SAE International™

SURFACE VEHICLE STANDARD

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Superseding J2614 JAN2003

Welded and Cold-Drawn, High Strength (500 MPa Tensile Strength) Low Alloy Steel Hydraulic Tubing, Sub-Critically Annealed for Bending and Flaring

RATIONALE

This SAE standard has been revised as part of the SAE five year review process and to bring this document into line with global standardization.

1. SCOPE

This specification covers sub-critically annealed electric resistance welded and cold-drawn single-wall high strength low alloy steel tubing intended for use in hydraulic pressure lines and in other applications requiring tubing of a quality suitable for bending, flaring, cold forming, welding and brazing.

The grade of material produced to this specification is of micro-alloy content and is considerably stronger and intended to service higher pressure applications than like sizes of the grades of material specified in SAE J525 and SAE J2467. Due to the alloy content of the material, the forming characteristics of the finished tube are equal to or better, when compared to SAE J525 and SAE J2467. Nominal reference working pressures for this tubing are listed in ISO 10763 for metric tubing and SAE J1065 for inch tubing.

CAUTION: When brazing or welding is used as a tube end joining method, the structural integrity of the tube material can potentially be compromised due to the degradation of the areas affected by the thermal effect applied to the tubing; therefore, the ISO 10763 and SAE J1065 nominal reference working pressures may not be applicable.

Brazed and/or welded tube assembly configurations made to specific geometry and components bill of material in association with this material, may require qualification testing in accordance with ISO 19879 Test Methods for Hydraulic Fluid Power Connections. Cold forming the tube end configurations avoids this systemic testing by not compromising the tube material structural integrity.

2. REFERENCES

2.1 Applicable Publications

The following publications form a part of this specification to extent specified herein. Unless other specified, the latest issue of the SAE publications shall apply.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

2.1.1 SAE Publications

Available from SAE International, 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 J409 Product Analysis—Permissible Variations from Specified Chemical Analysis of a Heat or Cast of Steel

SAE J525 Welded and Cold Drawn Low-Carbon Steel Tubing Annealed for Bending and Flaring

SAE J533 Flares for Tubing

SAE J1065 Nominal Reference Working Pressures for Steel Hydraulic Tubing

SAE J1677 Tests and Procedures for Steel and Copper Nickel Tubing

SAE J2467 Welded and Cold-Drawn, SAE 1021 Carbon Steel Tubing Normalized for Bending and Flaring

2.1.2 ISO Publications

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 10763 Plain-end, seamless and welded steel tubes—Dimensions and nominal working pressures

ISO 19879 Metallic tube connections for fluid power and general use—Test methods for hydraulic fluid power connections

2.2 Related Publications

The following publications are provided for informational purposes only and are not a required part of this document.

2.2.1 SAE Publications

Available from SAE International, 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 J514 Hydraulic Tube Fittings

SAE J518 Hydraulic Flanged Tube, Pipe, and Hose Connections, Four-Bolt Split Flange Type

SAE J1392 Steel, High Strength, Hot Rolled Sheet and Strip, Cold Rolled Sheet, and Coated Sheet

SAE J1453 Fitting—O-Ring Face Seal

SAE J2551 Recommended Practices for Fluid Conductor Metallic Tubing Applications

SAE J2833 Welded and Cold-Drawn, High Strength (690 MPa Tensile Strength) Low Alloy Steel Hydraulic Tubing, Stress Relieved Annealed for Bending and Flaring

2.2.2 ISO Publications

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 3304 Plain end seamless precision steel tubes—Technical conditions for delivery

ISO 3305 Plain end welded precision steel tubes—Technical conditions for delivery

ISO 4200 Plain end steel tubes, welded and seamless—General tables of dimensions and masses per unit length

ISO 4397 Connectors and associated components—Nominal outside diameters of tubes and nominal inside diameters of hoses

ISO 4399 Connectors and associated components—Nominal pressures

ISO 5598 Fluid power systems and components—Vocabulary

ISO 6162 Four-screw split-flange connections

ISO 6163 Round flange, 8 and 12 screw connections

ISO 6164 Four-screw, one-piece square-flange connections

ISO 6605 Tests and test procedures

ISO 8434 Metallic tube connections for fluid power and general use

ISO 10583 Test methods for tube connections

2.2.3 EN Publications

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

EN 10305-2 Steel tubes for precision applications—Technical delivery conditions—Part 2: Welded cold drawn tubes

