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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

# SURFACE VEHICLE STANDARD

SAE J2467

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## Welded and Cold-Drawn, SAE 1021 Carbon Steel Tubing Normalized for Bending and Flaring



**1. *Scope*—**The SAE Standard covers normalized electric resistance welded, cold-drawn, single-wall, SAE 1021 carbon steel pressure tubing intended for use as pressure lines and in other applications requiring tubing of a quality suitable for bending, flaring, forming, and brazing.

The grade of material produced to this specification is higher in carbon content and manganese content than the grade of material specified in SAE J525. The material produced to this specification is intended to service higher pressure applications than like sizes of SAE J525. Due to the higher carbon and manganese content, however, the forming characteristics of the finished tube is diminished somewhat when compared to SAE J525. Special attention to the overall forming requirements of the finished assembly should be taken into consideration when utilizing material produced to this specification.

**2. *References***

**2.1 Applicable Publications—**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 J525—Welded and Cold Drawn Low-Carbon Steel Tubing Annealed for Bending and Flaring
SAE J533—Flares for Tubing
SAE J1677—Tests and Procedures for SAE Low-Carbon Steel and Copper Nickel Tubing

**2.2 Related Publications—**The following publications are provided for information purposes only and are not a required part of this document.

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

SAE J1065—Pressure Ratings for Hydraulic Tubing and Fittings
SAE J1453—Fitting—O-Ring Face Seal



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3. ***Manufacture—***The tubing shall be made from flat rolled steel shaped into a tubular form, the edges of which are joined and fused together by electric resistance welding. After forming and welding, the tubing shall be normalized and subjected to a cold drawing operation that shall result in a 15% minimum reduction in cross sectional area, of which 8% shall consist in a reduction of wall thickness. Subsequent to cold drawing, the tubing shall be *normalized* via an atmospherically controlled method to produce a finished product that will meet all requirements of this document.

4. ***Dimensions and Tolerances—***The tolerances applicable to the tubing outside diameter and inside diameter are shown in Table 1. The tolerances applicable to tubing wall thickness are shown in Table 2. Dimensional tolerances can only apply to two of the three tubing dimensions (OD, ID, or wall). Unless otherwise agreed upon between the purchaser and tube producer, dimensional tolerances shall apply to the tube *OD* and *wall* dimension.

**TABLE 1—TUBING DIAMETER TOLERANCES**

| Nominal Tubing OD[1][2] mm | Tube OD Tolerance ±mm | TUBE ID Tolerance ±mm |
|---|---|---|
| Up to 9.50 | 0.05 | 0.05 |
| Over 9.50 to 15.88 | 0.06 | 0.06 |
| Over 15.88 to 50.80 | 0.08 | 0.08 |
| Over 50.80 to 63.50 | 0.10 | 0.10 |
| Over 63.50 to 76.20 | 0.13 | 0.13 |
| Over 76.20 to 100.00 | 0.15 | 0.15 |

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 2—TUBING WALL THICKNESS TOLERANCES**

