SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE STANDARD

SAE J1650

Issued 1993-03-16

Submitted for recognition as an American National Standard

SEAMLESS COPPER-NICKEL 90-10 TUBING

1. ***Scope***—This SAE Standard covers seamless copper-nickel tubing for use in hydraulic brake pressure conductors, general automotive applications, and other similar uses.

2. ***References***

2.1 Applicable Document—The following publication forms a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

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

SAE J533—Flares for Tubing

3. ***Manufacture***—This tubing shall be made from 90-10 copper-nickel and cold drawn to size. It shall then be annealed in such a manner as to produce a finished product which will meet all of the requirements in this document.

4. ***Dimensions and Tolerances***—The standard nominal diameters and the applicable dimensions and tolerances are shown in Table 1.

TABLE 1—TUBING DIMENSIONS AND TOLERANCES[1]

Dash Size	Nominal Tubing OD mm	Nominal Tubing OD in	Outside Diameter[1] Tolerance ± Basic	Outside Diameter[1] Tolerance ± mm	Outside Diameter[1] Tolerance ± in	Wall Thickness Basic mm	Wall Thickness Basic in	Wall Thickness Tolerance[2] ± mm	Wall Thickness Tolerance[2] ± in
-2	3.18	0.125	0.125	0.05	0.002	0.64	0.025	0.13	0.005
-3	4.76	0.188	0.188	0.08	0.003	0.71	0.028	0.08	0.003
-4	6.35	0.250	0.250	0.08	0.003	0.71	0.028	0.08	0.003
-5	7.94	0.312	0.312	0.08	0.003	0.71	0.028	0.08	0.003
-6	9.52	0.375	0.375	0.08	0.003	0.71	0.028	0.08	0.003
-7	11.11	0.438	0.438	0.10	0.004	0.76	0.030	0.08	0.003
-8	12.70	0.500	0.500	0.10	0.004	0.89	0.035	0.09	0.0035
-9	14.29	0.562	0.562	0.10	0.004	0.89	0.035	0.09	0.0035
-10	15.88	0.625	0.625	0.10	0.004	0.89	0.035	0.09	0.0035

[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.
[2] The tolerances listed represent the maximum permissible deviation at any point.

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5. ***Quality***—Finished tubing shall be clean, smooth, and round, both inside and outside, and shall be free from scale and injurious defects. Surface imperfections such as handling marks, die marks, or shallow pits shall not be considered injurious defects provided such defects are within the tolerances specified for diameter and wall thickness. The inside of the tubing shall be clean and free from any contamination which will impair the processing or serviceability of the tubing.

6. ***Material***—Tubing shall be made from copper-nickel alloy UNS C70600.

7. ***Mechanical Properties***—The finished tubing shall have mechanical properties as tabulated in Table 2:

TABLE 2—MECHANICAL PROPERTIES

Properties	Values
Yield Strength, min (0.2% offset)	110 MPa (16 000 psi)
Tensile Strength, min	290 MPa (42 000 psi)
Elongation in 2 in (50 mm)	14-40%
Hardness (Rockwell 30 T scale), max	65

8. ***Performance Requirements***—The finished tubing shall satisfactorily meet the following performance requirements. Test specimens shall be taken from tubing which has not been subjected to cold working after the final processing of the finished sized tubing.

8.1 Flaring Test—A test section cut from the finished tubing, having squared and deburred ends, shall withstand being double flared at one end to the dimensions shown in SAE J533. The test section shall be held firmly and squarely in the die and the punch, while being forced down, shall be guided parallel to the axis of the tubing. The flare shall exhibit no evidence of splitting or flaws in area A (Figure 1).

a. Area B—The flare seat, defined as the surface within the 90-degree included angle. Conical surface shall be smooth and free from cracks or other irregularities which could cause leaks after assembly.
b. Area C—The surface beyond the length of the double thickness created by the flare.

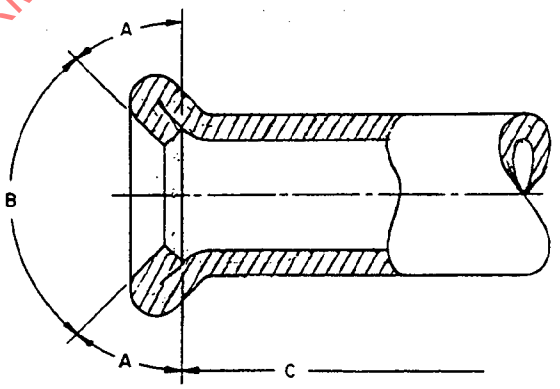

FIGURE 1—INVERTED FLARE

8.2 Bending Test—The finished tubing shall withstand bending on a centerline radius equal to three times the tubing outside diameter without undue reduction of area or flattening where proper bending fixtures are used.

8.3 **Pressure Proof Test**—Unless otherwise specified, the finished tubing shall withstand a hydrostatic proof test with no evidence of failure, at a pressure which will subject the material to a yield stress of 110 MPa (16 000 psi). Test pressures shall be determined by Barlow's formula for thin hollow cylinders under tension.

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

where:

D = outside diameter of tubing, mm (in)
P = hydrostatic pressure, MPa (psi)
S = allowable unit stress of material = 110 MPa (16 000 psi)
T = minimum wall thickness of tubing, mm (in)

No tube shall be tested beyond a hydrostatic pressure of 35 MPa (5000 psi) unless so specified.

8.4 **Nondestructive Electric Test**—In lieu of the hydrostatic test, where mutually agreed upon by the purchaser and manufacturer, all tubing shall be tested by passing it through an electric eddy current tester which is capable of detecting defects that would prevent the tubing from passing the hydrostatic proof test.

9. ***Corrosion Protection***—The inside and outside of the finished tubing shall be protected against corrosion during shipment and normal storage. If a corrosion preventive compound is applied, it shall be such that after normal storage periods it can readily be removed by cleaning agents normally used in manufacturing.

PREPARED BY THE SAE FLUID CONDUCTORS AND CONNECTORS
TECHNICAL COMMITTEE S1—AUTOMOTIVE AND HYDRAULIC TUBE AND FITTINGS