SAE International™

SURFACE VEHICLE STANDARD

J1453-1

ISSUED FEB2007

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Specification for O-Ring Face Seal Connectors: Part 1—Tube Connection Details and Common Requirements for Performance and Tests

RATIONALE

This standard is being revised to update it to the latest designs tested and approved by the SAE FCCTC SC1 subcommittee. It also introduces two new sizes (-5 and -14).

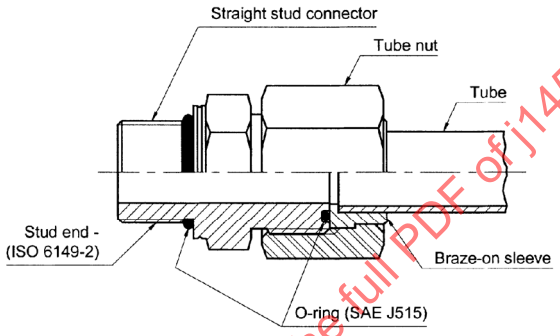

FIGURE 1 - TYPICAL REPRESENTATION OF O-RING FACE SEAL (ORFS) CONNECTORS WITH METRIC STUD END (SEE SAE J1453-3 FOR SAE J1926-2 STUD END CONNECTORS AND FIGURE 2 FOR TYPICAL TUBE AND HOSE CONNECTONS)

FOREWORD

The JUN2002 edition of SAE J1453 was published as a single document covering the requirements for inch O-ring face seal connectors with SAE J1926-2 inch stud ends. In 1995 ISO 8434-3 was published covering the requirements for O-ring face seal connectors with ISO 6149-2 metric stud ends. This revision of SAE J1453 adopts the parts covered within ISO 8434-3 and the rationalized dimensions from ISO 8434-3 for both the inch and metric stud end face seal connectors. SAE J1453 has been organized into three sections as follows:

1. SAE J1453-1—Specifications for O-Ring Face Seal Connectors—Part 1: Tube Connection Details and Common Requirements for Performance and Tests

2. SAE J1453-2—Specifications for O-Ring Face Seal Connectors—Part 2: Requirements, Dimensions, and Tests for Steel Unions, Bulkheads, Swivels, Braze Sleeves, Connectors, Caps, and Connectors with ISO 6149-2, Metric Stud Ends

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3. SAE J1453-3—Specifications for O-Ring Face Seal Connectors—Part 3: Requirements, Dimensions, and Tests for Steel Unions, Bulkheads, Swivels, Braze Sleeves, Connectors, Caps, and Connectors with SAE J1926-2 Inch Stud Ends

SAE J1453-2 parts are technically equivalent to ISO 8434-3 parts; SAE J1453-3 parts are technically equivalent to SAE J1453 JUN2002 parts. Parts supplied to SAE J1453 JUN2002 shall now be supplied to SAE J1453-3.

NOTE: A common face seal connection between SAE J1453 and ISO 8434-3 standards provides for manufacturing efficiency. This revision of SAE J1453 provides for this commonality. However, the revision allows designated parts in SAE J1453-1 and SAE J1453-3 to deviate to dimensions shown in June, 2002, edition of SAE J1453 until December 31, 2008. These permissible deviations are given in Appendix A of this document. On January 1, 2009, all parts shall conform to the dimensions given in this document. All of Appendix A, except Figure A1 and Table A1, and Appendix B will be deleted from this document, effective January 1, 2009. The rationale for this deviation is to allow manufacturers time to change tooling to the new dimensions agreed to within ISO 8434-3.

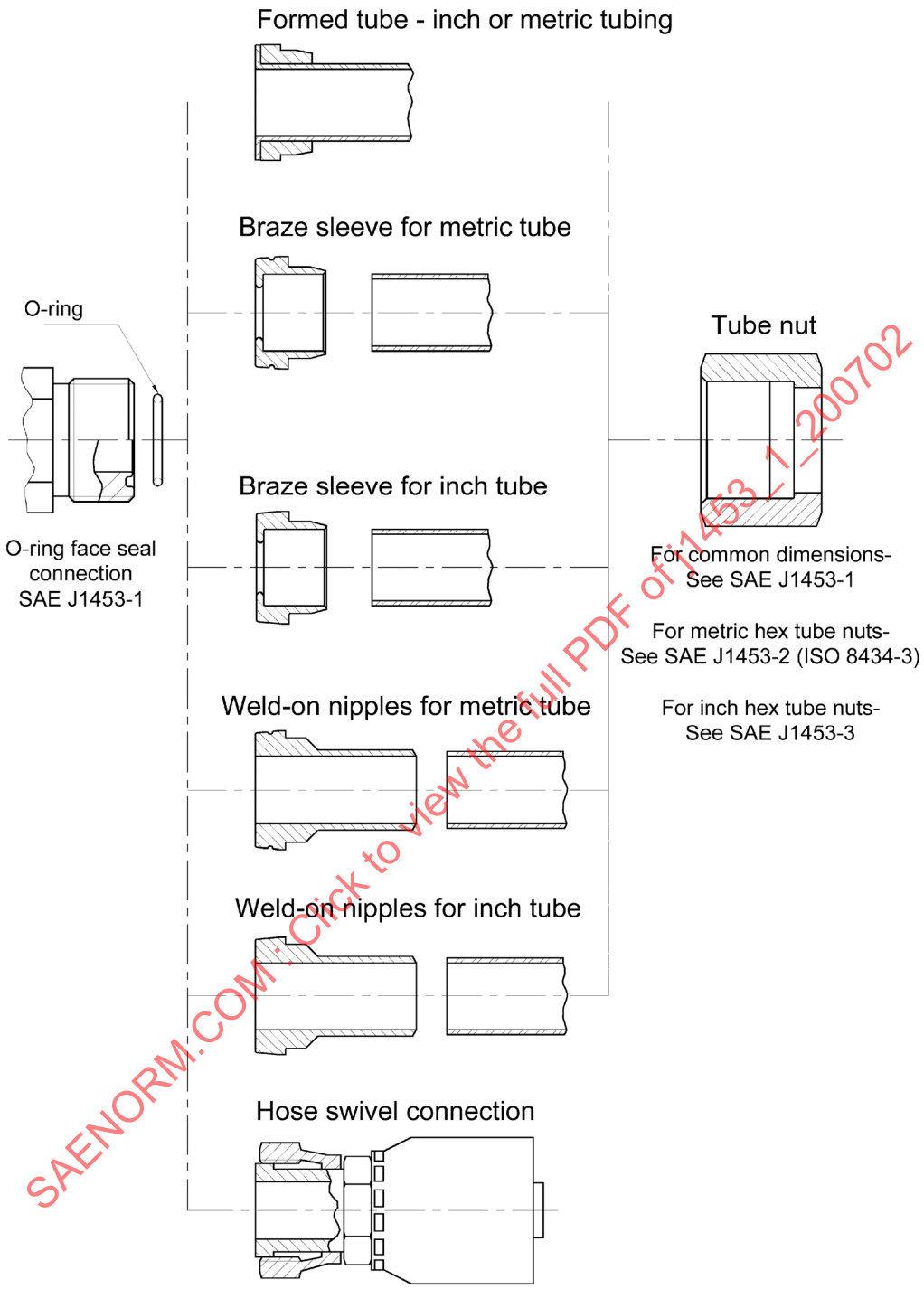


FIGURE 2 - TYPICAL O-RING FACE SEAL CONNECTIONS TO INCH OR METRIC TUBING OR HOSE

TABLE 1 - QUICK REFERENCE CHART: TUBE OD TO METRIC PORT STUD END SIZES, HEX NUT SIZES, QUALIFICATION TEST TORQUES AND CONNECTOR WORKING PRESSURES

