

**Performance Requirements for SAE J844 Non-metallic Air Brake Tubing and Push  
to Connect Fitting Assemblies Used in Vehicular Air Brake Systems**

1. **Scope**—This SAE Standard is intended to establish uniform performance criteria and methods of testing push to connect tube fittings, with SAE J844 air brake tubing as used in vehicular air brake systems.

The specific tests and performance criteria applicable to the tubing are set forth in SAE J844. The test values contained in this performance standard are for test purposes only. For environmental and usage limitations, see SAE J844.

1.1 **General Requirements**

- a. Test temperature shall use  $\pm 3$  °C as the test tolerance range.
- b. Dry Air shall be a minimum of  $-50$  °C dew point
- c. Tubing shall be cut square at 90 degrees  $\pm 7$  degrees
- d. Precondition all test samples at 700 kPa  $\pm 70$  kPa for 30 s without any leakage.
- e. New samples shall be used for all tests.

2. **References**

- 2.1 **Applicable Publications**—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

- 2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J844—Nonmetallic Air Brake Tubing

SAE J2024—Contaminants for Testing Air Brake Components and Auxiliary Pneumatic Devices

- 2.1.2 ASTM PUBLICATION—Available from ASTM, 100 Barr Harbor, West Conshohocken, PA 19428-2959.

ASTM B 117—Salt Spray (Fog) Testing

ASTM D 4329—Standard Practice for Fluorescent UV exposure of Plastics

ASTM G 53—Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV- Condensation Type) for Exposure on Nonmetallic Materials

ASTM G 151—Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

ASTM G 154—Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

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**2.2 Related Publications**—The following publications are provided for information purposes only and are not a required part of this specification.

2.2.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE HS J806—SAE Oil Filter Procedure

2.2.2 FEDERAL PUBLICATION—Available from the Superintendent of Documents, U. S. Government Printing Office, Mail Stop: SSOP, Washington, DC 20402-9320.

DOT FMVSS 571.106 (49CFR 571.106) Brake Hoses

### **3. Requirements for Metallic and Non-metallic Fittings**

#### **3.1 Tensile Tests**

3.1.1 DESCRIPTION—Both hot and cold tensile tests shall be conducted with different unaged assemblies (fittings attached within 30 days of test date). Tests consist of subjecting the assembly to increasing tensile load in a suitable testing machine until the specified force value or elongation percentage has been obtained.

3.1.2 APPARATUS—A tensile testing machine with suitable indicating device shall be used for the tensile test. The fixtures for holding the test specimens shall be arranged so the tubing and fittings have a straight centerline corresponding to the direction of the machine pull. The lower part of the fixture shall be equipped with a container of sufficient dimensions to submerge the required length of tubing in water. A means of heating the water to boiling shall be provided.

3.1.3 TEST SAMPLES—The tubing sample shall be obtained from current production stock and cut to a length sufficient to obtain 150 mm  $\pm$  6 mm of tubing between end fittings after assembly. Assemble fittings to the tubing using the manufacturer's recommendations.

#### **3.1.4 PROCEDURE**

3.1.4.1 *High Temperature Tensile Test (5 samples)*—Place the test specimen in the tensile machine with the lower fitting and 102 mm (+6/-0 mm) of tubing submerged below the surface of the boiling distilled water such that the outside diameter is exposed to the water. Continue boiling for 5 min (+5/-0 min.) Apply load at a rate of pull of 25 mm/min. The test specimen shall elongate 50%, that is 150 mm increased to 225 mm, or shall withstand the load listed in Table 1 without causing separation from the fitting.

3.1.4.2 *Conditioned Tensile Test (5 samples)*—Condition test specimen at -40 °C for 30 min (+0.5/-0 min), normalize at room temperature then submerge in boiling water for 15 min. Repeat for a total of four complete cycles. Allow the test specimen to normalize at room temperature for 30 min. Conduct the tensile test within 30 min after the normalizing period while at ambient temperature of 24 °C. Apply load at a rate of 25 mm/min. The test specimen shall elongate 50%, that is 150 mm increased to 225 mm, or shall withstand the load listed in Table 1 without causing separation from the fitting.

3.1.4.3 *Water Absorption and Tensile Test (5 samples)*—After immersion in distilled water at 24 °C for 70 h, conduct tensile test on the specimen by applying a load at the rate of 25 mm/min. The tube assembly shall withstand without separation of the tube and end fittings a tensile pull as listed in Table 1.

