2' + t_2''$$

t_1 = Accelerated Aging Time = 100 hours.

t_1' = Accelerated Aging Time for First Plateau = 99.8 hours.

t_1'' = Accelerated Aging Time for Second Plateau = 28.2 hours.

t_2 = Normal Service Life.

t_2' = Partial Service Life for First Aging Plateau.

t_2'' = Partial Service Life for Second Aging Plateau.

T_1 = Accelerated Aging Temperature = 343°F = 172.78°C = 445.98°K.

T_1' = Accelerated Aging Temperature for First Plateau = 329°F = 165°C = 438.2°K.

T_1'' = Accelerated Aging Temperature for Second Plateau = 344°F = 173.33°C = 446.53°K.

T_2 = Normal Service Temperature = 150°F = 65.56°C = 338.76°K.

E_a = Actuation Energy = 0.77 eV (Limiting Material Considered to be the Silatstic - 732 RTV).

k_B = Boltzmann's Constant = 8.617×10^{-5} ev/°K.

$$t_1/t_2 = \{\exp(E_a/k_B)(1/T_1 - 1/T_2)\}$$

$$t_2 = t_1/\{\exp(E_a/k_B)(1/T_1 - 1/T_2)\}$$

$$t_2 = 100/\{0.77/8.617 \times 10^{-5}) \ (1/445.98 - 1/338.76)\}$$

$$t_2 = 100/\{\exp(8935.8245)(0.0022422 - 0.0029519)\}$$

$$t_2 = 100/\{\exp(8935.8245)(-0.0007097)\}$$

$$t_2 = 100/0.0017612$$

$$t_2 = 56779.47 \text{ hours} = 6.48 \text{ years} = 6.5 \text{ years}.$$

$t_2' = t_1'/\{\exp(E_a/k_B)(1/T_1' - 1/T_2)\}$

$t_2' = 99.8/\{\exp(0.77/8.617 \times 10^{-5})(1/438.2 - 1/338.76)\}$

$t_2' = 99.8/\{\exp(8935.8245)(0.002282 - 0.0029519)\}$

$t_2' = 99.8/\{\exp(8935.8245)(-0.0006699)\}$

$t_2' = 99.8/0.0025314$

$t_2' = 39707.17$ hours = 4.53 years = 4.5 years.

$t_2'' = t_1''/\{\exp(E_a/k_B)(1/T_1'' - 1/T_2)\}$

$t_2'' = 28.2/\{\exp(0.77/8.617 \times 10^{-5})(1/446.53 - 1/338.76)\}$

$t_2'' = 28.2/\{\exp(8935.8245)(0.0022394 - 0.0029519)\}$

$t_2'' = 28.2/\{\exp(8935.8245)(-0.0007125)\}$

$t_2'' = 28.2/0.0017176$

$t_2'' = 16418.26$ hours = 1.87 years = 1.9 years.

$t_2 = 6.5$ years

$t_2' = 4.5$ years

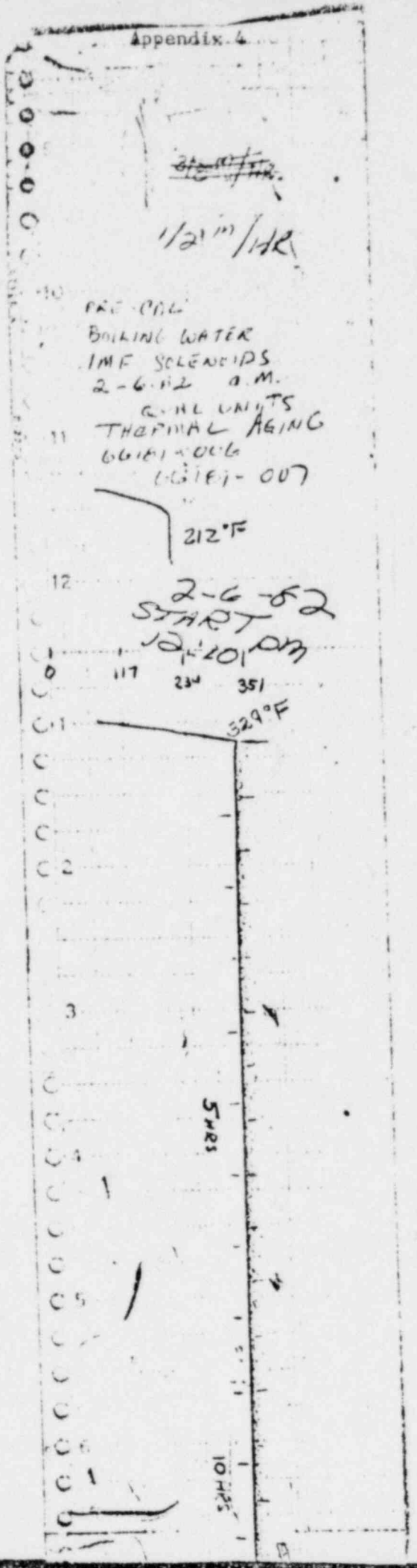
$t_2'' = 1.9$ years

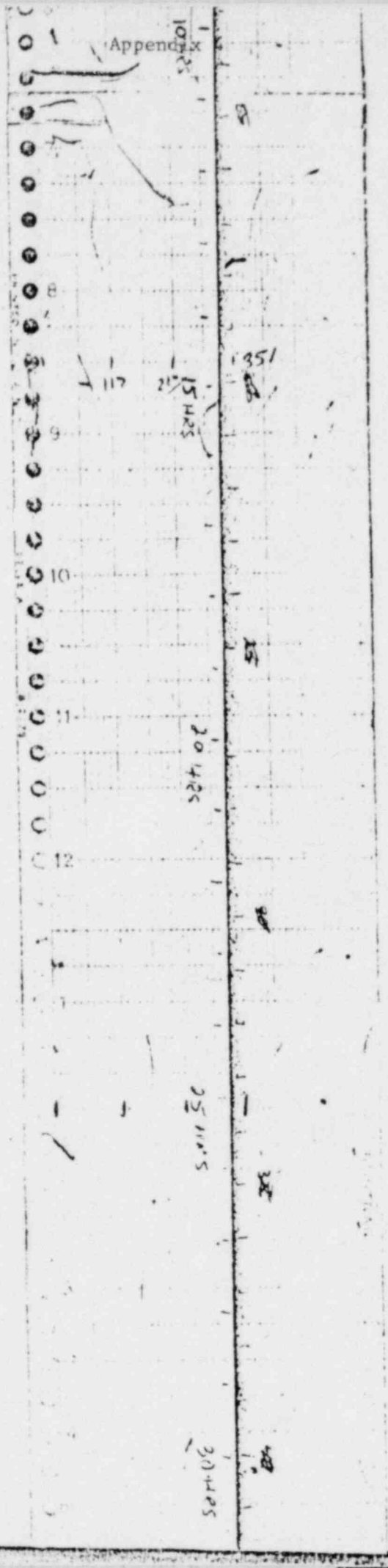
$t_2 = t_2' + t_2''$

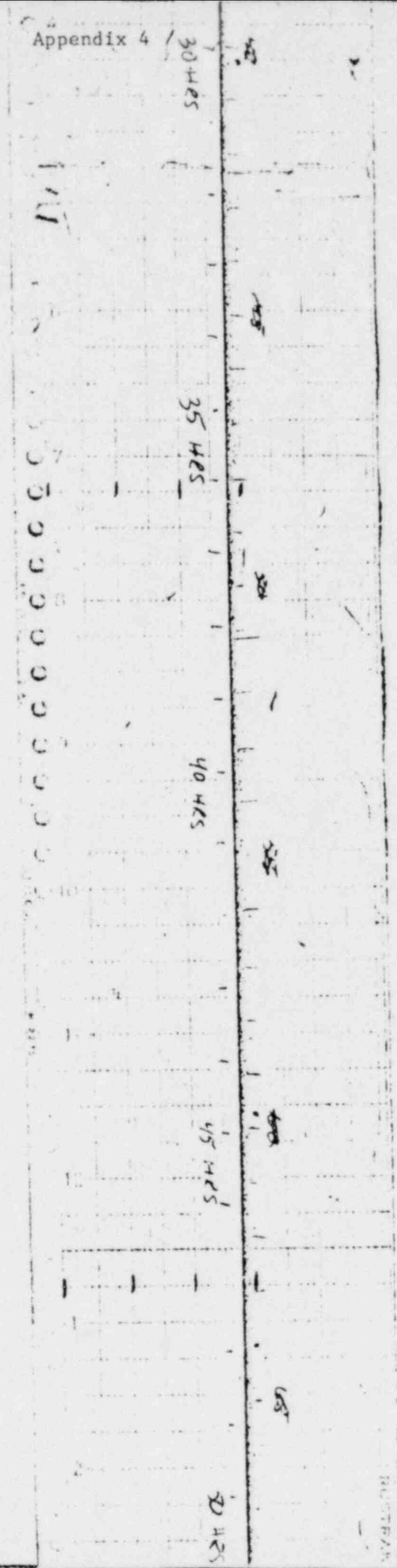
$6.5 = 4.5 + 1.9$

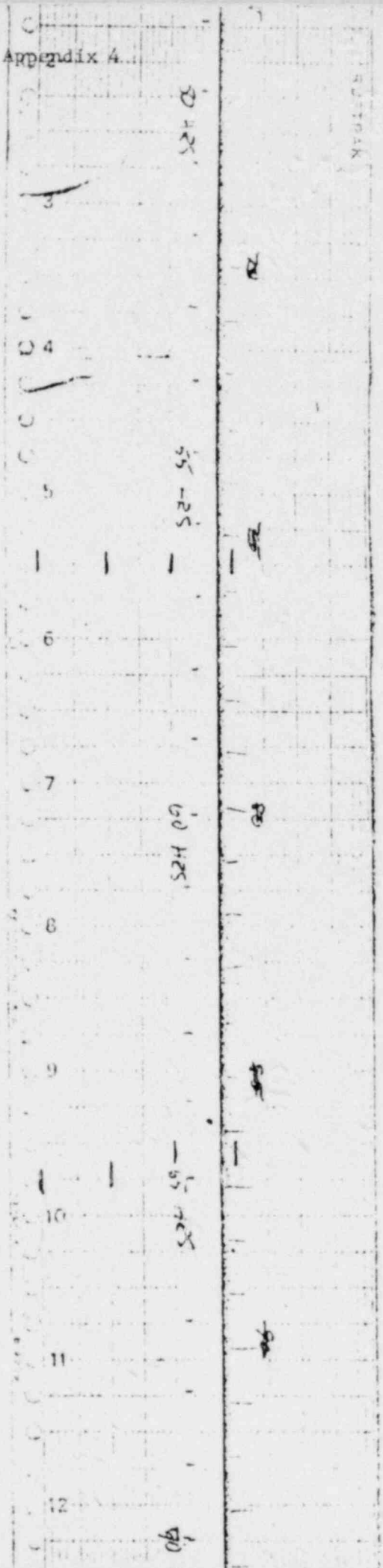
$6.5 = 6.4$

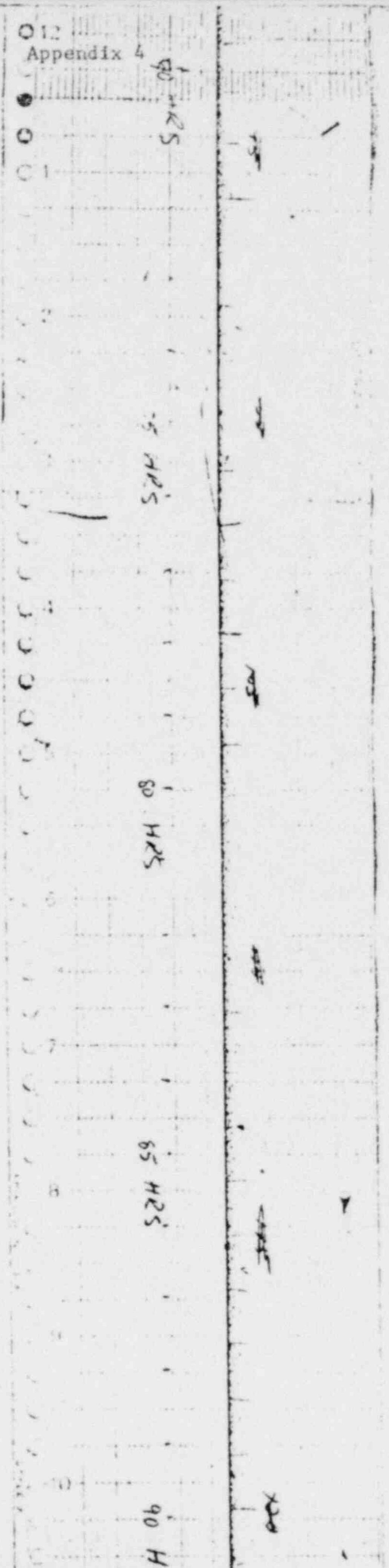
Total Normal Service Life = 6.4 years.

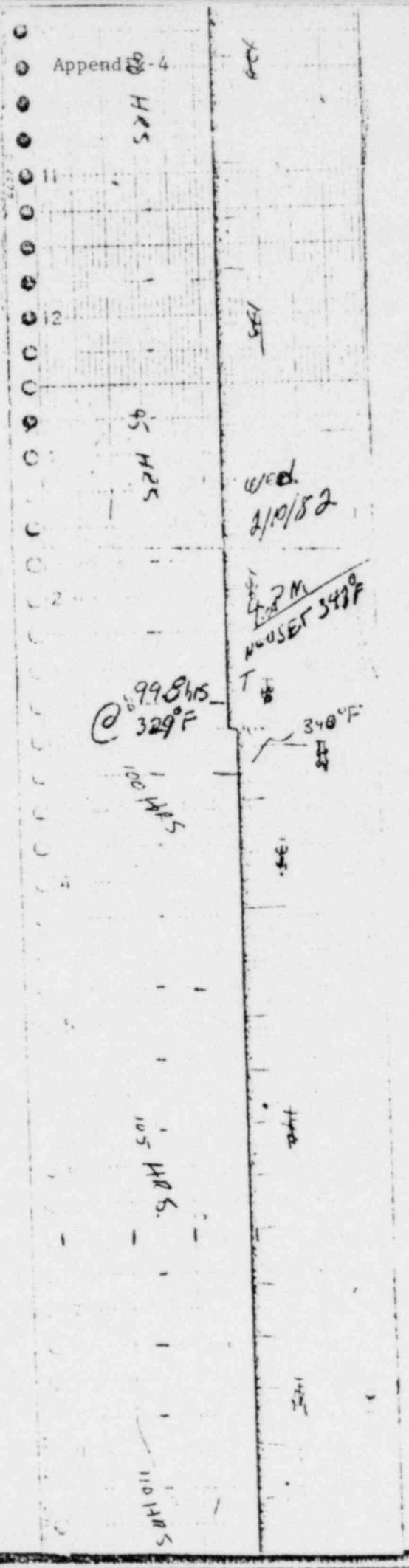

1/2" /HR
PRE-CAL
BOILING WATER
IMF SOLENOIDS
2-6-62 A.M.
GENL UNITS
THERMAL AGING
GGIEJ-0006
GGIEJ-007
212°F
2-6-62
START
12:20 PM
0
117
234
351
329°F
5 HRS
10 HRS

