SAE INTERNATIONAL

SURFACE VEHICLE STANDARD

J533™ MAY2020

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Superseding J533 FEB2017

Flares for Tubing

RATIONALE

The 37 degree double flare wall thickness of 1.25 mm for the 10 mm OD tube in Table 2 and 1.24 mm for the 9.52 mm OD in Table 3 were changed to 1 mm and 0.89 mm, respectively. This was done to resolve issues for manufacturers and users where it was difficult to hold the form resulting in thread engagement loss and stripping of threads when assembled. This condition was especially pronounced using stainless steel tubing. A footnote related to this was added to the tables.

1. SCOPE

This SAE Standard covers specifications and performance requirements for 37 degree and 45 degree single and double flares for tube ends intended for use with SAE J512, SAE J513, SAE J514, and ISO 8434-2 connectors. The flares described in this document are intended for use with SAE metallic tube materials. Considerations such as the effects of wall thickness selection for specific working pressures, identifying appropriate length of thread engagements for specific applications with mating connectors and other associated criteria, shall be the responsibility of the user. For applicable nominal reference working pressures for hydraulic tubing, refer to SAE J1065 and ISO 10763.

In an effort to standardize within a global marketplace and ensure that companies can remain competitive in an international market, it is the intent of this document to promote the use of metric tube and connector sizes, which will:

- Lead to one global system.
- Guide users to a preferred system.
- Reduce complexity.
- Eliminate inventory duplications.

1.1 Relationship of SAE Standard to ISO Standard

Flares as described in this updated document are compatible with ISO 8434-2.

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Tel: +1 724-776-4970 (outside USA)
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SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/J533_202005

2. REFERENCES

2.1 Applicable Documents

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

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 +1 724-776-4970 (outside USA), www.sae.org.

SAE TSB 003 Rules for Use of SI (Metric) Units

SAE J512 Automotive Tube Fittings

SAE J513 Refrigeration Tube Fittings - General Specifications

SAE J514 Hydraulic Tube Fittings

SAE J1065 Nominal Reference Working Pressures for Steel Hydraulic Tubing

SAE J2879 Automotive Hydraulic Brake Tube Joints

2.1.2 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), www.asme.org.

ASME Y14.5 Dimensioning and Tolerancing

2.1.3 ISO Publications

Copies of these documents are available online at http://webstore.ansi.org/.

ISO 8434-2 Metallic Tube Connections for Fluid Power and General Use

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 information purposes only and are not a required part of this SAE Technical Report.

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 +1 724-776-4970 (outside USA), www.sae.org.

SAE J356 Welded, Flash-Controlled, Low-Carbon Steel Tubing Normalized for Bending, Double Flaring, Beading, Forming, and Brazing

SAE J524 Seamless Low-Carbon Steel Tubing Annealed for Bending and Flaring

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

SAE J526 Welded Low-Carbon Steel Tubing Suitable for Bending, Flaring, Beading, Forming and Brazing

SAE J527 Brazed Double Wall Low-Carbon Steel Tubing

SAE J1176 External Leakage Classifications for Hydraulic Systems

SAE J1273 Recommended Practices for Hydraulic Hose Assemblies

SAE J1290 Automotive Hydraulic Brake System - Metric Tube Connections

SAE J1677 Tests and Procedures for Carbon Steel and High Strength Low Alloy Steel Tubing

SAE J2435 Welded Flash Controlled, SAE 1021 Carbon Steel Tubing, Normalized for Cold Forming, Welding, and Brazing

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

SAE J2551-1 Recommended Practices for Fluid Conductor Carbon, Alloy and High Strength Low Alloy Steel Tubing Applications - Part 1: Design and Fabrication

SAE J2551-2 Recommended Practices for Fluid Conductor Carbon, Alloy and High Strength Low Alloy Steel Tubing Applications - Part 2: General Specifications and Performance Requirements

SAE J2551-3 Recommended Practices for Fluid Conductor Carbon, Alloy and High Strength Low Alloy Steel Tubing Applications - Part 3: Procurement SAE J2593Information Report for the Installation of Fluid Conductors and Connectors

SAE J2613 Welded Flash Controlled, High Strength (500 MPa Tensile Strength) Hydraulic Tubing, for Bending, Double Flaring, Cold Forming, Welding, and Brazing

SAE J2614 Welded and Cold-Drawn, High Strength (500 MPa Tensile Strength) Hydraulic Tubing, for Bending, Flaring, Cold Forming, Welding, and Brazing

2.2.2 ISO Publications

Copies of these documents are available online at http://webstore.ansi.org/.

