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SAE J51 JUL88

Automotive Air Conditioning Hose

SAE Standard
Revised July 1988

Submitted for Recognition as an American National Standard

SAE The Engineering Society For Advancing Mobility Land Sea Air and Space ®

400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

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MATERIALS STANDARD

SAE J51

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AUTOMOTIVE AIR CONDITIONING HOSE

1. SCOPE:

This specification covers reinforced rubber and reinforced thermoplastic hose, or hose assemblies, intended for conducting liquid and gaseous dichlorodifluoromethane (refrigerant 12) in automotive air conditioning systems. The hose shall be designed to minimize permeation of refrigerant 12 and contamination of the system and to be serviceable over a temperature range of -30 to 120°C (-22 to 248°F). Specific construction details are to be agreed upon between user and supplier.

2. MANUFACTURE:

2.1 Size: Standard dimensions are given in Table 1.

2.2 Type A1 and A2 - Rubber, Textile Reinforced: The hose shall be built having a seamless oil resistant synthetic rubber tube. The reinforcement shall consist of textile yarn, cord, or fabric adhered to the tube and cover. The outer cover shall be heat and ozone-resistant synthetic rubber. It is recommended that the cover be pin-pricked.

NOTE: Commercial product normally offered for Type A1 hose has been a one braid reinforcement of rayon textile yarn with a smaller OD than Type A2 hoses. Type A2 hose has been been a two braid hose. Hose fittings for Type A1 and A2 hoses are not normally interchangeable.

TABLE 1 - Automotive Air Conditioning Hose Dimensions[b,c]

Inside Diameter													
Size		Type A1, A2, B1				Type C				Type B2, D[a]			
		Max		Min		Max		Min		Max		Min	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
4.8	3/16					5.1	0.202	4.6	0.182	5.4	0.214	4.8	0.188
6.4	1/4	7.0	0.275	6.2	0.245	6.7	0.265	6.1	0.240				
8	5/16	8.6	0.337	7.8	0.307	8.3	0.327	7.6	0.300	8.7	0.343	8.0	0.313
9.5	3/8					9.9	0.390	9.1	0.360				
10	13/32	11.1	0.436	10.2	0.401	10.7	0.423	9.9	0.389	11.1	0.437	10.3	0.406
13	1/2	13.6	0.535	12.4	0.490	13.2	0.520	12.2	0.480	13.7	0.539	12.7	0.500
16	5/8	16.8	0.660	15.6	0.615	16.5	0.650	15.2	0.680	16.9	0.667	15.9	0.625
22	7/8									23.3	0.917	22.2	0.875
29	1-1/8									29.8	1.172	28.6	1.125

Outside Diameter																	
Type A1				Type A2				Type B1				Type C[b]		Type B2, D[a]			
Max		Min		Max		Min		Max		Min		Max		Max		Min	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
														13.7	0.530	12.7	0.500
15.1	0.594	13.5	0.532					16.5	0.648	15.3	0.602	8.3	0.328				
												11.4	0.450	17.6	0.695	16.7	0.656
19.1	0.750	17.5	0.688	19.8	0.781	18.3	0.719	18.8	0.742	17.7	0.696	13.5	0.530				
												15.2	0.600	20.0	0.789	18.9	0.743
23.0	0.906	21.4	0.844	23.8	0.937	22.2	0.875	21.2	0.835	20.0	0.789	16.1	0.635	24.0	0.945	22.8	0.899
25.4	1.000	23.8	0.937	26.2	1.031	24.6	0.969	23.8	0.937	22.2	0.875	18.8	0.740	28.0	1.101	26.8	1.055
28.5	1.124	27.8	1.062	29.4	1.156	27.8	1.094	27.0	1.062	25.4	1.000	23.4	0.920	32.2	1.266	30.6	1.205
														38.9	1.531	37.3	1.469

[a]Dimensions for 3/16 in size apply only to Type B2 hose.

[b]Fitting compatibility-fittings for thermoplastic hose may not necessarily be interchangeable. Therefore, it is recommended that fittings for hose be properly matched. Fittings or hose manufacturers' recommendations, or both, should be followed.