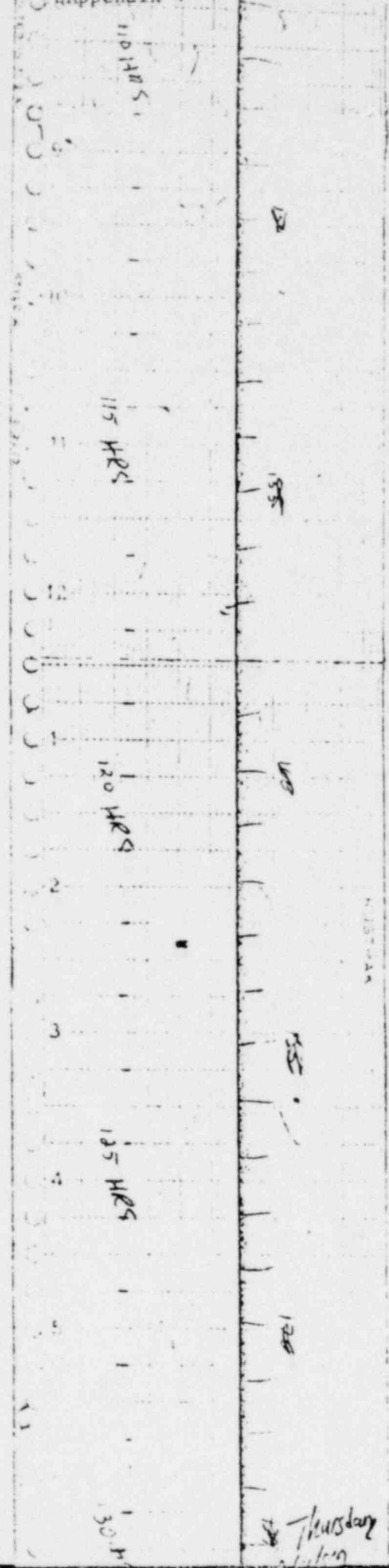


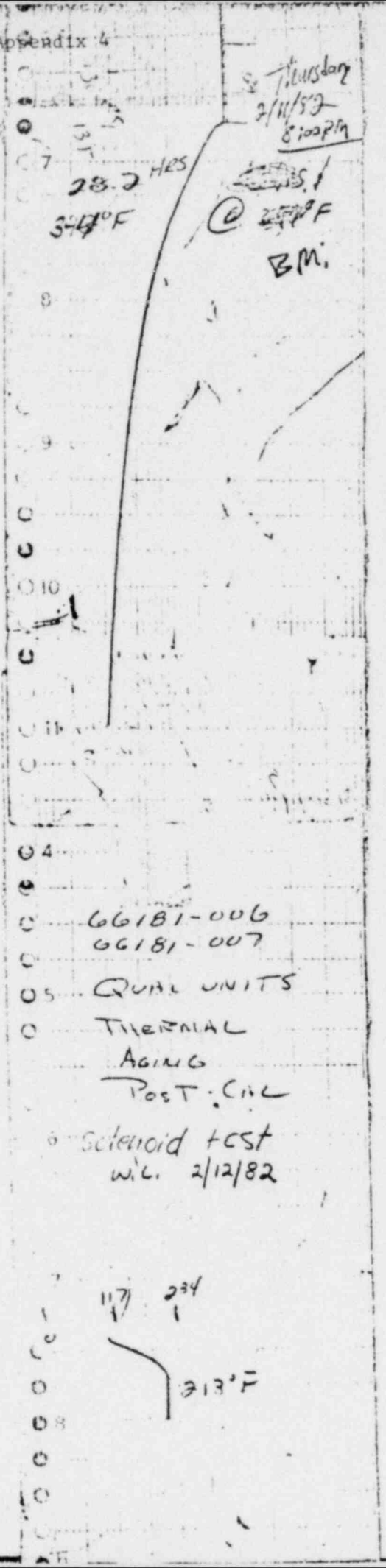

30 HRS
35 HRS
40 HRS
45 HRS
50 HRS

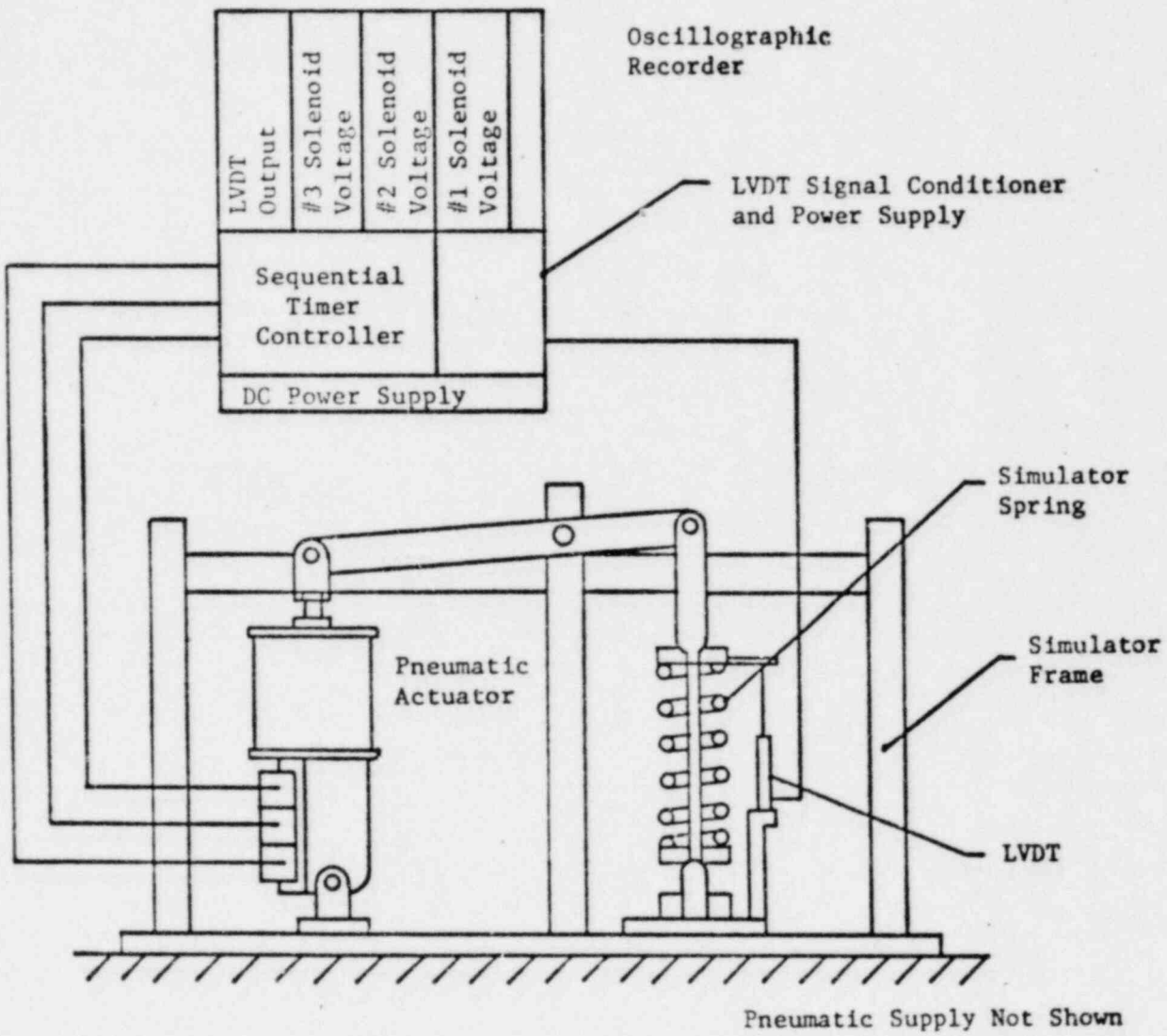

60 Hz
55 - 25
55 + 25




11
12
2
wed.
2/10/82
NOUSET 343°F
@ 99.6hrs
329°F
340°F


115 HRS
120 HRS
125 HRS
Thursday


Thursday
2/11/82
8:00 PM
28.2 HRS
@
BM.
66181-006
66181-007
QUAL UNITS
THERMAL
AGING
POST CAL
Solenoid test
W.L. 2/12/82
117
234
313°F

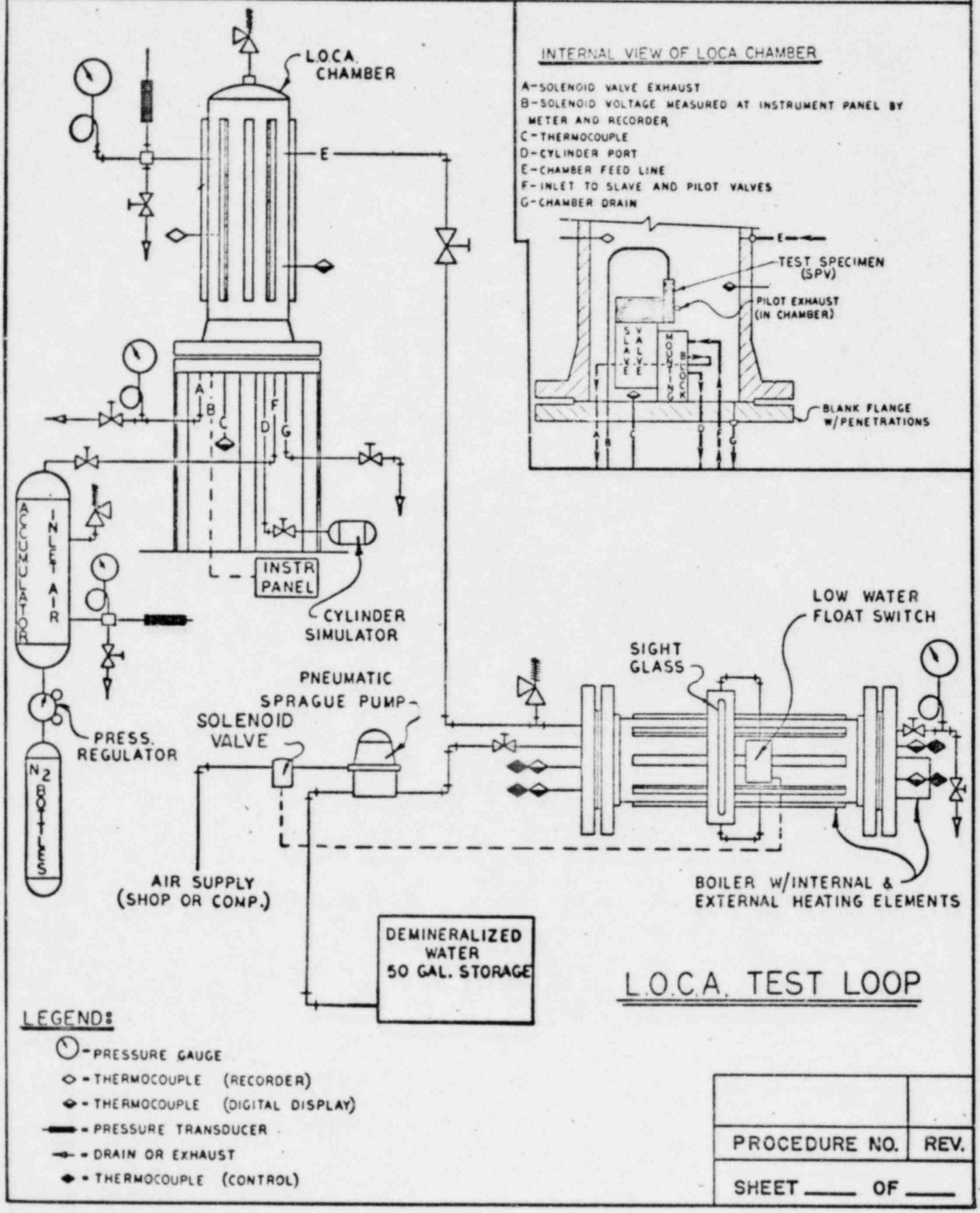


Mechanical Aging Test Apparatus

PROCEDURE NO.	REV.
SHEET ___ OF ___	

CROSBY

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS



L.O.C.A. TEST LOOP

LEGEND:

- PRESSURE GAUGE
- THERMOCOUPLE (RECORDER)
- THERMOCOUPLE (DIGITAL DISPLAY)
- PRESSURE TRANSDUCER
- DRAIN OR EXHAUST
- THERMOCOUPLE (CONTROL)

PROCEDURE NO.	REV.
SHEET ____ OF ____	

ENGINEERING CALCULATION

EC-872 Rev. 1

May 3, 1982

Justification of extended structure IMF-2 pilot mounting design of Crosby Drawing DS-C-66181 Rev. 0 compared to old design of Crosby Drawing SA-C-60761 Rev. B. (Qualification Reference: Wyle NEQ Test Report No. 44220-2, Qualification Test Report for One (1) Safety-Relief Valve Actuator, Crosby Model No. 8R10 SRV).

For

General Electric

San Jose

Crosby F.O. Number N94270-003

CROSBY | CROSBY VALVE & GAGE COMPANY WRENTHAM, MASSACHUSETTS | ENGINEERING CALCULATION CALCULATION NO. 872

VALVE
COMPONENT
PARAMETER

DRAWING NO.
PART NO.

The weight of the new pilot is 10.2 lb., slightly greater than for the old pilot, 7.9 lb. Also, the CG of the new pilot design is located further from the hold-down bolts. Therefore, there is an increase in force and moment reactions with the new design. Loading such as seismic accelerations would further increase these reaction differences. The increased loading on the four bolt hold-down pattern, due to the design change, is conservatively demonstrated for a seismic loading of 4.5g:

Pilot Design	Distance from CG to Bolt Pattern Center	X	Weight of Pilot	=	Moment Due to 1g. Loading
Old	1.3125 in.		7.9 lb.		10.4 in.-lb.
New	2.5 in.		10.2 lb.		25.5 in.-lb.

The difference in moment loading due to a 4.5g seismic acceleration is:

$$\Delta M = \frac{4.5\ (25.5 - 10.4)}{12}$$

$$\Delta M = 5.7 \text{ ft-lb}$$

In addition, the force loading is increased:

$$\Delta F = 4.5\ (10.2 - 7.9)$$

$$\Delta F = 10.4 \text{ lb.}$$

Both the 5.7 ft.-lb. moment and the 10.4 lb. force differences are reacted by the four bolt hold-down pattern. Because of the low magnitude of these load increases, it is concluded that the new pilot design results in insignificant load changes on the hold-down bolts and relief valve.

ENGINEER RONALD J. TOMANSKI DATE 3/1/82 CHECKED SB DATE 3/15/82

SHEET 1 OF 2

CROSBY

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

REVISION NUMBER	DATE	REASON FOR REVISION	CUSTOMER APPROVAL
-0	3-3-82		
-1	5-3-82	Changed Drawing Number	

EC-872	1
PROCEDURE NO.	REV.
SHEET 2 OF 2	

CROSBY

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

STRESS ANALYSIS
REVIEW AND/OR APPROVAL RECORD

CALCULATION NO. 872 REV NO. 1

FOR CROSBY PREPARED ANALYSIS:

PREPARED BY Ronald J. Pomawski DATE 5/3/82

CHECKED BY Stephen Gonyaw DATE 5/5/82

REVIEWED BY [signature] DATE 5/6/82
(Cognizant Engineer)

FOR CONSULTANT PREPARED ANALYSIS:

APPROVED BY _____ DATE _____
(Stress Analyst)

APPROVED BY _____ DATE _____
(Cognizant Engineer)

CROSBY

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

STRESS ANALYSIS
REVIEW AND/OR APPROVAL RECORD

CALCULATION NO. EC-872 REV NO. 0

FOR CROSBY PREPARED ANALYSIS:

PREPARED BY Ronald J. Pomarski DATE 3/3/82

CHECKED BY Stephen Sawyer DATE 3/15/82

REVIEWED BY [signature] DATE 5/6/82
(Cognizant Engineer)

FOR CONSULTANT PREPARED ANALYSIS:

APPROVED BY _____ DATE _____
(Stress Analyst)

APPROVED BY _____ DATE _____
(Cognizant Engineer)

STRESS ANALYSIS
REVIEW AND/OR APPROVAL RECORD

CALCULATION NO. EC-900 REV NO. 0

FOR CROSBY PREPARED ANALYSIS:

PREPARED BY Ronald J Tomaszki DATE 5/26/82

CHECKED BY [signature] DATE 5/26/82

REVIEWED BY [signature] DATE 5/26/82
(Cognizant Engineer)

FOR CONSULTANT PREPARED ANALYSIS:

APPROVED BY _____ DATE _____
(Stress Analyst)

APPROVED BY _____ DATE _____
(Cognizant Engineer)

CROSBY | CROSBY VALVE & GAGE COMPANY WRENTHAM, MASSACHUSETTS | ENGINEERING CALCULATION CALCULATION NO.

VALVE IMF-2 PILOT

COMPONENT

PARAMETER

DRAWING NO.

PART NO.

EC-900

MAY 26, 1982

POTENTIAL SEISMIC BINDING INVESTIGATION OF THE IMF-2 PILOT VALVE FOR CROSBY ENVIRONMENTAL TEST REPORT NUMBER 3977

CROSBY P.O. # N94270-093

ENGINEER _____ DATE _____ CHECKED _____ DATE _____

CROSBY | CROSBY VALVE & GAGE COMPANY, WRENTHAM, MASSACHUSETTS | ENGINEERING CALCULATION, CALCULATION NO.

VALVE [illegible] PILOT

COMPONENT PLUNGER/PLUNGER SLEEVE

PARAMETER POTENTIAL SEISMIC BINDING

DRAWING NO.

PART NO.

INTRODUCTION

THE PURPOSE OF THIS REPORT IS TO VERIFY THAT THERE IS NO POTENTIAL FOR BINDING BETWEEN THE PLUNGER AND PLUNGER SLEEVE DUE TO SEISMIC LOADING.

USING VERY CONSERVATIVE ASSUMPTIONS, THE MAXIMUM POSSIBLE SEISMIC DEFLECTION IS COMPARED TO THE MINIMUM CLEARANCE BETWEEN THE PARTS.

ENGINEER [illegible] DATE 5/21/82 CHECKED [illegible] DATE 5/26/82

CROSBY | CROSBY VALVE & GAGE COMPANY, WRENTHAM, MASSACHUSETTS | ENGINEERING CALCULATION, CALCULATION NO. [illegible]

VALVE [illegible]
COMPONENT PLUNGER/PLUNGER SLEEVE
PARAMETER POTENTIAL SEISMIC BINDING

DRAWING NO.
PART NO.

THE TOTAL HEIGHT OF THE BODY CAVITY IS 2.9 INCHES, FROM WHERE THE PLUNGER SLEEVE IS SCREWED INTO THE BODY TO THE START OF THE BODY CAVITY (WHERE THE NUT CONTACTS THE NUT O-RING). THE PLUNGER COULD POTENTIALLY BIND WITH THE PLUNGER SLEEVE AT LESS THAN 1/3 THIS HEIGHT. HOWEVER, AS A CONSERVATIVE ASSUMPTION, THE DEFLECTION AT THE END OF A CANTILEVER BEAM 2.9 INCHES LONG WITH THE MINIMUM CROSS-SECTIONAL PROPERTIES OF THE PLUNGER SLEEVE WILL BE CONSIDERED TO BE THE MAXIMUM POSSIBLE SEISMIC DEFLECTION. AN ADDITIONAL CONSERVATISM IS THAT NO STRUCTURAL STIFFNESS IS CONSIDERED FOR THE YOKE ASSEMBLY, WHICH IS MUCH STIFFER THAN THE ASSUMED PLUNGER SLEEVE SECTION.

THE MAXIMUM SEISMIC ACCELERATION IS 16 g. THE WEIGHT OF THE PLUNGER PLUS YOKE ASSEMBLIES IS 1.5 LB. THE MINIMUM ALLOWABLE CLEARANCE BETWEEN THE PLUNGER AND PLUNGER SLEEVE IS 0.0045 INCH.

$$\delta = \frac{1}{8} \frac{WL^3}{EI}$$

ENGINEER [illegible] DATE [illegible] CHECKED [illegible] DATE [illegible]

CROSBY | CROSBY VALVE & GAGE COMPANY WRENTHAM, MASSACHUSETTS | ENGINEERING CALCULATION CALCULATION NO.

VALVE [illegible]

COMPONENT [illegible]/PLUNGER SLEEVE

PARAMETER POTENTIAL SEISMIC BINDING

DRAWING NO.

PART NO.

$$\delta = \frac{1}{E}\,\frac{(16)(1.5)(2.9)^3}{(26.85\times10^6)(.00277)}$$

WHERE $I = \frac{\pi}{64}(D_o^4 - D_i^4) = \frac{\pi}{64}(.75^4 - .714^4) = .00277\ IN^4$

$$\delta = .00098"$$

$\delta < .0045$ INCH. THEREFORE, THERE IS NO POTENTIAL FOR BINDING BETWEEN THE PLUNGER AND PLUNGER SLEEVE DUE TO THE NOTED SEISMIC LOADINGS.

ENGINEER [illegible] DATE [illegible] CHECKED [illegible] DATE 5/26/82

CROSBY | CROSBY VALVE & GAGE COMPANY, WRENTHAM, MASSACHUSETTS | ENGINEERING CALCULATION, CALCULATION NO.