ISO 2944 Fluid Power Systems and Components - Nominal Pressures

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 6605 Tests and Test Procedures

ISO 10583 Hydraulic Fluid Power - Test Methods for Tube Connections

ISO 13486-1 Road Vehicles - Hydraulic Braking Systems - Double-Flare Pipes, Tapped Holes, Male Fittings and Tube Seats

3. GENERAL SPECIFICATIONS

3.1 Dimensions

3.1.1 Unless otherwise noted, all dimensions are in millimeters. GD&T symbols and interpretation shall be per ASME Y14.5. Single and double 45 degree flares shall conform to the dimensions specified in Figure 1 and Table 1. The recommended maximum nominal wall thicknesses allow adequate thread engagement of tube nut to tubing that is normally considered to be suitable for flaring. Adequate thread engagement can be impaired when using wall thicknesses greater than those listed in this document. This standard is not recommended for automotive hydraulic brake tubes; refer to SAE J2879 for automotive hydraulic brake applications.

3.1.2 Single and double 37 degree flares for metric OD tubing shall conform to the dimensions specified in Figure 2 and Table 2. Single and double 37 degree flares for inch OD tubing shall conform to the dimensions specified in Figure 3 and Table 3. The maximum nominal wall thicknesses allow adequate thread engagement of tube nut to tubing that is normally considered to be suitable for flaring. Adequate thread engagement can be impaired when using wall thicknesses greater than those listed in this document.

3.1.3 The length of the flare seat decreases as tube walls increase if no chamfer is present. A chamfer placed on the OD of heavier wall tubing will provide enhanced sealability for 37 degree single flares. Figure 4 and Table 4 provide recommended chamfer dimensions for heavier wall OD tubing.

