

# Metric Nonmetallic Air Brake System Tubing – SAE J1394 APR83

SAE Standard  
Approved April 1983

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# METRIC NONMETALLIC AIR BRAKE SYSTEM TUBING—SAE J1394 APR83

## SAE Standard

Report of the Fluid Conductors and Connectors Technical Committee, approved April 1983.

**1. Scope<sup>1</sup>**—This standard covers the minimum requirements for metric sizes of nonmetallic tubing as manufactured for use in air brake systems. Non-reinforced products are designated type A and reinforced products type B. It is not intended to cover tubing for any portion of the system which operates below  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ), above  $+93^{\circ}\text{C}$  ( $+200^{\circ}\text{F}$ ), above a maximum working gage pressure of 1.0 MPa (150 psi), or in an area subject to attack by battery acid. This tubing is intended for use in the brake system for connections which maintain a basically fixed relationship between components during vehicle operation. *Coiled tube assemblies* required for those installations where flexing occurs are covered by this standard and SAE J1131 to the extent of setting minimum requirements on the essentially straight tube and tube fitting connections which are used in the construction of such assemblies.<sup>2</sup>

### 2. Installation and Assembly Recommendations

**2.1 End Fittings**—End fittings are to be assembled to the tubing in accordance with the fitting manufacturer's recommendations. The fitting may be of the design shown in the proposed metric version of SAE J246, or any other design suitable for use with metric size nonmetallic air brake tubing. Performance test requirements for nonmetallic air brake assemblies are covered in SAE J1131.

**2.2 Non-Coiled Tubing**—Non-coiled tubing should not be used in flexing applications such as frame to axle.

**2.3 Support and Routing**—When installed in a vehicle this tubing shall be routed and supported so as to:

- Eliminate chafing, abrasion, kinking, or other mechanical damage.
- Minimize fatigue conditions.
- Be protected against road hazards by installation in a protected location or by providing adequate shielding at vulnerable areas.
- Not be exposed to temperatures, internal or external, over  $+93^{\circ}\text{C}$  ( $+200^{\circ}\text{F}$ ) or below  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ).
- Not be exposed to attack by battery acid.
- Avoid excessive sag.

<sup>1</sup> The metric values contained herein are to be regarded as standard; the inch-pound values in parentheses may only be approximate. See SAE J844 for Nonmetallic Air Brake System Tubing (inch-dimensioned) and SAE J1149 for Metallic Air Brake System Tubing and Pipe.

<sup>2</sup> Federal regulations covering designed requirements and accepted applications for coiled tube assemblies are set forth in 49CFR393.45.

**3. Identification**—Air brake tubing shall be labeled in contrasting color with the legend repeated every 380 mm (15 in) or less along the entire length of tubing in legible block capital letters.

The following minimum information, in the order listed, is required. Additional information and/or another lay line may be added, if necessary.

- Metric airbrake
- SAE J1394
- Type A or B
- Nominal tubing O.D. in mm—6, 8, 12 or 16
- Tubing manufacturer's identification

**4. Manufacture**—The tubing shall be manufactured to comply with the requirements outlined in this standard.

**5. Construction**—Type A tubing shall consist of a single wall extrusion of 100% virgin nylon (polyamide) containing additives which provide heat and light resistance. Type B tubing shall consist of a core extrusion of 100% virgin nylon (polyamide) containing additives which provide heat resistance. This core shall be reinforced with polyester braid or equivalent and covered with a protective jacket of 100% virgin nylon (polyamide) containing additives which provide heat and light resistance. The protective covering shall be bonded to the core through the interstices of the braid. The inner core and outer jacket shall be of contrasting colors.

**6. Dimensions and Tolerances**—The tubing shall conform to dimensions shown in Table 1 under all conditions of moisture. Conformance with this requirement shall be determined on samples which have been subjected to  $110^{\circ}\text{C}$  ( $230^{\circ}\text{F}$ )<sup>3</sup> for 4 h<sup>4</sup> in a circulating air oven, and on separate samples which have been immersed in boiling water for 2 h. Dimensional tests shall be made after samples have been returned to room temperature for ½–3 h.

**7. Mechanical Properties**—The tubing shall conform to the mechanical properties shown in Table 2, when tested according to the method outlined in this standard.

<sup>3</sup> All test temperatures specified may vary by  $\pm 3^{\circ}\text{C}$  ( $\pm 5^{\circ}\text{F}$ ).

<sup>4</sup> All times are minimum unless otherwise specified.