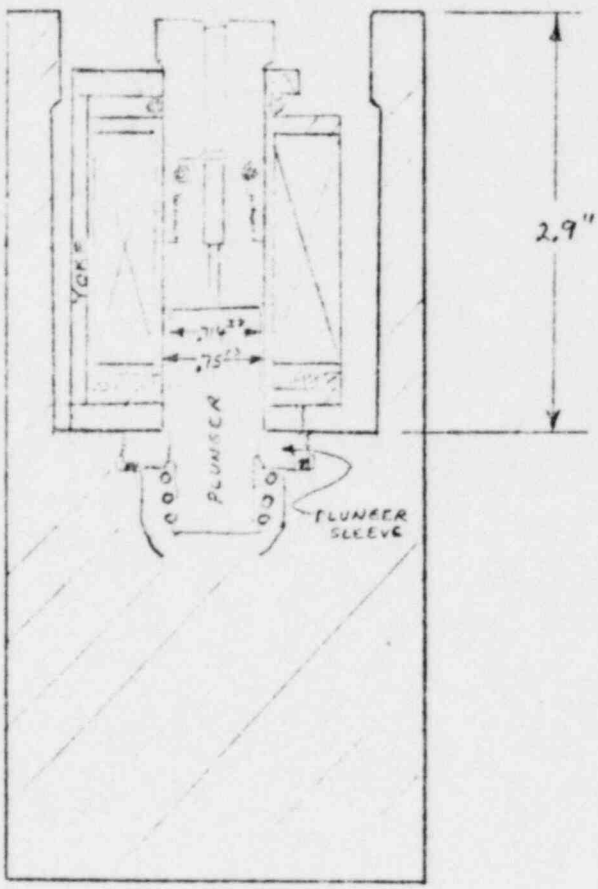
VALVE [illegible]

COMPONENT

PARAMETER

DRAWING NO.

PART NO.



ENGINEER [illegible] DATE [illegible] CHECKED [illegible] DATE [illegible]

CROSBY

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

REVISION NUMBER	DATE	REASON FOR REVISION	CUSTOMER APPROVAL
INITIAL ISSUE	5/26/82		

EE-900	0
PROCEDURE NO.	REV.
SHEET 6 OF 6	

LIST OF DATA ACQUISITION INSTRUMENTS

Instrument:	Gould Brush Recorder 2400
Manufacturer:	Gould Mfg. Inc.
Model Number:	2007-4490-00
Serial Number:	02014
Range:	50mm channel span
Accuracy:	± 0.5% of full scale
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

Instrument:	Fluke Digital Multimeter
Manufacturer:	John Fluke Mfg. Co. Inc.
Model Number:	8000A
Serial Number:	26904 Crosby I.D. Number: 299
Range:	Multi-range
Accuracy:	± 0.3% or better
Date of Calibration:	12/22/81
Calibration Due:	12/23/82

Instrument:	Fluke Digital Multimeter
Manufacturer:	John Fluke Mfg. Co. Inc.
Model Number:	8600A
Serial Number:	0875144
Range:	Multi-range
Accuracy:	± 0.3% or better
Date of Calibration:	1/22/82
Calibration Due:	7/22/82

Instrument:	DC Milliamperes Meter
Manufacturer:	Simpson Electric Co.
Model Number:	1702
Serial Number:	1578
Range:	Multi-range
Accuracy:	½ of 1% full scale in horizontal position
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

Instrument:	Milliamperes Recorder
Manufacturer:	Rustrack Mfg. Co. Inc.
Model Number:	288
Serial Number:	A239237
Range:	0 to 600 ma
Accuracy:	± 2% of full scale
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

Instrument:	Oscillographic Visicorder
Manufacturer:	Honeywell - Heiland Division
Model Number:	1508-R13678HK
Serial Number:	15-564
Range:	4 inch channel span
Accuracy:	± 3% of reading
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

LIST OF DATA ACQUISITION INSTRUMENTS (continued)

Instrument:	Doric Trendicator
Manufacturer:	Applied Measurements Inc.
Model Number:	402A
Serial Number:	106162
Range:	0-1000°F
Accuracy:	± 1°
Date of Calibration:	Prior to each test. Thermalcouple checked
Calibration Due:	against boiling water

Instrument:	Pressure Transducer
Manufacturer:	BLH Electronics
Model Number:	0780-200 Type GP
Serial Number:	96378
Range:	0-200 psig
Accuracy:	0.7% of readout
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

Instrument:	Pressure Transducer
Manufacturer:	BLH Electronics
Model Number:	0780-350 Type GP
Serial Number:	54262
Range:	0-350 psig
Accuracy:	0.7% of readout
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

Instrument:	Dead Weight Tester
Manufacturer:	Ametek - Mansfield and Green Division
Model Number:	TQ-15
Serial Number:	3350
Range:	0-1500 psig
Accuracy:	± 0.1% of output pressure
Date of Calibration:	Mansfield and Green Assembly and Calibration
Calibration Due:	No. M-84826-00-G 8/13/68

Instrument:	Sorensen D.C. Power Supply
Manufacturer:	Raytheon Co.
Model Number:	DCR-300-8A
Serial Number:	656
Range:	0-400 volts dc; 0-10 amperes dc
Accuracy:	0.25% of output voltage
Date of Calibration:	Prior to each test series against a Fluke
Calibration Due:	multimeter

Instrument:	Sorensen D.C. Power Supply
Manufacturer:	Raytheon Co.
Model Number:	DCR-150-3BM22
Serial Number	0445
Range:	0-200 volts dc; 0-5 amperes dc
Accuracy:	0.25% of output voltage
Date of Calibration:	Prior to each test series against a
Calibration Due:	Fluke multimeter

LIST OF DATA ACQUISITION INSTRUMENTS (continued)

Instrument:	Pressure Gage
Manufacturer:	Crosby Valve & Gage Co.
Model Number:	
Serial Number:	383
Range:	0-300 psig
Accuracy:	± 1.5 psig - full scale
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

Instrument:	Pressure Gage
Manufacturer:	Crosby Valve & Gage Co.
Model Number:	
Serial Number:	371
Range:	0-600 psig
Accuracy:	± 3 psig - full scale
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

Instrument:	Pressure Gage
Manufacturer:	Crosby Valve & Gage Co.
Model Number:	
Serial Number:	231
Range:	0-600 psig
Accuracy:	± 3 psig - full scale
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

Instrument:	Pressure Gage
Manufacturer:	Crosby Valve & Gage Co.
Model Number:	
Serial Number:	236
Range:	0-500 psig
Accuracy:	± 2.5 psig - full scale
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

Instrument:	Pressure Gage
Manufacturer:	Crosby Valve & Gage Co.
Model Number:	
Serial Number:	206
Range:	0-500 psig
Accuracy:	± 2.5 psig - full scale
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

Instrument:	Pressure Gage
Manufacturer:	Crosby Valve & Gage Co.
Model Number:	
Serial Number:	374
Range:	0-500 psig
Accuracy:	± 2.5 psig - full scale
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

LIST OF DATA ACQUISITION INSTRUMENTS (continued)

Instrument:	Pressure Gage
Manufacturer:	Crosby Valve & Gage Co.
Model Number:	
Serial Number:	416
Range:	0-500 psig
Accuracy:	± 2.5 psig - full scale
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

Instrument:	Pressure Gage
Manufacturer:	Crosby Valve & Gage Co.
Model Number:	
Serial Number:	388
Range:	0-400 psig
Accuracy:	± 2 psig - full scale
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

Instrument:	Pressure Gage
Manufacturer:	Crosby Valve & Gage Co.
Model Number:	
Serial Number:	384
Range:	0-300 psig
Accuracy:	± 1.5 psig - full scale
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

Instrument:	Type J Thermocouple Calibrator
Manufacturer:	Altek Industries Corp.
Model Number:	Series 22 TC Source
Serial Number:	N/A
Range:	0-500°F
Accuracy:	± 0.1% of span ± 1 degree
Date of Calibration:	3/9/82 against NBS calibrated LN#8686
Calibration Due:	Millivolt potentiometer serial number 1829905

Instrument:	Temperature Recorder
Manufacturer:	Rustrack Mfg. Co. Inc.
Model Number:	
Serial Number:	A254770
Range:	0 to 600°F
Accuracy:	± 2% of full scale
Date of Calibration:	N/A
Calibration Due:	Prior to each test series

ISOMEDIX

March 16, 1982

Mr. W.D. Greenlaw
Crosby Valve and Gage Company
43 Kendrich Street
Wrentham, Mass. 02093

Dear Mr. Greenlaw:

This will summarize parameters pertinent to the irradiation of two (2) IME-2 Pilot Valves, Part No. S66181, as per your Purchase Order #70808.

The specimens were exposed to a Cobalt-60 gamma source for a period of 48 hours at an average dose rate of .66 megarads per hour. The calculated dose based on dosimetry was 31 megarads. Halfway through the exposure, the specimens were rotated 180 degrees to give a more uniform dose distribution.

Dosimetry was performed using Harwell Red 4034 Perspex dosimeters, utilizing a Bausch and Lomb Model 710 spectrophotometer as the readout instrument. This system is calibrated directly with NBS, with the last readout calibration being September 8, 1981. A copy of the dosimetry correlation report is available upon request.

Irradiation was conducted in air at ambient temperature and pressure. Radiant heat from the source heated the samples somewhat, but the temperature did not exceed 130 degrees F, as indicated by previous measurements on an oil solution in the same relative position.

Irradiation was initiated on February 18, 1982 and was completed on February 21, 1982.

Very truly yours,

ISOMEDIX, INC.

David P. Constantine

David P. Constantine

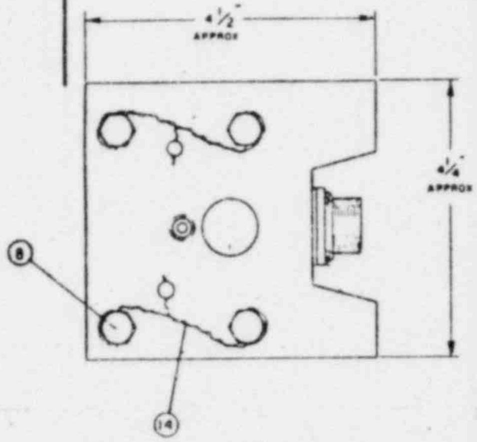
DC/mjb

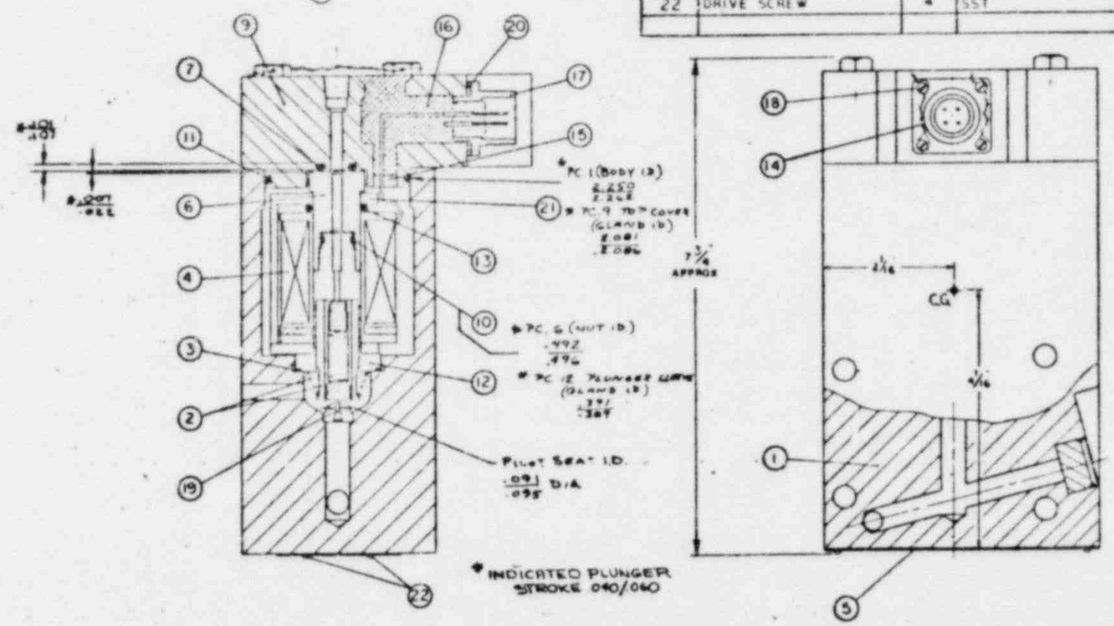
cc: Mr. George Dietz
Mr. Richard Olmsted

REV	DESCRIPTION	BY	CHK	APPROVED
A 4-82	CRCTD CRIT. DIM. ITEM NO 2 MAT'L WAS SST/VITON-N SEATS			
B 5-82	PC NO 17 REMARKS WAS CANNON MS310 2R-14S			

LIST OF MATERIALS

ITEM	DESCRIPTION	QTY	MATERIAL	MATERIAL SPEC	SEE NOTE		REMARKS
1	BODY ASSEMBLY	1	ALUMINUM	6061-T6			ANODIZED
a	BODY	1	"	"			"
b	PLUG	1	"	"			
2	PLUNGER & SPRING ASSY	1	SST/VITON-N/E SEATS				PETER PAUL 73N1-1301
3	GASKET (SLEEVE)	1	VITON-E	E608			SQ O-RING PARKER
4	COIL ASSEMBLY	1	COPPER/PHENOLIC				
5	NAMEPLATE	1	SST	304			
6	NUT	1	LOW CARBON STEEL	AISI C-1215			NICKEL PLATED
7	O-RING (NUT)	1	VITON-E	E608			2-204 PARKER
8	BOLTS	4	SST	18-8			5/16-24 UNF-2A 2" LG
9	TOP COVER	1	ALUM	6061-T6			ANODIZED
10	O-RING (SLEEVE)	1	VITON-E	E608			2-012 PARKER
11	O-RING (TOP COVER)	1	VITON-E	E608			2-137 PARKER
12	PLUNGER SLEEVE	1	SST	330 & 430			PETER PAUL 70-11019
13	O-RING (YOKE SPACER)	1	VITON-E	E608			2-123 PARKER
14	LOCKWIRE	AS REQ	SST	304			Ø 1/32
15	POTTING BARRIER	1	VITON-E	E608			
16	POTTING	AS REQ	STYCAST	TYPE 2850 KT			
17	ELECTRICAL CONNECTOR	1	ALUM ALLOY		1		CANNON CVA2R-14S-2PN
18	CONN. SCREWS	4	SST	18-8			4-40UNC-2A 5/16 LG
19	BODY SEAT	1	SST	316			PETER PAUL 70-28001
20	CONN GASKET	1	VITON-E	E608			
21	YOKE ASSEMBLY	1	CS	C-1018 OR SA-105			CAD PL/CROMATE DIP
22	DRIVE SCREW	4	SST				





PILOT SHOWN ENERGIZED

& CRITICAL DIM'S

NOTES

1) NO. SHOWN IS SHELL STYLE & SIZE ONLY (CONTACT TYPE & ARRANGEMENT NOT SHWN)
2) APPROX WEIGHT 10.2 LBS
3) FIELD REPAIR/REFURBISHMENT NOT RECOMMENDED. CLASS 1E EQUIPMENT SUPPLIED AS ASSEMBLY ONLY

COIL ELECTRICAL CHARACTERISTICS

HOLDING CURRENT - .172 AMPS NOM
IN RUSH CURRENT - .172 AMPS NOM
POWER AT 125 VDC - 22 WATTS NOM
COIL RESISTANCE AT 70°F - 727 OHMS NOM
MAX OPERATING TEMPERATURE - 350°F
LOCA ENVIRONMENT - 340°F MAX.

CROSBY VALVE AND GAGE CO
HOLDING CURRENT .172 AMPS
IN RUSH CURRENT .172 AMPS
POWER AT 125 VDC 22 WATTS

NAMEPLATES

MAX. OPERATING TEMPERATURE 350°F
COIL RESISTANCE AT 70°F 727 OHMS
SERIAL NUMBER 66181-XXX

ASSEMBLY NO 66181

CROSBY — CROSBY VALVE & GAGE CO. WRENTHAM, MASS. 02093

PREPARED BY DML
CHECKED BY
APP'D

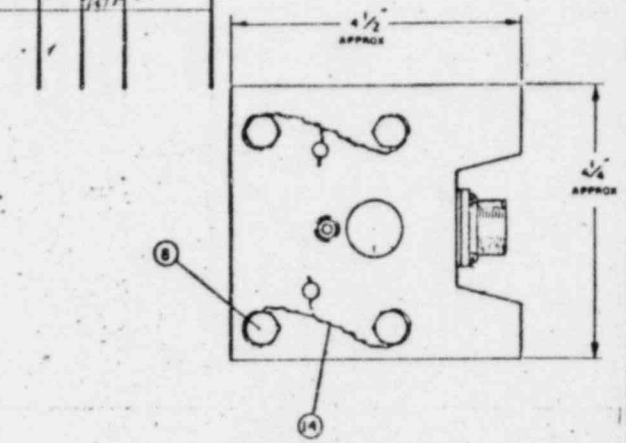
DRAWING TITLE: IMF-2 PILOT VALVE

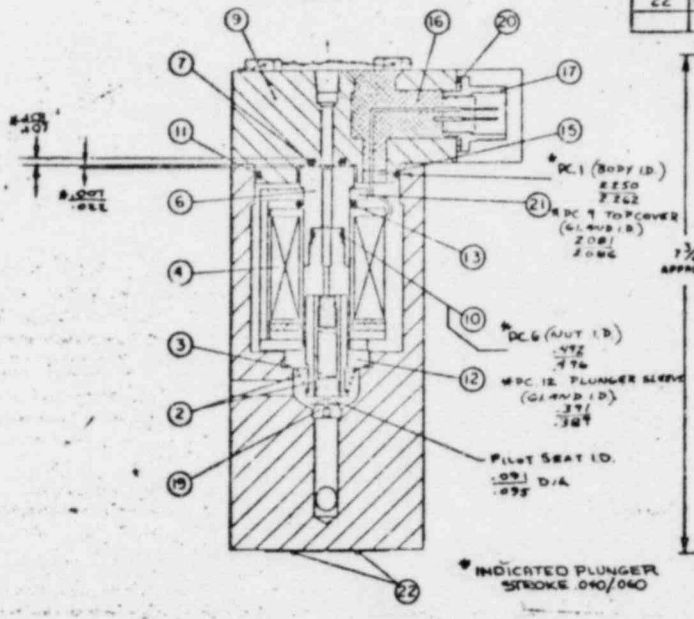
DRAWING NO. DS-C-66181 REV B

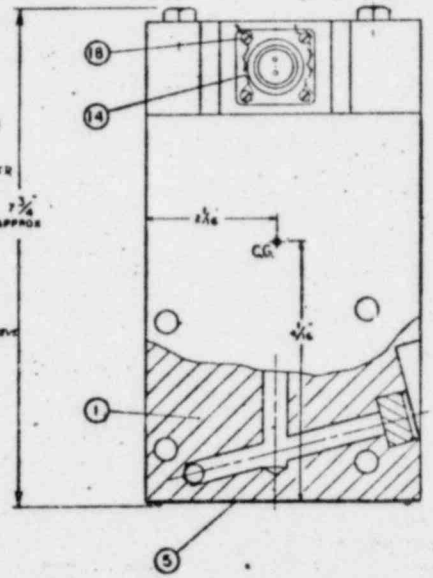
REV	DESCRIPTION	BY	CHK	APPROVED
A 4-82	CRCTD CRIT DIM, ITEM NO 2 MATL WAS SST/VITON N SEATS			
B 5-82	SERIAL NO. WAS 66181			
C 9-82	PC NO 17 REMARKS WAS CANNON MS3102 H-10S			

LIST OF MATERIALS

ITEM	DESCRIPTION	QTY	MATERIAL	MATERIAL SPEC	SEE NOTE		REMARKS
1	BODY ASSEMBLY	1	ALUMINUM	6061-T6			ANODIZED
a	BODY	1	"	"			"
b	PLUG	1	"	"			"
2	PLUNGER & SPRING ASSY	1	SST/VITON N/E SEATS				PETER PAUL 75N1-1501
3	GASKET (SLEEVE)	1	VITON-E	E60B			SQ O RING PARKER
4	COIL ASSEMBLY	1	COPPER/PHENOLIC				
5	NAMEPLATE	1	SST	304			
6	NUT	1	LOW CARBON STEEL	AISI C-1215			NICKEL PLATED
7	O RING (NUT)	1	VITON-E	E60B			2-204 PARKER
8	BOLTS	4	SST	18-8			Fig 24 UNJF-2A .2 LG
9	TOP COVER	1	ALUM	6061-T6			ANODIZED
10	O-RING (SLEEVE)	1	VITON-E	E60B			2-012 PARKER
11	O-RING (TOP COVER)	1	VITON-E	E60B			2-137 PARKER
12	PLUNGER SLEEVE	1	SST	330 & 430			PETER PAUL 70-11019
13	O-RING (YOKE SPACER)	1	VITON-E	E60B			2-123 PARKER
14	LOCKWIRE	AS REQ	SST	304			.032
15	POTTING BARRIER	1	VITON-E	E60B			
16	POTTING	AS REQ	STYCAST	TYPE 2850 KT			
17	ELECTRICAL CONNECTOR	1	ALUM ALLOY		1		CANNON CV-2P-KSK-4PN
18	CONN SCREWS	4	SST	18-8			4-40 UNC-2A 5/16 LG
19	BODY SEAT	1	SST	316			PETER PAUL 70-2a001
20	CONN GASKET	1	VITON-E	E60B			
21	YOKE ASSEMBLY	1	CS	C-1018 OR SA-105			CAD PL/CROMATE DIP
22	DRIVE SCREW	4	SST				







PILOT SHOWN ENERGIZED

* CRITICAL DIM'S.