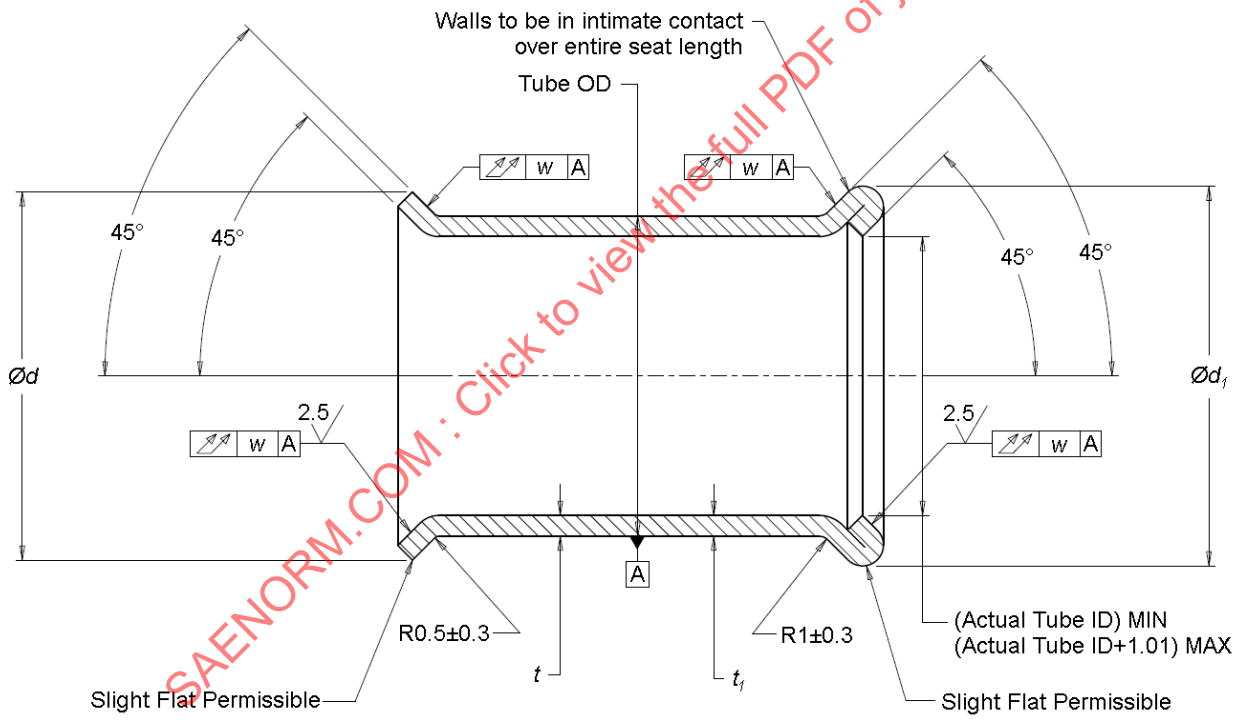

Figure 1 - Single and double 45 degree flares for tubing

Table 1 - Dimensions of single and double 45 degree flares for inch tubing
(see Figure 1 for dimension callouts)

Nominal Inch Tube OD	SAE Dash Size	Single Flare Diameter *d* Min	Single Flare Diameter *d* Max	Double Flare Diameter d_1 Min	Double Flare Diameter d_1 Max	Single Flare Wall Thickness *t* Max	Double Flare Wall Thickness t_1 Max	Total Runout *w* Max
3.18	-2	4.4	4.6	5	5.4	0.89	0.63	0.35
4.76	-3	6.1	6.3	6.7	7.1	0.89	0.71	0.35
6.35	-4	8	8.3	8.7	9.1	1.24	0.83	0.35
7.94	-5	9.9	10.3	10.4	10.8	1.24	0.89	0.35
9.52	-6	12	12.4	12.3	12.7	1.65	1.24	0.35
11.11	-7	13.9	14.2	14.1	14.5	1.65	1.24	0.35
12.7	-8	15.4	15.8	15.9	16.3	2.11	1.24	0.35
14.29	-9	16.8	17.2	17.7	18.1	2.11	1.24	0.35
15.88	-10	18.6	19	19.2	19.6	2.41	1.24	0.43
19.05	-12	22.9	23.3	22.8	23.2	2.77	1.24	0.43
22.22	-14	26	26.4	26.7	27.3	2.77	1.24	0.54
25.4	-16	29	29.4	29.9	30.3	3.05	1.24	0.54