(NOTE: In cases of conflict, values shown in the body of SAE J1453-2 and ISO 6149-2 take precedence)

Nominal Metric Tube OD[1] mm	Inch Tube OD or Hose ID Dash Size[1]	Nominal Inch Tube OD mm	O-Ring Face Seal End Thread In	O-Ring Face Seal and Swivel End Tube Nut Hex mm	O-Ring Face Seal End Qualification Test Torque[2] N·m	Port Stud End ISO 6149-2 Thread[4] mm	Port Stud End ISO 6149-2 Nut Hex mm	Port Stud End ISO 6149-2 Qualification Test Torque[2] N·m	Connector Working Pressure, Face Seal[3] and Nonadjustable Stud End MPa	Connector Working Pressure, Adjustable Stud End MPa
6	– 4	6.35	9/16-18	17	25	M12X1.5	17	35	63	40
8	– 5	7.94	5/8-18	19	30	M14X1.5	19	45	63	40
10	– 6	9.52	11/16-16	22	40	M16X1.5	22	55	63	40
12	– 8	12.70	13/16-16	24	55	M18X1.5	24	70	63	40
16	–10	15.88	1-14	30	60	M22X1.5	27	100	40	40
20	–12	19.05	1-3/16-12	36	90	M27X2	32	170	40	40
22	–14	22.23	1-5/16-12	41	115	M30X2	36	235	40	35
25	–16	25.40	1-7/16-12	41	125	M33X2	41	310	40	35
30	–20	31.75	1-11/16-12	50	170	M42X2	50	330	25	25
38	–24	38.10	2-12	60	200	M48X2	55	420	25	20

1. The size symbol for all tube sizes shall be the tube OD or nominal hose ID in millimeters, except dash size symbols may be used for braze sleeve and weld nipple for inch tubing.
2. Torque values listed in Table 1 are for controlled testing to establish compliance to the performance requirements as set forth in paragraph 4.2. Recommended assembly torques by manufacturers may vary from those shown.
3. This covers unions, caps, bulkheads, swivels and plugs.
4. Screw threads on the port end of the connectors shall be metric per ISO 261.

TABLE 2 - QUICK REFERENCE CHART: TUBE OD TO INCH PORT STUD END SIZES, HEX NUT SIZES, QUALIFICATION TEST TORQUES AND WORKING PRESSURES

(CAUTION: In case of conflict, values shown in the body of SAE J1453-3 and SAE J1926-2 take precedence.)

Nominal Inch Tube OD or Hose ID Dash Size[1]	Nominal Inch Tube OD in	Nominal Inch Tube OD mm	Nominal Metric Tube OD mm	O-Ring Face Seal End Thread[2] in ref.	O-Ring Face Seal and Swivel End Tube Nut Hex in	O-Ring Face Seal End Qualification[3] Test Torque N·m	Port Stud End SAE J1926-2 (ISO 11926-2) Thread[3] in ref.	Port Stud End SAE J1926-2 (ISO 11926-2) Adjustable Inch Nut Hex in	Port Stud End SAE J1926-2 (ISO 11926-2) Qualification[3] Test Torque N·m	Connector Working Pressure[4], Face Seal and Nonadjust-able Stud End MPa	Connector Working Pressure, Adjustable Stud End MPa
– 4	0.250	6.35	6	9/16-18	11/16	25	7/16-20	5/8	20[5]	63	41.3
– 6	0.312	7.94	8	5/8-18	3/4	30	1/2-20	11/16	40	63	41.3
– 6	0.375	9.52	10	11/16-16	13/16	40	9/16-18	3/4	45	63	41.3
– 8	0.500	12.70	12	13/16-16	15/16	55	3/4-16	15/16	85	63	41.3
–10	0.625	15.88	16	1-14	1-1/8	60	7/8-14	1-1/16	100	41.3	41.3
–12	0.750	19.05	20	1-3/16-12	1-3/8	90	1-1/16-12	1-3/8	170	41.3	41.3
–14	0.875	22.22	22	1-5/16-12	1-1/2	115	1-3/16-12	1-1/2	235	41.3	38.0
–16	1.000	25.40	25	1-7/16-12	1-5/8	125	1-5/16-12	1-5/8	270	41.3	34.5
–20	1.250	31.75	30	1-11/16-12	1-7/8	170	1-5/8-12	1-7/8	285	27.5	27.5
–24	1.500	38.10	38	2-12	2-1/4	200	1-7/8-12	2-1/8	370	27.5	20.7

1. The dash size symbol applicable to all tube ends and straight thread O-ring boss ends shall consist of the number of sixteenth inch increments contained in the outside diameter of the tubing (nominal OD) or inside diameter of the hose (nominal hose ID).
   For example: –4 = 4/16 = 0.25 = 6.35 mm inch tube size or hose, or corresponding port.
2. See SAE J1453-1 for Screw Thread information.
3. Torque values listed in Table 2 are for controlled testing to establish compliance to the performance requirements set forth in paragraph 4.2. Recommended assembly torques by manufacturers may vary from those shown.
4. This covers unions, caps, bulkheads, swivels and plugs.
5. For –4 only, adjustable torque is given. For nonadjustable torque is 35 N·m.

TABLE OF CONTENTS

1. SCOPE

1.1 Purpose

The three parts of SAE J1453 cover material, dimensional, and performance requirements of steel O-ring face seal (ORFS) connectors for tubing and the O-ring face seal interface and nut portion of hose stem assemblies for nominal tube diameters of 6 mm through 38 mm and for nominal hose diameters of 6.3 mm through 38 mm.

1.2 Field of Application

These connectors are intended for general application and hydraulic systems on industrial equipment and commercial products, where elastomeric seals are acceptable to overcome leakage and variations in assembly procedures. These connectors are capable of providing leak proof full flow connections in hydraulic systems operating from 95 kPa vacuum to the working pressures shown in Tables 1 and 2. Since many factors influence the pressure at which a hydraulic system will or will not perform satisfactorily, these values should not be construed as guaranteed minimums. For any application, it is recommended that sufficient testing be conducted and reviewed by both the user and manufacturer to ensure that required performance levels are met.

For use of these connectors in conditions outside the pressure and temperature limits specified, the manufacturers must be consulted.

Both metric and inch tubing can be accommodated by changing only the sleeve to match the tube diameters. In the past, these connectors have been used predominantly with inch tubing. For new designs, the use of metric tubing should be considered.

