

TEST METHODS, HOSE ASSEMBLIES, TETRAFLUOROETHYLENE (TFE)

0. INTRODUCTION

This standard has been prepared to standardize on the test methods for qualification of tetrafluoroethylene (TFE) hose and hose assemblies used in aircraft fluid systems. The tests are intended to simulate the most strenuous demands encountered in aircraft. Compliance with these test methods is necessary for hose and hose assemblies which are used in systems where a malfunction could affect the safety of flight.

I. SCOPE AND FIELD OF APPLICATION

This standard describes the test methods for flexible TFE hose and hose assemblies used in aircraft fluid systems in the pressure and temperature ranges covered by pressure classes B, D and E, and temperature types I, II and III of MA 2001 - ISO 6771. It applies to the hose and the hose coupling. The tests and assembly requirements for the connecting end fitting are covered in the procurement specification.

This standard applies each time that it is referred to in a procurement specification or other definition document.

Fluids and materials used for the tests are listed in Appendix A.

This standard is a word-for-word equivalent of ISO/DP 8829 with the exception that U.S., material, test and process specifications are used where ISO equivalents are not available. Areas in this document that differ from the ISO/DP 8829 are indicated by a line on the margin.

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2. REFERENCES

2.1 Specifications

2.1.1 Federal

P-D-680	Dry Cleaning Solvent
TT-I-735	Isopropyl Alcohol
TT-S-735	Standard Test Fluid, Hydrocarbon, Type II

2.1.2 Military

MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-T-5624	Turbine Fuel, Aviation, grade JP4
MIL-H-8446	Hydraulic Fluid, Non-Petroleum Base, Aircraft
MIL-L-7808	Lubrication Oil, Aircraft Turbine Engine, Synthetic Base
MIL-T-27602	Trichloroethylene, Oxygen Propellant Compatibility
MIL-H-83282	Hydraulic Fluid, Fire Resistant, Synthetic, Hydrocarbon Base, Aircraft

Copies may be obtained from the procuring activity or as directed by the contracting office.

2.2 Standards

MA 2001 - ISO 6771	Aerospace Fluid Systems, Pressure and Temperature Classifications
MA 2002 (ISO 6772)	Impulse Testing of Hydraulic Hose, Tubing and Fitting Assemblies
MA 2003 - ISO 6773	Thermal Shock Testing of Piping and Fittings
ARP 1153 (ISO 7258)	Method for Determining Relative Specific Gravity, PTFE Tubing
AS 1055 (ISO/TR 2685)	Fire Resistance, Fire Test and Performance Requirements for Flexible Hose and Rigid Tube Assemblies

Copies may be obtained from the S.A.E., 400 Commonwealth Drive, Warrendale, PA 15096

2.3 Other Publications

ASTM D792	Specific Gravity and Density of Plastics by Displacement
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Copies may be obtained from the American Society for Testing and Materials,
1916 Race Street Philadelphia PA 19103

3. DEFINITIONS

Room Temperature	Temperature in the test laboratory between 15° and 32°C (60° and 90°F).
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Sleeve	Flame and heat retardent elements, normally tubular, slipped over the hose assembly and fastened to the hose fitting
Fire Cuff	Flame and fire retardent element, normally (silicone) rubber, molded over the hose and hose fittings

4 TESTS ON TFE INNER TUBES

4.1 Density and Relative Density

This test is intended to control the cristallinity of TFE inner tubes: The relative density of TFE tubing shall be measured in accordance with ARP 1153 (ISO 7258 Method A or B). The density of the TFE tubing shall be measured in accordance with ASTM D792 (ISO 7258, Method C).

4.2 Tensile Test and Elongation

This test is intended to determine the mechanical properties of the TFE tubing:

4.2.1 Test Conditions

Test specimens shall be conditioned for at least two hours at room temperature (see paragraph 3).