EN 10305-3 Steel tubes for precision applications—Technical delivery conditions—Part 3: Welded cold sized steel tubes

EN 10305-4 Steel tubes for precision applications—Technical delivery conditions—Part 4: Seamless cold drawn tubes for hydraulic and pneumatic power systems

EN 10305-6 Steel tubes for precision applications—Technical delivery conditions—Part 6: Welded cold drawn steel tubes for hydraulic and pneumatic power systems

2.2.4 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A 513 Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Tubing

3. MANUFACTURE

The tubing shall be made from a single strip of steel shaped into a tubular shape, the edges of which are joined and fused by electric resistance welding.

The tubing shall be sub-critically annealed via a controlled method to produce a finished product, which will meet all requirements of this document.

3.1 Sub-Critically Anneal

An annealing treatment in which steel is heated to below the A1 temperature, then slowly cooled to room temperature. A1 temperature is the critical transformation temperature depending on steel classification.

4. DIMENSIONS AND TOLERANCES

The tolerances applicable to tubing outside diameter are shown in Table 1. The tolerances applicable to tubing wall thickness are shown in Table 2. Particular attention shall be given to areas adjacent to the weld to insure against thin spots and/or sharp indentations.

TABLE 1 - TUBING OUTSIDE DIAMETER TOLERANCE

Nominal Tubing OD[1][2] mm	Tube OD and ID Tolerance mm
Up to 10	± 0.05
Over 10 to 16	± 0.06
Over 16 to 50	± 0.08
Over 50 to 60	± 0.10
Over 60 to 80	± 0.13
Over 80 to 110	± 0.15

1. OD measurements shall be taken at least 50 mm from the end of tubing.
2. For nominal tubing OD's to be used in conjunction with this tubing, refer to the various fluid carrier connector standards and SAE J533 for recommended maximum nominal wall thickness for double flaring.

TABLE 2 - TUBING WALL THICKNESS TOLERANCES

Wall Thickness Range mm	For Nominal Tubing Outside Diameter Through 22 mm[1] mm	For Nominal tubing Outside Diameter Over 22 mm Through 48 mm[1] mm
Up to 0.8	± 0.05	± 0.05
Over 0.8 to 2.4	± 0.05	+ 0.05 -0.08
Over 2.4 to 3.3	+ 0.05 -0.08	+ 0.05 -0.10
Over 3.3 to 3.7	—	+ 0.05 -0.10
Over 3.7 to 4.5	—	+ 0.08 -0.10
Over 4.5 to 5.5	—	± 0.10
Over 5.5	—	+ 0.10 -0.15

1. Plus tolerances include allowance for crown on flat-rolled steel.

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 1000 mm straight edge against the tube while lying on it's 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 shall include, but not limited to, punch-cut ends, double-cut ends and rotary-cut ends. Care shall be taken to minimize the distortion of the tube ends. Distortion of the tube must not affect the normal re-cutting processes that will be performed by the end user. Ends that require further processing will be addressed by agreement between the producer and the tube purchaser.

5.3 Finish

The outside surface finish of the tube is critical to prevent possible leak paths on double flare connections, mechanical formed connections or applications where the outside surface of the tube becomes the sealing surface of the finished connection. The outside surface finish of the tube shall be free of excessive roll marks, score marks, chatter marks or other surface imperfections that may be considered detrimental to the function of the finished tube.

5.4 Thermal Treatment

The tubing is to be sub-critically annealed by heating to a temperature below the transformation point and then slowly cooled to room temperature. Special attention to the mechanical properties, especially the Rockwell B85 Hardness Target, should be made to produce tubing suitable for bending and forming for hydraulic pressure applications. However, to obtain acceptable hardness characteristics, the yield strength and the tensile strength shall not be compromised and 30% minimum elongation shall be maintained.

6. MATERIAL

The tubing shall be made from alloy steel strip 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 purchaser's representative, if requested, and shall be 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	0.18 Max
Manganese	1.50 Max
Sulfur	0.035 Max
Phosphorus	0.035 Max
Silicon	0.35 Max
Aluminum	0.020 Min
Micro Alloying Elements	0.15 Max