2. REFERENCES

2.1 Applicable Publications

The following standards contain information which through reference in this text, constitute provisions of this document. All standards are subject to revision, and parties to agreements based on this document shall apply the most recent edition of the standards. Members of IEC and ISO maintain registers of currently valid International Standards. Unless otherwise indicated, the latest version of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE, 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 J356 Welded Flash Controlled Low Carbon Steel Tubing Normalized for Bending, Double Flaring, and Beading

SAE J515 Hydraulic O-Rings

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 J846 Coding System for Identification of Fluid Conductors and Connectors

SAE J1644 Metallic Tube Connections for Fluid Power and General Use—Test Methods for Threaded Hydraulic Fluid Power Connectors

SAE J1453-2 Specification for O-Ring Face Seal Connectors—Part 2: Requirements, Dimensions, and Tests for Steel Unions, Bulkheads, Swivels, Braze Sleeves and Connectors with ISO 6149-2 Metric Stud Ends

SAE J1453-3 Specification for O-ring Face Seal Connectors—Part 3: Requirements, Dimensions, and Tests for Steel Unions, Bulkheads, Swivels, Braze Sleeves and Connectors with SAE J1926-2 Inch Stud Ends

SAE J1926-2 Connections for General Use and Fluid Power: Ports and Stud Ends with ISO 725 Threads and O-Ring Sealing—Part 2: Heavy Duty (S Series) Stud Ends

SAE J2593 Information Report for the Installation of Fluid Conductor and Connectors

2.1.2 ANSI Publication

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

ANSI B4.2 Preferred Metric Limits and Fits

2.1.3 ASME Publications

Available from the ASME, 22 Law Drive, PO Box 2900, Fairfield, NJ 07007-2900, Tel: 973-882-1170, www.asme.org.

ASME B1.1 Unified Inch Screw Threads

ASME B46.1 Surface Texture (Surface Roughness, Waviness and Lay)

2.1.4 ASTM Publications

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

ASTM B 633 Standard Specifications for Electrodeposited Coatings of Zinc on Iron and Steel

ASTM B 117 Method of Salt Spray (Fog) Test

2.1.5 ISO Publications

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

ISO 48 Vulcanized rubbers—Determination of hardness (Hardness between 30 and 85 IRHD)

ISO 68-2 ISO general purpose screw threads—Basic profile—Part 2: Inch screw thread

ISO 2768-1 General Tolerances—Part 1: Tolerances for linear and angular dimensions without individual tolerances indications

ISO 3304 Plain end seamless precision steel tubes, technical conditions of delivery

ISO 3305 Plain end welded precision steel tubes

ISO 3448 Industrial liquid lubricants—ISO viscosity classification

ISO 4397 Fluid power systems and components—Connectors and associated components—Outside diameters of tubes and inside diameter of hoses

ISO 5598 Fluid power systems and components—Vocabulary

ISO 5864 ISO inch screw threads—Allowances and tolerances

ISO 6149-2 Connections for fluid power and general use—Part 2: Heavy duty (S) series stud ends—Dimensions, design, test methods and requirements

ISO 6508 Metallic materials—Hardness test—Rockwell test (scales A - B - C - D - E - F - G - H - K)

ISO 6803 Rubber or plastic hoses and hose assemblies—Hydraulic pressure impulse test without flexing

ISO 8434-3 Metallic tube connections for fluid power and general use—Part 3: O-ring face seal connectors

ISO 9227 Corrosion tests in artificial atmospheres - Salt spray tests

ISO 11926-2 Connections for general use and fluid power—Ports and stud ends with ISO 725 threads and O-ring sealing—Part 2: Heavy duty (S) series stud ends

3. DEFINITIONS

For this part of SAE J1453, the definitions given in ISO 5598 and the following definitions shall apply:

3.1 Fluid Power

(From ISO 5598) Means by which energy is transmitted, controlled, and distributed using a pressurized fluid as the medium.

3.2 Connector

(From ISO 5598) Leakproof device to connect pipelines (conductors) to one another or to equipment.

3.3 Fastening Thread

Terminal thread of a complete connector.

3.4 Run

Two axially aligned outlets of a tee or cross. See Figure 3.

FIGURE 3 - RUN AND BRANCH ILLUSTRATION

3.5 Branch

Side outlet of a tee or cross.

3.6 Chamfer

Removal of a conical portion at the entrance of a thread to assist assembly and prevent damage to the start of the thread.

3.7 Torques

3.7.1 Assembly Torque

The maximum torque to be applied in order to achieve a satisfactory final assembly.

3.7.2 Qualification Test Torque

The torque used to verify conformance of the connector to the requirements of this standard.

3.7.3 Overtorque

The torque the nut shall withstand without deformation that renders it unusable.

3.8 Working Pressure

(From ISO 5598) Pressure at which the apparatus is being operated in a given application as shown in SAE J1453-2 and SAE J1453-3.

3.9 Adjustable Stud End

A stud end connector that allows for connector orientation before final tightening of the locknut to complete the connection. This type of stud end is typically used on shaped connectors (e.g., tees, crosses and elbows).

3.10 Nonadjustable Stud End

A stud end connector that does not require specific orientation before final tightening of the connection because it is only used on straight connectors.

3.11 Preferred

Commonly used readily available parts.

3.12 Nonpreferred

Parts which are low volume, considered specials and their use requires special consideration. Dimensions for nonprererred parts are given to provide standardization within the industry.

3.13 Jump Size Connector

Connectors with unpaired end connections, for example, M14 stud end with 12 mm tube end.

3.14 Size Designation

Connector sizes are designated by the nominal outside diameter of the tubing or nominal inside diameter of hose. See SAE J846 for specific size details.

4. REQUIREMENTS

4.1 Material

4.1.1 Connector Bodies

Bodies shall be manufactured from carbon steel that will provide the minimum pressure/temperature requirements specified for each component or assembly. They shall have characteristics that make them suitable for use with fluid to be conveyed and to provide an effective joint. Weld-on components shall be made from a material that is suitable for welding.

4.1.2 Component Construction

Connectors may be made by forging, cold forming or machining from bar stock. Carbon steel connectors made from multiple components shall be bonded together with materials having a melting point of not less than 1000 °C.

4.1.3 Nuts

Unless otherwise specified, nuts to be used with carbon steel bodies shall be made of carbon steel. In tube assemblies where sleeves are copper brazed, nuts become annealed, reducing their strength. Nuts for copper brazed assemblies shall be made of suitable higher strength material to meet the performance requirements. High-strength nuts (style B nuts) shall be identified by a turned diameter, d_{14}, as shown in Figure 7, Nut Style B.

4.1.4 For materials other than steel, contact the manufacturer.

4.2 Performance

Connectors shall meet the following performance requirements when tested per Section 5:

4.2.1 Application Temperature

Carbon steel connectors shall meet the working pressures when used at temperatures between –40 °C and +120 °C. For pressures or temperatures outside this range, the manufacturer shall be consulted.

4.2.2 Cyclic Endurance (Impulse) Test

Connectors shall exceed one million impulse cycles when tested at 133% of the working pressure shown in SAE J1453-2 or SAE J1453-3 to verify the fatigue strength of the connector.