4.2.2 Testing Machine

Tension tests shall be conducted on a power-driven machine which maintains a uniform rate of grip separation at 50 mm/min (2 inch/min) and which has a suitable dynamometer and a device for measuring the applied force within $\pm 2\%$. If the capacity range cannot be changed during a test as in the case of pendulum dynamometers, the applied force at break shall be measured within $\pm 2\%$, and the smallest tensile force measured shall be accurate to within $\pm 10\%$. If the dynamometer is of the compensating type for measuring tensile stress directly, means shall be provided to adjust for the cross-sectional area of the specimen. The response of the recorder shall be sufficiently rapid that the applied force is measured accurately during the extension of the specimen to rupture. If the test machine is not equipped with a recorder, a device shall be provided that indicates after rupture the maximum force applied during extension. Test machines shall be capable of measuring elongation in increments of 10%.

4.2.3 Micrometers

The micrometer used for measuring flat specimen thickness shall be capable of exerting a pressure of 22 ± 5 kPa (3.2 ± 0.7 psi) on the specimens and of measuring the thickness to within ± 0.025 mm (0.001 inch).

Note — Dial micrometers exerting a force of 0.80 ± 0.15 N (85 gf) on a circular foot 6.35 mm (0.25 inch) in diameter, or 0.20 ± 0.04 N (20 gf) on a circular foot 3.2 mm (0.125 inch) in diameter conform to this pressure requirement. A micrometer should not be used to measure the thickness of specimens narrower in width than the diameter of the foot unless the contact pressure is properly adjusted.

4.2.4 Calibration of Testing Machine

The testing machine shall be calibrated. If the dynamometer is of the strain-gage type, calibrate the test machine at one or more forces daily at regular intervals.

4.2.5 Tensile Test Specimens

Tensile test specimens shall be in accordance with Figure 1.

Note—Careful maintenance of die cutting edges is of extreme importance and can be obtained by light daily honing and touching up the cutting edges with jewelers' hard honing stones. The condition of the die may be judged by investigating the rupture point on any series of broken specimens. When broken specimens are removed from the clamps of the testing machine, it is advantageous to pile these specimens and note if there is any tendency to break at or near the same portion of each specimen. Rupture points consistently occurring at the same place may be an indication that the die is dull, nicked, or bent at that particular position.

4.2.6 Determination of Tensile Strength and Elongation

Place specimens in the jaws of the testing machine, using care to adjust the specimen symmetrically in order that the tension will be distributed uniformly over the cross section. Start the machine and note continuously the distance between the jaws, taking care to avoid parallax. At rupture, measure and record the elongation to the nearest 10% on the scale.

4.2.7 Calculation

- a. Calculate the tensile strength as follows:

$$\text{Tensile strength, MPa} = F/A$$

where:

- F = observed force, in Newtons (N) required to rupture the specimens, and
 A = cross-sectional area, in mm² of the unstretched specimen
 (Note: 1 N/mm² = 1 MPa)

- b. Calculate the elongation as follows:

$$\text{Elongation, \%} = (L - L_0)/L_0 \times 100$$

where:

- L = observed distance between the jaws at rupture of the specimen, and
 L₀ = original distance between the jaws

4.3 Tube Roll and Proof Test

This test is intended to verify that there are no flaws in the sintered tube:

4.3.1 Tube Rolling

Each tube shall be passed, in a single pass, through six sets of metal rollers so that it is subjected to the following sequence of diametral flexings; rollers shall be arranged to prevent inadvertent rotation of the tube. It is assumed that the tube is in a horizontal position and that pressure of the first set of rolls is exerted vertically; angles given for the final three sets of rolls may be taken as either clockwise or counterclockwise from the vertical diameter of the tube. Roller angles are specified in Table I. A tolerance of ± 2 degree is allowed on each roller angle. The roller gap dimensions are specified in Table II.

TABLE I. ROLLER FUNCTIONS AND ANGLES

Phase	Type of Action	Roller Angle degree
A	Flattening	0
B	Flattening	90
C	Rounding	0
D	Flattening	45
E	Flattening	135
F	Rounding	45

Roller gaps shall not be larger than specified in Table II below for each size.