[c]Concentricity based on total indicator reading between inside bore of hose and outer surface of hose shall not exceed the following values:

Types A1, A2, B1, B2, and D		Type C
Sizes 6.4 mm (1/4 in) and under	0.8 mm (0.030 in)	Sizes 6.4 mm (1/4 in) and under 0.5 mm (0.020 in)
Sizes over 6.4 mm to 22 mm (1/4 to 7/8 in)	1.0 mm (0.040 in)	Sizes over 6.4 mm to 13 mm 0.6 mm (0.025 in) (1/4 to 1/2 in)
Sizes over 22 mm (7/8 in)	1.3 mm (0.050 in)	Sizes over 13 mm (1/2 in) 0.8 mm (0.030 in)

2.3 Type B1 and B2 - Rubber, Wire Reinforced: The hose shall be built having a seamless oil resistant synthetic rubber tube. The reinforcement shall consist of steel wire adhered to the rubber tube. The cover shall consist of a heat resistant textile yarn impregnated with a synthetic rubber cement.

NOTE: Type B1 hose is currently not being manufactured. Commercial product normally offered for Type B1 hose has been a one braid reinforcement of wire with unique ID and OD dimensions. Type B2 hose has been a one braid reinforcement of wire with ID and OD dimensions conforming to those specified in SAE 100R5 hose and compatible with SAE 100R5 hose fittings. Hose fittings for Types B1 and Type B2 are not normally interchangeable.

2.4 Type C - Thermoplastic, Textile Reinforced: The hose shall have a thermoplastic tube. The reinforcement shall consist of suitable textile yarn. The outer cover shall be heat and ozone resistant. It is recommended that the cover be pin-pricked.

2.5 Type D - Thermoplastic, Textile Reinforced, Rubber Covered: The hose shall have a thermoplastic tube. The reinforcement shall consist of textile yarn, cord, or fabric adhered to the tube and cover. It is recommended that the cover be pin-pricked.

3. HOSE IDENTIFICATION:

The hose shall be identified with the SAE number, type, and size of inside diameter in fraction of inches or metric mm equivalents, or both, and hose manufacturer's code marking. This marking shall appear on the outer cover of the hose at intervals not greater than 380 mm (15 in).

4. TESTING:

The test procedures described in the current issue of ASTM D 380 shall be followed whenever applicable.

4.1 Test Conditions: The temperature of the testing room shall be maintained at 23 ± 2°C (73 ± 3.6°F). The temperature of the test hose or hose assemblies shall be stabilized for 24 h at the testing room temperature prior to testing.

4.2 Permeation Tests: Hose and hose assemblies shall not permit effusion of refrigerant 12 at a rate greater than that listed in Table 2 when tested at the specified temperature. Hose and hose assemblies intended for high pressure side service (discharge and liquid line applications) shall be tested at 100 ± 2°C (212 ± 3.6°F). Hose and hose assemblies intended for low pressure side service (suction line applications) shall be tested at 80 ± 2°C (176 ± 3.6°F).

The permeation test is designed to measure, by loss of mass, the rate of effusion of refrigerant 12 through the hose wall. The apparatus required consists of canisters with internal volumes of 475 - 525 cm^3 (29 - 32 in^3) and a 21 mPa (3000 psi) minimum burst pressure with appropriate fittings to connect to the hose assemblies, halogen detector, circulating air oven capable of maintaining uniform test temperature throughout the test periods, and a weighing scale capable of mass measurements to 0.1 g accuracy.

TABLE 2 - Allowable Permeation Rate

Test Temperature		Reference Pressure		Maximum Allowable Loss of Refrigerant 12			
				$kg/m^2/year^a$		$lb/ft^2/year^a$	
°C	°F	mPa	psig	Types B2 A1, A2, B1	Types C, D	Types B2 A1, A2, B1	Types C, D
100	212	3.24	470	93	22	20	5
80	176	2.21	320	58	14	12	3

[a]Based on internal surface area of the hose.

4.2.1 Procedure: Four hose assemblies, having a free hose length of 1 m are required. Three of the hose assemblies shall be used for determining the loss of refrigerant and the fourth assembly shall be run as an empty plugged blank to be used as a means of determining the mass loss of the hose body alone.

Measure the free length of hose in each assembly at zero gage pressure to the nearest 1 mm (0.04 in). Connect each of the four hose assemblies to a canister and obtain the total mass of each test unit including end plugs to the nearest 0.1 grams.