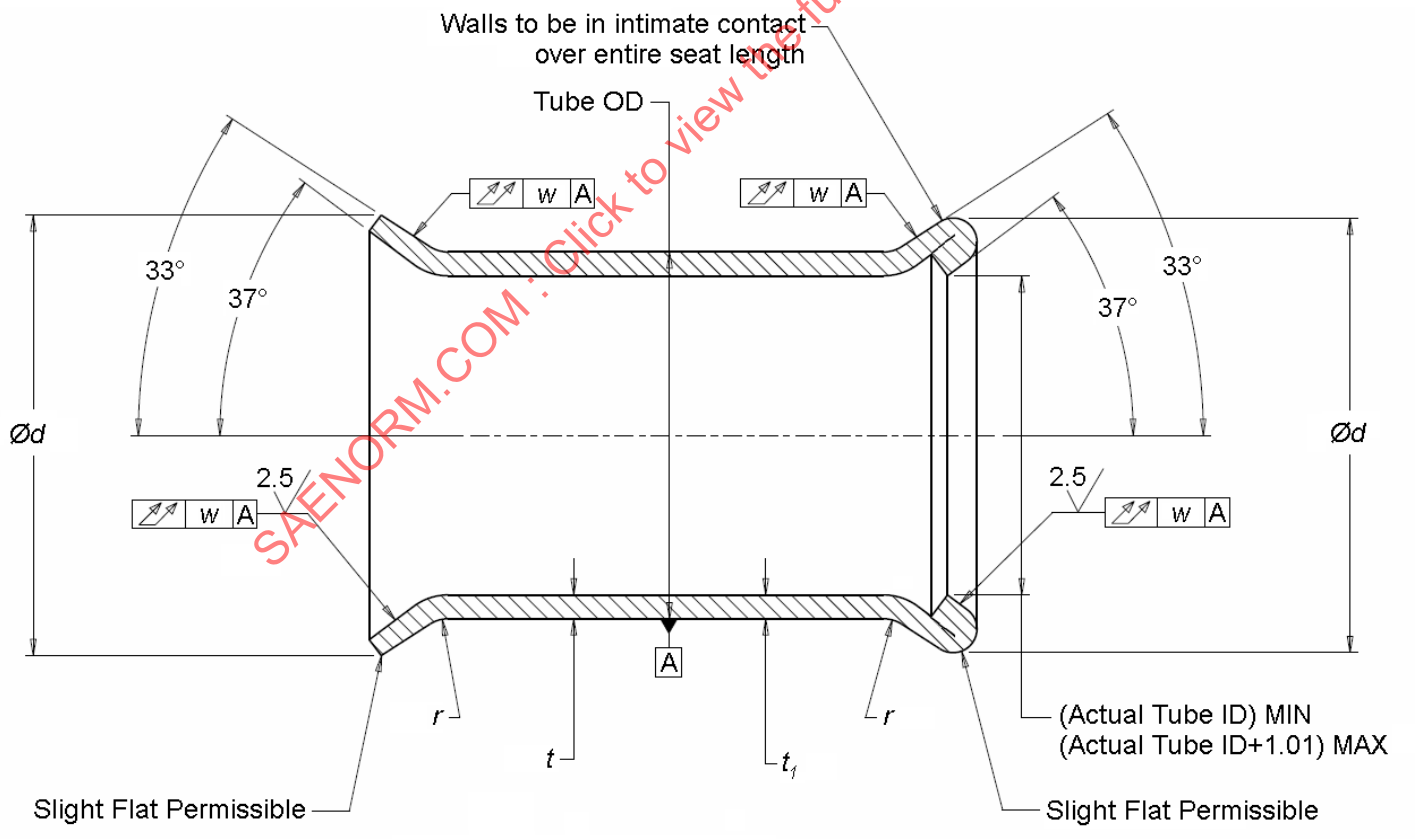

Figure 2 - Single and double 37 degree flares for metric OD tubing

Table 2 - Dimensions of single and double 37 degree flares for metric OD tubing (see Figure 2 for dimension callouts)

Nominal Metric Tube OD	Single and Double Flare Diameter		Radius	Single Flare Max Wall Thickness	Double Flare Max Wall Thickness	Total Runout
	d Min	*d* Max	*r* ±0.5	*t*[1] Max	t_1[2] Max	*w* Max
6	8.6	9.7	0.8	1.5	1	0.35
8	10.2	11.3	0.8	1.5	1	0.35
10	11.7	12.7	1	1.5	1	0.35
12	16	17.3	1.5	2	1.25	0.35
16	19.3	20.2	1.5	2.5	1.5	0.43
20	23.4	24.7	2	3	1.5	0.43
25	29.7	31	2.3	3	1.5	0.54
30/32	37.6	38.9	2.3	3	1.5	0.54
38	43.2	45.3	2.8	3	1.5	0.54
50	59.2	61.2	2.8	3.5	1.5	0.54

(1) For optional improved flare contact for 37 degree single flares, chamfers shown in Table 4 are recommended.

(2) Wall thicknesses greater than those specified may require a longer tube nut to insure adequate thread engagement. Special tube nut designs shall be as agreed upon between manufacturer and customer.