NOTES

1) NO. SHOWN IS SHELL STYLE & SIZE ONLY (CONTACT TYPE & ARRANGEMENT NOT SHWN)
2) APPROX WEIGHT 10.2 LBS
3) FIELD REPAIR/REFURBISHMENT NOT RECOMMENDED. CLASS 1E EQUIPMENT SUPPLIED AS ASSEMBLY ONLY.

COIL ELECTRICAL CHARACTERISTICS

HOLDING CURRENT = .172 AMPS NOM.
IN RUSH CURRENT = .172 AMPS NOM
POWER AT 125 VDC = 22 WATTS NOM.
COIL RESISTANCE AT 70°F = 727 OHMS NOM.
MAX OPERATING TEMPERATURE = 350°F
LOCA ENVIRONMENT - 340°F MAX.

CROSBY VALVE AND GAGE CO.
HOLDING CURRENT .172 AMPS
IN RUSH CURRENT .172 AMPS
POWER AT 125 VDC 22 WATTS

NAMEPLATES

MAX. OPERATING TEMPERATURE 350°F
COIL RESISTANCE AT 70°F 727 OHMS
SERIAL NUMBER 66274-XXX

PREPARED BY [illegible]
CHECKED BY [illegible]
APPD [illegible]

ASSEMBLY NO. 66274
CROSBY VALVE & GAGE CO. WRENTHAM, MASS. 02093
DRAWING TITLE: IMF-2 PILOT VALVE
DRAWING NO. DS-C-66274
REV C

CROSBY

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS.

ENGINEERING PROCEDURE

TITLE: QUALITY ASSURANCE PLAN

For
The Crosby IMF-2 Solenoid Pilot Valve

APPROVAL W. D. Greenlaw 4/9/82
DIRECTOR OF ENGINEERING DATE
CROSBY VALVE & GAGE COMPANY

	NAME	TITLE	SIGNATURE	DATE
PREPARED BY	D. Olmsted	Assoc. Engr.		April 9, 1982
APPROVED BY	L. Thompson	Princ. Engr.		April 9, 1982
APPROVED BY	J.J. Greene	QA Manager		April 9, 1982
APPROVED BY				

QAP-3325	0
PROCEDURE NO.	REV.

SHEET NO. 1 OF 7

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

1. Scope

1.1 This QAP is the basic document for the control of design, materials, procurement, manufacture and test of all safety-related solenoid pilot valves produced as Crosby Assembly No. S66181. This document shall be in accordance with ANSI/ASME NQA-1 and fulfills the requirements of Section II, Paragraph 2 of NQA-1.

2. References

2.1 G.E. Specification No. 22A6441.

2.2 Crosby DFL No. 3325, Revision No. 0 (attached).

2.3 Crosby Assembly and Test Procedure No. T-16362.

2.4 Crosby Weld Procedure W-13093.

2.5 G.E. Purchase Order No's. 205-AJ985 and 205-AJ986.

2.6 Crosby Data Sheet No. DS-C-66181.

2.7 Crosby Qualification Test Procedure No. T-16361.

2.8 Crosby QA Manual QC-105.

2.9 ANSI/ASME NQA-1-1979, Quality Assurance Program Requirements for Nuclear Power Plants.

3. Quality Assurance Program

3.1 Organization and responsibility for the Quality Assurance Program shall be as delineated in Crosby QC-105, Section 1.

3.2 Design Control

3.2.1 Nominal design parameters shall be established and identified by the Crosby Data Sheet (No. DS-C-66181).

3.2.2 All parts shall have a unique Crosby Part Number and all parts shall have a controlled part specification card.

3.2.3 The assembly shall be a frozen design controlled by Crosby DFL No. 3325, Revision No. 0.

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

3. Quality Assurance Program (Continued)

3.2 Design Control (Continued)

3.2.4 The design shall be verified by successful Type Testing to the Qualification Test Program referenced by G.E. Specification No. 22A6441 and Crosby Qualification Test Procedure No. T-16361.

3.3 Material Control

3.3.1 All material and/or other vendor services shall be purchased to the requirements of the part specification cards and the Quality Assurance/ Quality Control requirements of DFL 3325, Revision No. 0, (attached).

3.3.2 All purchased parts and material shall be inspected to the requirements of the Purchase Order and the part specification card upon receipt.

3.3.3 All parts and material shall be identified by appropriate tags or labels and segregated by Part Number and Purchase Order Number until released to assembly or manufacturing.

3.3.4 The assembly area shall maintain part identification and segregation by part number until the part is put into an assembly.

3.4 Document Control

3.4.1 All part drawings, part specification cards and the data sheet are controlled by the DFL and may not be revised in any manner without a revision to the DFL at the direction of the Principal Engineer. Changes made shall not invalidate the qualification of the design.

3.4.2 All part drawings shall be controlled by the Drafting Supervisor under the requirements of Crosby QC-105, Section V with the additional constraints invoked by this QAP and DFL No. 3325, Revision No. 0.

3.4.3 All part specification cards shall be controlled by the Specification Supervisor under the requirements of Crosby QC-105, Section VI, with the additional constraints invoked by this QAP and DFL No. 3325, Revision No. 0.

3.4.4 Copies of all Purchase Orders, manufacturing route sheets, assembly and test inspection reports and any material rejection notices (MRN's) that apply to parts actually used for production assembly shall be kept on file under the direction of the Cognizant Engineer and/or the QA Manager.

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

4. Manufacturing Control

4.1 All Purchase Orders and manufacturing route sheets shall be initiated at the direction of the Cognizant Engineer or his delegee and shall be prepared in conformance to the requirements of the Quality Assurance/Quality Control requirements attachment to the Design Freeze List.

4.2 Assembly, Test and Inspection

4.2.1 All assembly operations and test requirements are as defined by Crosby Procedure No. T-16362 under the direction of the Cognizant Engineer.

4.2.2 Inspection report requirements are as defined by Crosby Procedure No. T-16362 and QC-105, Section VII under the direction of the QA Manager.

4.2.3 All test data shall be recorded on Crosby Form QC-278 under the surveillance of the QC Department. The QC Inspector shall place his stamp adjacent to any operation, inspection or test which he performs or witnesses.

4.3 Control of Gaging and Measuring Equipment

4.3.1 All standard gages and instruments shall be controlled by QC-105, Section XIII, under the direction of the QA Manager.

4.3.2 Unique or special equipment necessary to meet the production test requirements of T-16362 shall be procured, maintained and used at the direction of the Cognizant Engineer.

4.4 Control of Non-Conformities

4.4.1 Non-conforming materials or parts shall be processed in conformance with QC-105, Section XVI, with the exception to Paragraph 6.6 that the MRB Engineering Division Representative shall be the Cognizant Engineer or his delegee.

4.4.2 Any anomolies that occur during the assembly and test operations shall be reported to the Principal Engineer for disposition and recorded in the test report.

5. Any processes that are not specifically controlled or excluded by this QAP shall be controlled by the applicable sections of Crosby QC-105.

DESIGN FREEZE LIST - QAP 3325

QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS
Attachment to DFL-3325

Description	Part Number	Drawing No.	Rev. No.	Material	Material Certs.	Process Certs./ Data Sheets	Inspections/Tests
Body & Plug Assm.	S-66176	SA-C-66176	0	Aluminum 6061-T6 Anodized	Certificate of Conformance	Plating Certificate of Conformance	100% Dimensional and Aerotatic Shell Test for T-16362
Body	109551	SA-C-66176					
Plug	109552	G-109552	0				
Yoke Assembly	S-66180	SA-E-66180	0	Carbon Steel - Cadmium Plated	Certificate of Conformance	Plating Certificate of Conformance	100% Dimensional
Yoke End Plate	109553	G-109553	0				
Yoke Tube	109572	G-109572	0				
Nut	109554	F-109554	0	C-1215 Nickel Plated	Certificate of Conformance	Plating Certificate of Conformance	100% Dimensional
Top Cover	109555	G-109555	0	Aluminum 6061-T-6 Anodized	Certificate of Conformance	Plating Certificate of Conformance	100% Dimensional
Sleeve Assembly	109557	F-109557	0	Peter Paul Part No. 70-11019	Certificate of Conformance	QC-278	100% Remachined Dimension
Bolts	109559	G-109559	0	18-8 SST	Certificate of Compliance		
Potting Barrier	109560	G-109560	0	Viton E	Certificate of Compliance		
Coil Form Assembly	S-66178	SA-C-66178	0				
Coil Form	109561	F-109561	0	Aluminum 6061-T-6 Anodized	Certificate of Compliance	Plating Certificate of Compliance	100% Dimensional
Kapton Tape ½"	109562	N.D.			Certificate of Conformance		
Kapton Tape 1"	109571	N.D.			Certificate of Conformance		
Kapton Film	109563	G-109563		Dow Corning - RTV-732	Certificate of Conformance		
RTV	109564	N.D.					
Coil Form Spacer	109565	G-109565	0	Glass Filled Silicone			
Coil Assembly	S-66179	SA-C-66178	0			Certificate of Compliance	Resistance Check
Magnet Wire	109566	N.D.		33 AWG Polyimide Insulation	Certificate of Compliance		

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CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

DESIGN FREEZE LIST - QAP 3325

QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS
Attachment to DFL-3325

Description	Part Number	Drawing No.	Rev. No.	Material	Material Certs.	Process Certs./ Data Sheets	Inspections/Tests
Coil Assembly	S-66177	SA-C-66177	0				
Solder	109567	N.D.		60% #18 Gage	Certificate of Compliance		
Kapton Lead Wire	109568	N.D.			Certificate of Compliance		
Stycast	109569	N.D.		Emerson & Cumings 2850 Kt Catalyst 9			
Nameplate	109570	F-109570	0	SST			
O-Ring	109573	N.D.		Viton E	Certificate of Conformance	QC-278	Per T-16362
Plunger & Spring Assembly	106722			Peter Paul Part No. 73NI-1501	Certificate of Compliance	QC-278	Per T-16362
Gasket (Sleeve)	106733			Viton E	Certificate of Conformance	QC-278	Per T-16362
O-Ring (Sleeve)	106729			Viton E	Certificate of Compliance	QC-278	Per T-16362
O-Ring (Top Cover)	106730			Viton E	Certificate of Compliance		
O-Ring (Yoke Spacer)	107273			Viton E	Certificate of Compliance		
Lockwire	102155			SST			
Electrical Connector	107869			Cannon CVA2E-14S-2PW			
Electrical Connector Screws	106740			SST			
Body Seat	106724	C-103797	0	Peter Paul Part No. 70-28001	Certificate of Compliance	QC-278	Per T-16362
Electrical Connector Gasket	107871	C-107871	0	Viton E	Certificate of Conformance		
Drive Screws	19453			SST			

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CROSBY VALVE & GAGE COMPANY
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REVISION NUMBER	DATE	REASON FOR REVISION	CUSTOMER APPROVAL
-0	4/9/82		

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CROSBY

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS.

ENGINEERING PROCEDURE

TITLE: QUALITY ASSURANCE PLAN

For

The Crosby IMF-2 Solenoid Pilot Valve

APPROVAL W. D. Greenlaw 5/13/82

DIRECTOR OF ENGINEERING DATE
CROSBY VALVE & GAGE COMPANY

	NAME	TITLE	SIGNATURE	DATE
PREPARED BY	D. Olmsted	Assoc. Engr.		May 13, 1982
APPROVED BY	L.J. Thompson	Princ. Engr.		May 13, 1982
APPROVED BY	J.J. Greene	QA Manager		May 13, 1982
APPROVED BY				

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CROSBY

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

1. Scope

1.1 This QAP is the basic document for the control of design, materials, procurement, manufacture and test of all safety-related solenoid pilot valves produced as Crosby Assembly No. S66274. This document shall be in accordance with ANSI/ASME NQA-1 and fulfills the requirements of Section II, Paragraph 2 of NQA-1.

2. References

2.1 G.E. Specification No. 22A6441.

2.2 Crosby DFL No. 3328, Revision No. 0 (attached).

2.3 Crosby Assembly and Test Procedure No. T-16362.

2.4 Crosby Weld Procedure W-13093.

2.5 G.E. Purchase Order No's. 205-AJ985 and 205-AJ986.

2.6 Crosby Data Sheet No. DS-C-66274.

2.7 Crosby Qualification Test Procedure No. T-16361.

2.8 Crosby QC Manual QC-105.

2.9 ANSI/ASME NQA-1-1979, Quality Assurance Program Requirements for Nuclear Power Plants.

3. Quality Assurance Program

3.1 Organization and responsibility for the Quality Assurance Program shall be as delineated in Crosby QC-105, Section 1.

3.2 Design Control

3.2.1 Nominal design parameters shall be established and identified by the Crosby Data Sheet (No. DS-C-66274).

3.2.2 All parts shall have a unique Crosby Part Number and all parts shall have a controlled part specification card.

3.2.3 The assembly shall be a frozen design controlled by Crosby DFL No. 3328, Revision No. 0.

CROSBY VALVE & GAGE COMPANY
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3. Quality Assurance Program (Continued)

3.2 Design Control (Continued)

3.2.4 The design shall be verified by successful Type Testing to the Qualification Test Program referenced by G.E. Specification No. 22A6441 and Crosby Qualification Test Procedure No. T-16361.

3.3 Material Control

3.3.1 All material and/or other vendor services shall be purchased to the requirements of the part specification cards and the Quality Assurance/ Quality Control requirements of DFL 3328, Revision No. 0, (attached).

3.3.2 All purchased parts and material shall be inspected to the requirements of the Purchase Order and the part specification card upon receipt.

3.3.3 All parts and material shall be identified by appropriate tags or labels and segregated by Part Number and Purchase Order Number until released to assembly or manufacturing.

3.3.4 The assembly area shall maintain part identification and segregation by part number until the part is put into an assembly.

3.3.5 Materials purchased to the requirements of QAP-3325 acceptable for use in assemblies manufactured to this QAP for all parts that are common to both assemblies (Assembly No's S66181 and S66274).

3.4 Document Control

3.4.1 All part drawings, part specification cards and the data sheet are controlled by the DFL and may not be revised in any manner without a revision to the DFL at the direction of the Principal Engineer. Changes made shall not invalidate the qualification of the design.

3.4.2 All part drawings shall be controlled by the Drafting Supervisor under the requirements of Crosby QC-105, Section V with the additional constraints invoked by this QAP and DFL No. 3328, Revision No. 0.

3.4.3 All part specification cards shall be controlled by the Specification Supervisor under the requirements of Crosby QC-105, Section VI, with the additional constraints invoked by this QAP and DFL No. 3328, Revision No. 0.

3.4.4 Copies of all Purchase Orders, manufacturing route sheets, assembly and test inspection reports and any material rejection notices (MRN's) that apply to parts actually used for production assembly shall be kept on file under the direction of the Cognizant Engineer and/or the QA Manager.

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4. Manufacturing Control

4.1 All Purchase Orders and manufacturing route sheets shall be initiated at the direction of the Cognizant Engineer or his delegee and shall be prepared in conformance to the requirements of the Quality Assurance/Quality Control requirements attachment to the Design Freeze List.

4.2 Assembly, Test and Inspection

4.2.1 All assembly operations and test requirements are as defined by Crosby Procedure No. T-16362 under the direction of the Cognizant Engineer.

4.2.2 Inspection report requirements are as defined by Crosby Procedure No., T-16362 and QC-105, Section VII under the direction of the QA Manager.

4.2.3 All test data shall be recorded on Crosby Form QC-278 under the surveillance of the QC Department. The QC Inspector shall place his stamp adjacent to any operation, inspection or test which he performs or witnesses.

4.3 Control of Gaging and Measuring Equipment

4.3.1 All standard gages and instruments shall be controlled by QC-105, Section XIII, under the direction of the QA Manager.

4.3.2 Unique or special equipment necessary to meet the production test requirements of T-16362 shall be procured, maintained and used at the direction of the Cognizant Engineer.