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TABLE II. GAP DIMENSIONS FOR ROLLING

DN (dash)	Flattening Gap - Maximum				Rounding Gap - Maximum			
	10,500 kPa (1,500 psi) hose		21,000 kPa (3,000 psi) and 28,000 kPa (4000 psi) hose		10,500 kPa (1,500 psi) hose		21,000 kPa (3,000 psi) and 28,000 kPa (4000 psi) hose	
	mm	(in)	mm	(in)	mm	(in)	mm	(in)
05 (03)	5.2	(0.203)	—	—	5.5	(0.218)	—	—
06 (04)	5.5	(0.218)	7.1	(.281)	5.5	(0.218)	6.4	(.250)
08 (05)	5.5	(0.218)	—	—	6.4	(0.250)	—	—
10 (06)	5.5	(0.218)	7.1	(.281)	7.9	(0.312)	8.3	(.328)
12 (08)	5.9	(0.234)	8.3	(.328)	9.5	(0.375)	11.9	(.469)
16 (10)	6.4	(0.250)	8.3	(.328)	12.7	(0.500)	14.7	(.578)
20 (12)	6.4	(0.250)	8.3	(.328)	12.7	(0.500)	17.5	(.688)
25 (16)	6.4	(0.250)	8.3	(.328)	19.1	(0.750)	21.0	(.828)
32 (20)	7.9	(0.312)	11.1	(.438)	22.2	(0.875)	25.4	(1.000)
40 (24)	9.5	(0.375)	—	—	31.8	(1.250)	—	—

4.3.2

Proof Test

Following the roll test the tube shall be held for not less than two minutes at pressures as shown in Table III, using water or air as the test medium.

TABLE III. PROOF PRESSURES OF HOSE INNER TUBE

Size DN (dash)	Proof Pressure			
	10,500 kPa (1,500 psi) hose		21,000 kPa (3,000 psi) and 28,000 kPa (4000 psi) hose	
	kPa	(psi)	kPa	(psi)
05 (03)	2690	(390)	—	—
06 (04)	2480	(360)	2620	(380)
08 (05)	2000	(290)	—	—
10 (06)	1590	(230)	1930	(280)
12 (08)	1240	(180)	1520	(220)
16 (10)	1170	(170)	1170	(170)
20 (12)	965	(140)	890	(130)
25 (16)	621	(90)	660	(95)
32 (20)	448	(65)	660	(95)
40 (24)	310	(45)	—	—

4.4 Electrical conductivity test

- 4.4.1 The test specimen shall be a 350mm (14 inch) length of TFE hose tube, with braid removed. The inner surface of the tube shall be washed first with solvent per P-D-680 (Appendix A(7) and then with isopropyl alcohol per TT-I-735 (Appendix A(2) to remove surface contamination. The tube inside shall then be thoroughly dried at room temperature).
- 4.4.2 The test specimen shall then be arranged vertically as shown on Figure 2. The relative humidity shall be kept below 70 percent. One thousand volts direct current shall be applied between the upper (salt water or mercury) electrode and lower (adapter) electrode. The salt water solution shall be 450 grams of Na Cl in 1 liter chemically pure water.
- 4.4.3 The current shall be measured with an instrument with a sensitivity of at least 1 microampere (1×10^{-6}).

5. HOSE AND HOSE ASSEMBLY TESTS

5.1 Stress Degradation Test

This test is intended to verify that the hose inner tube has been sintered and quenched to the proper crystallinity, to eliminate stress cracking or creep with subsequent leakage:

- 5.1.1 21,000 kPa (3000 psi) and 28,000 kPa (4000 psi) Hose

The hose assemblies shall be subjected to the following test sequence:

- a. The hose assemblies shall be filled with a high-temperature test fluid per MIL-L-7808 (Appendix A(3)) and placed in an oven which shall be maintained at $204^{\circ} \pm 5^{\circ}\text{C}$ ($400^{\circ} \pm 10^{\circ}\text{F}$). The nominal working pressure specified by the procurement specification shall be applied to the hose assemblies.

Note — Precautions shall be taken to assure that the hose assemblies do not come in contact with parts of the oven that are at a higher temperature.

- b. After a minimum of 20 hours at 204°C (400°F), the pressure shall be gradually released and the assemblies removed from the oven, drained, and cooled to room temperature. The assemblies shall then be flushed with a quantity of new test fluid per MIL-L-7808 (Appendix A(3)), equivalent in volume to at least twice the test sample volume and drained.