Load three of the test units with 0.6 mg of liquid refrigerant 12 per mm^3 of each test unit's volume to a total variance of ±5 grams. Check the loaded test units with a halogen detector at a sensitivity of 11 g/year (1 lb/40 years) to be sure that they do not leak. Any suitable method for safely loading may be used.

Two suggested methods are as follows:

Method I - Hose assemblies may be conveniently loaded by conditioning the hose assemblies, connected canisters, and refrigerant 12 cylinder in a cold box for 4 h minimum at a temperature below the boiling point of the refrigerant 12. Using the density of the refrigerant 12 at the conditioning temperature, the proper load weight may be calculated in terms of volume at that temperature. While keeping the refrigerant 12, hose assemblies, and connected canisters at the conditioning temperature, they may be loaded by measuring the calculated volume of liquid refrigerant 12 with a graduate. The filled hose assemblies and connected canisters should be capped while still at the conditioning temperature, but may be removed from the cold box to complete the tightening to ensure proper seal.

4.2.1 (Continued):

Method II - The hose assemblies and connected canisters may be loaded at room temperature by transferring the refrigerant 12 under pressure through suitable valves and connections. A suitable apparatus consists of a refrigerant 12 cylinder, liquid accumulator, piston pump, and controls for metering the required charge.

Place the three loaded and one blank test units in the air oven at the specified test temperature for a period of 30 ± 5 min to drive off surface moisture. Do not bend the hose in a curve with a diameter smaller than 20 times the outside diameter of the hose while in the oven. Check the loaded test units for leakage and weight all test units not less than 15 min or more than 30 min after removal from the oven. Record the mass obtained as the original mass.

Place the test units back in the air oven at the specified temperature for 24 hours. At the end of the 24 h period, remove the test units, weight in the same manner as previously specified, and return to the oven. If a loss of 20 g or more occurs, discontinue the test, check for leaks, and repeat test procedure.

Consider the first 24 h period as the preconditioning period. Disregard the mass loss during this period in final calculations. Seventy-two hours after the preconditioning weighing, weigh in the same manner as previously described. Calculate the 72 h mass loss. Determine the effusion rate by subtracting the corresponding mass loss of the blank from that of the loaded test unit. Express the effusion rate in kg/m^2/year or lb/ft^2/year. Calculate the rate of loss of refrigerant 12 mass for the loaded test units as follows:

$$R = \left[\frac{(A - B)}{L_1} - \frac{(C - E)}{L_2} \right] \cdot \frac{K}{D}$$

Where: A = Initial mass after preconditioning period of loaded test unit, g.
B = Final mass after 72 h period of loaded test unit, g.
C = Initial mass after preconditioning period of blank test unit, g.
D = Nominal hose inside diameter, mm.
E = Final mass after 72 h period of blank test unit, g.
K = 38.7
R = Rate of refrigerant 12 mass loss, kilograms per square meter per year.
L_1 = Free hose length of loaded test unit, m.
L_2 = Free hose length of blank test unit, m.

Or Where: D = Nominal hose inside diameter, in.
K = 12.3
R = Rate of refrigerant 12 mass loss, pounds per square foot per year.
L_1 = Free hose length of loaded test unit, in.
L_2 = Free hose length of blank test unit, in.

4.3 Integrity Test: The hose shall show no signs of tube splitting causing rupture when tested at 107 ± 2°C (225 ± 3.6°F) for 24 h when loaded with refrigerant 12 as described in the Permeation Test. Three test units are required.[1] This test may be conducted as a separate test or as part of the Permeation Test by running the 24 h preconditioning period at 107 ± 2°C (225 ± 3.6°F).

4.4 Aging Test: The hose shall show no cracks or other disintegration when tested as specified after aging at 120 ± 2°C (248 ± 3.6°F) for 168 hours. The mandrel used shall have a diameter eight times the nominal OD for Types A1, A2, B1, B2, and D, and shall have a diameter twice the minimum bend radius shown in Table 3 for Type C. The test unit shall have a free hose length not less than 300 mm (12 in) or more than 1000 mm (39 in).