4.4 Control of Non-Conformities

4.4.1 Non-conforming materials or parts shall be processed in conformance with QC-105, Section XVI, with the exception to Paragraph 6.6 that the MRB Engineering Division Representative shall be the Cognizant Engineer or his delegee.

4.4.2 Any anomolies that occur during the assembly and test operations shall be reported to the Principal Engineer for disposition and recorded in the test report.

5. Any processes that are not specifically controlled or excluded by this QAP shall be controlled by the applicable sections of Crosby QC-105.

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

DESIGN FREEZE LIST - QAP 3328

QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS
Attachment to DFL-3328

Description	Part Number	Drawing No	Revision No.	Material	Material Certs.	Process Certifications/ Data Sheets	Inspection Tests
Body & Plug Assembly	S-66176	SA-C-66176	0	Aluminum 6061-T6 Anodized	Certificate of Conformance	Plating Certificate of Conformance	100% Dimensional and Aerotatic Shell Test for T-16362
Body	109551	SA-C-66176	0				
Plug	109552	C-109552	0				
Yoke Assembly	S-66180	SA-E-66180	0	Carbon Steel - Cadmium Plated	Certificate of Conformance	Plating Certificate of Conformance	100% Dimensional
Yoke End Plate	109553	C-109553	0				
Yoke Tube	109572	C-109572	0				
Nut	109554	F-109554	0	C-1215 Nickel Plated	Certificate of Conformance	Plating Certificate of Conformance	100% Dimensional
Top Cover	106392	C-106392	0	Aluminum 66061-T6 Anodized	Certificate of Conformance	Plating Certificate of Conformance	100% Dimensional
Sleeve Assembly	109557	F-109557	0	Peter Paul Part No. 70-11019	Certificate of Conformance	QC-278	100% Remachined Dimension
Bolts	109559	C-109559	0	18-8 SST	Certificate of Conformance		
Potting Barrier	109560	C-109560	0	Viton E	Certificate of Compliance		
Coil Form Assembly	S-66178	SA-C-66178	0				
Coil Form	109561	F-109561	0	Aluminum 66061-T6 Anodized	Certificate of Compliance	Plating Certificate of Compliance	100% Dimensional
Kapton Tape ½"	109562	N.D.			Certificate of Conformance		
Kapton Tape 1"	109571	N.D.			Certificate of Conformance		
Kapton Film	109563	C-109563	0		Certificate of Conformance		
RTV	109564	N.D.		Dow Corning - RTV-732 Glass Filled Silicone			
Coil Form Spacer	109565	C-109565	0				
Coil Assembly	S-66179	SA-C-66178	0			Certificate of Compliance	Resistance Check
Magnet Wire	109566	N.D.		33 AWG Polyimide Insulation	Certificate of Compliance		

CROSBY VALVE & GAGE COMPANY
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DESIGN FREEZE LIST - QAP 3328

QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS
Attachment to DFL-3328

Description	Part Number	Drawing No	Revision No.	Material	Material Certs.	Process Certifications/ Data Sheets	Inspection Tests
Coil Assembly	S-66177	SA-C-66178	0				
Solder	109567	N.D.		KMS #18 Cage	Certificate of Compliance		
Kapton Lead Wires	109568	N.D.			Certificate of Compliance		
Stycast	109569	N.D.		Emerson & Cumminge 2850 Kt Catalyst 9			
Nameplate	109570	P-109570	0	SST			
O-Ring	109573	N.D.		Viton E	Certificate of Conformance	QC-278	Per T-16362
Plunger & Spring Assembly	106722			Peter Paul Part No. 73NI-1501	Certificate of Compliance	QC-278	Per T-16362
Gasket (Sleeve)	106733			Viton E	Certificate of Conformance	QC-278	Per T-16362
O-Ring (Sleeve)	106729			Viton E	Certificate of Compliance	QC-278	Per T-16362
O-Ring (Top Cover)	106730			Viton E	Certificate of Compliance		
O-Ring (Yoke Spacer)	107273			Viton E	Certificate of Compliance		
Lockwire	102155			SST			
Electrical Connector	106738			Cannon CVA-2E-10SL-4PN			
Electrical Connector Screws	106740			SST			
Body Seat	106724	G-103797	0	Peter Paul Part No. 70-28001	Certificate of Compliance	QC-278	Per T-16362
Electrical Connector Gasket	106741	G-106741	0	Viton E	Certificate of Conformance		
Drive Screws	19453			SST			

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REVISION NUMBER	DATE	REASON FOR REVISION	CUSTOMER APPROVAL
-0 RWO 5/27/82	5/13/82		
-1 i.h. 5/27/82 RWO 5/27/82 G/WDP 5/27/82	5/27/82	Part Number Corrections	

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CROSBY

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS.

ENGINEERING PROCEDURE

TITLE: TEST PROCEDURE

FOR THE
PRODUCTION ASSEMBLY AND TESTING OF THE
CROSBY IMF SOLENOID VALVE PILOT ASSEMBLY

APPROVAL W. D. Greenlaw 2/3/82
W. D. Greenlaw
DIRECTOR OF ENGINEERING DATE
CROSBY VALVE & GAGE COMPANY

	NAME	TITLE	SIGNATURE	DATE
PREPARED BY	M. Brunelli	Engr. Tech.	M. Brunelli	February 3, 1982
APPROVED BY	S. Gonyaw	Sr. Proj. Eng.		February 3, 1982
APPROVED BY	L. Thompson	Prin. Engineer		February 3, 1982
APPROVED BY	J. J. Greene	QA Manager		February 3, 1982

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CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

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CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

1. Scope

1.1 This test procedure implements the production assembly and testing of the model IMF solenoid valve pilot assembly for the 8xRx10 HB-DF and 6xRx10 HB-BP dual function safety relief valves.

2. Reference Documents

2.1 Crosby Procedure No. MPP-4400.

2.2 Crosby Data Sheet DS-C-66181. -2

2.3 Crosby QAP No. 3325. -2

2.4 Crosby Procedure No. T-16361. -2

3. Quality Assurance Requirements

3.1 Crosby Quality Assurance surveillance shall be equivalent to that described in Crosby Procedure MPP-4400.

3.2 All test data shall be recorded on Crosby Form QC-278 under the surveillance of the QC Department. The QC Inspector shall place his stamp adjacent to any operation, inspection or test which he performs or witnesses. -2

3.3 A Product Certification shall be provided to the customer with each pilot assembly.

3.4 All parts shall be inspected and critical dimensions verified and recorded prior to assembly.

4. Cleaning -2

4.1 All metallic parts shall be cleaned thoroughly using an ultrasonic cleaner prior to, and upon completion of any machining, welding, anodizing or plating operations.

4.2 All non-metallic parts shall be cleaned using alcohol.

5. Preassembly Shell Test

5.1 All pilot housings must be aerostatic shell tested after plug welding and befor anodizing.

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5. Preassembly Shell Test (Continued)

5.1 (Continued)

5.1.1 Housings shall be mounted to a suitable adaptor plate and the cap opening closed with a suitable blank.

5.1.2 Pressurize the housing to 313 psig air/N2 and immerse in demineralized water. No visible leakage is permitted.

5.1.3 Stamp each housing above the weld with an 1/8" letter "A" after successfully aerostatic testing.

5.1.4 The pilot housings shall be stored in protective pallets until anodized.

6. Preassembly Inspection

6.1 Prior to the assembly of each pilot, the body seat dimension is to be calculated as shown in Figures 1-A through 1-D of Table 2 and described in Table 3. The body seat (Figure 1-E, of Table 2) is to be machined to dimension prior to staking.

6.2 Each pilot plunger, sleeve and spring assembly shall be tested by depressing and rotating the plunger every 90° to verify that it is free from binding prior to assembly. Verification that results comply shall be noted on Crosby Form QC-278.

6.3 Measure coil resistance and ambient temperature and record on Crosby Form QC-278. Note: Coil resistance: 727 ± 10% ohms at 70°F. -2

6.4 Do not assemble pilot until all Quality Assurance paperwork is complete.

7. Pilot Assembly

Note: The following parenthetical part numbers refer to Crosby Data Sheet, DS-C-66181. -2

7.1 Press body seat (19) into pilot body (1) with staking punch (T-61539A-2). Measure seat height as shown in Figures 1-A and 1-F of Table 2 and described in Table 3. Record seat height on Crosby Form QC-278. Crimp with seat crimping punch (T-61539A-3). Note: Use nut adapter (T-61539A-1) with staking and crimping punches.

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7. Pilot Assembly (Continued)

7.2 Lubricate "O" Ring (10) lightly (Super-O-Lube) and place onto sleeve assembly (12).

7.3 Lubricate seal (3) lightly (Super-O-Lube) and place in pilot housing. Slide plunger and spring assembly (2) into sleeve assembly. Check for freedom of movement.

7.4 Lubricate sleeve assembly threads (Neolube). Screw sleeve assembly into pilot housing with pin wrench (T-16359A-4) and nut adaptor (T-16359A-1) taking care not to crimp sleeve. Torque to 120 in.-lbs.

7.5 Sleeve to Pilot and Plunger to Seat Seals Leak Test

Upon completion of the sleeve assembly installation the semi-assembled pilot shall be mounted to test fixture (T-4567) and subjected to a leakage test of the plunger seat and sleeve to pilot seals.

7.5.1 Pressurize the seat cavity to 200 ± 2 psig air/N2 for a test duration of five (5) minutes after pressure is reached.

7.5.2 Add demineralized water to the pilot chamber around the sleeve assembly and a small amount to the pilot vent hole. When pressure is reached and stabilized, isolate the pilot assembly from the supply volume for the duration of the test.

7.5.2.1 There shall be no drop in pressure as determined by a gage attached to the test fixture or any visible leakage around the sleeve assembly joint and the pilot vent hold for the duration of the test. Record results on Crosby Form QC-278.

7.6 Insert coil assembly (4) and "O" ring (13) into yoke assembly (21).

7.7 Insert coil and yoke assembly into pilot housing taking care not to damage coil and lead wires. -2

7.8 Install nut (6) onto sleeve assembly and torque to 120 in.-lbs. Lubricate nut threads (Neolube). -2

7.9 Sleeve Assembly to Pilot Body Seal Verification Test

Each semi-assembled pilot assembly shall be mounted to a test fixture (T-1234) and isolated from the supply volume and subjected to a leakage test of the sleeve assembly to pilot body joint.

CROSBY VALVE & GAGE COMPANY
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7. Pilot Assembly (Continued)

7.9 Sleeve Assembly to Pilot Body Seal Verification Test (Continued)

7.9.1 Energize the coil with 105 vdc and pressurize the seat cavity. The test pressure shall be 200 ± 2 psig air/N2 and the test duration shall be five (5) minutes after pressure is reached. -2

7.9.2 When pressure is reached and stabilized, isolate the pilot assembly from the supply volume for the duration of the test.

7.9.2.1 Acceptance Criteria

There shall be no drop in the pilot cavity pressure for the duration of the test as determined by a gage attached to the test fixture. Record results on Crosby Form QC-278.

7.10 Lubricate "O" Rings (7) and (11) lightly (Super-O-Lube) and install onto top cover (9).

7.11 Cut coil lead wires at a length of 3-3/16" from the coil form top surface. Insert potting barrier (15) onto lead wires. Strip lead wire insulation for approximately 1/8". Crimp on connector contacts using the Cannon Crimping Tool (No. M22520/1-01). Note: Care must be taken not to damage lead wires.

7.12 Install top cover into pilot body. Note: Care must be taken when installing top cover not to dislodge "O" ring (7) and not to damage lead wires when feeding through top cover.

7.13 Locate potting barrier in proper location. Install four (4) mounting screws (8) and torque to 120 in.-lbs. Lubricate threads lightly (Never-Seez). -2

7.14 Top Cover and Nut Seal Verification Test

Upon completion of the top cover installation the pilot assembly must be mounted with suitable adaptors at the potting cavity, the connector face and the pilot vent hole and subjected to a leakage test of the top cover and nut seals.

7.14.1 Pressurize the pilot assembly through the potting cavity to 50 ± 2 psig air/N2 for a test duration of five (5) minutes after pressure is reached.

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7. Pilot Assembly (Continued)

7.14 Top Cover and Nut Seal Verification Test (Continued)

7.14.1 (Continued)

7.14.1.1 Acceptance Criteria -3

There shall be no visible leakage through the top cover to pilot body interface or the pilot vent hole as determined by a liquid leak detector spray. Record results on Crosby Form QC-278.

7.15 Install the two (2) solenoid data plates (5) with four (4) drive screws (22). Note: Pilot assembly Serial Number, 66181-XXX.

7.16 The pilot assembly is to be placed in a protective bin until tested.

8. Preconnector Potting Test

Each pilot assembly prior to potting shall be mounted to a test block and subjected to a system leakage and an electrical characteristic test.

8.1 System Leakage Test

Each pilot assembly shall be mounted to a test block and subjected to a system leakage test in both the fully opened and fully closed positions. The test pressure shall be 200 ± 2 psig air/N2 for each position. The test duration shall be ten (10) minutes in each position after pressure is reached.

8.1.1 Acceptance Criteria

There shall be no visible leakage through the pilot vent, connector port or pilot to cover interface as determined a liquid leak detector spray. Record results on Crosby Form QC-278.

8.2 Electrical Characteristic Test

Upon completion of the system leakage test, all pilot assemblies shall be mounted to a static stand test block and subjected to an electrical characteristic test.

8.2.1 Check coil resistance and ambient temperature. Record coil resistance and temperature on Crosby Form QC-278.

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8. Preconnector Potting Tests (Continued)

8.2 Electrical Characteristic Test (Continued)

8.2.2 The minimum pick up voltage and current, and the maximum drop out voltage and current with no pressure applied to the pilot assembly shall be measured. The ambient temperature, minimum pick up and maximum drop out voltages and currents shall be recorded on Crosby Form QC-278. Note: Maximum pick up voltage: 80 volts dc.

8.2.3 The minimum pick up voltage and current and the maximum drop out voltage and current tests shall be repeated with the pilot assembly pressurized with air/N2 at 90 ± 2 psig. Record the ambient temperature, minimum pick up and maximum drop out voltages and currents shall be recorded on Crosby Form QC-278. Note: Maximum pick up voltage: 70 volts dc.

9. Connector Potting

Upon completion of the pretesting, all pilot assemblies shall have the connector to top cover interface potted.

9.1 Install gasket (20) over connector (17) body. Insert contacts into connector body, slots "A" and "B", until they lock. Install remaining two (2) contact pins into slots "C" and "D". Roll lead wires into the lead hole taking care not to damage the lead insulation. Install the connector to top cover with the four (4) mounting screws (18). Lubricate threads lightly (Never-Seez). Note: When Inserting Connector, Care Must Be Taken To Feed Lead Wire Into Top Cover.

9.2 Check for continuity, coil resistance and shorts through the connector terminals. Note: Coil resistance: 727 ± 10% ohms.

9.3 The mixing of Stycast 2850 Kt and Catalyst 9 shall be performed for each pilot assembly as follows. Note: All mixing and measuring must be performed using glass or stainless steel equipment.

9.3.1 Preheat in oven the Stycast 2850 Kt, Catalyst 9 and the pilot assembly at 150°F for one (1) hour.

9.3.2 For each pilot assembly add and thoroughly blend 1.7 grams of Catalyst 9 for each 100 grams of Stycast 2850 Kt.

9.3.3 Pour mixed epoxy with pilot assembly to cover until potting cavity is full and lead wires are covered. Note: Pot life is thirty (30) minutes.

9.3.4 After pouring, clean any splattered potting from housing.

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9. Connector Potting (Continued)

9.3 (Continued)

9.3.5 Place potted pilot assembly in oven at 150°F for two (2) hours for curing.

9.3.6 Upon completion of curing allow pilot assembly to cool slowly to room temperature before proceeding with any testing.

9.4 Upon completion of the potting operation and pilot assembly has cooled to room temperature, check for continuity, coil resistance and shorts through the connector terminals. Record coil resistance and ambient temperature on Crosby Form QC-278. Note: The pilot assembly is to be placed in a protective bin until tested.

10. Test Procedure

10.1 System Leakage Test

Each pilot assembly shall be mounted to a test block and subjected to a system leakage test in both the fully opened and fully closed positions. The test pressure shall be 200 ± 2 psig air/N2 for each position. The test duration shall be ten (10) minutes in each position after pressure is reached.

10.1.1 Acceptance Criteria

There shall be no visible leakage through the pilot vent, connector or pilot to cover interface as determined by a liquid leak detector spray. Record results on Crosby Form QC-278.

10.2 Electrical Characteristic Test

Upon completion of the system leakage test, all pilot assemblies shall be mounted to a static stand test block and subjected to an electrical characteristic test.

10.2.1 Check coil resistance and ambient temperature. Record coil resistance and temperature on Crosby QC-278.

10.2.2 The minimum pick up voltage and current, and the maximum drop out voltage and current with no pressure applied to the pilot assembly shall be measured. The ambient temperature, minimum pick up and maximum drop out voltage and currents shall be recorded on Crosby Form QC-278. Note: Maximum pick up voltage: 80 volts dc. -2

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WRENTHAM, MASS

10. Test Procedure (Continued)

10.2 Electrical Characteristic Test (Continued)

10.2.3 The minimum pick up voltage and current and the maximum drop out voltage and current tests shall be repeated with the pilot assembly pressurized with air/N2 at 90 ± 2 psig. Record the ambient temperature. Minimum pick up and maximum drop out voltages and currents shall be recorded on Crosby Form QC-278. Note: Maximum pick up voltage: 70 volts dc. -2

10.3 Operability Test

The pilot assembly shall be mounted to a test SRV actuator in sets of three (3) and the SRV actuator shall be subjected to a seventy (70) cycle operability test against a simulated safety relief valve load of 250 psi and the disc insert. The supply pressure shall be 150 ± 5 psig from a ten (10) gallon accumulator and solenoid supply voltage shall be 103 to 105 volts dc. The SRV actuator shall be cycled by energizing the pilots as tabulated below:

	No. of Cycles
Furthest Pilot Assembly	20
Middle Pilot Assembly	20
Closest Pilot Assembly	20
All Pilot Assemblies	10

10.3.1 Acceptance Criteria

10.3.1.1 The elapsed time between initiation of the signal to the solenoid valve assembly and the start of load simulator motion shall not exceed 0.100 seconds. Measure opening response time for the first and last cycle for each pilot individually and all pilot assemblies together. Record the maximum and minimum response time for each on Crosby Form QC-278.