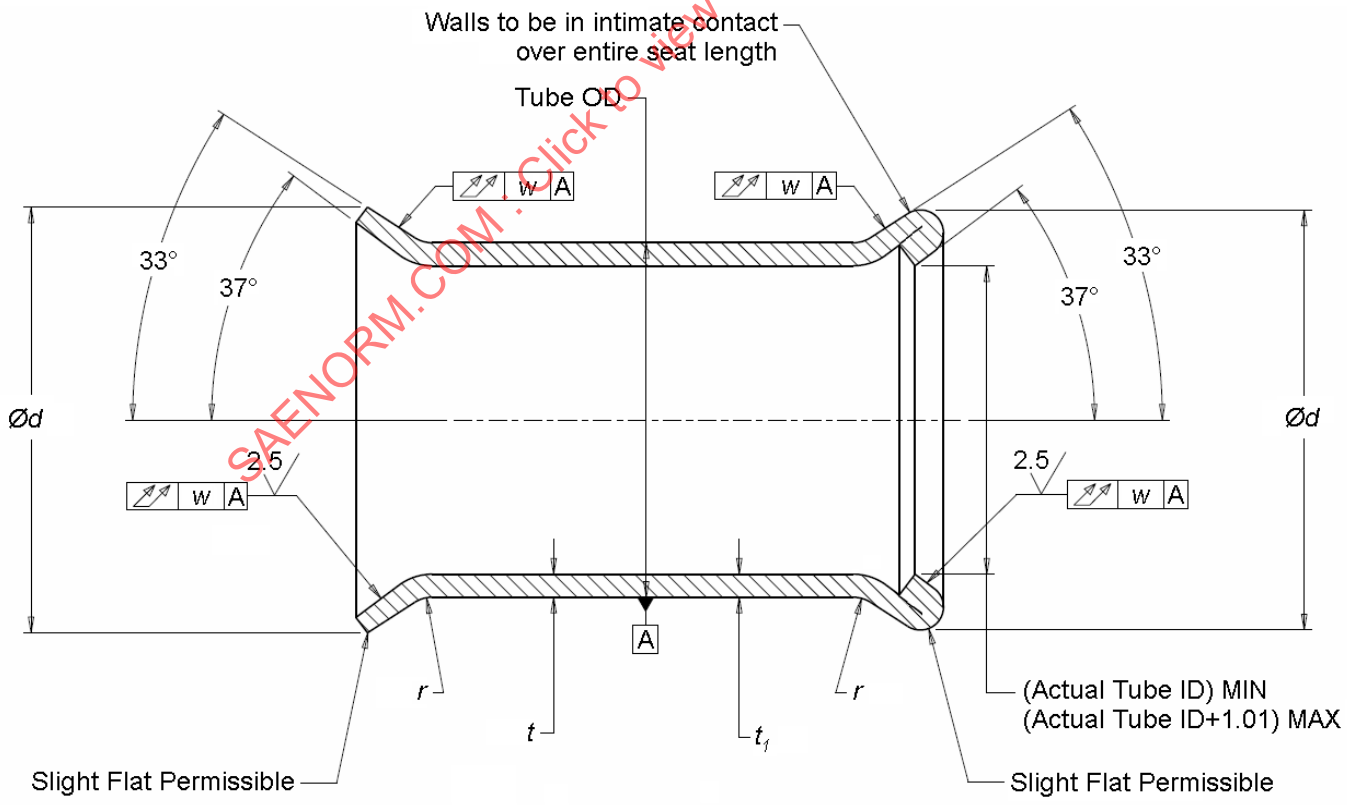

Figure 3 - Single and double 37 degree flares for inch OD tubing

Table 3 - Dimensions of single and double 37 degree flares for inch OD tubing (see Figure 3 for dimension callouts)

Nominal Inch Tube OD	SAE Dash Size	Single and Double Flare Diameter d Min	Single and Double Flare Diameter d Max	Radius r ±0.5	Single Flare Wall Thickness t(1) Max	Double Flare Wall Thickness t_1(2) Max	Total Runout w Max
3.18	-2	4.6	5.1	0.8	0.89	0.63	0.35
4.76	-3	6.6	7.1	0.8	0.89	0.71	0.35
6.35	-4	8.6	9.7	0.8	1.65	0.89	0.35
7.94	-5	10.2	11.3	0.8	1.65	0.89	0.35
9.52	-6	11.7	12.7	1	1.65	0.89	0.35
12.7	-8	16	17.3	1.5	2.11	1.24	0.35
15.88	-10	19.3	20.2	1.5	2.41	1.24	0.43
19.05	-12	23.4	24.7	2	2.77	1.24	0.43
22.22	-14	26.4	27.2	2	2.77	1.65	0.43
25.4	-16	29.7	31	2.3	3.05	1.65	0.54
31.75	-20	37.6	38.9	2.3	3.05	1.65	0.54
38.1	-24	43.2	45.3	2.8	3.05	1.65	0.54
50.8	-32	59.2	61.2	2.8	3.4	1.65	0.54

(1) For optional improved flare contact for 37 degree single flares, chamfers shown in Table 4 are recommended.

(2) Wall thicknesses greater than those specified may require a longer tube nut to insure adequate thread engagement. Special tube nut designs shall be as agreed upon between manufacturer and customer.