TABLE 3 - Minimum Bend Radius for Type C Hose

Size		Minimum Bend Radius	
mm	in	mm	in
4.8	3/16	51	2.0
6.4	1/4	76	3.0
8	5/16	89	3.5
9.5	3/8	102	4.0
10	13/32	114	4.5
13	1/2	127	5.0
16	5/8	165	6.5

4.4.1 Procedure: Coil the uncapped hose assembly around the mandrel of the designated size. Place in a circulating air oven for the time and at the temperature specified. After removal from the oven, allow the hose assembly to cool to room temperature, then open the hose assembly to a straight length and examine the hose externally for cracks or other disintegration. Place the hose assembly under an internal hydrostatic pressure of 2.4 mPa (350 psi) for a period of 5 minutes. Report any leakage through the hose as evidence of cracking.

4.5 Cold Test: The hose shall show no evidence of cracking or breaking when tested as specified. The mandrel used for Types A1, A2, B1, B2, and D shall have a diameter eight times the nominal OD of the hose and for Type C shall have a diameter twice the minimum bend radius shown in Table 3. The test hose assembly shall have a free hose length not less than 450 mm (18 in) or more than 1000 mm (39 in).

[1]Failure of this test is indicated by a weight loss exceeding 20% of the original refrigerant 12 mass.

4.5.1 Procedure: Load the test hose assembly to 70% of capacity with refrigerant 12 at room temperature. For convenience, the hose assembly and refrigerant 12 may be chilled below the boiling point of the refrigerant 12 in order that the refrigerant 12 may be handled in the liquid state. Place the loaded hose assembly in an air oven at 70 ± 2°C (158 ± 3.6°F) for 48 hours. Remove hose assembly from the air oven and allow it to cool to room temperature. Allow the liquid to remain in the hose assembly. Place the hose assembly in a straight position along with designated size mandrel in a cold chamber at -30°C (-22°F) for 24 hours. The cold chamber shall be capable of maintaining a uniform atmosphere of cold dry air or a mixture of air and carbon dioxide at the specified temperature with a tolerance of ±2°C (±3.6°F). Without removing the hose assembly from the cold chamber, bend it through 180 deg over the mandrel of the designated size at a uniform rate within a time period of 4 - 8 seconds. Allow the hose assembly to warm to room temperature and exhaust the refrigerant 12. Place the hose assembly under an internal hydrostatic pressure of 2.4 mPa (350 psi) for a period of 5 minutes. Report any leakage through the hose as evidence of cracking.

4.6 Vacuum Test: The collapse of the outside diameter of the hose shall not exceed 20% of the original outside diameter when subjected to a reduced pressure (vacuum) of 81 kPa (24 in of mercury) for 2 minutes.

4.6.1 Procedure: The test hose assembly shall have a free hose length not less than 610 mm (24 in) nor more than 1000 mm (39 in). This hose assembly shall be subjected to the vacuum test followed by length change test and then burst test. Bend the hose assembly to a "U" shape with the inside radius of the base of the "U" being five times the nominal outside diameter of the hose. Apply a reduced pressure (vacuum) of 81 kPa (24 in of mercury) to the bent hose assembly for 2 minutes. At the end of the 2 min period, while the hose is still under reduced pressure, measure the outside diameter of the hose at the base of the "U," to determine the minimum diameter in any plane.

4.7 Length Change: All hose types shall not contract in length more than 4% or elongate more than 2% when subjected to a pressure of 2.4 mPa (350 psi). Test in accordance with ASTM D 380.

4.8 Bursting Strength: The minimum bursting strength for all hose and hose assemblies except the 5/8 ID Types A1 and A2 shall be 12 mPa (1750 psi). 5/8 ID Types A1 and A2 are intended for low pressure side service and shall have minimum bursting strengths of 8.5 mPa (1250 psi). Test in accordance with ASTM D 380.

4.9 Proof Test: All hose shall satisfactorily withstand a hydrostatic proof test with a minimum hydrostatic pressure equal to 50% of the minimum required burst strength for a period not less than 30 s or more than 5 minutes.

4.10 Extraction Test: The extractables of the inside surface of the hose tube shall not exceed 118 g/m^2 (76 mg/in^2) and any extractables shall be oily or soft/greasy in nature. The test hose assembly shall have a free hose length not less than 450 mm (18 in) or more than 1000 mm (39 in).