3.1.4.4 *Acceptance Criteria*

**TABLE 1—TENSILE REQUIREMENTS**

Nominal Tubing OD (in)	Tensile Load (Newtons)
5/32	225
3/16	225
1/4	225
5/16	335
3/8	670
1/2	900
5/8	1450
3/4	1560

**3.2 Air Leakage (5 Samples)**

- 3.2.1 DESCRIPTION—This test is designed to evaluate the effects of high and low system pressures on the fitting assembly at high and low temperatures.
- 3.2.2 APPARATUS—The equipment must be capable of controlling the ambient air temperature between  $-40\text{ }^{\circ}\text{C}$  and  $104\text{ }^{\circ}\text{C}$  while applying 1035 kPa or 70 kPa dry air to the test lines. A mass flow meter capable of determining air leakage shall be provided.
- 3.2.3 TEST SAMPLES—Cut tubing sample to a length sufficient to obtain 460 mm between fittings after assembly. Assemble identical fittings to the tubing using the manufacturer's recommendation.
- 3.2.4 PROCEDURE—Place both ends of the test samples in temperature cycling cabinet and connect to a pressure source capable of  $70\text{ kPa} \pm 7\text{ kPa}$  and  $1035\text{ kPa} \pm 70\text{ kPa}$  pneumatic pressure. Pressure 4 c/h, alternating between  $70\text{ kPa} \pm 7\text{ kPa}$  and  $1035\text{ kPa} \pm 70\text{ kPa}$ . Subject the test samples while under pressure to  $24\text{ }^{\circ}\text{C}$  for 2 h,  $104\text{ }^{\circ}\text{C}$  for 12 h,  $24\text{ }^{\circ}\text{C}$  for 2 h,  $-40\text{ }^{\circ}\text{C}$  for 2 h, and  $24\text{ }^{\circ}\text{C}$  again for 2 h in the order listed.

See Table 2 and Figure 1.

**TABLE 2—AIR LEAKAGE TEST CONDITIONS**

Time (hours)	Pressure (kPa)	Temperture ( $^{\circ}\text{C}$ )
2	1035	24
14	1035	104
16	1035	24
18	1035	-40
20	1035	24

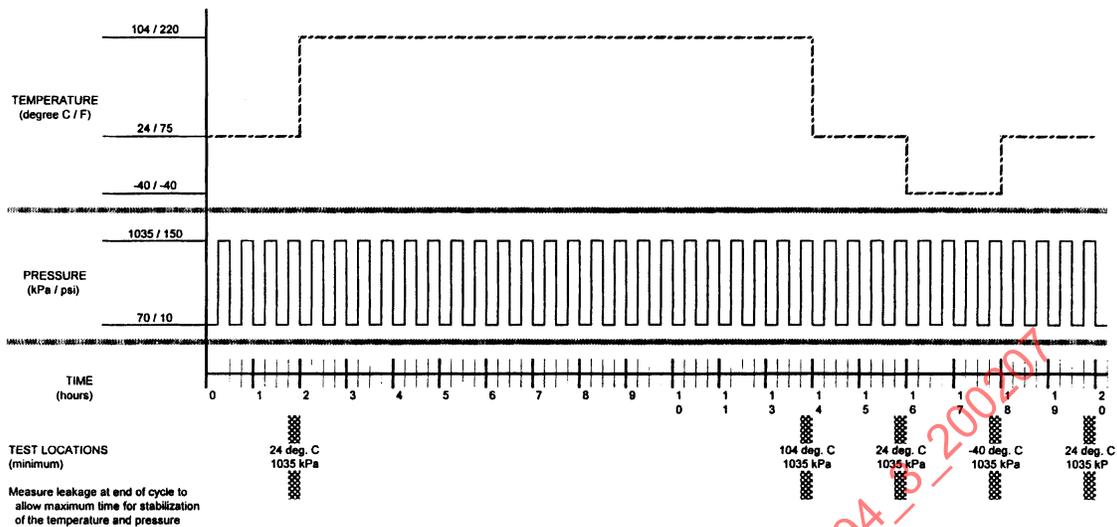


FIGURE 1—AIR LEAKAGE TEST CYCLE CHART

- 3.2.5 ACCEPTANCE CRITERIA—After the pressure in the assembly is allowed to stabilize, the test specimen is considered a failure if the average leakage per fitting on any assembly at specified test conditions in Table 2 exceeds the amounts listed in Table 3.

