

CROSBY VALVE & GAGE COMPANY
WRENTHAM, MASS.

ENGINEERING PROCEDURE

TITLE: TEST PROCEDURE

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

GENERAL ELECTRIC
NUCLEAR ENERGY BUSINESS GROUP

McNeill 6-28-82
FOR INFORMATION DATE

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APPROVAL *W. D. Greenlaw* W. D. Greenlaw 1/18/82

DIRECTOR OF ENGINEERING DATE
CROSBY VALVE & GAGE COMPANY

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

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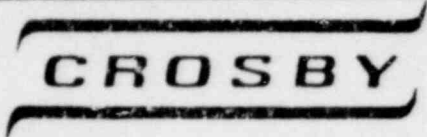
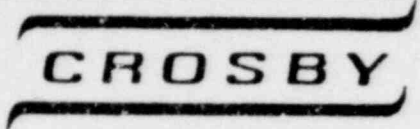


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1. Scope

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.
- 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 $727 \pm 10\%$ 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.

4.2 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 $105 \pm 0/-2$ vdc. The acuator shall be cycled by energizing the pilots as tabulated below.

	<u>No. of Cycles</u>
Top Pilot Assembly	5
Bottom Pilot Assembly	5

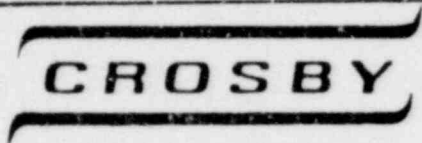
4.2.2 Acceptance Criteria

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

4.3.1 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 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.

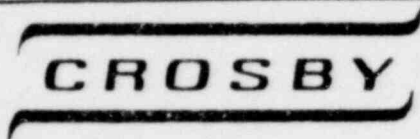
4.3.2.3 Leakage at the conclusion of the environmental testing of Paragraph 8 shall be consistent with the basic operability requirements for actuation of the SRV (i.e., solenoid to open and hold open/close upon signal/termination of signal to the solenoid).

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 psig 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 x 10⁷ 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.

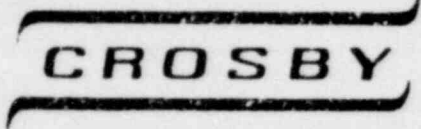
8. Environmental Test

- 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:

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8. Environmental Test (Continued)

8.4 (Continued)

8.4.1 (Continued)

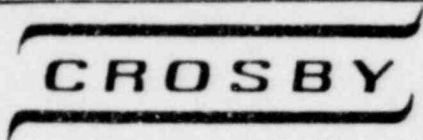
<u>Cycle Number</u>	<u>Voltage</u>
1	< 105 vdc
2	< 105 vdc
3	~ 125 vdc
4	~ 138 vdc
5	< 105 vdc
6	< 105 vdc

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.

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.

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.

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8. Environmental Test (Continued)

8.5 Interruption of Test

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.

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.

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 assemblies shall operate at their required operating voltages, at each point where cycling is required during all testing to be considered successful.

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:

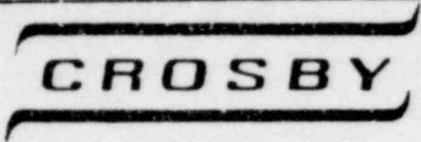
10.2.1 Test procedure used.

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.