- c. The hose assemblies shall then be filled with hydraulic test fluid per MIL-H-5606 (Appendix A(4)). The nominal working pressure specified by the procurement specification shall be applied and held for a minimum of two (2) hours at room temperature.
- d. The procedure specified in steps a, b, and c shall be repeated a total of three (3) times.
- e. Within four (4) hours after the final two (2) hour pressurization period, the hose assemblies shall be drained and flushed with trichloroethylene per MIL-T-27602 (Appendix A(5)) and placed in an oven for one (1) hour. The temperature of the oven shall be maintained at $70^{\circ}\text{C} \pm 5^{\circ}\text{C}$.
- f. Within eight hours after completion of the drying process the hose assemblies shall be removed from the oven, cooled to room temperature, and then subjected to an air under water test. To conduct this test, the hose assemblies shall be installed in an apparatus constructed similar to that shown in Figure 3.
- g. The test setup with the installed hose assembly shall be immersed in water. Nominal pressure shall be applied for 15 minutes to allow any entrapped air in the hose to escape.
- h. The pressure shall be held an additional five (5) minute period, during which time the effused gas shall be collected from the test sample, including the juncture of the hose and the fitting, but not including the fitting nut. After the five (5) minute period of pressurization, the average rate of effusion through the hose and two (2) fittings shall be computed into milliliter per minute per meter of hose length.

5.1.2 10,500 kPa (1,500 psi) Hose

The hose assemblies shall be tested in the same manner as specified in 5.1.1 except that the test temperature shall be $232^{\circ} \pm 5^{\circ}\text{C}$ ($450^{\circ} \pm 10^{\circ}\text{F}$) instead of 204°C (400°F).

5.2 Pneumatic Effusion Test

This test is intended to show that the hose inner tube does not have excessive porosity: The hose assemblies shall be subjected for 1 hour to nominal pressure using dry air or N_2 at room temperature. The gas escaping from the hose assembly during the second half hour shall be

collected and measured, using the water displacement method and an air collecting device similar to that depicted in Figure 3.

Note—The fluid in the test device shall be water which has been treated for pH control and wetting of the hose by adding 1.5 % by volume of water softener or wetting agent.

5.3 Electrical Conductivity Test

This test is intended to show that the tube is sufficiently conductive to prevent build-up of excessive electrostatic charges which could cause arcing and pin holes. The conductivity test shall be conducted as follows:

- a. The test specimen shall be a length of hose (with braid and one end fitting) as shown in Figure 4. The inner surface of the tube shall be washed first with solvent per P-D-680 (Appendix A(1) and then with isopropyl alcohol per TT-I-735 (Appendix A(2) to remove surface contamination and thoroughly dried at room temperature. The wire braid shall flare out as shown in Figure 4 to prevent contact with the end of the TFE tube. One steel adapter of appropriate size shall be assembled to the hose end fitting as shown on Figure 4.
- b. The test specimen shall then be arranged vertically. The relative humidity shall be kept below 70%. One thousand (1,000) volts direct current shall be applied between the upper (salt water or mercury) electrode and the lower (adapter) electrode. The salt water solution shall be 450 grams Na CL in 1 liter chemically pure water.
- c. The current shall be measured with an instrument with a sensitivity of at least one (1) microampere (1×10^{-6} ampere).

5.4 Visual and Dimensional Inspection

Hose assemblies shall be inspected using the normal tools and procedures.

5.5 Elongation and Contraction

This test is intended to verify that the proper reinforcing angle was used. With the hose held in a straight position, unpressurized, a 250 mm gage length shall be marked off on the hose and the hose then subjected to the nominal operating pressure shown in the procurement specification. After a minimum of (5) minutes, while still pressurized, the gage length shall be measured and the change in length calculated.