4.2.3 Proof Test

Connectors shall meet the required proof pressures to verify a minimum of a 2:1 Proof to Working pressure ratio.

4.2.4 Burst Test

Connectors shall meet the required burst pressures to verify a minimum of a 4:1 Burst to Working pressure ratio to determine the ultimate strength of the connector.

4.2.5 Vacuum Test

Connectors shall be capable of withstanding a vacuum of 95 kPa (0.95 bar) negative gauge pressure for 5 minutes without leakage.

4.2.6 Nut Overtorque Test

Face seal nuts shall be capable of withstanding the overtorque specified in Table 3 with no indication of failure.

Definitions of nut failure are:

a. The nut cannot be removed by hand after breakaway.

b. The nut cannot swivel freely by hand.

c. The nut will not retract to its original position by hand.

d. Any visible cracks or severe deformation that would render the nut unusable.

TABLE 3 - FACE SEAL NUT (FIGURE 7) QUALIFICATION TEST TORQUE AND OVERTORQUE REQUIREMENTS

Nominal Tube OD Metric Tubing mm	Nominal Tube OD Inch Tubing Dash Size	Nominal Tube OD Inch Tubing mm	Thread Size(1) ref.	Test Torque +10% 0 N·m	Test Overtorque N·m
6	– 4	6.35	9/16-18	25	32
8	– 5	7.94	5/8-18	30	45
10	– 6	9.52	11/16-16	40	54
12	– 8	12.70	13/16-16	55	81
16	–10	15.88	1-14	60	136
20	–12	19.05	1-3/16-12	90	180
22	–14	22.22	1-5/16-12	115	230
25	–16	25.40	1-7/16-12	125	270
30	–20	31.75	1-11/16-12	170	380
38	–24	38.10	2 - 12	200	450

1. See 4.3.8.

4.3 Design

4.3.1 Across Flats Dimensions

See SAE J1453-2 for metric wrench flat dimensions and SAE J1453-3 for inch wrench flat dimensions.

4.3.2 Hex Chamfer

Unless otherwise specified or shown, hex corners are chamfered 15 to 30 degrees to a diameter equal to the width across flats with a tolerance of +0.0/–0.4 mm.

For connections other than ISO 6149 and SAE J1926, a 5 degree chamfer starting at the undercut diameter behind the threads or outside diameter of the threads shall be allowed, provided the hex width at corners is not reduced below that produced by the 30 degree chamfer previously described.

4.3.3 Dimensional Specifications

Connectors shown in SAE J1453-2 and SAE J1453-3 shall conform to the dimensions in their respective tables. Dimensions specified apply to finished parts, including any plating or other treatments. The tolerance value for all dimensions not otherwise limited shall be ±0.4 mm. Nonstandard connectors may have additional tolerances.

4.3.4 Passage Tolerance

Where passages in straight connectors are machined from opposite ends, the offset at the meeting point shall not exceed 0.4 mm. No cross sectional area at a junction of passages shall be less than that of the smallest passage.

4.3.5 Angular Tolerance

Angular tolerance on axis of end on elbows, tees, and crosses shall be ±2.5 degrees for tube sizes up to 10 mm and ±1.5 degrees for all larger sizes.

4.3.6 Contour Details

Details of contour shall be to the manufacturer's option, as long as the dimensions given in the tables are maintained. Abrupt reduction of a section shall be avoided. Junctions of small external sections and adjoining relatively heavy sections shall be blended by means of ample fillets.

4.3.7 Sharp Corners

Unless otherwise noted, all sharp corners shall be broken 0.15 mm max.

4.3.8 Screw threads

The screw threads on the tube/hose connection ends of the connectors shall be inch screw thread per ASME B1.1 (ISO 68-2 and ISO 5864) Straight threads shall be class 2A or 2B except for internal minor diameter of the face seal nut thread which has been modified, see Table 8. External class 2A threads which are plated or coated may exceed 2A diameters but shall not exceed maximum of 3A diameters. Internal threads of all classes must be within specified limits after plating or coating.

When external threads are produced by thread rolling and the body is not undercut, the unthreaded area adjacent to the shoulder may be reduced to the minimum pitch diameter.

4.4 Manufacturing

4.4.1 General Workmanship

Workmanship shall conform to the best commercial practice to produce high quality connectors. Connectors shall be free from visual contaminants, all hanging burrs, loose scale and slivers which might be dislodged in use and any other defects that might affect the function of the parts.

4.4.2 Surface Finish

Unless otherwise specified, surface finish on all machined surfaces shall be Ra < 6.3 µm.

4.4.3 Plating

The external surfaces and threads of all carbon steel parts shall be plated or coated with a suitable material that passes a 72 h salt spray test in accordance with ASTM B 117 (ISO 9227). Any appearance of red rust during the 72 h salt spray test shall be considered failure, except for the following:

a. All internal fluid passages.

b. Edges such as hex points, serrations and crests of threads where there may be mechanical deformation of the plating or coating typical of mass produced parts or shipping effects.

c. Areas where there is mechanical deformation of the plating or coating caused by crimping, flaring, bending or other post-plate metal forming operations.

d. Areas where the parts are suspended or affixed in the test chamber where condensate can accumulate.

NOTE: Zinc plating with Hexavalent Chromate conversion coatings are not preferred due to environmental reasons. Internal fluid passages shall be protected from corrosion during storage. Changes in plating may affect assembly torques and require requalification, when applicable.

Braze-on Connectors and Weld Nipples - Braze-on type connectors, weld nipples and style “B” nut (520110) shall be protected from corrosion by an oil film or other corrosion protection coating, but does not need to meet the 72 h salt spray test requirement.

4.5 Assembly Procedures Information

See SAE J1453-2 or SAE J1453-3.

5. TEST METHODS AND QUALITY PROCEDURES

5.1 Test Procedures

The test procedures shall be per SAE J1644.

5.2 Test Frequency

Qualification testing shall be required when there is a change in design, material or process.

5.3 Required Tests and Sample Size

Table 4 lists the sample type to be tested and applicable tests. The sequence of test shall be from left to right.

TABLE 4 - TEST TYPE AND SEQUENCE

Sample Type	Quantity Per Size	Vacuum Test	Proof Pressure Test	Burst Pressure Test	Cyclic Endurance (Impulse Test)	Overtorque Test
Stud Straight	3	X	X	X		
Stud Elbow	3	X	X	X		
Swivel Elbow(1)	3	X	X	X		
Stud Straight	6		X		X	
Stud Elbow	6		X		X	
Swivel Elbow(1)	6		X		X	
Swivel Elbow(1)	3					X
Nut, Style A	3					X
Nut, Style B	3					X

1. 90 degree Swivel Elbow

5.4 Test Pressures

For test pressures see SAE J1453-2 or SAE J1453-3.

5.5 O-Rings

O-ring material shall conform to SAE J515 Type 1 and the applicable size specified. (90 durometer nitrile)

5.6 Annealing

All components requiring copper brazing to assemble and Style B nuts supplied as unplated individual items shall be processed through a 1000 °C minimum annealing process before burst, cyclic endurance and torque testing.