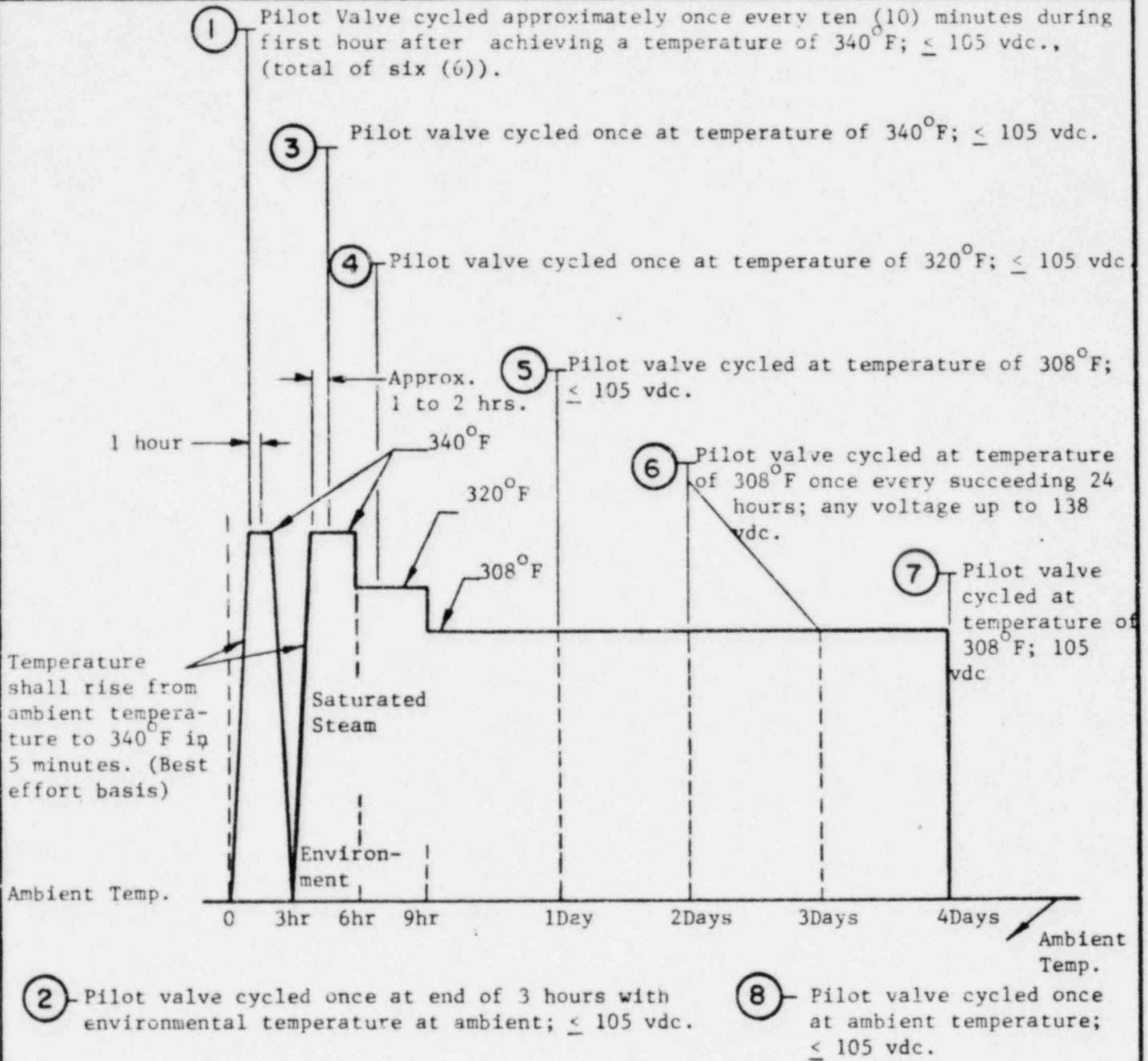
10.2.6 Description with photographs of test facility/set-up, instrumentation and significant inspection results.

10.2.7 Crosby Engineering Calculation of the Seismic Loading.

10.2.8 Caclulation of thermal aging temperature.

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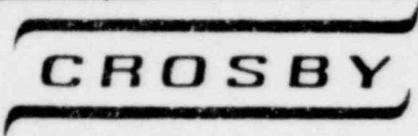


Air Supply - 90 psid
Supply Voltage - 105 volts dc maximum for deenergized pilot test except where otherwise specifically required, 138 volts dc minimum for constantly energized pilot test during the period this pilot is energized.

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

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FIGURE I



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.

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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

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

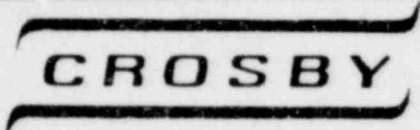
Fully Closed Fully Open
(200 ± 2 psig) (200 ± 2 psig)

Test Pressure: _____
Test Duration (10 Minutes): _____
Results: _____

CROSBY: _____ Signed _____ Date _____

FIGURE 3

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QC-277

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

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

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

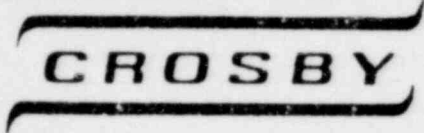
CROSBY: _____
Signed _____ Date _____

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.

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.)

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.

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.)

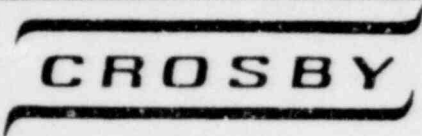
12. System Leakage Test

	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 Environmental Testing Reference Frame Test

13. Minimal 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

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

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

CROSBY: _____ Signed _____ Date _____

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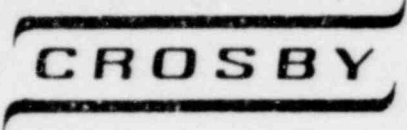
16. Post Test Inspection

16.1 Comments

CROSBY: _____
Signed _____ Date _____

Figure 3

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REVISION NUMBER DATE REASON FOR REVISION CUSTOMER APPROVAL

-0 1/18/82

-1 *MB 2-2-82* 1/29/82 Changes in the order of Testing.
2-2-82
V.P. 2-2-82
J.P. 2/3/82

-2 *RWD FOR MB* 2/17/82 Deleted Crosby Test Report No. 3865.
2-17-82 *V.P. 2-17-82* Added paragraphs 3.6, 10.1.2 and
J.P. 2/17/82 *2-17-82* 10.2.7. Revised paragraph 8.4 per
discussions with G.E.

-3 3/25/82 Clarification of Testing Requirements
MB 4/5/82 *V.P. 4/5/82* per G.E. request.
J.P. 4/5/82 *4-8-82*

-4 4/26/82 Revised per Crosby Engineering
MB 4/26/82
V.P. 4/27/82
J.P. 4/28/82 *4-30-82*

-5 5/27/82 Revised Paragraph 3.5
MB 5/27/82
V.P. 5/27/82 *WAP 5/27/82*
J.P. 5/27/82

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