5.6 Volumetric Expansion

This test is intended to determine the increase in volume that occurs when a hose assembly is pressurized:

5.6.1 Test Set-Up

The test set-up shall be designed in such a way that air pockets cannot form. There shall be only one low point between the reservoir and the pump (see Figure 5). The internal passages shall not have constrictions or surface roughness that could allow air pockets. The hose end fittings and system tubes shall be sufficiently strong and rigid to allow only negligible expansion under test pressure. The test fluid shall be distilled water. The pump pressure shall be increased at a rate of 2000 kPa/sec (285 psi/sec) to 3000 kPa/sec (430 psi/sec).

5.6.2 Variation in Volume

The test procedure shall be as follows, and as illustrated in Figure 5.

- a. The hose assembly to be tested shall be installed at D.
- b. The valve C shall be set to the position indicated in the diagram.
- c. Valve E shall be opened.
- d. Valve F shall be closed.
- e. The pump shall be operated until the water is visible in the tube G.
- f. The valve E shall be closed.
- g. The hose assembly shall be subjected to the appropriate proof pressure for 3 minutes and the system checked for leakage.
- h. The valve E shall be opened.
- i. The water level shall be brought to zero in tube G, using the pump and valve F.
- k. The valve F and then valve E shall be closed.
- l. The pressure in the system shall be raised to the appropriate test pressure and held there for 3 to 6 minutes.
- m. The valve C shall be closed.
- n. The valve E shall be opened.
- o. The increase in the volume of the hose assembly is indicated by the difference in level in the graduated tube. Subtract from this the expansion of the rest of the system which has been measured beforehand.

5.7 Leakage Test

This test is intended to demonstrate that the hose will not rupture at 70% of the minimum required burst pressure: The hose assemblies shall be pressurized with water or system fluid to 70% of the minimum room temperature burst pressure shown in the procurement specification and held for five (5) minutes minimum. The pressure shall then be reduced to zero (0) kPa, after which it shall again be raised to 70% of the minimum room temperature burst pressure for a final five (5) minute check.

5.8 Proof Pressure Test

This test is intended to verify the structural integrity of a hose assembly prior to its use: All hose assemblies shall be tested to the proof pressure specified in the procurement specification for not less than 30 seconds and not more than five (5) minutes. The test fluid may be either water or system fluid. Proof pressure test of hose assemblies having firesleeves shall use water as the test medium. Proof pressure shall be held for a minimum of two (2) minutes, during which time any firesleeves installed on the specimens shall be pulled back from the end fittings, and prior to the installation of fitting cuffs or sleeves.

Note — The proof test shall be repeated if temperature is applied during the installation of cuffs or sleeves.

5.9 Burst

This test is intended to establish failure mode under overpressure at room temperature and at high temperature. The testing shall be conducted as described below: The hose assemblies shall be tested in the straight condition, the end opposite to the pressure source being left free. The assemblies shall be observed throughout the test. The type of failure, and the pressure at which it occurred, shall be recorded.

5.9.1 Room Temperature Burst Pressure Test

The hose assemblies shall be subjected to pressure and the pressure increased until burst of the assembly occurs. The test fluid shall be hydraulic fluid or water. Pressure shall be applied with a rate of pressure rise of $150,000 \pm 37,500$ kPa (1500 ± 375 bar) per minute ($20,000 \pm 5,000$ psi per minute).

Note — The room temperature burst pressure shall be in accordance with the procurement document. For system pressures of class B per MA 2001-ISO 6771 (10,500 kPa) and over it shall never be less than four times the nominal pressure.

5.9.2 High Temperature Burst Pressure Test

The hose assemblies shall be filled with a suitable test fluid. The 10,500 kPa (1500 psi) hose assemblies shall be soaked for one hour with ambient and fluid temperature at $232^{\circ}\text{C} \pm 5^{\circ}\text{C}$ ($450^{\circ}\text{F} \pm 10^{\circ}\text{F}$) all others at $204^{\circ}\text{C} \pm 5^{\circ}\text{C}$ ($400^{\circ}\text{F} \pm 10^{\circ}\text{F}$). After one hour, the pressure shall be raised to the rated operating pressure and held there for five minutes. The high ten penative penapressure shall be increased at the rate of $150,000 \pm 37,500$ kPa (1500 ± 375 bar) per minute (20000 ± 5000 psi/min) until rupture or leakage occurs.