5.7 Qualification Test Torques

Test torques for the O-ring face seal end shall conform to the minimum values in Table 3, and the test torques for the stud ends shall conform to the minimum values given in the applicable stud end standard. (For inch stud ends see SAE J1926-2 and for metric stud ends see ISO 6149-2.) Torque values listed in Table 3 are for controlled testing to establish compliance to the performance requirements for face seal ends in SAE J1453 part 2 and part 3. Recommended assembly torques by manufacturers may vary from the torques in Table 3.

6. LABELLING, MARKING, AND PACKAGING

6.1 Marking of Components

Connector bodies and tube nuts shall be permanently marked with the manufacturer's name or trademark. A code identifier, as agreed upon between the purchaser and manufacturer, may be used instead of the manufacturer's name or trademark.

6.2 Connector Protection

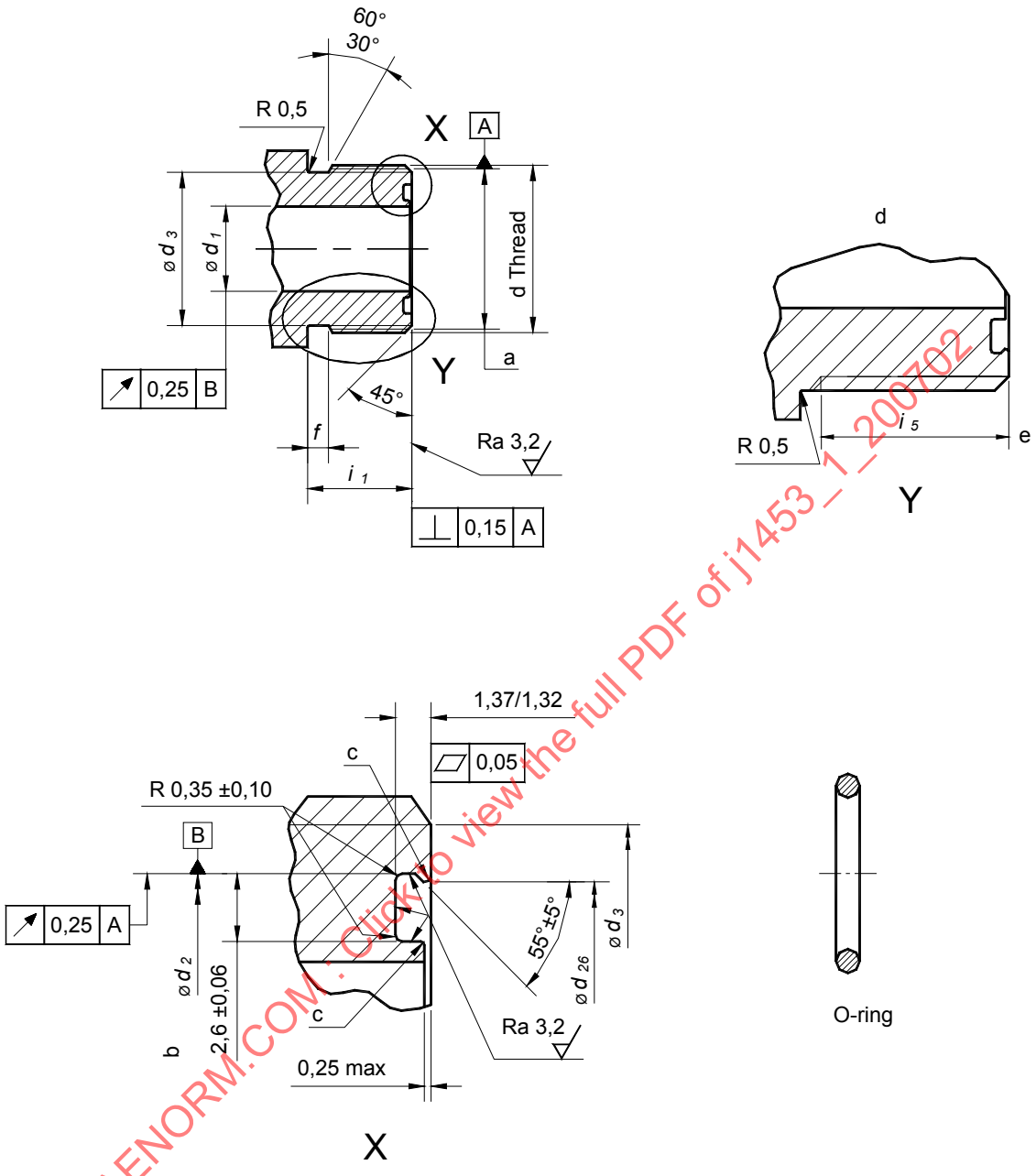
By a method agreed between manufacturer and user, the face of the connectors and threads (both internal and external) shall be protected by the manufacturer from nicks and scratches which would be detrimental to the connector's function. Passages shall be securely covered to prevent the entrance of dirt or other contaminants. Paper caps and plugs are not permitted.

Braze-on type connectors require protection on the sealing face and threaded end only.

Nuts and sleeves that are furnished separately from the connector shall be protected from rust but do not require capping.

6.3 Ordering Designations

See SAE J1453-2 or SAE J1453-3 for ordering information.



NOTE 1: For O-ring size information, see SAE J515.
NOTE 2: See Figure C1, Appendix C, for Surface Acceptance Criteria.
NOTE 3: For straight sided groove dimensions see Annex A.

a. Pitch Diameter
b. Groove O.D.
c. Sharp edge or burr not allowed: break corner 0.13 +0/–0.05
d. Optional construction for shapes and long straights.
e. Minimum full thread depth.