TABLE 3—LEAKAGE TEST REQUIREMENTS

Test Temperature (°C)	Maximum Leakage (Standard Cubic Centimeters/minute)
104	3
24	5
-40	7

### 3.3 Vibration Test (5 samples)

- 3.3.1 DESCRIPTION—This test is designed to evaluate the effects of vibration on a tube and fitting assembly under varying internal pressures and ambient temperatures. Leakage rate is used to gauge acceptability.
- 3.3.2 APPARATUS—Equipment capable of vibrating one end of the test specimen at 600 c/min through 12 mm displacement in a plane perpendicular to the tube while the other end is held rigid. The distance between the static and vibrating head is to be such, that when the assembly is displaced 12 mm, no parallel pull to the longitudinal axis of the assembly will occur. The equipment must be capable of automatically adjusting the system pressure to compensate for fluctuating temperatures between  $-40^{\circ}\text{C}$  and  $104^{\circ}\text{C}$  and associated air pressure of 830 kPa dry air during the test process. A mass flow meter capable of determining air leakage shall be provided.
- 3.3.3 TEST SAMPLES—Allowing 12.7 mm slack, cut tubing sample to a length sufficient to obtain 460 mm between fittings after assembly. Assemble identical fittings to the tubing using the manufacturer's recommendation.
- 3.3.4 PROCEDURE—Allowing 12 mm slack, mount the lines straight in the vibrating machine. Oscillate one end of the lines at 600 cycles/minute ( $\pm 20$  cpm) through a total stroke of 12 mm for a total of 1000000 cycles (+ 50 000/-0 cycles), while maintaining test conditions as shown in Table 4. Starting at  $104^{\circ}\text{C}$ , vary the ambient air temperature from  $104^{\circ}\text{C}$  to  $-40^{\circ}\text{C}$  at 250000 vibration cycle intervals. Using a mass flow meter, observe for fitting leakage during and after the test.

TABLE 4—VIBRATION TEST REQUIREMENTS

Test Cycles	Test Pressure (kPa)	Test Temperature (°C)
0/250 000	0	104
250 001/500 000	0	-40
500 001/750 000	827	104
750 001/1 000 000	827	-40

3.3.5 ACCEPTANCE CRITERIA—The test is considered a failure if the average leakage per fitting on any assembly at test temperatures exceeds the amounts listed in Table 3.

#### 3.4 Fitting Separation Pressure Test Requirements (5 samples)

3.4.1 DESCRIPTION—This test is intended to evaluate fitting retention at proof pressure of 2760 kPa  $\pm$  70 kPa and at minimum separation pressure.

3.4.2 APPARATUS—The test apparatus consists of a suitable source of hydraulic pressure and the necessary gauges and piping.

3.4.3 TEST SAMPLES—Cut tubing sample to obtain 300 mm between fittings after assembly. Assemble fittings to the tubing using the manufacturer's recommendations.

3.4.4 PROCEDURE—Plug one end of the test specimen and mount in the apparatus with the end unrestrained. Apply proof pressure at room temperature, 24 °C to the test specimen and hold for 30 s. Increase pressure at a constant rate so as to reach the specified minimum separation pressure within a time period of 3 to 15 s.

3.4.5 ACCEPTANCE CRITERIA—Fittings shall not separate from the tubing nor shall the assembly visibly leak at less than specified minimum separation pressure of 5500 kPa  $\pm$  70 kPa.

#### 3.5 Frozen Water Retention Test (5 Samples)

3.5.1 DESCRIPTION—This test is intended to evaluate the effects of frozen water on fitting retention while assembly is pressurized to 2760 kPa  $\pm$  70 kPa.

3.5.2 APPARATUS—The test apparatus consists of a suitable source of pneumatic pressure and the necessary gauges and piping.

3.5.3 TEST SAMPLES—The tubing sample shall be obtained from current production stock and cut to a length sufficient to obtain 150 mm  $\pm$  6 mm of tubing between end fittings after assembly. Assemble fittings to the tubing using the manufacturer's recommendations.

3.5.4 PROCEDURE—Submerge one end of fitting assembly in water for 15 s, then remove the specimen from the water making sure the orientation of the fitting is such that no water is allowed to drain. Place test specimen in -10 °C air for a minimum of 1 h or until completely frozen. Conduct pressure test on the specimen while at -10 °C by applying 2760 kPa  $\pm$  70 kPa pneumatic pressure and hold for 5 min.

3.5.5 ACCEPTANCE CRITERIA—Fittings shall not separate from the tubing at the specified minimum test pressure of 2760 kPa.

