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SURFACE VEHICLE STANDARD

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(R) WELDED FLASH CONTROLLED LOW-CARBON STEEL TUBING NORMALIZED FOR BENDING, DOUBLE FLARING, AND BEADING

1. ***Scope***—This SAE Standard covers normalized electric resistance welded flash controlled single-wall, low-carbon steel pressure tubing intended for use as pressure lines and in other applications requiring tubing of a quality suitable for bending, flaring, beading, and brazing.

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 J533—Flares for Tubing
SAE J1677—Tests and Procedures for SAE Low-Carbon Steel and Copper Nickel 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 outside flash shall be removed to provide a smooth surface. The inside flash shall be of uniform contour, free from saw-tooth peaks, and controlled in height by seam-welding techniques or by cutting, but not by hammering or rolling. The inside flash height shall conform to the following as in Table 1.

The tubing shall be normalized to produce a finished product which will meet all requirements of this document.

TABLE 1—INSIDE FLASH HEIGHT

Nominal Wall Thickness mm	Maximum Flash Height[1] Thru 25.4 mm OD mm	Maximum Flash Height[1] Over 25.4 mm OD mm
0.90	0.13	0.25
0.90 thru 1.65	0.20	0.25
1.65	0.25	0.25

[1] For tubes having an ID greater than 8 mm, the height of the inside weld flash shall be measured with a ball micrometer having a 3.96 mm ± 0.41 mm radius on the anvil or ball point. For tubes having an ID 8 mm or less, screw thread micrometers shall be used. The height of the flash shall be the difference between the thickness of the tubing wall at the point of maximum height of the flash and the average of the wall thickness measured at points adjacent to both sides of the flash.

4. ***Dimensions and Tolerances***—The tolerances applicable to tubing outside diameter are shown in Table 2. The tolerances applicable to tubing wall thickness are shown in Table 3. Particular attention shall be given to areas adjacent to the weld to insure against thin spots and/or sharp indentations.

TABLE 2—TUBING OUTSIDE DIAMETER TOLERANCE

Nominal Tubing OD[1,2] mm	Tube OD Tolerance ±mm
Up to 9.53	0.06
Over 9.53 to 15.88	0.08
Over 15.88 to 28.57	0.09
Over 28.57 to 50.80	0.13
Over 50.80 to 63.50	0.15
Over 63.50 to 76.20	0.20
Over 76.20 to 88.90	0.23
Over 88.90 to 101.60	0.25

[1] OD measurements shall be taken at least 50 mm from the end of the tubing.

[2] Refer to SAE J514 for nominal tubing OD to be used in conjunction with standard hydraulic tube fittings and SAE J533 for recommended maximum nominal wall thickness for double flaring.

TABLE 3—TUBING WALL THICKNESS TOLERANCES

Nominal Wall Thickness[1] mm	Nominal Tubing Outside Diameter Thru 25 mm Plus[2]/Minus mm	Nominal Tubing Outside Diameter Over 25 mm Thru 50 mm Plus[2]/Minus mm	Nominal Tubing Outside Diameter Over 50 mm Thru 100 mm Plus[2]/Minus mm
0.71	0.05/0.08	0.08/0.08	0.10/0.08
0.89	0.05/0.10	0.08/0.10	0.10/0.10
1.25	0.05/0.13	0.08/0.13	0.10/0.13
1.65	0.10/0.15	0.13/0.20	0.15/0.20
2.11	0.10/0.15	0.15/0.20	0.18/0.20
2.41	0.10/0.15	0.15/0.25	0.18/0.25
2.77	0.10/0.15	0.20/0.25	0.23/0.25
3.05	0.10/0.20	0.20/0.25	0.23/0.25
3.40	0.10/0.20	0.20/0.25	0.23/0.25
3.75	—	0.20/0.28	0.23/0.28
4.19	—	0.20/0.28	0.23/0.28
4.57	—	0.20/0.28	0.23/0.28
5.16	—	0.20/0.30	0.23/0.30
5.59	—	0.20/0.30	0.23/0.30
6.05	—	0.33/0.46	0.36/0.46
6.58	—	0.33/0.51	0.36/0.51

[1] For intermediate wall thicknesses, the tolerance for the next heavier wall thickness shall apply.
[2] Plus tolerances include allowance for crown on flat-rolled steel.

5. ***Quality***—Lengths of finished tubing shall be reasonably straight and have smooth ends free from burrs. Finished tubing shall be free from scale and injurious imperfections and shall have a workmanlike finish. Outside surface imperfections such as handling marks, straightening marks, light die marks, or shallow pits shall not be considered injurious provided the imperfections are not detrimental to the function of the tubing. The removal of such surface imperfections shall not be required.

   The inside surface shall be free of weld splatter, pits, and all other injurious imperfections detrimental to the function of the tubing.

6. ***Material***—Tubing shall be made from low carbon, hot- or cold-rolled steel conforming to the chemical composition in Table 4. If rimmed steel is used, it shall be single strand. The steel shall be made by the open hearth basic oxygen or electric furnace process. A ladle analysis of each heat shall be made to determine the percentages of the elements specified. The chemical composition thus determined shall be reported to the purchaser, or his representative, if requested, and shall conform to the requirements specified. If a check analysis is required, the tolerances shall be as specified in SAE J409, Table 3.

TABLE 4—CHEMICAL REQUIREMENTS

Element	Cast or Heat Analysis, Weight %
Carbon	0.18 max
Manganese	0.30 thru 0.60
Phosphorus	0.04 max
Sulfur	0.05 max

7. ***Mechanical Properties***—The finished tubing shall have mechanical properties as tabulated in Table 5.

TABLE 5—MECHANICAL PROPERTIES

Properties	Values
Yield Strength, min	170 MPa
Ultimate Strength, min	310 MPa
Elongation in 50 mm, min	35%[1]
Hardness (Rockwell B), 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 Hardness Test (5.6)

8.6 Tensile Test (5.7)

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

8.8 Nondestructive Electronic Test (5.9)