FIGURE 4 - O-RING FACE SEAL CONNECTION

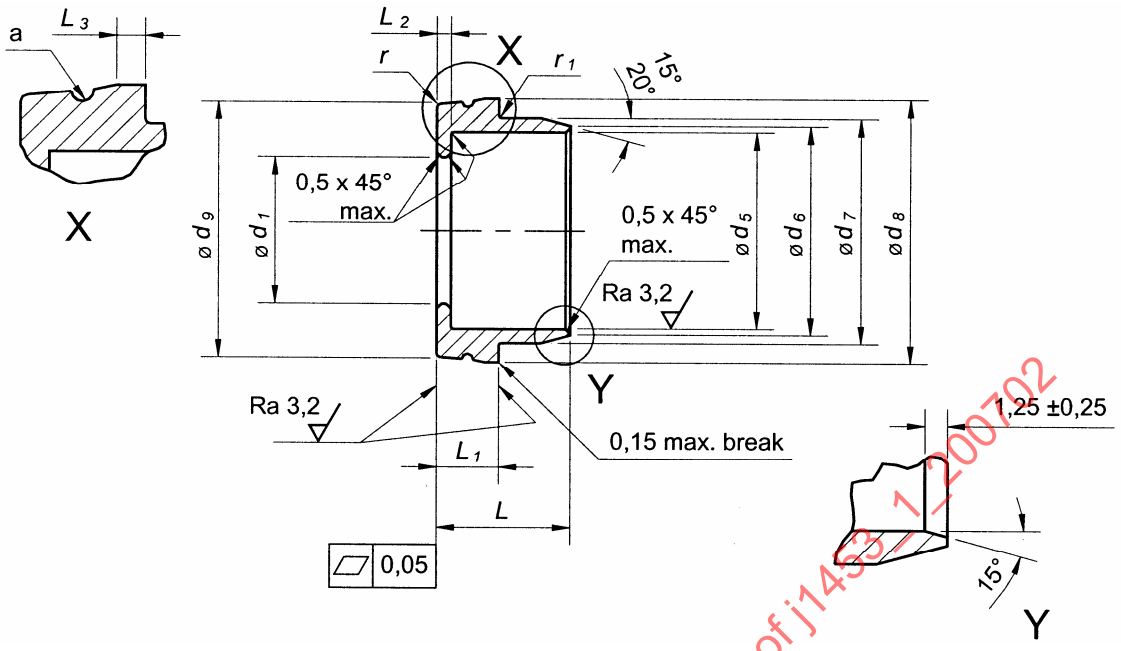
TABLE 5 - DIMENSIONS OF O-RING FACE SEAL CONNECTIONS

(NOTE: Straight sided groove dimensions are given in SAE J1453-1 Appendix A and can be used as agreed between user and manufacturer)

Dimensions in mm

Nominal Metric Tube OD mm	Nominal Inch Tube OD Dash Size	Nominal Inch Tube OD mm	d[1] Thread in.	d_1 nom.	d_1 tol.[2]	d_2 nom.	d_2 tol.	d_3 nom.	d_3 tol.	Style B d_{26} ±0.15	f nom.	f tol.	i_1 ±0.4	i_5 min	O-ring[3] ARP No.
6	– 4	6.35	9/16-18 UNF	4.5	±0.1	11.00	±0.08	12.25	±0.15	10.6	2.4	±0.3	10.0	9.0	011
8	– 5	7.94	5/8-18 UNF	5.5	±0.1	12.07	±0.08	13.70	±0.25	11.5	2.4	±0.3	10.0	9.0	[4]
10	– 6	9.52	11/16-16 UN	6.5	±0.2	12.8	±0.08	15.10	±0.25	12.25	2.8	±0.4	11.0	10.5	012
12	– 8	12.70	13/16-16 UN	9.5	±0.2	15.97	±0.08	18.25	±0.25	15.40	2.8	±0.4	13.0	12.0	014
16	–10	15.88	1-14 UNS	12.5	±0.2	19.2	±0.08	22.60	±0.40	18.5	3.1	±0.4	15.5	14.0	016
20	-12	19.05	1-3/16-12 UN	15.5	±0.2	22.37	±0.10	27.00	±0.40	21.65	3.7	±0.5	17.0	15.0	018
22	–14	22.22	1-5/16-12 UN	18.0	±0.2	25.58	±0.13	30.20	±0.40	24.7	3.7	±0.5	17.5	15.5	020
25	–16	25.40	1-7/16-12 UN	20.5	±0.2	27.1	±0.13	33.35	±0.40	26	3.7	±0.5	17.5	15.5	021
30	–20	31.75	1-11/16-12 UN	26.0	±0.3	33.45	±0.13	39.75	±0.40	32.75	3.7	±0.5	17.5	15.5	025
38	–24	38.10	2-12 UN	32.0	±0.3	41.37	±0.13	47.65	±0.40	40.65	3.7	±0.5	17.5	15.5	029

1. In accordance with ASME B1.1 (ISO 68-2 and ISO 5864).
2. Reference: Per ISO 2768-1, Tolerance Class, m.
3. Dash size per SAE AS568A.
4. Size is 8.5±0.16x1.78 mm.



Style A Style B, Optional Construction

a. Identification groove for Metric Tube Sleeve Only, centrally located on "L_1" surface, 1.5 wide X 0.5 deep max. Shape optional.

FIGURE 5 - BRAZE-ON SLEEVE

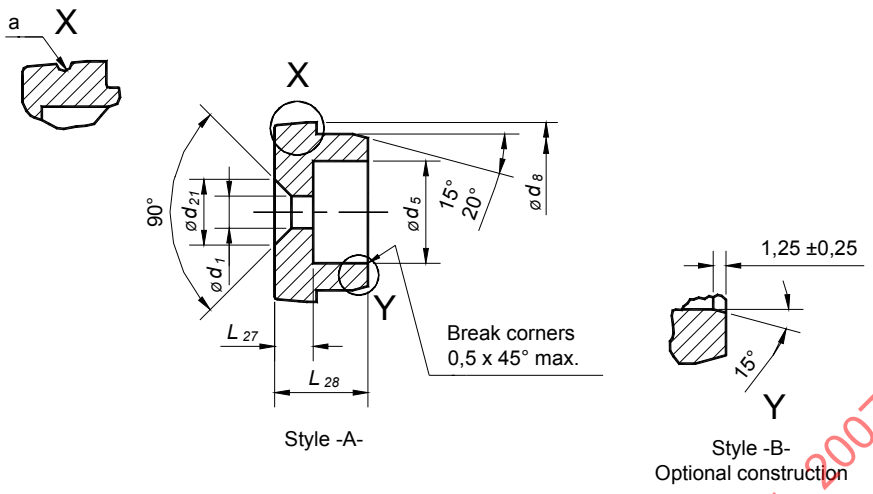
TABLE 6 - DIMENSIONS OF BRAZE-ON SLEEVE FOR METRIC AND INCH TUBING

(NOTE: Dimensions shown are required after 01JAN2009; alternate dimensions given in SAE J1453-1 Appendix A are permissible until 31DEC2008)

Dimensions in millimeters

Metric Tube OD	Metric Tube d_5 (1) ±0.05	Inch Tube Dash Size	Inch Tube OD	Inch Tube d_5 (1) ±0.05	d_1 nom.	d_1 tol.	d_6 0 −0.3	d_7 ±0.1	d_8 0 −0.15	d_9 ±0.15	L ±0.3	L_1 ±0.15	L_2 ±0.15	L_3 ±0.5	r max.	r_1 +0.15 0
6	6.15	– 4	6.35	6.50	4.5	±0.1	9.0	10.20	12.75	--	9.5	4.0	1.0	--	0.25	0.15
8	8.15	– 5	7.94	8.09	5.5	±0.1	10.5	11.70	14.35	--	9.5	4.0	1.0	--	0.25	0.15
10	10.15	– 6	9.52	9.68	6.5	±0.1	11.8	13.25	15.75	--	9.5	4.5	1.0	--	0.25	0.15
12	12.15	– 8	12.70	12.85	9.5	±0.1	15.1	16.30	18.90	--	9.5	5.0	1.0	--	0.25	0.15
16	16.15	–10	15.88	16.03	12.5	±0.2	19.2	20.75	23.45	22.60	10.5	6.0	1.5	1.3	0.25	0.25
20	20.18	–12	19.05	19.23	15.5	±0.2	22.1	23.75	27.85	27.00	14.0	6.5	1.5	1.3	0.40	0.25
22	22.18	–14	22.23	22.41	18.0	±0.2	25.3	26.90	31.00	30.15	14.0	6.5	1.5	1.3	0.40	0.25
25	25.18	–16	25.40	25.58	20.5	±0.2	28.1	28.70	34.20	33.35	15.5	7.0	1.5	1.3	0.40	0.40
30	30.20	–20	31.75	31.95	26.0	±0.3	34.0	35.60	40.55	39.70	15.5	7.0	1.5	1.3	0.40	0.40
38	38.20	–24	38.10	38.30	32.0	±0.3	42.0	43.55	48.50	47.65	15.5	7.0	1.5	1.3	0.40	0.40

1. Actual bore size and depth depends upon joining process. Tolerance was changed to agree with ISO. Dimensions given are for silver brazing.



a. Identification groove for Metric Tube Sleeve Only, centrally located on "L_1" surface, 1.5 wide X 0.5 deep max. Shape optional.