TABLE 1—DIMENSIONS AND TOLERANCES

Tubing Type	Tubing Size				Minimum Wall Thickness		OD Tolerances		ID Tolerances	
	OD		ID							
	mm	in	mm	in	mm	in	mm	in	mm	in
A	6.0	0.236	4.0	0.157	0.9	0.035	±0.1	±0.004	±0.1	±0.004
A	8.0	0.315	6.0	0.236	0.9	0.035	±0.1	±0.004	±0.1	±0.004
B	12.0	0.472	9.0	0.354	1.35	0.053	±0.15	±0.006	±0.15	±0.006
B	16.0	0.629	12.0	0.472	1.8	0.071	±0.15	±0.006	±0.15	±0.006

TABLE 2—MECHANICAL PROPERTIES

Tubing Type	Nominal Tubing OD	Minimum Burst Pressure at $24^{\circ}\text{C}$ ( $75^{\circ}\text{F}$ ) <sup>a</sup>		Test Bend Radius <sup>b</sup>		Maximum Stiffness	
	mm	MPa	psi	mm	in	N	lbf
A	6	7.6	1,100	20	0.75	9	2
A	8	6.2	900	32	1.25	27	6
B	12	6.9	1,000	45	1.75	90	20
B	16	6.0	875	70	2.75	225	50

<sup>a</sup> With moisture content of tubing 0.06% max.

<sup>b</sup> For test purposes only.

**8. Performance Requirements**—The tubing shall satisfactorily meet the following performance tests (see Footnotes 3, 4, 5, and 6).

**8.1 Leak Test<sup>6</sup>**—The tubing manufacturer shall subject each continuous length of tubing to test at a gage pressure of 1.4 MPa (200 psi) with an appropriate gas for a period of time sufficient to determine the presence of any leaks. Defective sections shall be cut off and scrapped. The remaining tubing shall be recoupled at the points where defective sections were removed and again subjected to the 1.4 MPa (200 psi) pressure test. The procedure shall be repeated until all sections of tubing designated for distribution to users have successfully withstood the test.

**8.2 Moisture Absorption<sup>5</sup>**—Expose sample of tubing for 24 h in a circulating air oven at 110°C (230°F). Remove from oven, weigh immediately, and expose for 100 h at 100% relative humidity and 24°C (75°F). Within 5 min from humidity conditioning, wipe surface moisture from both the interior and exterior surfaces of the tubing and re-weigh. Moisture absorption shall not exceed 2% by weight.

**8.3 Ultraviolet Resistance<sup>5</sup>**—Place sample of tubing on a turntable 430 mm (17 in) in diameter, rotating at  $33 \pm 3$  rpm, with a RS-4\* sunlamp or equivalent centrally located 230 mm (9 in) above the table. Expose for 1200 h using a new bulb that has been seasoned for 50 h prior to test. Do not permit temperature of tubing to exceed 50°C (122°F) during

the test (a fan cooling unit may be utilized). Immediately following this exposure, subject the tubing to the impact test shown in Fig. 1. Tubing shall show no evidence of cracks. Subject tubing to Room Temperature Burst Test as specified in paragraph 8.10. Tubing shall withstand no less than 80% of the burst pressure shown in Table 2.

\*RS-4 sunlamp is manufactured by General Electric Company<sup>7</sup>  
 Cuyahoga Lamp Plant  
 Nela Park  
 Noble Road  
 Cleveland, OH 44112

\*RS-4 sunlamp is available from George W. Gates Co. Inc.  
 P. O. Box 216  
 Hempsted Turnpike and Lucille Ave.  
 Franklin Square  
 Long Island, NY 11010

The RS-4 sunlamp is a 100 W, 3 klm mercury arc lamp with an outer glass jacket which eliminates wave lengths below 285 nm.

**8.4 Cold Temperature Flexibility<sup>5</sup>**—Expose sample of tubing for 24 h in a circulating air oven at 110°C (230°F). Remove from oven and within 30 min expose for 4 h at -40°C (-40°F). Also expose a mandrel

<sup>5</sup> Normally considered a *Qualification Test*.

<sup>6</sup> Normally considered an *Inspection Test* conducted on each lot of tubing and where a lot is defined as "the output of one production shift of one size and color of tubing."

<sup>7</sup> The manufacturer and distributor of the sunlamp are listed due to the fact that at the present time they are the only known suppliers.

NOMINAL TUBE O.D.	HOLE DIA D mm	HOLE DIA D in
6	6.8	0.268
8	8.8	0.346
12	12.8	0.504
16	16.8	0.661

NOTE: Impact apparatus may be drilled to accept any combination of tube sizes listed in chart

0.454 kg (1.0 lb) mass, with a diameter of 31.75 mm (1.25 in) and a 15.88 mm (0.625 in) spherical radius on both ends. Mass falls 304.8 mm (12.0 in).