10.3.1.2 The elapsed time between switch-out and the signal to the solenoid valve and the start of load simulator motion shall not exceed 0.900 seconds. Measure closing time for the first and last cycle for each pilot individually and all pilot assemblies together. Record the maximum and minimum response time for each on Crosby Form QC-278.

10.3.1.3 No maintenance of the pilot assembly shall be permitted during the operability test. If maintenance is required, retest of the pilot assembly will also be required.

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10. Test Procedure (Continued)

10.4 Each pilot assembly shall be subjected to a system leakage test in the fully opened and fully closed position as per Paragraph 10.1 above. The test pressure shall be 200 ± 2 psig air/N2 for each position. The test duration shall be ten (10) minutes in each position after pressure is reached. -2

11. Packaging and Shipping

11.1 Upon completion of all testing, the four (4) connector mounting screws (18) and the four (4) top cover mounting screws (8) shall be lock wired.

11.2 Upon test review, acceptance, and sign off of test forms by Crosby Engineering, the pilot assembly shall be securely packaged and shipped to the designated customers. Note: Care must be taken to protect the pilot assembly electrical connectors. -2

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WRENTHAM, MASS

FLOW CHART

TABLE 1

Preassembly Shell Test

Pilot Anodizing

Preassembly Inspection

Pilot Assembly and Seal Verification Tests

System Leakage Test

Electrical Characteristic Test

Connector/Top Cover Potting

System Leakage Test

Electrical Characteristic Test

Operability Test

Package and Ship

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WRENTHAM, MASS

TABLE 2

Measurements of Body Seat Dimension and Minimum Plunger Travel

Body Assembly (S66176)

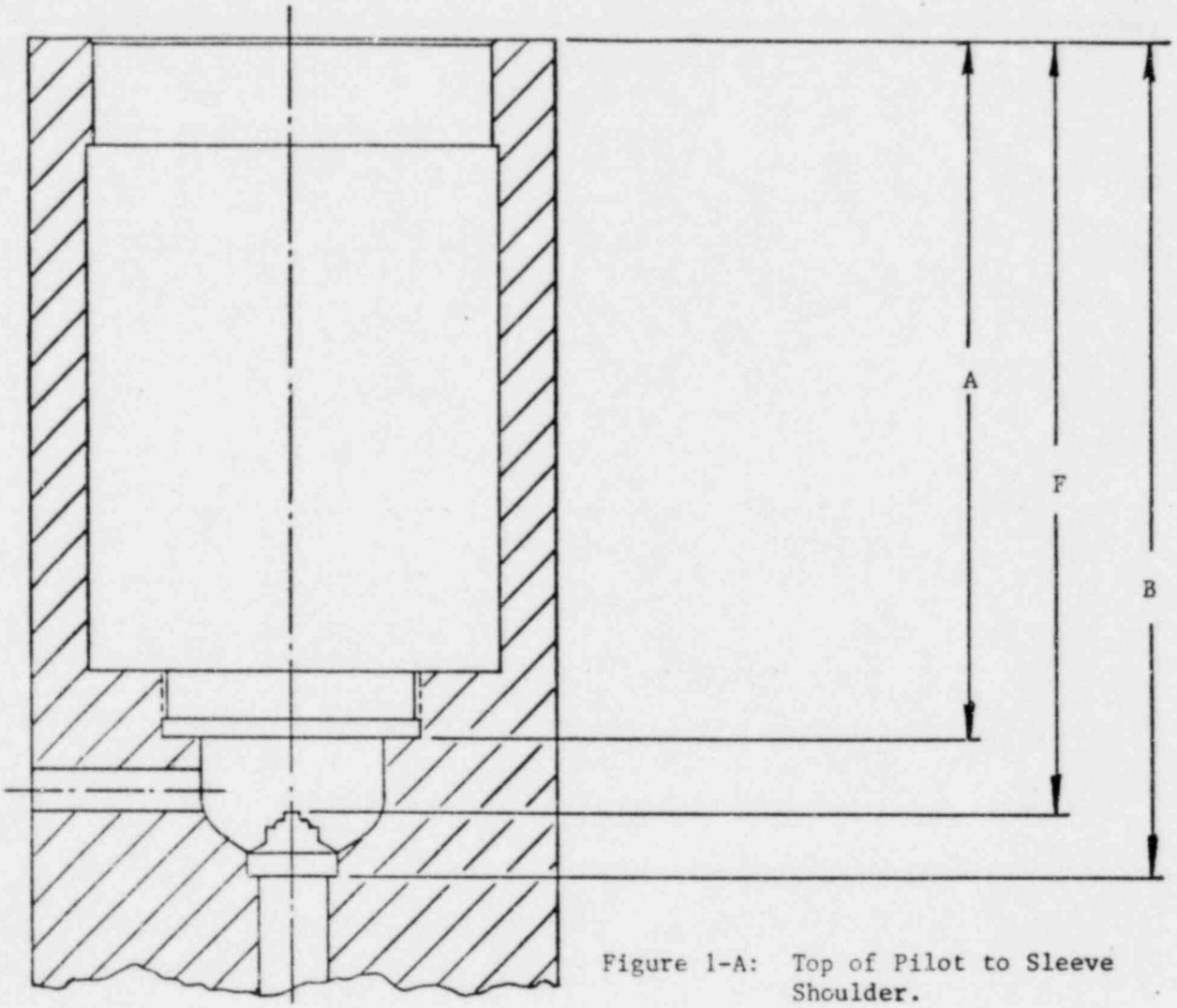

Figure 1-A: Top of Pilot to Sleeve Shoulder.

Figure 1-B: Top of Pilot to Bottom Seat Plane.

Figure 1-F: Top of Pilot to Top of Body Seat.

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TABLE 2

Plunger and Spring Assembly (106733)

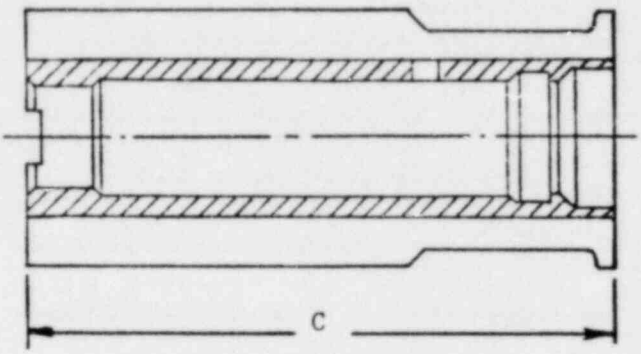

Figure 1-C: Plunger Length

Plunger Sleeve (109557)

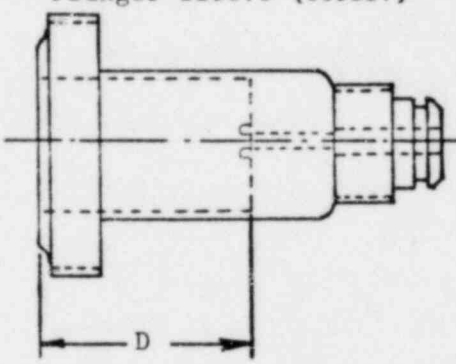

Figure 1-D: Sleeve Shoulder to Sleeve Backface.

Body Seat (106724)

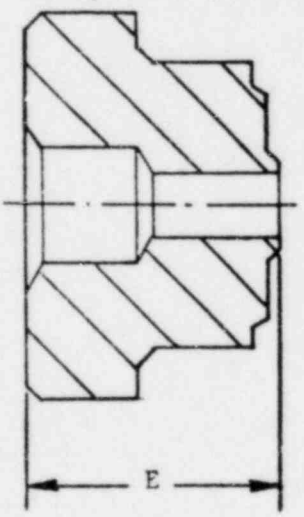

Figure 1-E: Body Seat Dimension.

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WRENTHAM, MASS

QC-279

TABLE 3

Body Seat Dimension and Plunger Travel Calculation

Pilot Assembly Serial Number: _____

A = _____ (Top of pilot to sleeve shoulder; Figure 1-A)

B = _____ (Top of pilot to bottom seat plane; Figure 1-B)

C = _____ (Plunger length; Figure 1-C)

D = _____ (Sleeve shoulder to sleeve backface; Figure 1-D)

Sc = B-A = _____ (Seat cavity)

Pe = C-D = _____ (Plunger extension)

E = Sc-Pe-.033 = _____ (Body seat dimension = Seat cavity - Plunger extension - .033)

Note: Finish machine body seat to dimension "E" before staking into pilot assembly.

Sh (Calculated) = Sc-E = ____ (Seat height calculated)

Note: Stake body seat into pilot and measure dimension "F".

F = _____ (Top of pilot to top of body seat; Figure 1-F)

Sh (Actual) = F-A = _____ (Seat height actual)

Note: Record seat height on QC Form QC-278.

Pc = Sh-Pe = _____ (Plunger travel = .030 to 035)

Note: Record plunger travel on QC-Form QC-278.

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WRENTHAM, MASS

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TABLE 4

Pilot Valve Assembly and Test Data Sheet

Pilot Assembly Serial Number: _____

Part	Dimension	Inspector Date and Stamp
Body Seat I.D.	.091/.095	
Seat Height		
Plunger Travel	.030/.035	

Plunger and Spring Assembly Non-binding Verification

CROSBY: _____
Signed Date

Coil Resistance: _____ ohms. Temperature: _____ °F

Sleeve to Pilot and Plunger to Seat Seal Leakage Test

Test Pressure (200 ± 2 psig): _____

Test Duration (5 Minutes): _____

Results: _____

CROSBY: _____
Signed Date

ASSEMBLED BY: _____
Signed Date

Q.C. SURVEILLANCE: _____
Signed Date

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TABLE 4 (Continued)

Pilot Assembly Serial Number: _____

Sleeve Assembly to Pilot Body Seal Test

Test Pressure (200 ± 2 psig): _____

Test Duration (5 Minutes): _____

Results: _____

CROSBY: _____
Signed Date

Top Cover and Nut Seal Verification Test -1

Test Pressure (50 ± 2 psig): _____

Test Duration (5 Minutes): _____

Results: _____

CROSBY: _____
Signed Date

Prepotting Tests

System Leakage Test

	Fully Closed	Fully Open
Test Pressure (200 ± 2 psig):	_____	_____
Test Duration (10 Minutes):	_____	_____
Results:	_____	_____

CROSBY: _____
Signed Date

Q.C. SURVEILLANCE: _____
Signed Date

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WRENTHAM, MASS

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TABLE 4 (Continued)

Pilot Assembly Serial Number: _____

Electrical Characteristic Test

Coil Resistance: _____ ohms. Temperature: _____ °F

Minimum Pick Up Voltage (No Pressure Applied): _____ vdc
Minimum Pick Up Current (No Pressure Applied): _____ ma
Maximum Drop Out Voltage (No Pressure Applied): _____ vdc
Maximum Drop Out Current (No Pressure Applied): _____ ma

Minimum Pick Up Voltage (90 psig Applied): _____ vdc
Minimum Pick Up Current (90 psig Applied): _____ ma
Maximum Drop Out Voltage (90 psig Applied): _____ vdc
Maximum Drop Out Current (90 psig Applied): _____ ma

CROSBY: _____
Signed Date

Post Potting Coil Resistance _____ ohms. Temperature: _____ °F

Production Tests

System Leakage Test

	Fully Closed	Fully Open
Test Pressure (200 ± 2 psig):	_____	_____
Test Duration (10 Minutes):	_____	_____
Results:	_____	_____

CROSBY: _____
Signed Date

Q.C. SURVEILLANCE: _____
Signed Date

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TABLE 4 (Continued)

Pilot Assembly Serial Number: _____

Electrical Characteristic Test

Coil Resistance: _____ ohms. Temperature: _____ °F

Minimum Pick Up Voltage (No Pressure Applied): _____ vdc
Minimum Pick Up Current (No Pressure Applied): _____ ma
Maximum Drop Out Voltage (No Pressure Applied): _____ vdc
Maximum Drop Out Current (No Pressure Applied): _____ ma

Minimum Pick Up Voltage (90 psig Applied): _____ vdc
Minimum Pick Up Current (90 psig Applied): _____ ma
Maximum Drop Out Voltage (90 psig Applied): _____ vdc
Maximum Drop Out Current (90 psig Applied): _____ ma

CROSBY: _____
Signed Date

Operability Test

No. of Cycles: _____

Opening Response Time (≤0.100 Second)
(Switch-in to Start of Motion): Minimum: _____ sec. Maximum: _____ sec.

Closing Response Time (≤0.900 Second)
(Switch-out to Start of Motion): Minimum: _____ sec. Maximum: _____ sec.

All Three (3) Pilots

No. of Cycles: _____

Opening Response Time (≤0.100 Second)
(Switch-in to Start of Motion): Minimum: _____ sec. Maximum: _____ sec.

Closing Response Time (≤0.900 Second)
(Switch-out to Start of Motion): Minimum: _____ sec. Maximum: _____ sec.

CROSBY: _____
Signed Date

Q.C. SURVEILLANCE: _____
Signed Date

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TABLE 4 (Continued)

System Leakage Test

	Fully Closed	Fully Open
Test Pressure (200 ± 2 psig):		
Test Duration (10 Minutes):		
Results:		

CROSBY: _____
Signed Date

Q.C. SURVEILLANCE: _____
Signed Date

ENGINEERING REVIEW: _____
Signed Date

CROSBY

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WRENTHAM, MASS

REVISION NUMBER	DATE	REASON FOR REVISION	CUSTOMER APPROVAL
-0	2/3/82		
-1	4/2/82	Upgrading Test Methods	
-2	4/9/82	G.E. Comments	
-3	4/21/82	Added Paragraph 7.14.1.1	

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CROSBY VALVE & GAGE COMPANY
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ENGINEERING PROCEDURE

TITLE: TEST PROCEDURE

TEST PLAN FOR ENVIRONMENTAL QUALIFICATION OF
CROSBY IMF SOLENOID VALVE PILOT ASSEMBLY

APPROVAL W. D. Greenlaw 1/18/82

DIRECTOR OF ENGINEERING DATE
CROSBY VALVE & GAGE COMPANY

	NAME	TITLE	SIGNATURE	DATE
PREPARED BY	M. Brunelli	Engr. Tech.	M. Brunelli	January 18, 1982
APPROVED BY	S. Gonyaw	Sr. Proj. Engr.	S. Gonyaw	January 18, 1982
APPROVED BY	L. Thompson	Prin. Engr.	L. Thompson	January 18, 1982
APPROVED BY	J. J. Greene	QA Manager	J. J. Greene	January 18, 1982

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1. Scope

1.1 This Procedure defines the Environmental Qualification Testing of two (2) Crosby Solenoid Valve Pilot Assemblies which were assembled and tested to Crosby Procedure No. T-16362.

2. Test Sample Description

2.1 The two (2) randomly selected test units represent a modification of the Solenoid Valve Pilot Assembly for the Crosby 6xRx10 HB-65 and 8xRx10 HB-DF Dual Function Safety Relief Valves.

3. Reference Documents

3.1 G.E. Specification No. 22A6441, Revision No. 3.

3.2 IEEE Standard 323-1974.

3.3 Crosby Procedure No. MPP-4400.

3.4 Crosby Procedure No. T-16362.

3.5 Crosby Data Sheet DS-C-66181. -5

3.6 QAP No. 3325.

4. Reference Frame Testing

Each Pilot Assembly shall be subjected to a Reference Frame Test as follows:

4.1 Electrical Characteristic Test

4.1.1 The electrical characteristic test is to be performed on a static stand test block.

4.1.2 Check for continuity, coil resistance, and shorts through the connector terminals. Record coil resistance and ambient temperature on Crosby Form QC-277. Note: Coil resistance 727 ± 10% OHMS at 70°F.

4.1.3 The minimum pick up voltage and current, and the maximum drop out voltage and current with no pressure applied to the pilot assembly shall be measured. The ambient temperature, minimum pick up and maximum drop out voltages and currents shall be recorded on Crosby Form QC-277.

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4. Reference Frame Testing (Continued)

4.1 Electrical Characteristic Test (Continued)

4.1.4 The minimum pick up voltage and current and the maximum drop out voltage and current tests shall be repeated with the pilot assembly pressurized with air/N2 at 90 ± 2 psig. Record the ambient temperature, minimum pick up and maximum drop out voltages and currents on Crosby Form QC-277.

-4

4.2 Operability Test

4.2.1 Each pilot assembly shall be subjected to a five (5) cycle operability test against a simulated safety relief valve load of 250 psi at the SRV inlet. The air/N2 supply pressure shall be 90 ± 2 psig from a ten (10) gallon accumulator and the solenoid pilot supply voltage shall be 105 + 0/-2 vdc. The acutator shall be cycled by energizing the pilots as tabulated below.

	No. of Cycles
Top Pilot Assembly	5
Bottom Pilot Assembly	5

4.2.2 Acceptance Criteria

4.2.2.1 In the initial reference frame test and the reference frame tests of Paragraph 5, 6 and 7, the elapsed time between initiation of the signal to the solenoid valve pilot assembly and the start of load simulator motion shall not exceed .100 seconds. Measure opening response time for the first and last cycle for each pilot. Record the maximum and minimum response time for each on Crosby Form QC-277.

4.2.2.2 The elapsed time between switch out of the signal to the solenoid valve pilot assembly and the start of the load simulator motion shall not exceed .900 seconds. Measure closing response time for the first and last cycle for each pilot. Record the maximum and minimum response time for each on Crosby Form QC-277.

4.2.2.3 Only operability (open and hold open/close upon energization/deenergization of the solenoid) is required for acceptability during and at the conclusion of the environmental test of Paragraph 8. Response times noted shall be for information only.

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4. Reference Frame Testing (Continued)

4.3 System Leakage Test -4

4.3.1 Each pilot assembly shall be mounted to a test SRV actuator and subjected to a system leakage test in both the open (actuator fully stroked) and closed positions. The air/N2 test pressure shall be 200 ± 2 psig for each position. The test duration shall be ten (10) minutes in each position after pressure is reached.

4.3.2 Acceptance Criteria

4.3.2.1 In the initial reference frame testing, there shall be no visible leakage through the pilot vent, connector or cap-to-housing interface as determined by a liquid leak detector spray. Test results shall be recorded on Crosby Form QC-277.

4.3.2.2 Leakage for reference frame testing following the aging events of Paragraph 5, 6 and 7 shall not interfere with the pilot valve function and shall be consistent with the basic operability requirements imposed by Reference 2.1 on the solenoid and (to the extent applicable) on the SRV and its actuator.

4.3.2.3 Leakage at the conclusion of the environmental testing of Paragraph 8 shall be consistent with the basic operability requirements for actuation of the SRV (i.e., solenoid to open and hold open/close upon signal/termination of signal to the solenoid).