**3.6 Reassembly Test (5 samples)**

- 3.6.1 DESCRIPTION—This test is intended to evaluate the effects of repeated assembly and disassembly of a tube and fitting. Leakage rate is used to gauge acceptability.
- 3.6.2 APPARATUS—The test apparatus consists of a suitable source of pneumatic pressure and the necessary gauges and piping. A mass flow meter capable of determining air leakage shall be provided.
- 3.6.3 TEST SAMPLES—Cut tubing sample to obtain 305 mm between fittings after assembly. Assemble fittings to the tubing using manufacturer's recommendations.
- 3.6.4 PROCEDURE—The tube and fitting connections shall be assembled, pressurized to 830 kPa  $\pm$  70 kPa pneumatic for 5 min, depressurized and disassembled five times. Tube end must not be trimmed between each assembly and disassembly cycle. Reassemble a sixth time and pressurize the test specimen to 830kPa  $\pm$  70 kPa with pneumatic pressure at room temperature of 24 °C, hold for 5 min and check for leakage.
- 3.6.5 ACCEPTANCE CRITERIA—The test is considered a failure if the average leakage per fitting on any assembly at test temperatures exceeds the amounts listed in Table 3.

**3.7 Oil Compatibility Test (5 samples)**

- 3.7.1 DESCRIPTION—This test is intended to evaluate the effects of contaminated compressor oil as described in SAE J2024 Section 3 at high and low temperatures on fitting performance.
- 3.7.2 APPARATUS—The test apparatus consists of a suitable source of hydraulic pressure, 1035 kPa, and necessary gauges and piping in environmental test chambers at 100°C and -40°C.
- 3.7.3 TEST SAMPLES—Cut tubing sample to obtain a minimum of 300 mm between fittings after assembly. Assemble fittings to the tubing using manufacturer's recommendations.
- 3.7.4 PROCEDURE—Fill test specimens with contaminated oil mixture consisting of 11 parts SAE 15W40CD type oil and 1 part SOFTC-2A contaminate. Subject specimens to 100 °C, and atmospheric pressure for 72 h, then apply internal pressure of 1035 kPa  $\pm$  70 kPa for 5 min while maintaining temperature of 100 °C. Reduce to atmospheric pressure and permit test specimens to return to room temperature (24 °C); then subject test specimens to -40 °C and atmospheric pressure for 24 h. Then apply internal pressure of 1035 kPa  $\pm$  70kPa for 5 min while maintaining a temperature of -40 °C.
- 3.7.5 ACCEPTANCE CRITERIA—Tubing shall not rupture or disconnect from the fittings.

**3.8 Fitting Assembly Corrosion Resistance Test (5 samples)**

- 3.8.1 DESCRIPTION—This test is designed to test the effects of salt spray corrosion on fitting assembly performance.
- 3.8.2 APPARATUS—Utilize the apparatus described in ASTM B 117 Salt Spray (Fog) Testing. Mix a salt solution five parts by weight of sodium chloride to 95 parts of distilled water, using sodium chloride substantially free of nickel and copper, and containing on a dry basis not more than 0.1% of sodium iodide and not more than 0.3 percent of total impurities. Ensure that the solution is free of suspended solids before the solution is atomized. After atomization at 35 °C, ensure that the collected solution is in the pH range of 6.5 to 7.2. Make the pH measurement at 25 °C. Maintain a compressed air supply to the nozzle or nozzles free of oil and dirt and between 70 and 170 kPa. The test sample shall be supported or suspended 30 degrees from the vertical and parallel to the principal direction of the horizontal flow of fog through the chamber. The test sample shall not have contact with any metallic material or any material capable of acting as a wick.

Condensation that falls from the test sample shall not return to the solution reservoir for respraying. Condensation from any source shall not fall on the test sample or the solution collectors. Spray from the nozzles shall not be directed onto the test samples.

- 3.8.3 **TEST SAMPLES**—The test sample shall consist of two end fittings and a minimum of 200 mm of tubing between fittings.
- 3.8.4 **TEST PROCEDURE**—Subject the test samples to the salt spray continuously for 72 h. Regulate the mixture so that each collector will collect from 1 to 2 mL of solution per hour for each 80 cm<sup>2</sup> of horizontal collecting area. Maintain exposure zone temperature at 35 °C. Upon completion, remove the salt deposit from the surface of the tube assembly by washing gently or dipping in clean running water not warmer than 38 °C and then drying immediately. Allow the test assemblies to stabilize at 24 °C, then pressurize to 840 kPa ± 70kPa pneumatic pressure for 5 min.
- 3.8.5 **ACCEPTANCE CRITERIA**—After 72 h exposure to salt spray, the fittings shall show no pit corrosion on the fitting surface. The average leakage per fitting on any assembly shall not exceed in amount listed in Table 3.