| Nominal Wall Thickness[1] | Nominal Tubing Outside Diameter Through 22 mm +/– mm | Nominal Tubing Outside Diamter Over 22 mm Through 48 mm +/– mm | Nominal Tubing Outside Diameter Over 48 mm Through 100 mm +/– mm |
|---|---|---|---|
| 0.89 | 0.05/0.05 | 0.05/0.05 | 0.05/0.05 |
| 1.00 | 0.05/0.05 | 0.05/0.08 | 0.05/0.08 |
| 1.25 | 0.05/0.05 | 0.05/0.08 | 0.05/0.08 |
| 1.50 | 0.05/0.05 | 0.05/0.08 | 0.05/0.08 |
| 1.65 | 0.05/0.05 | 0.05/0.08 | 0.05/0.08 |
| 2.00 | 0.05/0.05 | 0.05/0.08 | 0.08/0.08 |
| 2.11 | 0.05/0.05 | 0.05/0.08 | 0.08/0.08 |
| 2.41 | 0.05/0.05 | 0.05/0.08 | 0.08/0.08 |
| 2.50 | 0.05/0.08 | 0.05/0.10 | 0.08/0.08 |
| 2.77 | 0.05/0.08 | 0.05/0.10 | 0.08/0.08 |
| 3.00 | 0.08/0.08 | 0.05/0.10 | 0.08/0.08 |
| 3.05 | 0.08/0.08 | 0.05/0.10 | 0.08/0.08 |
| 3.40 | — | 0.05/0.10 | 0.08/0.08 |
| 3.75 | — | 0.05/0.10 | 0.08/0.08 |
| 4.00 | — | 0.08/0.10 | 0.08/0.10 |
| 4.19 | — | 0.08/0.10 | 0.08/0.10 |
| 4.57 | — | 0.10/0.10 | 0.08/0.13 |
| 5.00 | — | 0.10/0.13 | 0.10/0.13 |
| 5.16 | — | 0.10/0.13 | 0.10/0.13 |
| 5.59 | — | 0.10/0.15 | 0.10/0.15 |
| 6.00 | — | 0.13/0.15 | 0.13/0.15 |
| 6.05 | — | 0.13/0.15 | 0.13/0.15 |
| 6.58 | — | 0.13/0.15 | 0.13/0.15 |

1. For intermediate wall thickness, the tolerance for the next heavier wall thickness shall apply.



## *5. Manufacturing Standards*

**5.1 Straightness**—Tubing shall be straightened to a tolerance of 0.8 mm in 1000 mm. Straightness tolerances shall be measured by placing a 915 mm straight edge against the tube while lying on its neutral axis. The point of maximum deflection of the tube from the straight edge should not be more than allowed by the specification when measured with a feeler gauge.

**5.2 Tubing End Condition**—The tubing will be produced using normal mill cut-off practices. This will include, but is not limited to double-cut ends, saw-cut, and rotary-cut ends. Care will be taken to minimize the distortion of the tube ends. Distortion of the tube ends must not affect the normal re-cutting processes that will be performed by the end user. Ends that require further processing will be by agreement between the producer and tube purchaser.

**5.3 Surface Finish—**The outside and inside surface finish of the tube are critical in order to prevent possible leak paths on flared fittings, mechanical form fittings, or other applications where the surface of the tube becomes the sealing surface. The surface of the tube shall be free of excessive roll marks, score marks, chatter marks, or other surface imperfections that would be considered detrimental to the function of the tubing.

**5.4 Thermal Treatment—**The tubing is to be heated to a temperature above the upper transformation point via an atmospherically controlled method, and then cooled in a protective atmosphere.

***6. Material—***Tubing shall be made from low-carbon, flat rolled steel conforming to the chemical composition in Table 3. 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 3—CHEMICAL REQUIREMENTS**

| Element | Cast or Heat Analysis, Weight % |
|---|---|
| Carbon | 0.17 min/0.23 max |
| Manganese | 0.60 through 0.90 |
| Phosphorus | 0.04 max |
| Sulfur | 0.05 max |

***7. Mechanical Properties—***The finished tubing shall have mechanical properties as tabulated in Table 4.

**TABLE 4—MECHANICAL PROPERTIES**

| Properties | Values |
|---|---|
| Yield Strength, min | 275 MPa |
| Ultimate Strength, min | 415 MPa |
| Elongation in 50 mm, min | 25% |
| Hardness (Rockwell B), max | 75(1) |

1. 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.

**8.1 Flattening Test—**SAE J1677 - paragraph 5.1

**8.2 Flaring Test—**SAE J1677 - paragraphs 5.5.1 and 5.5.3

**8.3 Reverse Flattening Test—**SAE J1677 - paragraph 5.2

**8.4 Expansion Test—**SAE J1677 - paragraph 5.4

**8.5 Hardness Test—**SAE J1677 - paragraph 5.6

**8.6 Tensile Test—**SAE J1677 - paragraph 5.7

**8.7 Pressure Proof Test—**SAE J1677 - paragraph 5.8, performed when agreed upon between the purchaser and the producer (where allowable unit stress of material(s) = 220 MPa (80% of minimum yield strength).)