NOTE 1: For Dimensions not shown, see Figure 5 and Table 6.

FIGURE 6 - BRAZE-ON REDUCING SLEEVE

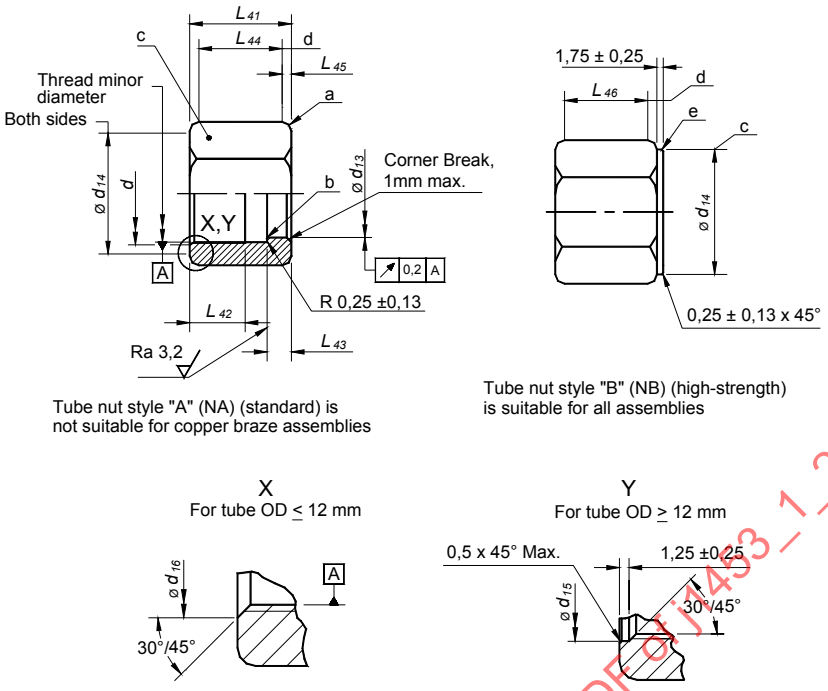
TABLE 7 - DIMENSIONS OF BRAZE-ON REDUCING SLEEVE

(NOTE: Dimensions shown are required effective 01JAN2009; alternate dimensions given in SAE J1453-1 Appendix A are permissible until 31DEC2008)

Dimensions in mm

Metric Nominal Tube Reduction Size Code Face Tube Seal X End	Metric Nominal Tube Reduction d_5[1] ref.	Inch Nominal Tube Reduction Dash Size[2] Face Tube Seal - End	Inch Nominal Tube Reduction	Inch Nominal Tube Reduction d_5 ref.	d_1 ref.	d_8 ref.	d_{21} ±0.5	L_{27} ±0.15	L_{28} ±0.3
8 X 6	6.15	5 - 4	7.94 - 6.35	6.50	4.5	14.35	5.5	2	10.5
10 X 6	6.15	6 - 4	9.52 - 6.35	6.50	4.5	15.75	6.5	2	10.5
10 X 8	8.15	6 - 5	9.52 - 7.94	8.09	5.5	15.75	6.5	2	10.5
12 X 6	6.15	8 - 4	12.70 - 6.35	6.50	4.5	18.90	9.5	3.5	12
12 X 8	8.15	8 - 5	12.70 - 7.94	8.09	5.5	18.90	9.5	3.5	12
12 X 10	10.15	8 - 6	12.70 - 9.52	9.68	6.5	18.90	9.5	3.5	12
16 X 6	6.15	10 - 4	15.88 - 6.35	6.50	4.5	23.45	12.5	5	13.5
16 X 8	8.15	10 - 5	15.88 - 7.94	8.09	5.5	23.45	12.5	5	13.5
16 X 10	10.15	10 - 6	15.88 - 9.52	9.68	6.5	23.45	12.5	5	13.5
16 X 12	12.15	10 - 8	15.88 - 12.70	12.85	9.5	23.45	12.5	5	13.5
20 X 6	6.15	12 - 4	19.05 - 6.35	6.50	4.5	27.85	15.5	6	14.5
20 X 8	8.15	12 - 5	19.05 - 7.94	8.09	5.5	27.85	15.5	6	14.5
20 X 10	10.15	12 - 6	19.05 - 9.52	9.68	6.5	27.85	15.5	6	14.5
20 X 12	12.15	12 - 8	19.05 - 12.70	12.85	9.5	27.85	15.5	6	14.5
20 X 16	16.15	12 – 10	19.05 - 15.88	16.03	12.5	27.85	15.5	5.5	14.5
22 X 8	8.15	14 - 5	22.22 - 7.94	8.09	5.5	31	18	6	14.5
22 X 10	10.15	14 - 6	22.22 - 9.52	9.68	6.5	31	18	6	14.5
22 X 12	12.15	14 - 8	22.22 - 12.70	12.85	9.5	31	18	6	14.5
22 X 16	16.15	14 - 10	22.22 - 15.88	16.03	12.5	31	18	5.5	14.5
22 X 20	20.18	14 - 12	22.22 - 19.05	19.23	15.5	31	18	3	15.5
25 X 12	12.15	16 - 8	25.40 - 12.70	12.85	9.5	34.20	20.5	7	15.5
25 X 16	16.15	16 - 10	25.40 - 15.88	16.03	12.5	34.20	20.5	6.5	15.5
25 X 20	20.18	16 - 12	25.40 - 19.05	19.23	15.5	34.20	20.5	4.5	17
25 X 22	22.18	16 - 14	25.40 - 22.22	22.40	18.0	34.20	20.5	4.5	17

1. Actual bore size and depth depends on joining process, dimensions given are for silver brazing.
2. The size symbol for all tube sizes shall be the tube OD or nominal hose ID in millimeters, except dash size symbols may be used for braze sleeve and weld nipple for inch tubing.



a. Chamfer or radius hex corners, L_{45} min. both ends.
b. Corner break, r_2.
c. For hex sizes and d_{14} values, see SAE J1453-2 and J1453-3.
d. Straight wrenching length.
e. Identification collar for high strength nut.