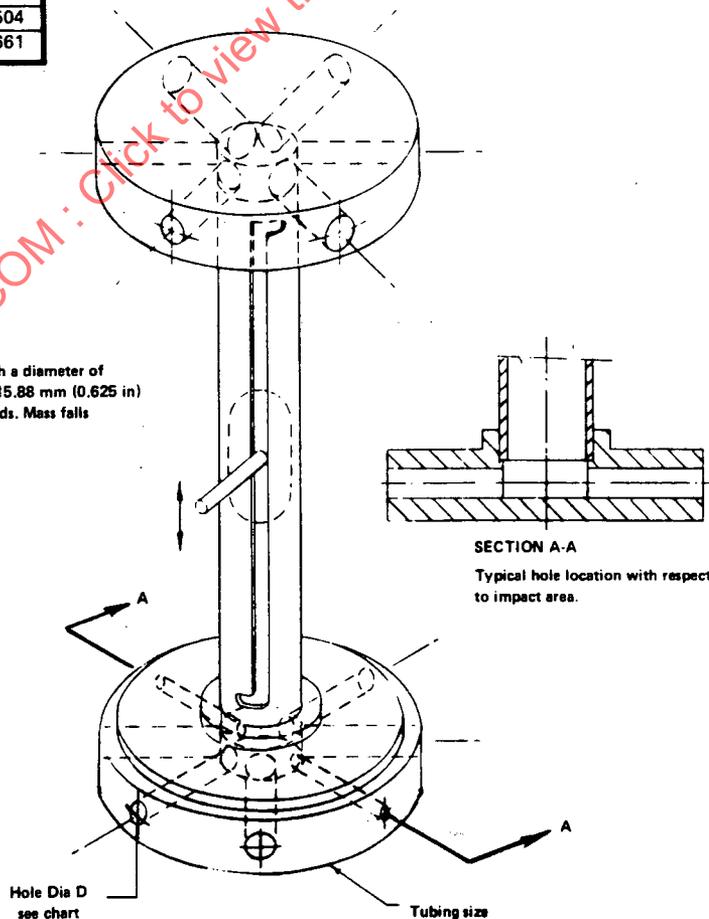


FIG. 1—TYPICAL NYLON TUBING IMPACT APPARATUS

at  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ) having a diameter equal to twelve times the nominal diameter of the tubing. (In order to obtain uniform temperatures, the tubing and mandrel may be supported by a nonmetallic surface during the entire period of test.) Immediately following this exposure, bend tubing 180 deg over the mandrel, accomplishing the bending motion within a period of 4–8 s. The tubing shall show no evidence of fracture.

**8.5 Heat Aging<sup>5</sup>**—Three separate heat aging tests shall be conducted; each phase shall be run on separate tubing samples. After the completion of each phase, tubing shall show no evidence of fracture or kinking. Subject tubing to Room Temperature Burst Test as specified in paragraph 8.10. Tubing shall withstand 80% of the burst pressure shown in Table 2.

**Phase 1**—Bend samples of tubing 180 deg around a mandrel having a diameter equivalent to twice the bend radius specified in Table 2. While in this position, expose tubing and mandrel for 72 h in an air circulating oven at  $110^{\circ}\text{C}$  ( $230^{\circ}\text{F}$ ). Remove from oven and permit tubing to return to  $24^{\circ}\text{C}$  ( $75^{\circ}\text{F}$ ) while still on the mandrel. Within 30 min after stabilization at  $24^{\circ}\text{C}$  ( $75^{\circ}\text{F}$ ), return the tubing to a straight position in a minimum of 4 s, then rebend (against the set) 180 deg around the mandrel, accomplishing the bending motion within a period of 4–8 s.

**Phase 2**—Expose samples of tubing for 72 h in a circulating air oven at  $110^{\circ}\text{C}$  ( $230^{\circ}\text{F}$ ). Remove from oven and permit tubing to return to  $24^{\circ}\text{C}$  ( $75^{\circ}\text{F}$ ). Within 30 min after stabilization at  $24^{\circ}\text{C}$  ( $75^{\circ}\text{F}$ ), subject tubing to the Impact Test shown in Fig. 1.

**Phase 3**—Immerse samples of tubing in boiling water for 2 h. Remove from water and permit to return to  $24^{\circ}\text{C}$  ( $75^{\circ}\text{F}$ ). Within 30 min after stabilization at  $24^{\circ}\text{C}$  ( $75^{\circ}\text{F}$ ), subject tubing to the Impact Test shown in Fig. 1.

**8.6 Resistance to Zinc Chloride<sup>5</sup>**—Bend tubing to the bend radius shown in Table 2. While in this position, immerse in a 50% (by weight) aqueous solution of zinc chloride for 200 h at  $24^{\circ}\text{C}$  ( $75^{\circ}\text{F}$ ). Remove

from solution. Tubing shall show no evidence of cracking on the outside diameter.