Note — The high temperature burst pressure shall be in accordance with the procurement specification. For system pressures of class B per ISO 6771 (10,500 kPa) and over it shall never be less than three times the nominal pressure.

5.10 Impulse

This test is intended to verify the service life of a hose assembly when exposed to hydraulic pressure cycling and surging: The procedure shall be as follows:

- a. Prior to the impulse test, the hose assemblies shall be aged and/or exposed to a salt solution soak test if so specified in the procurement specification.
- b. The hose assemblies shall be connected to rigid supports in the test rig and bent through 180° to the appropriate minimum bend radius specified in the procurement specification.
- c. Using system fluid or a high temperature test fluid per MIL-L-7808 (Appendix A(3), MIL-H-83282 A(6), or equivalent, hose assemblies for MA 2001-ISO 6771 class B system pressures (10,500 kPa) and above shall be subjected to impulse testing in accordance with MA 2002 (ISO 6772). During the test, the fluid and ambient temperatures shall vary per MA 2002 (ISO 6772). The test shall be run in such a manner that the hose assemblies shall be temperature-cycled a minimum of two times.

5.11 Flexibility

This test is intended to demonstrate the flexure fatigue performance of hose braids and fitting attachments: The hose assemblies shall be filled with system fluid per MIL-H-83282 (Appendix A(6), MIL-H-8446 (Appendix A(7) or equivalent and mounted in the assembly flex test setup as illustrated on Figure 6 and subjected to the following test sequence. Flexing shall occur at a rate of 70 ± 10 cycles per minute during portions c, d, and e.

- a. The test assemblies shall be held without pressure and without flexing at a temperature of $-55^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ($-65^{\circ}\text{F} \pm 2^{\circ}\text{F}$) for a minimum of one (1) hour.

- b. With no flexing, and the temperature still at -55°C , the test assemblies shall be pressurized to the specified proof pressure, for a minimum of five (5) minutes (first cycle only).
- c. Flexing shall begin while the test assemblies are pressurized to the nominal pressure, with the temperature still at -55°C , for a minimum of 4000 flex cycles.
- d. With the pressure reduced to zero (0) kPa, flexing shall continue for 1000 flex cycles at -55°C .
- e. The temperature shall be increased to 204°C and the hose assemblies flexed for a further 1000 cycles with pressure at zero (0) kPa. The pressure shall then be increased to the specified nominal pressure with the temperature held at 204°C . Flexing shall continue at that pressure and temperature for an additional 74,000 cycles until an accumulated total of 80,000 cycles is reached.
- f. Steps a, c, d, and e shall be repeated for a total of five (5) test sequences (i.e., 400,000 flexing cycles).
- g. After completion of step f, and with no flexing, the test assemblies shall be pressurized to the specified proof pressure with the temperature still at 204°C for a minimum of five (5) minutes (last cycle only).

5.12 Fuel Resistance Test

This test is intended to demonstrate the suitability of hydraulic hose for fuel system use. Samples shall be tested as follows:

- 5.12.1 The samples shall be filled with solvent conforming to P-D-680 (Appendix A(1) or fuel conforming to MIL-J-5161 (Appendix A(8) or MIL-T-5624 (Appendix A(9) and placed in an oven maintained at a temperature of $125^{\circ}\text{C} \pm 5^{\circ}\text{C}$ ($260^{\circ}\text{F} \pm 10^{\circ}\text{F}$) for a period of 48 hours. Precautions shall be taken to assure that the samples do not come in contact with parts of the oven that are at a higher temperature. Pressures equal to the specified nominal pressures shall be applied to the test samples throughout the 48-hour period.
- 5.12.2 At the end of the 48-hour period, the test samples shall be depressurized, drained, and allowed to cool for 20 minutes at room temperature. The samples shall then be filled with appropriate test fluid conforming to TT-I-735 (Appendix A(10) and a pressure equal to the rated nominal pressure applied and maintained at room temperature for a minimum of two hours.

