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# SURFACE VEHICLE STANDARD

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## (R) WELDED AND COLD DRAWN LOW-CARBON STEEL TUBING ANNEALED FOR BENDING AND FLARING

1. ***Scope***—This SAE Standard covers cold worked and annealed electric resistance welded single wall low-carbon steel pressure tubing intended for use as hydraulic lines and in other applications requiring tubing of a quality suitable for flaring and bending.

2. ***References***

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

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

SAE J409—Product Analysis—Permissible Variations from Specified Chemical Analysis of a Heat or Cast of Steel
SAE J514—Hydraulic Tube Fittings
SAE J1677—Tests and Procedures for SAE Low-Carbon Steel and Copper Nickel Tubing

**2.2 Related Publication**—The following publication is provided for information purposes only and is not a required part of this document.

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

SAE J533—Flares for Tubing

3. ***Manufacture***—The tubing shall be made from a single strip of steel shaped into a tubular form, the edges of which are joined and sealed by electric resistance welding. After forming and welding, the tubing shall be normalized and subjected to a cold-working operation that shall result in a 15% minimum reduction in cross-sectional area, of which at least 8% shall consist of a reduction in wall thickness. Subsequent to cold working, the tubing shall be annealed in such a manner as to produce a finished product which will meet all requirements of this document. Tubing that has been pickled to remove scale shall be suitably treated to eliminate any embrittlement induced by the pickling process.

4. ***Dimensions and Tolerances***—The tolerances applicable to tubing outside diameter, inside diameter, and wall thickness are shown in Table 1. Tubing shall be subject to any two of the tolerances specified, as designated by the purchaser.

**TABLE 1—TUBING OUTSIDE DIAMETER AND WALL THICKNESS TOLERANCE**

| Nominal Tubing OD[1,2] mm | Tolerance OD ±mm | Tolerance ID ±mm | Tolerance ± Wall Thickness (%) |
|---|---|---|---|
| Up to 9.53 | 0.05 | 0.05 | 15 |
| Over 9.53 to 15.9 inclusive | 0.06 | 0.06 | 10 |
| Over 15.9 to 50.8 inclusive | 0.08 | 0.08 | 10 |
| Over 50.8 to 63.5 inclusive | 0.10 | 0.10 | 10 |
| Over 63.5 to 76.2 inclusive | 0.13 | 0.13 | 10 |
| Over 76.2 to 101.6 inclusive | 0.15 | 0.15 | 10 |

[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] Refer to SAE J514 for nominal tubing outside diameters to be used in conjunction with standard hydraulic tube fittings.

5. ***Quality***—Lengths of finished tubing shall be reasonably straight and have smooth ends free from burrs. Tubing shall be free from scale and injurious defects and have a workmanlike finish. Surface imperfections such as handling marks, die marks, or shallow pits shall not be considered injurious defects provided such imperfections are within the tolerances specified for diameter and wall thickness. The removal of such surface imperfections is not required. There shall be no dimensional indications of the presence of the weld.

6. ***Material***—Tubing shall be made from low-carbon steel conforming to the following chemical composition in Table 2.



**TABLE 2—CHEMICAL REQUIREMENTS**

| Element | Cast or Heat Analysis[1] % by Weight |
|---|---|
| Carbon | 0.18 max |
| Manganese | 0.30-0.60 |
| Phosphorus | 0.040 max |
| Sulfur | 0.050 max |

[1] Check analysis tolerance shall be as specified in SAE J409, Table 3.

*7. **Mechanical Properties***—The finished tubing shall have mechanical properties as tabulated in Table 3:

**TABLE 3—MECHANICAL PROPERTIES**

| Properties | Values |
|---|---|
| Yield Strength, min | 170 MPa |
| Ultimate Strength, min | 310 MPa |
| Elongation in 50 mm, min | 35%[1] |
| Hardness (Rockwell B scale), max | 65[2] |

[1] For tubing having nominal outside diameter of 9.5 mm or less, and/or wall thicknesses of 0.9 mm or less, a minimum elongation of 25% is permissible.

[2] The hardness test shall not be required on tubing with a nominal wall thickness of less than 1.65 mm. Such tubing shall meet all other mechanical properties and performance requirements.

*8. **Performance Requirements***—The finished tubing shall satisfactorily meet the following performance tests. All tests are to be conducted in accordance with the procedures in SAE J1677. (The section listed in the parentheses is for the SAE J1677 document.)

**8.1 Flattening Test (5.1)**

**8.2 Flaring Test**—As Required (Double Flare 5.5.1)
(Single Flare 5.5.3)

**8.3 Reverse Flattening Test (5.2)**

**8.4 Expansion Test (5.4)**

**8.5 Pressure Proof Test (5.8)**—Where allowable unit stress of material(s) = 140 MPa.

**8.6 Nondestructive Electronic Test (5.9)**

*9. **Test Certificates***—A certificate of compliance to the performance requirements shall be furnished to the purchaser by the producer if requested in the purchase agreement.

*10. **Cleanliness***—The inside of tubing shall be clean and free from any contamination that cannot be readily removed by cleaning agents normally used in manufacturing.

*11. **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.

Extended corrosion resistance coatings, such as tern coating, galvanizing, epoxy paint, etc., are available and can be supplied at the request of the user.