5. Thermal Aging

5.1 The pilot assemblies shall be mounted to a test fixture and exposed in a chamber at a temperature and duration thermally equivalent to 343°F for 100 hours in an air atmosphere with uncontrolled humidity with 90 psig air/N2 applied to the inlet side of the solenoid pilot seat. (Refer to G.E. Specification No. 22A6441, Revision No. 3).

5.2 The reference frame test of Paragraph 4 shall be repeated and recorded on Crosby Form QC-277.

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6. Mechanical Aging (Normal Room Ambient)

6.1 Each pilot assembly shall be mounted to a test SRV actuator and mechanically cycled 1000 times against an equivalent load of 250 psi at the SRV inlet by energizing each solenoid pilot valve 500 times. Air/N2 pressure used at the solenoid pilot valve shall be 200 ± 5 psig from a ten (10) gallon accumulator. The pilot supply voltage shall be 138 +2/-0 vdc.

6.2 The reference frame test of Paragraph 4 shall be repeated and recorded on Crosby Form QC-277.

7. Radiation Aging

7.1 Upon completion of the reference frame testing the pilot assemblies shall be irradiated to a cumulative total integrated dose of 3.0×10^7 rads (air equivalent gamma.

7.2 After radiation aging, the reference frame test of Paragraph 4 shall be repeated and recorded on Crosby Form QC-277.

8. Environmental Test

8.1 Each pilot assembly shall be mounted in a chamber which maintains a controlled saturated steam environment (Figure 1).

8.2 An air/N2 supply capable of maintaining a 90 psi differential acting across the pilot assembly and 0 to 250 vdc power supply shall be connected to the pilot valve. Actual test voltages shall be as specified below.

8.3 Recording device (s) shall monitor the pilot valve operation (i.e., voltage, current and inlet pressure) and environmental conditions (i.e., pressure and temperature) over the entire duration of the test.

8.4 Each of the two (2) pilot assemblies shall be independently tested in separate 4 day tests.

8.4.1 Refer to the profile of Figure 1. After reaching the temperature of 340°F on the first ramp, each pilot valve is cycled six (6) times during the first hour after the 340°F temperature is reached. These six (6) cycles are to be performed as follows: -3

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8. Environmental Test (Continued)

8.4 (Continued)

8.4.1 (Continued)

Cycle Number	Voltage
1	≤ 105 vdc
2	≤ 105 vdc
3	≈ 125 vdc
4	≈ 138 vdc
5	≤ 105 vdc
6	≤ 105 vdc

-3

Times of cycling events and voltages to be used are give on Figure 1 for the remaining cycles. Coil resistance is to be checked at each cycle. (See Paragraph 8.4.2). If the continuously energized solenoid (see Paragraph 8.4.2) is energized at the end of the first hour (i.e., after the first six (6) cycles), two (2) additional cycles shall be applied to this solenoid between the second and third hour, by deenergizing and cycling. One (1) cycle shall be at a voltage ≤ 105 vdc and the other shall be a cycle at ∿ 138 vdc. If this solenoid is energized between the first six (6) cycling events, these two (2) additional cycles are not required. -3

8.4.2 One (1) pilot valve shall be energized continuously at 138 +2/-0 volts dc and cycled (i.e., deenergized and reenergize) one (1) or more times at each plateau on the temperature/pressure profile of Figure 1. During or at the end of the first six (6) cycles on the first 340° plateau of Figure 1, the voltage shall be applied and increased to the maximum level (138 +2/-0 vdc). All conditions shall be monitored and recorded as per Paragraph 8.3 throughout the test. Further cycling shall be performed by deenergizing, energizing at the required voltages and then increasing the voltage back up to 138 +2/-0 vdc. -3

8.4.3 One (1) pilot valve shall remain in the deenergized condition except during the periodic cycling at each plateau on the temperature/pressure profile as indicated on Figure 1. Except where otherwise required, the voltage shall be ≤ 105 vdc for the duration of the test. Note that some cycles are performed at a specific voltage other than at ≤ 105 vdc. All conditions shall be monitored and recorded as per Paragraph 8.3 throughout the test. -3

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8. Environmental Test (Continued)

8.5 Interruption of Test -3

8.5.1 Any failure of the test system (not including the test unit) shall be corrected, and the system brought back up to and thermally stabilized at the required plateau temperature before the test (accumulation of time at temperature) may continue. -3

8.5.2 Any drop in chamber temperature below that required at the given plateau (such as feedwater pump operation) shall not be included as part of the total time at that plateau. -3

8.6 Acceptance Criteria

The constantly energized pilot assembly (Paragraph 8.4.1) shall hold open when energized and remain operable throughout all testing to be considered successful. Both pilot assembies shall operate at their required operating voltages, at each point where cycling is required during all testing to be considered successful. -3

9. Post Test Inspection

9.1 Following all testing both pilot valves shall be reference frame tested as per Paragraph 4 of this procedure and the results recorded on Crosby Form QC-277.

9.2 Upon completion of the reference frame test, both pilot valves shall be disassembled. All defects or anomalies shall be noted on Crosby Form QC-277.

10. Test Report

10.1 Upon completion of the above tests, a test report shall be generated including the following as a minimum.

10.1.1 Summary of the results and conclusions, details and recommendations regarding anomalies and test procedure and set-up.

10.1.2 Test Reports (QC277 & 278).

10.2 The test report shall also contain the following:

10.2.1 Test procedure used.

10.2.2 Calibration information.

10.2.3 Log sheets.

10.2.4 Instrumentation used.

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10. Test Report (Continued)

10.2 (Continued)

10.2.5 Pilot assembly identification and drawing references.

10.2.6 Description with photographs of test facility/set-up, instrumentation and significant inspection results.

10.2.7 Crosby Engineering Calculation of the Seismic Loading.

10.2.8 Caclulation of thermal aging temperature. -3

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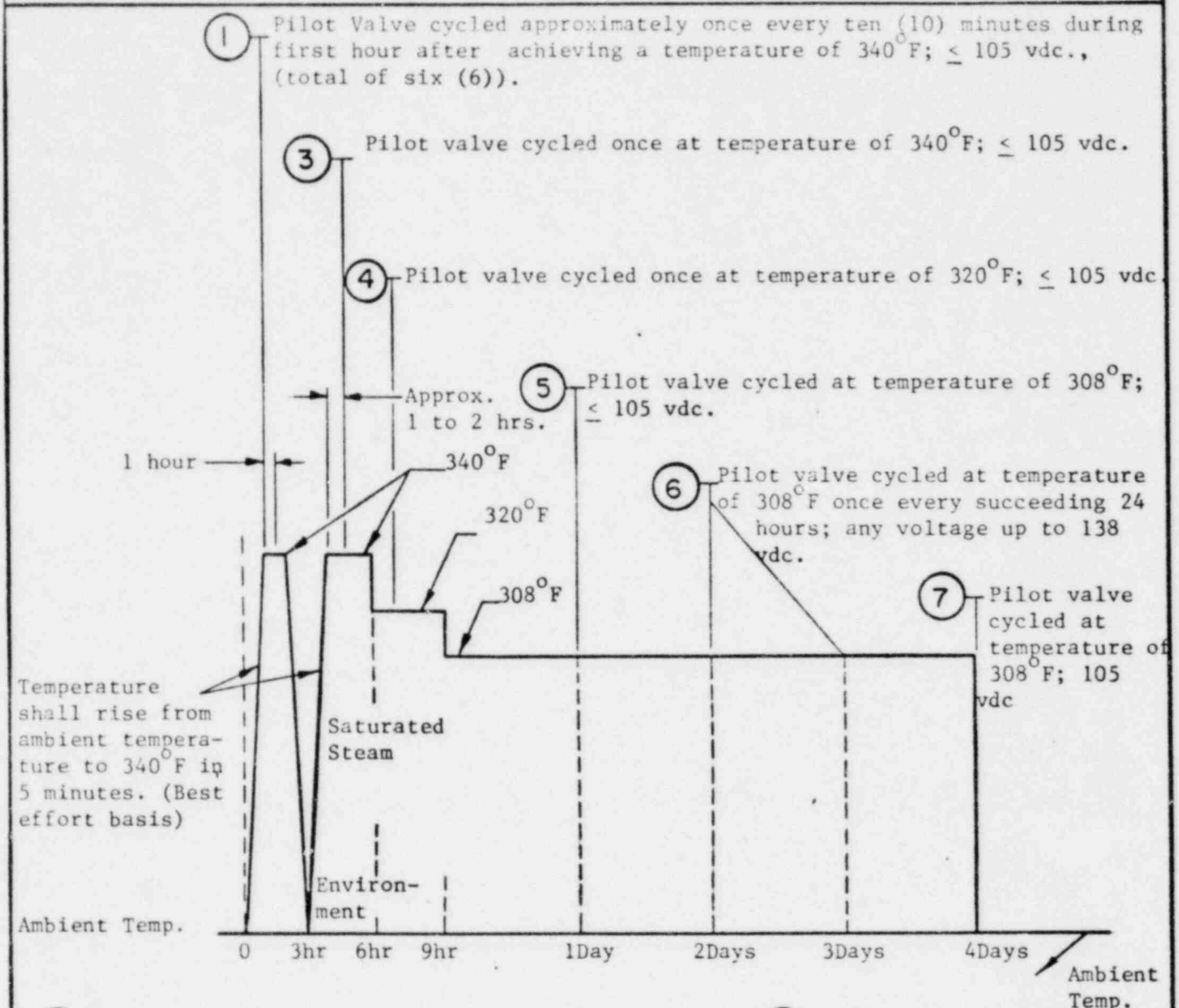

Saturated Steam Environment	
Pressure (psig)	Temp. (°F)
105	340
75	320
61	308

Air Supply - 90 psid
Supply Voltage - 105 volts dc maximum for deenergized pilot test except where otherwise specifically required, 138 volts dc minimum for constantly energized pilot test during the period this pilot is energized.

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FIGURE 1

CROSBY VALVE & GAGE COMPANY
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FLOW CHART

Environmental Qualification Testing for Crosby IMF Solenoid Valve Pilot Assembly. Test quantity will be two (2) units.

Reference Frame Testing

Pilot valve cycled in test fixture to establish mechanical and electrical characteristics.

Thermal Aging

Oven bake (uncontrolled air atmosphere) for a temperature and duration equivalent to 343°F for 100 hours. -3

Reference Frame Test

Mechanical Aging

1000 cycles under maximum operating conditions (200 psig and 138 volts dc) at room temperature.

Reference Frame Test

Radiation Aging

Total integrated dose of $3.0 \times 10^{+7}$ rads (air equivalent) gamma.

Reference Frame Test

Environmental Test

Test profile of Figure 1. Total test duration of four (4) days. Note: One (1) unit to be cycle tested. One (1) unit to be constantly energized at 138 volts dc.

Reference Frame Test

Post Test Inspection

FIGURE 2

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Crosby IMF Solenoid Valve Pilot Assembly Environmental
Qualification Test Form QC-277

Pilot Housing Serial Number _____.

- Reference Frame Testing -

1. Electrical Characteristic Test

Ambient Temperature: _____ °F.
Coil Resistance: _____ OHMS.

Minimum Pick Up Voltage (No Applied Pressure): _____ vdc.
Minimum Pick Up Current (No Applied Pressure): _____ ma.
Maximum Drop Out Voltage (No Applied Pressure): _____ vdc.
Maximum Drop Out Current (No Applied Pressure): _____ ma.

Minimum Pick Up Voltage (90 psig Applied): _____ vdc.
Minimum Pick Up Current (90 psig Applied): _____ ma.
Maximum Drop Out Voltage (90 psig Applied): _____ vdc.
Maximum Drop Out Current (90 psig Applied): _____ ma.

Ambient Temperature: _____ °F.
Coil Resistance: _____ OHMS.

2. Operability Test -4

No. of Cycles _____

Opening Response Time: _____
(Switch-in to Start of Motion): Minimum: _____ Maximum: _____ (≤ .100 sec.)

Closing Response Time: _____
(Switch-out to Start of Motion): Minimum: _____ Maximum: _____ (≤ .900 sec.)

3. System Leakage Test -4

	Fully Closed (200 ± 2 psig)	Fully Open (200 ± 2 psig)
Test Pressure:		
Test Duration (10 Minutes):		
Results:		

CROSBY: _____
Signed Date

FIGURE 3

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WRENTHAM, MASS

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Post Thermal Aging Reference Frame Test

4. Electrical Characteristic Test

Ambient Temperature: _____ °F.
Coil Resistance: _____ OHMS.

Minimum Pick Up Voltage (No Applied Pressure): _____ vdc.
Minimum Pick Up Current (No Applied Pressure): _____ ma.
Maximum Drop Out Voltage (No Applied Pressure): _____ vdc.
Maximum Drop Out Current (No Applied Pressure): _____ ma.

Minimum Pick Up Voltage (90 psig Applied): _____ vdc.
Minimum Pick Up Current (90 psig Applied): _____ ma.
Maximum Drop Out Voltage (90 psig Applied): _____ vdc.
Maximum Drop Out Current (90 psig Applied): _____ ma.

Ambient Temperature: _____ °F.
Coil Resistance: _____ OHMS.

5. Operability Test -4

No. of Cycles: _____

Opening Response Time: _____
(Switch-in to Start of Motion): Minimum: _____ Maximum: _____ (≤.100 sec.)

Closing Response Time: _____
(Switch-out to Start of Motion): Minimum: _____ Maximum: _____ (≤.900 sec.)

6. System Leakage Test -4

	Fully Closed (200 ± 2 psig)	Fully Open (200 ± 2 psig)
Test Pressure:		
Test Duration (10 Minutes):		
Results:		

CROSBY: _____
Signed Date

FIGURE 3

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Post Mechanical Aging Reference Frame Test

7. Electrical Characteristic Test

Ambient Temperature: _____ °F.
Coil Resistance: _____ OHMS.

Minimum Pick Up Voltage (No Applied Pressure): _____ vdc.
Minimum Pick Up Current (No Applied Pressure): _____ ma.
Maximum Drop Out Voltage (No Applied Pressure): _____ vdc.
Maximum Drop Out Current (No Applied Pressure): _____ ma.

Minimum Pick Up Voltage (90 psig Applied): _____ vdc.
Minimum Pick Up Current (90 psig Applied): _____ ma.
Maximum Drop Out Voltage (90 psig Applied): _____ vdc.
Maximum Drop Out Current (90 psig Applied): _____ ma.

Ambient Temperature: _____ °F.
Coil Resistance: _____ OHMS.

-4

8. Operability Test

No. of Cycles: _____

Opening Response Time: _____
(Switch-in to Start of Motion): Minimum: _____ Maximum: _____ (≤.100 sec.)

Closing Response Time: _____
(Switch-out to start of Motion): Minimum: _____ Maximum: _____ (≤.900 sec.)

-4

9. System Leakage Test

	Fully Closed (200 ± 2 psig)	Fully Open (200 ± 2 psig)
Test Pressure:		
Test Duration (10 Minutes):		
Results:		

CROSBY: _____
Signed Date

FIGURE 3

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Post Radiation Aging Reference Frame Test

10. Electrical Characteristic Test

Ambient Temperature: _____ °F.
Coil Resistance: _____ OHMS.

Minimum Pick Up Voltage (No Applied Pressure): _____ vdc.
Minimum Pick Up Current (No Applied Pressure): _____ ma.
Maximum Drop Out Voltage (No Applied Pressure): _____ vdc.
Maximum Drop Out Current (No Applied Pressure): _____ ma.

Minimum Pick Up Voltage (90 psig Applied): _____ vdc.
Minimum Pick Up Current (90 psig Applied): _____ ma.
Maximum Drop Out Voltage (90 psig Applied): _____ vdc.
Maximum Drop Out Current (90 psig Applied): _____ ma.

Ambient Temperature: _____ °F.
Coil Resistance: _____ OHMS.

-4

11. Operability Test

No. of Cycles: _____

Opening Response Time: _____
(Switch-in to Start of Motion): Minimum: _____ Maximum: _____ (≤.100 sec.)

Closing Response Time: _____
(Switch-out to start of Motion): Minimum: _____ Maximum: _____ (≤.900 sec.)

12. System Leakage Test -4

	Fully Closed (200 ± 2 psig)	Fully Open (200 ± 2 psig)
Test Pressure:		
Test Duration (10 Minutes):		
Results:		

CROSBY: _____
Signed Date

FIGURE 3

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WRENTHAM, MASS

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Post Environmental Testing Reference Frame Test

13. Minimual Pick-up Voltage: _____vdc. Current: _____ma.
During environmental testing (1st peak).

14. Electrical Characteristic Test

Ambient Temperature: _____°F.
Coil Resistance: _____OHMS.

Minimum Pick Up Voltage (No Applied Pressure): _____vdc.
Minimum Pick Up Current (No Applied Pressure): _____ma.
Maximum Drop Out Voltage (No Applied Pressure): _____vdc.
Maximum Drop Out Current (No Applied Pressure): _____ma.

Minimum Pick Up Voltage (90 psig Applied): _____vdc.
Minimum Pick Up Current (90 psig Applied): _____ma.
Maximum Drop Out Voltage (90 psig Applied): _____vdc.
Maximum Drop Out Current (90 psig Applied): _____ma.

Ambient Temperature: _____°F.
Coil Resistance: _____OHMS.

15. Operability Test -4

No. of Cycles: _____

Opening Response Time: _____
(Switch-in to Start of Motion): Minimum: _____ Maximum: _____ (≤.100 sec.)

Closing Response Time: _____
(Switch-out to start of Motion): Minimum: _____ Maximum: _____ (≤.900 sec.)