5.13 Low Temperature Flexing

This test is primarily intended to verify usability for fuel systems: The samples shall be filled with appropriate test fluid TT-S-753 (Appendix A(10)) and placed in a cold chamber maintained at a temperature of $-55^{\circ} \pm 1^{\circ}\text{C}$ ($-65^{\circ} \pm 2^{\circ}\text{F}$) for 24 hours. At the end of this time and while still at this temperature, the samples shall be bent around a mandrel with a radius equal to the minimum bend radius specified in the procurement specification. The bend shall then be reversed and returned to the straight position. This cycle shall be repeated for a total of five times allowing a maximum of ten seconds per cycle.

5.14 Pneumatic Leakage Test

This test is intended to verify usability of a hose assembly in areas where no pneumatic leakage is permissible. At room temperature, and while submerged under water, the hose assemblies shall be tested with air or N_2 at nominal pressure for at least five minutes.

5.15 Vacuum Test

This test is intended to verify assemblies for applications where negative pressures could occur: The samples shall be emptied, bent to the minimum bend radius as specified for the hose, and placed in an oven, maintained at $204^{\circ}\text{C} \pm 5^{\circ}\text{C}$ ($400^{\circ} \pm 10^{\circ}\text{F}$) unless specified otherwise in the procurement specification. The specified negative pressure shall then be applied to the assemblies and maintained. At the end of four hours, the assemblies shall be removed from the oven with the negative pressure maintained. When the samples have cooled to room temperature, the pressure shall be released and the hose inspected for collapse or defects. One end of each sample shall then be cut off within 25mm (one inch) of a fitting and a ball of the appropriate diameter as specified in the procurement specification shall be rolled through the length of the hose.

5.16 Pneumatic Surge Test

The hose assembly is installed in a gas system (air or nitrogen) fitted with rapid action valves as shown in Figure 7. The test, conducted at room temperature, consists of 16 times the following cycle:

- Nominal pressure is held in the hose assembly for 25 minutes
- It is then rapidly reduced to atmospheric pressure and held there for 5 minutes.

After this test, the hose assembly shall be subjected to proof pressure testing and shall be visually examined internally and externally.

5.17 Thermal Shock Test

The thermal shock test shall be as follows:

- a. Hose assemblies shall be air aged or unaged as specified in the procurement specification. The assemblies shall be subjected to the specified proof pressure for a minimum of five (5) minutes.
- b. The test assemblies shall then be mounted, empty, in a high temperature test fixture as illustrated in MA 2003 - ISO 6773, and the ambient temperature reduced to $-55^{\circ} \pm 1^{\circ}\text{C}$ ($-65^{\circ} \pm 2^{\circ}\text{F}$) for a minimum of two (2) hours. At the end of this period, while still at this temperature, high temperature test fluid at a temperature of $204^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($400^{\circ}\text{F} \pm 5^{\circ}\text{F}$) shall be suddenly introduced at a minimum pressure of 350 kPa (50 psi). Immediately after the hot oil has filled the assembly, the pressure shall be raised to the specified proof pressure for a minimum of five (5) minutes. Not more than 15 seconds shall elapse between the introduction of the high temperature oil at 350 kPa (50 psi) and the raising of the pressure to proof pressure.
- c. The test assemblies shall then be filled with a suitable high temperature test fluid at a pressure of 525 ± 175 kPa (75 ± 25 psi) and the test chamber and fluid temperature maintained at $204^{\circ} \pm 3^{\circ}\text{C}$ ($400^{\circ} \pm 5^{\circ}\text{F}$) for one (1) hour. At the end of this period, the assemblies shall be pressurized to the specified proof pressure for a minimum of five (5) minutes. The pressure shall then be released and, while still maintaining $204 \pm 3^{\circ}\text{C}$ ($400^{\circ} \pm 5^{\circ}\text{F}$) the pressure shall be increased at a rate of $150,000 \pm 37,500$ kPa/minute ($20,000 \pm 5000$ psi/minute) rise until failure is obtained. The hose assemblies shall be under continuous observation during the preceding test, and the pressure at which the failure occurred and the type of failure shall be recorded.

5.18 Fire Test

Hose assemblies having fire-protective elements such as cuffs or sleeves shall be tested in accordance with AS 1055 (ISO/TR 2685).