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**SAE J1394 MAY89**

**Metric Nonmetallic  
Air Brake System  
Tubing**

SAE Standard  
Revised May 1989

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**METRIC NONMETALLIC AIR BRAKE SYSTEM TUBING**

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. Nonreinforced products are designated type A and reinforced products type B. It is not intended to cover tubing for any portion of the system that 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 that 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.

<sup>1</sup>The metric values contained herein are to be regarded as standard; the in-lb 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.

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- 2.2 Noncoiled Tubing: Noncoiled 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°C (+200°F) or below -40°C (-40°F).
  - Not be exposed to attack by battery acid.
  - Avoid excessive sag.

### 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 that provide heat and light resistance. Type B tubing shall consist of a core extrusion of 100% virgin nylon (polyamide) containing additives that 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 that 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 that have been subjected to 110°C (230°F)<sup>3</sup> for 4 h<sup>4</sup> in a circulating air oven, and on separate samples that have been immersed in boiling water for 2 h. Dimensional tests shall be made after samples have been returned to room temperature for 0.5 - 3.0 h.

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

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.

TABLE 2 - Mechanical Properties

Tubing Type	Nominal Tubing OD	Minimum Burst Pressure at 24°C (75°F) <sup>a</sup>		Test Bend Radius <sup>b</sup>		Maximum Stiffness	
	mm	MPa	psi	mm	in	N	lbf
A	6	7.6	1100	20	0.75	9	2
A	8	6.2	900	32	1.25	27	6
B	12	6.9	1000	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>5</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>6</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>7</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. Subject tubing to room temperature burst test as specified in 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>8</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 that eliminates wave lengths below 285 nm.

<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.

<sup>5</sup>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>6</sup>A Qualification test.

<sup>7</sup>See Footnote 6.

<sup>8</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).

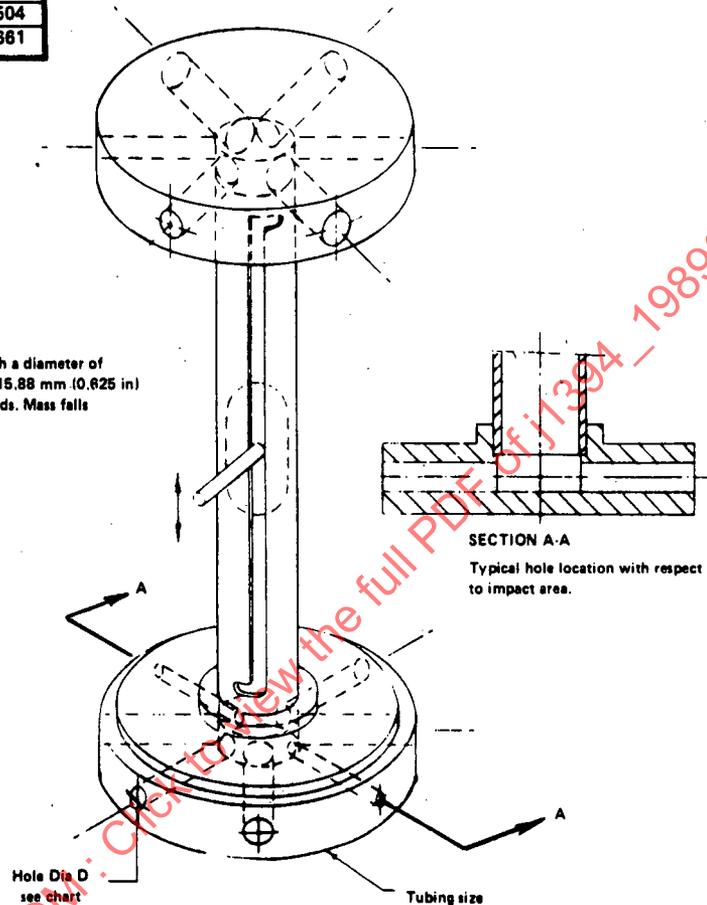


FIGURE 1 - Typical Nylon Tubing Impact Apparatus

- 8.4 Cold Temperature Flexibility<sup>9</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 at -40°C (-40°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.

<sup>9</sup>See Footnote 6.

- 8.5 Heat Aging<sup>10</sup>: Three separate heat aging tests shall be conducted; each phase shall be run on separate tubing samples. Subject tubing to room temperature burst test as specified in 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°C (230°F). Remove from oven and permit tubing to return to 24°C (75°F) while still on the mandrel. Within 30 min after stabilization at 24°C (75°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°C (230°F). Remove from oven and permit tubing to return to 24°C (75°F). Within 30 min after stabilization at 24°C (75°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°C (75°F). Within 30 min after stabilization at 24°C (75°F), subject tubing to the impact test shown in Fig. 1.

- 8.6 Resistance to Zinc Chloride<sup>11</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°C (75°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° at 16°C [61°F]).

