SAE International™

SURFACE VEHICLE STANDARD

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Metallic Air Brake System Tubing and Pipe

RATIONALE

This document is to satisfy periodic review requirements. Data on minimum recommended bend radii for copper tubing has been added.

1. SCOPE

This SAE Standard covers minimum requirements for two types of metallic tubing and pipe as used in automotive air brake systems. It includes material and performance specifications, corrosion precautions, and installation recommendations. Copper tubing is designated Type 1, and galvanized steel pipe Type 2.

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 version of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J463 Wrought Copper and Copper Alloys

SAE J476 Dryseal Pipe Threads

2.1.2 ASTM Publications

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A 120 Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses

ASTM A 370 Methods and Definitions for Mechanical Testing of Steel Products

ASTM E 8 Methods of Tension Testing of Metallic Materials

ASTM E 62 Method of Test for Antimony in Copper and Copper Base Alloys

ASTM E 79 Methods for Estimating the Average Grain Size of Wrought Copper and Copper Base Alloys

3. CORROSION PRECAUTIONS

In the design and selection of air brake system components, adequate provision shall be made to control corrosion due to galvanic coupling of widely dissimilar metals and alloys when such materials used for tubing, pipe, fittings, and attaching or supporting parts are in intimate contact with each other. Also, adequate provision shall be made to protect the tubing, pipe, and fittings from oxygen concentration cell type of corrosion. Where soft nonmetallic cushions are used to prevent metal-to-metal contact between supporting components and tubing, pipe, and fittings, the cushioning material shall be such that it will not absorb and retain significant amounts of water.

4. INSTALLATION RECOMMENDATIONS

The tubing or pipe installed in air brake systems shall be supported in such a manner as to minimize fatigue conditions. Metal-to-metal contact should be avoided by the use of soft nonmetallic cushions at points of support to control chafing and fretting. Tubing or pipe shall be protected against road hazards either by installation in a protected location or by providing adequate shielding at vulnerable areas. Protective loom, where used, shall be both water and acid resistant.

5. SPECIFICATIONS

5.1 Type 1—Copper Tubing

This material specification covers the minimum requirements for seamless annealed copper tubing that shall be used for automotive air brake lines.

5.1.1 Manufacture

The tubing shall be seamless cold drawn to size and bright annealed as a final operation in such a manner as to produce a finished product which will meet all requirements of this document.

5.1.2 Dimensions and Tolerances

The finished tubing shall conform to the dimensions and tolerances shown in Table 1, for the nominal diameter specified by the purchaser.

TABLE 1 - DIMENSIONS AND TOLERANCES OF AIR BRAKE TUBING

Nominal Tubing OD (in)	Outside Diameter[1] Specified mm	Outside Diameter[1] Specified in	Outside Diameter[1] Tolerance± mm	Outside Diameter[1] Tolerance± in	Wall Thickness (min) mm	Wall Thickness (min) in
1/4	6.35	0.250	0.05	0.002	0.75	0.0295
5/16	7.92	0.312	0.05	0.002	0.75	0.0295
3/8	9.53	0.375	0.05	0.002	0.75	0.0295
7/16	11.10	0.437	0.05	0.002	1.160	0.0455
1/2	12.70	0.500	0.05	0.002	1.160	0.0455
5/8	15.88	0.625	0.05	0.002	1.160	0.0455
3/4	19.05	0.750	0.06	0.0025	1.160	0.0455
1	25.40	1.000	0.06	0.0025	1.160	0.0455

1. The actual outside diameter shall be the average of the maximum and minimum outside diameters as determined at any one cross section through the tubing.

5.1.3 Quality

The finished tubing shall be clean, smooth, and round, free from internal and external mechanical imperfections, corrosion, scale, seams, and cracks.