### 3.9 Side Load Leakage Test (5 samples)

- 3.9.1 **DESCRIPTION**—This test is designed to evaluate the leakage effects of maximum side loading on a tube and fitting assembly at room temperature 24 °C. Leakage rate is used to gauge acceptability.
- 3.9.2 **APPARATUS**—Equipment must be capable of controlling air pressure to 1035 kPa through a manifold consisting of a fixed and an adjustable block (see Figure 2). A mass flow meter capable of determining air leakage shall be provided.

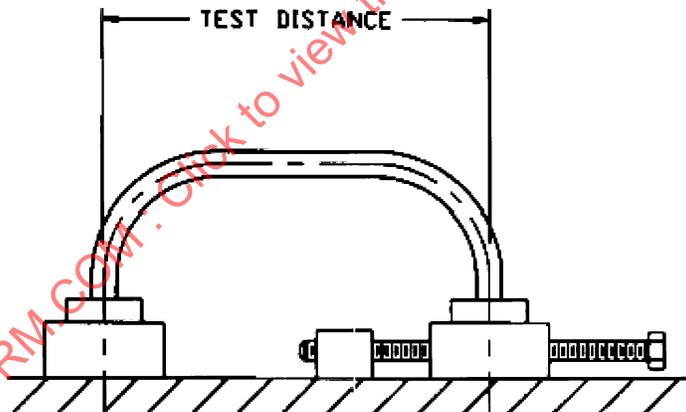


FIGURE 2—SIDE LOAD TEST FIXTURE

- 3.9.3 **TEST SAMPLES**—Prepare test sample using straight tube fittings. The length of tubing shall be determined by the following formula: Test specimen length =  $\pi(\text{minimum kink radius}^1) + 2(\text{fitting insertion depth})$ .
- 3.9.4 **TEST PROCEDURE**—Mount test specimen on test manifold blocks using identical tube fittings as shown in Figure 1. Using the adjustable block, increase the distance between the centerlines of the test fittings to equal the test distance listed in Table 5. Pressurize the test specimen to 1035 kPa at 24 °C for a period of 5 min. If the tubing kinks during the test, the test shall be restarted using another sample of tubing.

1. As listed in SAE J844 Table 3.

**TABLE 5—SIDE LOAD TEST REQUIREMENTS**

Nominal Tubing OD (in)	Test Distance (mm)
5/32	30
3/16	50
1/4	65
5/16	80
3/8	95
1/2	127
5/8	160
3/4	180

3.9.5 ACCEPTANCE CRITERIA—After 5 min, the test is considered a failure if the average leakage per fitting on any assembly at test temperature exceeds the amount listed in Table 3.

#### **4. Additional Requirements for Non-Metallic Fittings Only**

##### **4.1 Moisture Absorption (5 samples)**

4.1.1 DESCRIPTION—This test is designed to evaluate the resistance of non-metallic fitting components to moisture absorption. Change in weight is used to gauge acceptability.

4.1.2 APPARATUS—Equipment must be capable of controlling air temperature within a temperature range of 24 °C to 110 °C and relative humidity of 100% at 24 °C.

4.1.3 TEST SAMPLES—Unassembled non-metallic fitting components.

4.1.4 TEST PROCEDURE—Expose all samples of non-metallic components for 24 h in a circulating air oven at 110 °C. Remove from oven, weigh immediately and expose for 100 h at 100% relative humidity and 24 °C. Within 5 min from humidity conditioning, remove surface moisture from both interior and exterior surfaces of the non-metallic components and re-weigh.

4.1.5 ACCEPTANCE CRITERIA—Moisture absorption of each non-metallic components shall not exceed 2% by weight.

##### **4.2 Ultraviolet Resistance (5 samples)**

4.2.1 DESCRIPTION—This test is designed to evaluate the resistance of non-metallic fittings to ultraviolet radiation exposure.

4.2.2 APPARATUS—A more complete description of the apparatus may be found in ASTM D 4329. Use fluorescent UV apparatus that conforms to the requirements defined in ASTM G 151 and G 154 is required to conform to this practice. Unless otherwise specified, the spectral power distribution of the fluorescent UV lamp shall conform to the requirements in ASTM G 154 for a UVA 340 lamp.

4.2.3 TEST SAMPLES—Cut tubing sample to obtain 300 mm between fittings after assembly. Assemble fittings to the tubing using the manufacturer's recommendations.