**NOTE:** Fresh, anhydrous zinc chloride should be used to make a concentration of 50% (by weight) aqueous solution (specific gravity of 1.576 or a Baume rating of  $53^{\circ}$  at  $16^{\circ}\text{C}$  [ $61^{\circ}\text{F}$ ]).

**8.7 Resistance to Methyl Alcohol<sup>5</sup>**—Bend tubing to the bend radius shown in Table 2. While in this position, immerse in 95% methyl alcohol for 200 h at  $24^{\circ}\text{C}$  ( $75^{\circ}\text{F}$ ). Remove from solution. Tubing shall show no evidence of cracking.

**8.8 Stiffness<sup>5</sup>**—Use samples 280 mm (11 in) long. Insert a rod of suitable size into the tubing to maintain a straight position within  $\pm 3$  mm (0.120 in). Expose tubing and rod for 24 h in a circulating air oven at  $110^{\circ}\text{C}$  ( $230^{\circ}\text{F}$ ). Remove from oven and permit tubing and rod to return to  $24^{\circ}\text{C}$  ( $75^{\circ}\text{F}$ ). Within 30 min after stabilization at  $24^{\circ}\text{C}$  ( $75^{\circ}\text{F}$ ), remove rod and subject tubing to Stiffness Test shown in Fig. 2. Tubing shall require no more force than specified in Table 2 to deflect 50 mm (1.97 in).

**8.9 Boiling Water Stabilization and Burst Test<sup>5</sup>**—Immerse tubing in boiling water for 2 h. Remove from water and subject to the Room Temperature Burst Test as specified in paragraph 8.10. Tubing shall withstand no less than 80% of the burst pressure shown in Table 2.

**8.10 Room Temperature Burst Test<sup>5</sup>**—Tubing shall be stabilized (for  $\frac{1}{2}$ –3 h at  $24^{\circ}\text{C}$  ( $75^{\circ}\text{F}$ ) and tested by increasing pressure at a constant rate to reach the specified minimum burst pressure in Table 2 within a time period of 3–15 s. Tubing that bursts below the pressure specified in Table 2 shall be rejected.

**8.11 Cold Temperature Impact<sup>6</sup>**—Condition tubing by exposing one half of the samples for 24 h at  $110^{\circ}\text{C}$  ( $230^{\circ}\text{F}$ ) in a circulating air oven and one half of the samples in boiling water for 2 h; then expose all the samples to  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ) for 4 h. Also, expose impact test apparatus, shown in Fig. 1, to  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ). While tubing and apparatus are at

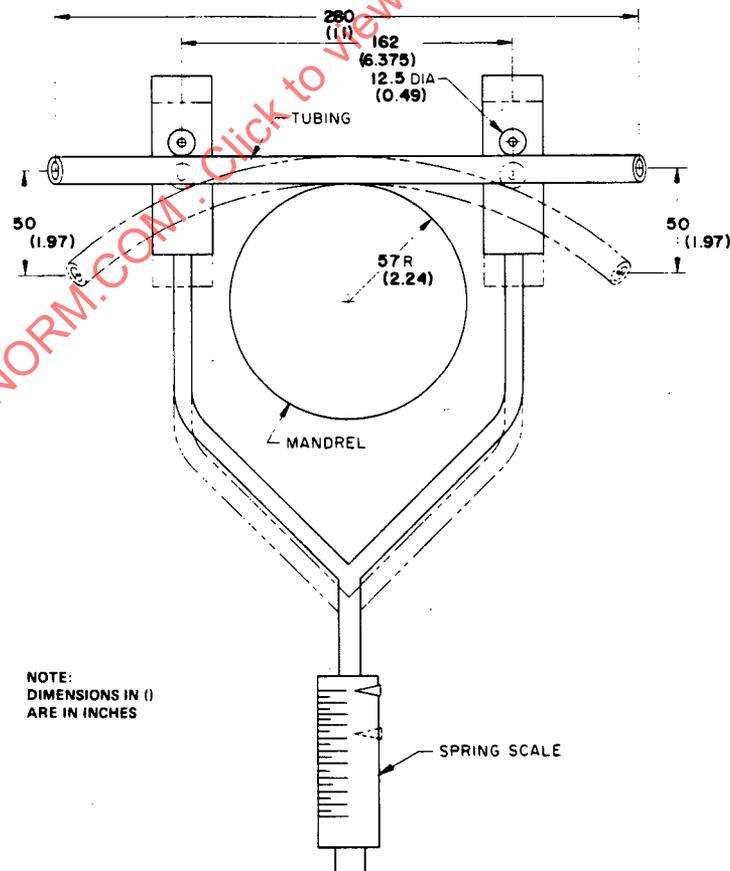


FIG. 2—STIFFNESS TEST APPARATUS