5.1.4 Material

The tubing shall be made from phosphorized, low residual phosphorus copper conforming to SAE J463, UNS C12200 which has the chemical composition as in Table 2:

TABLE 2 - CHEMICAL REQUIREMENTS

Element	Ladle Analysis % by Weight
Copper	99.90 min
Phosphorus	0.015-0.040

5.1.5 Mechanical Properties

The finished tubing shall have mechanical properties as tabulated in Table 3:

TABLE 3 - MECHANICAL PROPERTIES, COPPER TUBING

Yield Strength MPa (psi) Min[1]	Tensile Strength MPa (psi) min	Elongation in 50 mm (2 in), % min Tubing OD 19 mm (3/4 in) and smaller	Elongation in 50 mm (2 in), % min Tubing OD Over 19 mm (3/4 in)
62 (9000)	210 (30 000)	30	40

1. At 0.5% extension under load.

5.1.6 Grain Size

The tubing shall be furnished in either of two temper conditions with grain size as tabulated in Table 4:

TABLE 4 - GRAIN SIZE

Temper	Grain Size, mm
Light Annealed	0.015-0.040
Soft Annealed	0.040 min

5.1.7 Performance Requirements

The finished tubing shall satisfactorily meet the following performance tests. Test specimens shall be taken from tubing which has not been subjected to cold working after the anneal of the finished sized tubing.

5.1.8 Flaring Test

A test section cut from the finished tubing, having squared and deburred ends, shall withstand being flared at one end over a polished tapered mandrel of 60 degrees included angle until the actual average outside diameter is increased 40% without evidence of splitting or flaws. The axis of the mandrel and axis of the tubing shall be kept parallel during the flaring process and the test may be made in a die to restrict the expansion to 40%.

5.1.9 Pressure Proof Test

Unless otherwise specified, tubing supplied under this document shall withstand, with no evidence of failure, a hydrostatic proof test at a pressure equivalent to a hoop (circumferential) stress of 62 MPa (9000 psi). The test pressure shall be as determined from Barlow's formula for thin hollow cylinders under pressure:

$$P = \frac{2TS}{D} \qquad \text{(Eq. 1)}$$

where:

D = outside diameter of tubing, mm (in)
P = hydrostatic pressure, MPa (psi)
S = allowable unit stress of material = 62 MPa (9000 psi)
T = minimum wall thickness of tubing, mm (in)

The test pressure at a yield strength of 62 MPa (9000 psi) for the minimum wall thicknesses allowed are given in Table 5.

TABLE 5 - HYDROSTATIC TEST PRESSURES FOR AIR BRAKE TUBING

Nominal Tubing OD, in	Hydrostatic Test Pressure MPa	Hydrostatic Test Pressure psi	Nominal Tubing OD, in	Hydrostatic Test Procedure MPa	Hydrostatic Test Procedure psi
1/4	14.50	2100	1/2	11.00	1600
5/16	11.70	1700	5/8	8.95	1300
3/8	9.65	1400	3/4	6.90	1000
7/16	12.40	1800	1	5.50	800

5.1.10 Air Pressure Test

Each length of finished tubing shall be tested at the maximum operating air pressure, as specified by the purchaser. The tubing shall show no leakage at the test pressure. An electric eddy current test may be substituted for the air pressure test, providing the rejection limits are such that the hydrostatic and air pressure requirements can be guaranteed.

5.1.11 Identification

Tubing shall be permanently and legibly marked at intervals not greater than 381 mm (15 in) with the words Air Brake.

5.1.12 Methods of Test

All tests to determine conformance with the foregoing specifications shall be conducted in accordance with the following ASTM Standards:

5.1.12.1 Chemical Analysis

See ASTM E 62.

5.1.12.2 Grain Size

See ASTM E 79.

5.1.12.3 Tensile

See ASTM E 8.

5.1.13 Bending

Tubing shall be used for essentially straight runs; however, generous curves having a radius in excess of 32 times the outside diameter shall be permitted. In no case, shall heat be used to facilitate bending of tubing.

5.2 Type 2—Galvanized Steel Pipe

This material specification covers the minimum requirements for pipe that shall be used in automotive air brake lines.