16. System Leakage Test -4

	Fully Closed (200 ± 2 psig)	Fully Open (200 ± 2 psig)
Test Pressure:		
Test Duration (10 Minutes):		
Results:		

CROSBY: _____
Signed Date

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WRENTHAM, MASS

QC-277

16. Post Test Inspection

16.1 Comments

CROSBY: _____
Signed Date

Figure 3

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CROSBY

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS

REVISION NUMBER	DATE	REASON FOR REVISION	CUSTOMER APPROVAL
-0	1/18/82		
-1 MB 2-2-82 L.H. 2-2-82 ggf 2/3/82	1/29/82	Changes in the order of Testing.	
-2 RWO FOR MB 2-17-82 L.H. 2-17-82 ggf 2/17/82	2/17/82	Deleted Crosby Test Report No. 3865. Added paragraphs 3.6, 10.1.2 and 10.2.7. Revised paragraph 8.4 per discussions with G.E.	
-3 MB 4/5/82 ggf 4/5/82 L.H. 4/5/82	3/25/82	Clarification of Testing Requirements per G.E. request.	
-4 MB 4/26/82 L.H. 4/27/82 ggf 4/28/82	4/26/82	Revised per Crosby Engineering	
-5 MB 5/27/82 L.H. 5/21/82 ggf 5/21/82	5/27/82	Revised Paragraph 3.5	

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Appendix 13

JUSTIFICATION OF NON-PERFORMANCE NEGATIVE PRESSURE TEST

Negative Pressure Test

The CVG-01 SPV (Crosby No. DS-A-63790, DS-A-63580, DS-A-63825, and DS-A-63800 (Sheet 4)) was successfully tested during the GE/Wyle NEQ Test (Reference No. 44220-2) as required by GE specification 22A6551, Appendix 30 to Paragraph 30.8.4.1. Similarity of design between the IMF-2 (Crosby No's DS-C-66181, Rev B and DS-C-66274, Rev C) SPV and the CVG-01 SPV allows extrapolation of this test to justify a generic qualification for negative pressure for the IMF-2 SPV. Specifically, there are two (2) design parameters that need to be addressed for the effects of negative pressure; 1) mechanical operation, 2) effective pressure sealing.

1) The mechanical operation consistsonly of the plunger and sleeve assembly. The CVG and the IMF-2 have identical parts. (Peter Paul Part No's. 73NI-1501 and 70-11019).

2) Two (2) O-ring seals are of a different design on the IMF-2 SPV. The radial seal between the solenoid nut and the sleeve on the CVG-01 has been replaced with a face seal between the top cover and nut on the IMF-2. It is completely contained in a double sided O-ring gland, and every production unit is leak tested. The solenoid nut to body O-ring seal on the CVG-01 has been replaced with a radial O-ring seal between the top cover and body on the IMF-2. It also is contained in an O-ring groove, and all units are leak tested. All other seals, both internal and interface, are common to both SPV's.

Appendix 14

JUSTIFICATION FOR TEST RAMP

The initial five (5) minute temperature/pressure ramp required by the test plan could not be achieved during the LOCA test (reference Appendix 3) although the required end conditions were met. Two (2) possible effects of thermal shock considered as a result of the required ramp are; 1) permanent distortion or cracking of the SPV body and 2) non-operability due to non-uniform heating and expansion of the internal moving parts. Justification for the acceptability of the qualification test is as follows for each possible effect:

1) The IMF-2 SPV body is similar in design, size and material to the CVG-01 SPV body that was succesfully LOCA tested to the same requirements during the GE/ Wyle NEQ Test No. 44220-2 with no reported damage. (Reference Crosby drawing No's SA-C-60761, Revision B, and SA-C-66176, Revision 0).

2) The mechanical operating parts of the IMF-2 SPV are identical to the CVG-01 SPV parts. The CVG-01 operated normally after the ramp during the above identified Wyle LOCA test. Additionally, heating the mass of the body lessening the shock. The test did demonstrate operability at all temperatures traversed by the required ramp.

Based on the above, it is considered that the Wyle LOCA test results for CVG-01 are extendable to the IMF-2.

APPENDIX 15

VOLUMETRIC EQUIVALENTS OF POST-LOCA PNEUMATIC LEAKAGE

The Post-LOCA baseline leakage test of test specimen (SPV) 66181-006 was performed using a pressure decay method with the volumetic equivalent found as follows:

SRV Actuator Volume = 0.578 $ft.^3$

1¼ Inch Diameter Hose Volume = 0.085 $ft.^3$

One (1) Gallon Accumulator Volume = 0.134 $ft.^3$

Ambient Temperature = 73^oF.

Test Medium = Nitrogen (N_2).

Test Duration = 10 Minutes.

Leakage Test No. 1 (SRV 66181-006)

Starting Pressure (F_1) = 200 psig = 214.7 psia = 30916.8 psfa.

Ending Pressure (P_2) = 195 psig = 209.7 psig = 30196.8 psfa.

Temperature (T) = 73^oF = 532.7 ^oR.

Gas Constant (R) = 55.15 lb_f - ft./lb_m - ^oR.

System Volume (V) = 0.80 $ft.^3$

$P_1V = mRT$

$m_1 = P_1V/RT$

$m_1 = (30916.8)(0.80)/(55.15)(532.7)$

$m_1 = 24733.44/29378.41$

$m_1 = 0.842\ lb_m$

$m_2 = P_2V/RT$

$m_2 = (30196.8)(.8)/(55.15)(532.7)$

$m_2 = 0.822\ lb_m$

Appendix 15 (Continued)

Leakage Test No. 1 (SRV 66181-006) (Continued)

$\Delta Mass = m_1 - m_2$

$\Delta Mass = 0.842 - 0.822$

$\Delta Mass = 0.02\ lb_m$

Mass Flow Rate = .02 lb_m/10 minutes.

Mass Flow Rate = .002 lb_m/minute = .12 lb_m/hour.

Average Pressure $(P_{average}) = (P_1 + P_2)/2$

$(P_{average} = (30916.8 + 30196.8)/2$

$(P_{average}) = 30556.8$ psfa

Volumetric Flow Rate $(Q) = mRT/P_{average}$

$Q = (0.12)(55.15)(532.7)/30556.8$

$Q = 3525.41/30556.8$

$Q = 0.115\ ft.^3/hr.$

Volumetric Post-LOCA Pneumatic Leakage of SPV 66181-006 = 0.115 $ft.^3/hr.$

Leakage Test No. 2 (SPV 66181-007)

Starting Pressure (P_1) = 200 psig = 214.7 psia = 30916.8 psfa.

Ending Pressure (P_2) = 187 psig = 201.7 psia = 29044.8 psfa.

Temperature (T) = $73^oF = 532.7^oR$.

Gas Constant (R) = 55.15 lb_f - ft./lb_m - ^oR.

System Volume (V) = 0.80 $ft.^3$

$m_1 = P_1V/RT$

$m_1 = (30916.8)(0.80)/(55.15)(532.17)$

$m_1 = 24733.44/29378.41$

$m_1 = 0.842\ lb_m$

Appendix No. 15 (Continued)

Leakage Test No. 2 (SRV 66181-007) (Continued)

$m_2 = P_2V/RT$

$m_2 = (29044.8)(0.80)(55.15)(532.7)$

$m_2 = 23235.84/29378.41$

$m_2 = 0.791\ lb_m$

$\Delta Mass = m_1 - m_2$

$\Delta Mass = 0.842 - 0.791$

$\Delta Mass = 0.051\ lb_m$

Mass Flow Rate = $0.051\ lb_m$/10 minutes.

Mass Flow Rate = $0.005\ lb_m$/minute = $0.3\ lb_m$/hr.

Average Pressure $(P_{average}) = P_1 + P_2/2$

$(P_{average}) = (30916.8 + 29044.8)/2$

$(P_{average}) = 29980.8$ psfa

Volumetric Flow Rate $(Q) = {}_mRT/P_{average}$

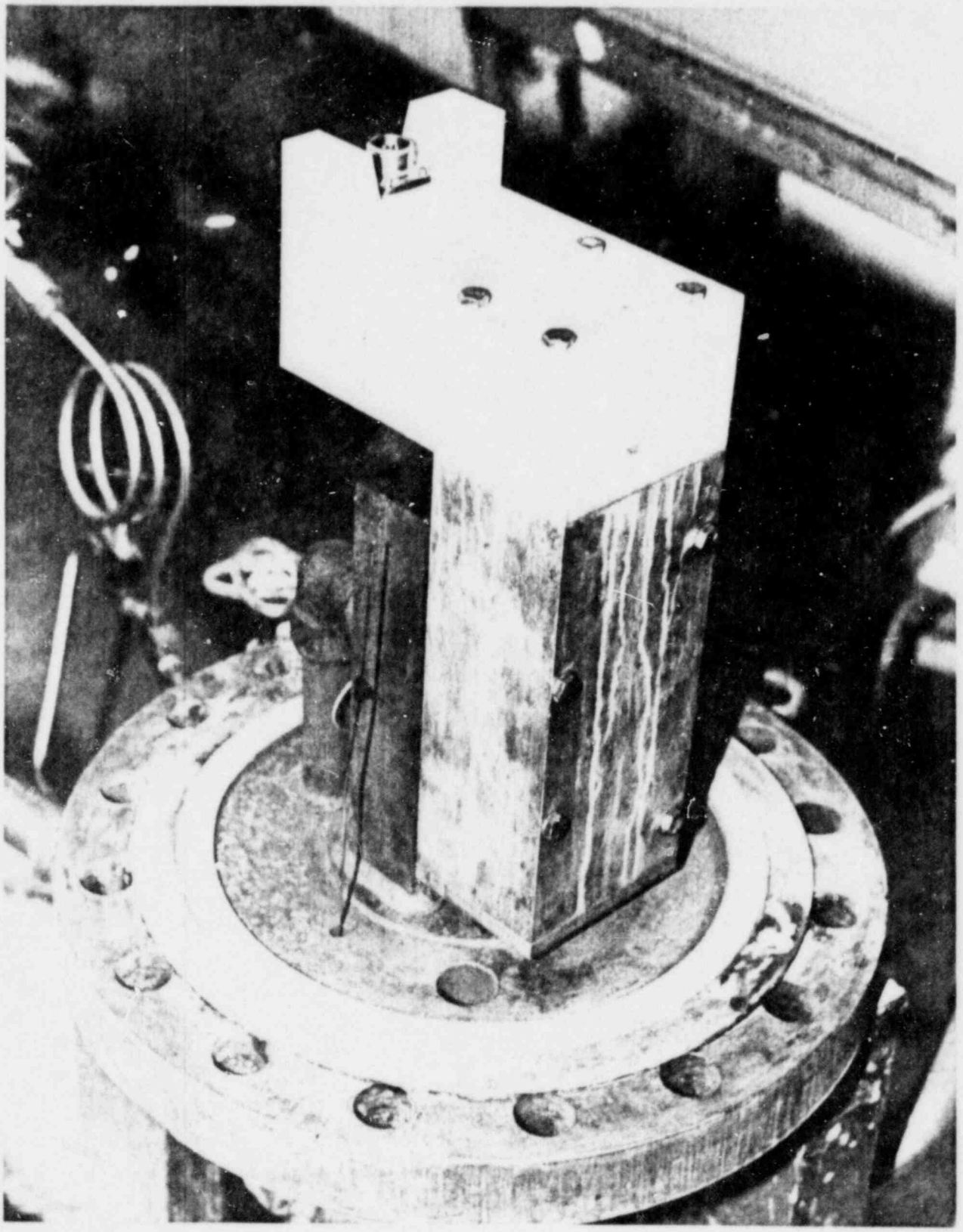
$Q = (0.3)(55.15)(532.7)/29980.8$

$Q = 8813.52/29980.8$

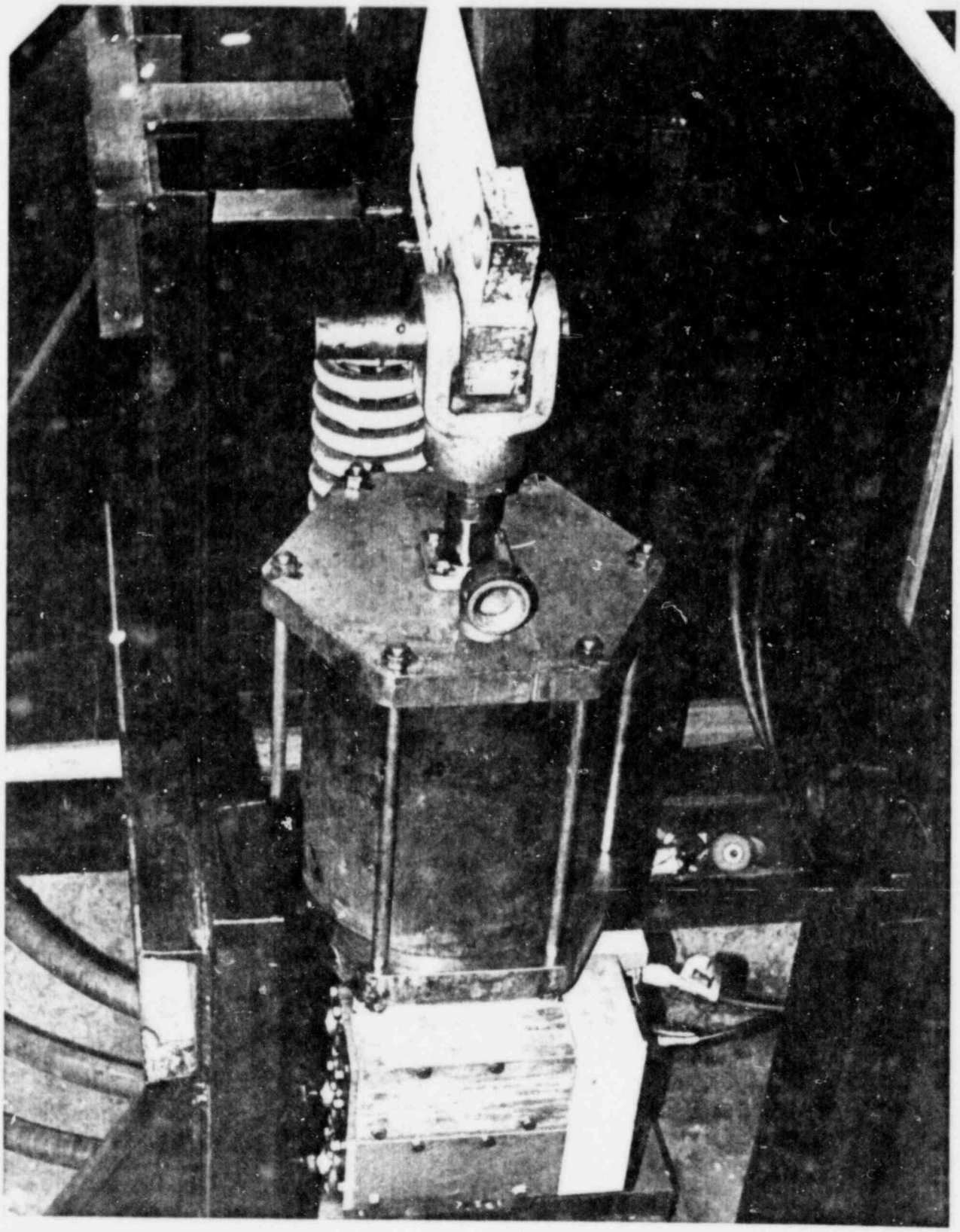
$Q = 0.294\ ft.^3/hr.$

Volumetric Post-LOCA Pneumatic Leakage of SPV 66181-006 = $0.294\ ft.^3/hr.$

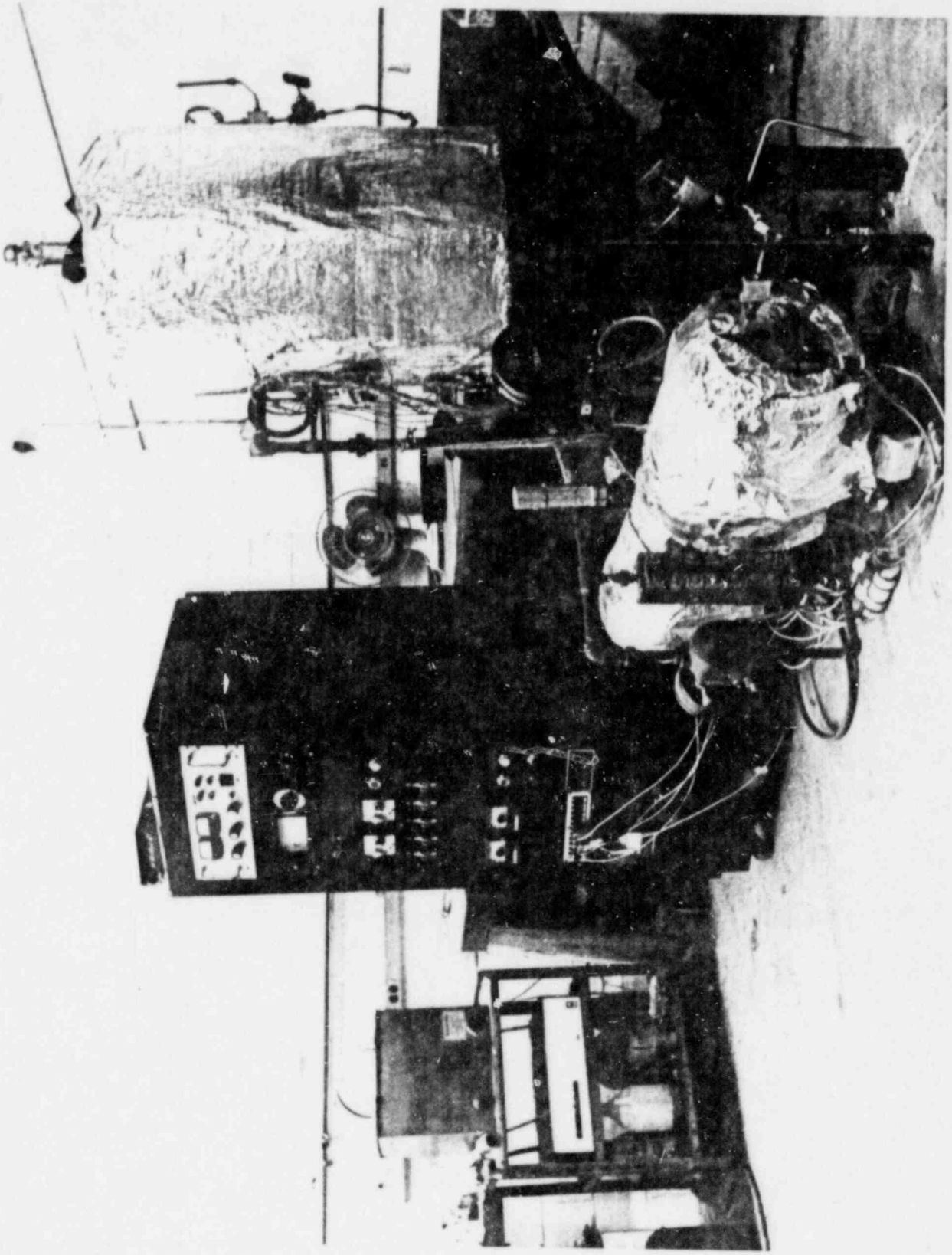
THERMAL AGING OVEN



TEST SPECIMEN MOUNTED IN LOCA TEST CHAMBER



BASELINE TIME RESPONSE AND MECHANICAL AGING SIMULATOR



LOCA TEST FACILITY