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INTERNATIONAL
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SURFACE VEHICLE STANDARD

SAE J356

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Submitted for recognition as an American National Standard

(R) Welded Flash-Controlled Low-Carbon Steel Tubing Normalized for Bending, Double Flaring, and Beading

1. *Scope*—The 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, double flaring, beading, forming, and brazing. Material produced to this specification is not intended to be used for single flare applications due to the potential leak path that would be caused by the ID weld bead.

This specification also covers SAE J356 Type-A tubing. The mechanical properties and performance requirements of standard SAE J356 and SAE J356 Type-A are the same. Therefore, the designated differences of Type-A tubing are not meant to imply that Type-A tubing is in anyway inferior to standard SAE J356. The Type-A designation is only meant to address the unique manufacturing differences of the small diameter, light wall sizes (typically 15.88 mm OD x 1.24 mm wall and smaller.) The primary differences between SAE J356 and SAE J356 Type-A are described in the following paragraph.

Type-A tubing is heat treated in-line to relieve stresses and is generally produced in coiled form. When Type-A tubing is produced in coil form, straight lengths of Type-A are only available through a secondary straightening and cut-to-length operation. Standard SAE J356 is produced as straight lengths and then receives a secondary normalizing operation. All standard SAE J356 requirements apply to Type-A tubing unless the specific requirement is noted with a "Type-A" designation. Standard SAE J356 is also available in the same sizes as Type-A, in which case all the standard SAE J356 specifications apply.

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 J533—Flares for Tubing
SAE J1677—Tests and Procedures for SAE Low-Carbon Steel and Copper Nickel Tubing

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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

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 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 via an atmospherically controlled method to produce a finished product which will meet all requirements of this document.

3.1 Type-A—The tubing shall be heat treated to relieve stresses via an atmospherically controlled method 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][2] Thru 25.4 mm OD mm	Maximum Flash Height[1][2] Over 25.4 mm OD mm
less than 0.90	0.13	0.25
0.90 through 1.65	0.20	0.25
greater than 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.
2. Tubing with an ID that is smaller than the producer's capability to scarf the ID weld bead shall be produced as a "flash in" tube. Seam welding techniques may be applied in order to control the ID flash height. The maximum ID flash height, however, will be determined by agreement between the producer and the purchaser.

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 9.50	0.06
Over 9.50 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	0.08/0.08
0.89	0.05/0.10	0.05/0.10	0.05/0.10
1.00	0.05/0.10	0.05/0.10	0.05/0.13
1.25	0.10/0.13	0.08/0.13	0.10/0.20
1.50	0.15/0.15	0.10/0.20	0.10/0.20
1.65	0.15/0.15	0.10/0.20	0.10/0.20
2.00	0.15/0.25	0.15/0.25	0.15/0.25
2.11	0.15/0.25	0.15/0.25	0.15/0.25
2.41	0.15/0.25	0.15/0.25	0.15/0.25
2.50	0.15/0.25	0.15/0.25	0.15/0.25
2.77	0.15/0.25	0.15/0.25	0.15/0.25
3.00	0.15/0.25	0.15/0.25	0.15/0.25
3.05	0.15/0.25	0.15/0.25	0.15/0.25
3.40	0.15/0.25	0.15/0.25	0.15/0.25
3.75	—	0.18/0.28	0.18/0.28
4.00	—	0.18/0.28	0.18/0.28
4.19	—	0.18/0.28	0.18/0.28
4.57	—	0.18/0.28	0.18/0.28
5.00	—	0.20/0.30	0.20/0.30
5.16	—	0.20/0.30	0.20/0.30
5.59	—	0.20/0.30	0.20/0.30
6.00	—	0.36/0.46	0.36/0.46
6.05	—	0.36/0.46	0.36/0.46
6.58	—	0.36/0.51	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. 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 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. The aforementioned straightness tolerance may be waived if agreed upon between producer and purchaser, and will not apply to Type-A tubing that is coil form.

5.2 Tubing End Condition—The tubing will be produced using normal mill cut-off practices. This will include, but is not limited to, punch-cut ends, double-cut ends, 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 Finish—The outside surface finish of the tube is critical in order to prevent possible leak paths on double flare fittings, mechanical form fittings, or other applications where the outside surface of the tube becomes the sealing surface. The outside 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.

5.4.1 TYPE-A—The tubing shall be heat treated to relieve stresses via an atmospherically controlled method.

6. Material—Tubing shall be made from low-carbon, flat-rolled steel conforming to the chemical composition in Table 4. 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	0.06 min/ 0.18 max
Manganese	0.30 thru 0.60
Phosphorus	0.04 max
Sulfur	0.05 max
Type-A	
Carbon	0.02 min/0.18 max
Manganese	0.10 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.

8.1 **Flattening Test—**SAE J1677, paragraph 5.1.

8.2 **Flaring Test—**SAE J1677, paragraph 5.5.1.

8.3 **Reverse Flattening Test—**SAE J1677, paragraph 5.2.

8.4 **Expansion Test—**SAE J1677, paragraph 5.4.

8.5 **Hardness Test—**SAEJ1677, 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) = 140 MPa (80% of minimum yield strength).

8.8 **Nondestructive Electronic Test—**SAE J1677, paragraph 5.9. The tests that are referenced in 5.9 of SAE J1677 are to be conducted after all cold-working tube manufacturing operations are performed on the tubing.

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. The tube producer must be able to certify that each heat lot used to produce the tubing complies with the performance requirement.

10. ***Cleanliness—***The inside and outside surfaces of the finished tubing shall be commercially bright, clean, and free from grease, oxide scale, carbon deposits, and any other contamination that cannot be readily removed by cleaning agents normally used in manufacturing plants.

11. ***Corrosion Protection—***The inside and outside surfaces 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., may be available and may be supplied at the request of the purchaser.

12. ***Packaging—***The tubing is to be packaged in such a way to allow it to be transported and stored, with normal care, without being damaged. Any special packaging will be by agreement between the producer and purchaser.

13. ***Notes***

13.1 **Marginal Indicia—**The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE FLUID CONDUCTORS AND CONNECTORS TECHNICAL COMMITTEE SC5—METALLIC TUBING