4.10.1 Procedure: Fill the hose assembly to capacity with trichlorotrifluoroethane (refrigerant TF) and then empty it immediately to remove any surface material. Load the hose assembly to approximately 70% capacity with refrigerant 12 at room temperature. For convenience, the hose assembly and refrigerant 12 may be chilled below the boiling point of refrigerant 12 in order that the refrigerant 12 may be handled in the liquid state. Place the loaded hose assembly in the air oven at 70 ± 2°C (158 ± 3.6°F) for 24 hours. At the end of the aging period, chill the hose assembly to -34°C (-30°F) or colder and pour the liquid refrigerant 12 into a weighed beaker and allow it to evaporate at room temperature. After the refrigerant 12 has evaporated, condition the beaker at approximately 70°C (158°F) for 1 h to remove condensed moisture, then weigh the beaker again. Report the extract in terms of grams per square meter (milligrams per square inch) of the hose inner surface based on the nominal inside diameter of the hose.

4.11 Change in Volume:

4.11.1 Rubber Materials: A specimen prepared from a rubber material inner tube of the hose shall show a volume change between -5 to +35% within 5 min after removal from ASTM Oil No. 3 in which it has been immersed for 70 h at a temperature of 100 ± 2°C (212 ± 3.6°F). Test in accordance with ASTM D 380.

4.11.2 Thermoplastic Materials: A specimen prepared from a thermoplastic material tube shall show a volume change between -35 to +5% when measured within 5 min after removal from ASTM Oil No. 3 in which it has been immersed for 70 h at a temperature of 100 ± 2°C (212 ± 3.6°F). Test in accordance with ASTM D 380.

4.12 Tensile Test of Hose Assembly: The minimum force required to separate the hose from the coupling shall not be less than specified in Table 4. The test hose assembly shall have a minimum free hose length of 300 mm (12 in). Test in accordance with ASTM D 380.

4.13 Ozone Test: This test is not applicable to hoses of types B1 and B2. When the hose is bent around a mandrel with a diameter 8 times the nominal diameter of the hose and exposed for 70 h to ozone air atmosphere in which the ozone partial pressure is 50 ± 5 mPa at 40 ± 2°C (104 ± 3.6°F), the outer cover of the hose shall show no cracks when examined under 7X magnification. The test hose shall be about 250 mm (10 in) longer than the mandrel circumference. Test in accordance with ASTM D 380.

TABLE 4 - Tensile Strength of Hose Assembly

Size		Types A1, A2, C, D		Types B1, B2	
mm	in	kg	lb	kg	lb
4.8	3/16	91	200	91	200
6.4	1/4	113	250	181	400
8	5/16	159	350	272	600
9.5	3/8	204	450		
10	13/32	227	500	329	725
13	1/2	249	550	329	725
16	5/8	249	550	329	725
22	7/8	249	550	329	725
29	1-1/8	249	550	329	725

4.14 Cleanliness Test: The bore of all hose and hose assemblies shall be clean and dry. When subjected to this test, there shall not be more than 270 mg/m^2 (25 mg/ft^2) of foreign material. The test hose shall not be less than 300 mm (12 in).

4.14.1 Procedure: Bend the hose or hose assembly to a "U" shape, the legs of the "U" being of equal length. Position the hose in a vertical plane and fill the hose to capacity with trichlorotrifluoroethane (refrigerant TF). Then filter the trichlorotrifluoroethane through a prepared Gooch crucible, sintered glass crucible, or 0.8 µm filter of known weight. After drying at approximately 70°C (158°F) for 20 min, determine by weight difference the insoluble contamination.

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4.15 Impulse Test: A minimum of two hose assemblies shall be installed in a test fixture and then subjected to a pulsating pressure from 170 ± 170 kPa (25 ± 25 psi) to 2.6 mPa ± 170 kPa (375 ± 25 psi) at 30 to 40 cycles per min using a petroleum base hydraulic oil such as refrigerant oil, power steering oil or automatic transmission oil having viscosity at 107 ± 2°C (225 ± 3.6°F) of 5.0 to 10.0 cSt, at 107 ± 2°C (225 ± 3.6°F) for a minimum of 150 000 cycles with no leakage or failure. For types A1, A2, B1, B2, and D, the minimum bend radius should be five times the nominal OD of the hose. For type C hoses, see Table 3.

Test in accordance with SAE J343 JUN87, Tests and Procedures for SAE 100R Series Hydraulic Hose and Hose Assemblies.