- 8.7 Resistance to Methyl Alcohol<sup>12</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°C (75°F). Remove from solution. Tubing shall show no evidence of cracking.

- 8.8 Stiffness<sup>13</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°C (230°F). Remove from oven and permit tubing and rod to return to 24°C (75°F). Within 30 min after stabilization at 24°C (75°F), remove rod and subject tubing to the stiffness test shown in Fig. 2. Tubing shall require no more force than specified in Table 2 to deflect 50 mm (1.97 in).

<sup>10</sup>See Footnote 6.

<sup>11</sup>See Footnote 6.

<sup>12</sup>See Footnote 6.

<sup>13</sup>See Footnote 6.

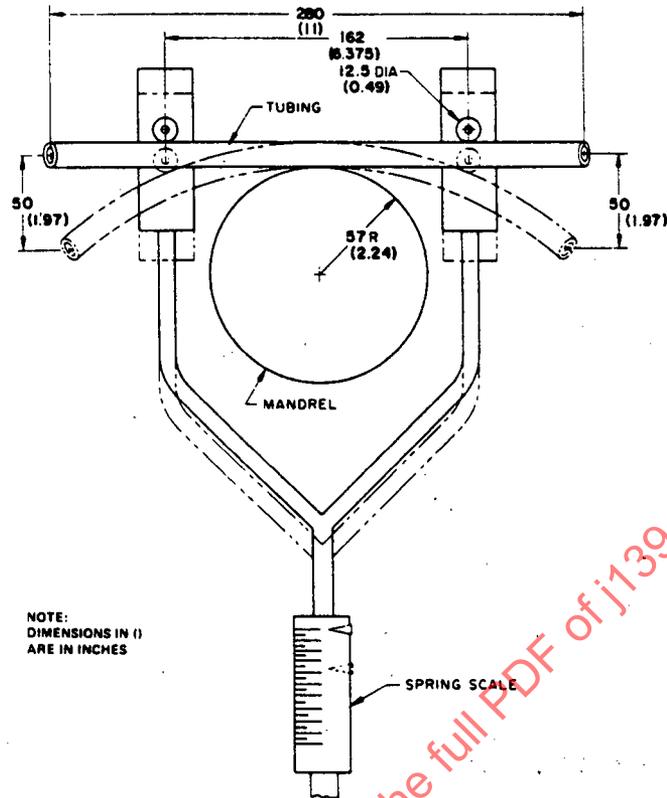


FIGURE 2 - Stiffness Test Apparatus

- 8.9 Boiling Water Stabilization and Burst Test<sup>14</sup>: Immerse tubing in boiling water for 2 h. Remove from water and subject to the room temperature burst test as specified in 8.10. Tubing shall withstand no less than 80% of the burst pressure shown in Table 2.
- 8.10 Room Temperature Burst Test<sup>15</sup>: Tubing shall be stabilized 0.5-3.0 h at 24°C (75°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>16</sup>: Condition tubing by exposing one half of the samples for 24 h at 110°C (230°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°C (-40°F) for 4 h. Also, expose impact test apparatus, shown in Fig. 1, to -40°C (-40°F). While tubing and apparatus are at this cold temperature (approximately -40°C), subject tubing to impact as specified. The tubing shall show no evidence of cracks. After impact testing, permit tubing to return to 24°C (75°F). Within 30 min after stabilization at 24°C (75°F), subject tubing to room temperature burst test as specified in 8.10. Tubing shall withstand at least 80% of the burst pressure shown in Table 2. Sample size shall be 10 specimens per lot. In the event of any failures, a second sample from the same lot consisting of 20 specimens shall be tested. If another failure occurs, the lot shall be rejected.

<sup>14</sup>See Footnote 6.<sup>15</sup>See Footnote 5.<sup>16</sup>See Footnote 5.

### 8.12 Adhesion Test<sup>17</sup>:

8.12.1 This test applies only to the reinforced products, Type B.

8.12.2 Condition: This test shall be conducted at 24°C (75°F) ambient temperature.

8.12.3 Procedure and Requirements: Cut a strip of tubing into a 6.0 mm (0.25 in) wide helical coil equal in length to five times the circumference of the tubing. Bend the helical coil in reverse of coiling so as to expose the braid gap between the outer jacket and the core tube section. Start by working a sharp knife blade into the braid gap to initiate separation, and then attempt to separate the outer jacket from the core tube at the braid interstices. The bonded surface (excluding the braided area) between the outer jacket and core section shall be inseparable for the entire test sample length.

### 8.13 Heat Aging Adhesion Test<sup>18</sup>:

8.13.1 Procedure: Subject samples to Phase 1 of the heat aging test procedure per 8.5.

8.13.2 Requirements: After completion of the Phase 1 procedure, the tubing shall meet the requirements of 8.12.

The phi (Ø) symbol is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.

<sup>17</sup>See Footnote 5.

<sup>18</sup>See Footnote 6.