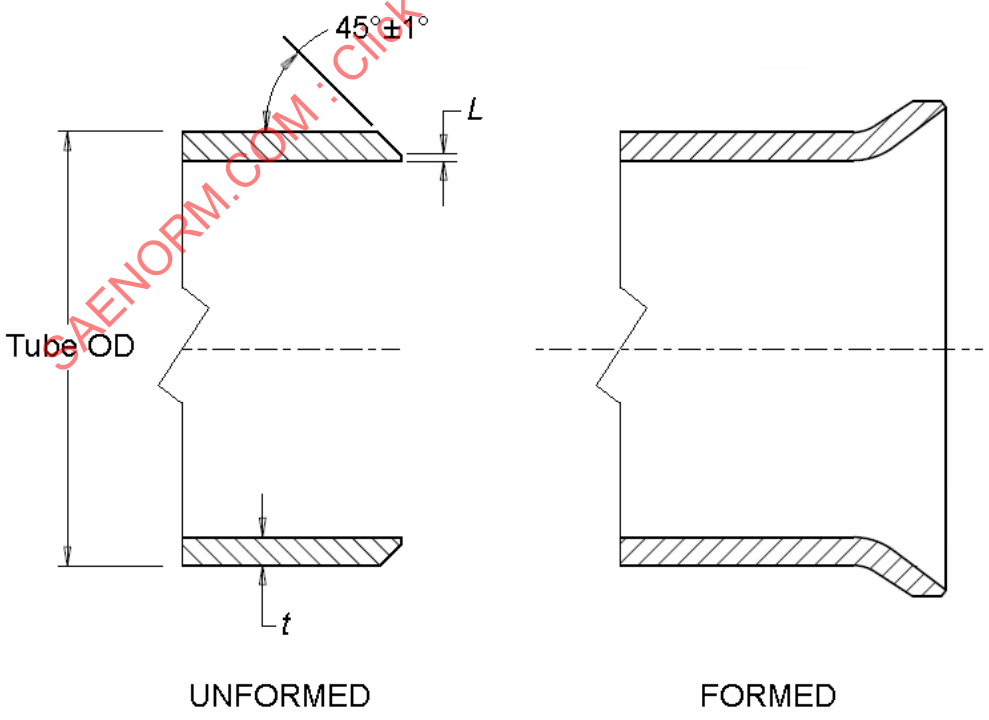

Figure 4 - Recommended chamfer for single 37 degree flares

Table 4 - Recommended chamfer dimensions for single 37 degree flares (see Figure 4 for dimension callouts)

Nominal Inch Tube OD	Nominal Metric Tube OD	SAE Dash Size	Tube Wall Thickness ≥*t*	*L*[1] Min
3.18		-2	0.89	0.2
4.76		-3	0.89	0.2
6.35	6	-4	0.89	0.2
7.94	8	-5	0.89	0.2
9.52	10	-6	0.89	0.2
12.7	12	-8	1.24	0.35
15.88	16	-10	1.24	0.35
19.05	20	-12	1.24	0.35
22.22		-14	1.24	0.35
25.4	25	-16	1.24	0.35
31.75	32	-20	1.24	0.35
38.1	38	-24	1.24	0.35
50.8	50	-32	1.65	0.4

(1) It is recommended that the *L* dimension be maintained as small as possible in order to maximize the length of the flare seat.

3.2 Deburring Prior to Flaring

Deburring operations on the tube end prior to flaring may be necessary to ensure satisfactory flares. Smoothly breaking the inside corner before single flaring is normally required to eliminate the cutoff burr which can otherwise create leakage paths across a substantial portion of the flare. Smoothly breaking the outside corner prior to single flaring, or both outside and inside corners prior to double flaring, is permissible on any tube material to minimize splitting.

3.3 Total Runout Inspection

Total runout can be measured by any suitable equipment that can provide accurate measurements. A common inspection set-up for total runout can be accomplished with a fixture fitted with a dial indicator as shown in Figures 5 and 6. The fixture includes a V-block to simulate the datum in which the tube can be rotated to allow the operator to obtain a total runout measurement. The dial indicator is set at the nominal angle (45 degree or 37 degree) in relation to the tube centerline. The entire sealing surface shall lie within the indicated tolerance envelope which is centered about the nominal seal surface geometry. The tube is rotated while dial indicator is swept back and forth across the surface. The measured total runout is the difference between the largest and smallest reading of the dial indicator.