FIGURE 7 - STANDARD AND HIGH STRENGTH TUBE NUT

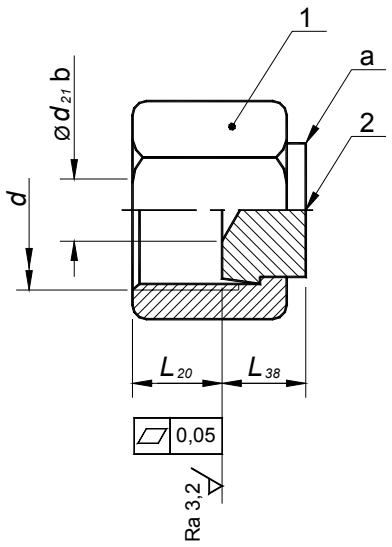
TABLE 8 - DIMENSIONS OF TUBE NUT

(NOTE: Dimensions shown are required after 01JAN2009; alternate dimensions given in SAE J1453-1 Appendix A are permissible until 31DEC2008)

Dimensions in mm

Nominal Tube OD Metric Tube mm	Nominal Tube OD Inch Tube Dash Size	Nominal Tube OD Inch Tube mm	d Thread	Thread Minor Dia. min.(1)	Thread Minor Dia. max.	d_{13} ±0.1	d_{15} ±0.3	d_{16} ±0.2	L_{41} ±0.5	L_{42} Min. Full Thread	L_{43} ±0.15	L_{44} min.	L_{45} min.	L_{46} min.	r_2 0 –0.15
6	– 4	6.35	9/16 - 18 UNF	12.9	13.1	10.5	--	14.7	15	9.0	3	10.5	0.4	8.5	0.15
8	– 5	7.94	5/8 - 18 UNF	14.5	14.7	12	--	16.3	16	9.0	4	11	0.4	9	0.15
10	– 6	9.52	11/16 - 16 UN	15.9	16.1	13.55	--	17.8	17	9.5	4	12	0.4	10	0.15
12	– 8	12.70	13/16 - 16 UN	19.1	19.3	16.6	--	21	20	11.5	5	14	0.5	12	0.15
16	–10	15.88	1 - 14 UNS	23.6	23.8	21.1	26	--	24	13.5	5.5	17	0.5	15	0.25
20	–12	19.05	1-3/16 - 12 UN	28	28.3	24.15	31	--	26.5	14.5	6.5	18.5	0.7	16.5	0.25
22	–14	22.22	1-5/16 - 12 UN	31.2	31.5	27.3	34	--	26.5	14.5	6.5	18	0.7	16	0.25
25	–16	25.40	1-7/16 - 12 UN	34.4	34.7	29.1	37	--	27.5	14.5	7	18.5	0.7	16.5	0.4
30	–20	31.75	1-11/16-12 UN	40.7	41	36	43.5	--	27.5	14.5	7	17	0.9	15	0.4
38	–24	38.10	2 - 12 UN	48.7	49	44	51.5	--	27.5	14.5	7	15.5	0.9	13.5	0.4

1. Modified minor diameter, shifted to the high side of the tolerance band in ISO 5864.



Key:

1. Tube nut
a. Stake insert – Must be free to turn.
b. Optional drill permissible.

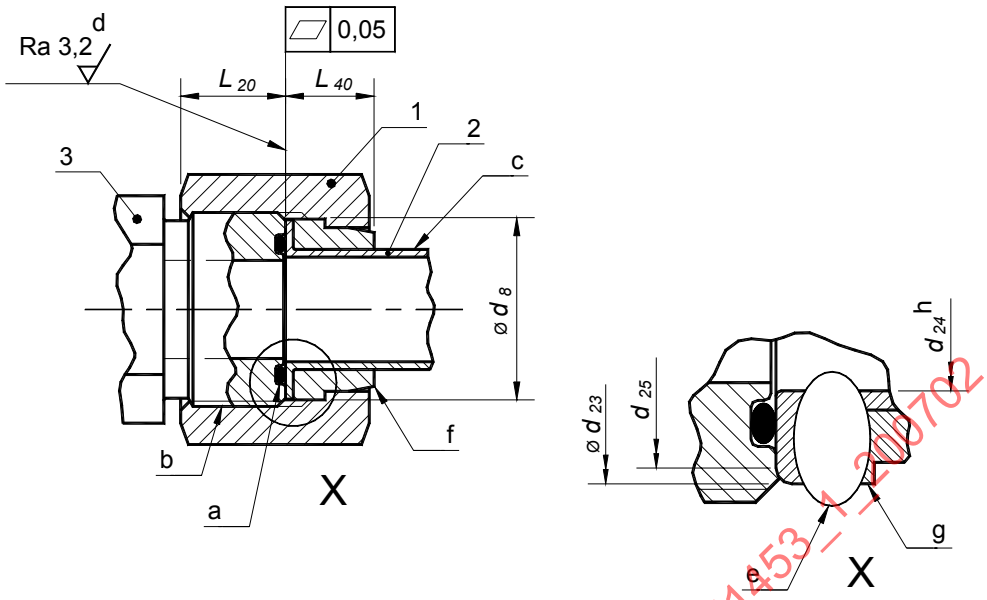
NOTE: For dimensions not shown see Fig. 5 and Table 6.

FIGURE 8 - CAP

TABLE 9 - DIMENSIONS OF CAP

Dimensions in mm

Nominal Tube OD Metric Tube mm	Nominal Tube OD Inch Tube Dash Size	Nominal Tube OD Inch Tube mm	d Thread	d_{21} max.	L_{20} ±0.8	L_{38} ±0.5
6	– 4	6.35	9/16-18	4.5	7.8	9
8	– 5	7.94	5/8-18	5.5	7.8	10
10	– 6	9.52	11/16-16	6.5	8.3	10.5
12	– 8	12.70	13/16-16	9.5	10	12
16	–10	15.88	1-14	12.5	12.5	13.5
20	–12	19.05	1-3/16-12	15.5	13.6	15
22	–14	22.22	1-5/16-12	18	13.5	15
25	–16	25.40	1-7/16-12	20.5	13.5	16
30	–20	31.75	1-11/16-12	26	13.5	16
38	–24	38.10	2-12	32	13.5	16



Key:

1. Tube nut Style “A” or “B,” See Fig. 7.
2. Tube
3. Mating male connector

a. This shall be the only seal point.
b. d – thread, mating male face seal connector end.
c. Circumferential or random grip marks of 0.1 maximum depth permissible on surface of tube.
d. Tube flatness and smoothness requirements for this surface apply to the area between d_{24} maximum and d_{25} minimum. Areas outside of this shall not protrude beyond the flat surface.
e. Tube and sleeve interface to be determined by the manufacturer, provided that the appropriate measures are taken to prevent flexural failure at the 90 degree bend of the tube.
f. Tail of the optional sleeve or formed pilot diameter shall be approximately flush with or protrude slightly beyond the back face of the nut.
g. Sleeve optional.
h. Diameter d_{24} minimum shall be equal to the connector or tube inside diameter, whichever is smaller. d_{24} maximum shall be as listed in Table 10.

NOTE 1: Formed tube end shall provide a sealing surface that can be assembled with a standard SAE J1453-2 or -3 connector and nut and meet the performance requirements for a working pressure equivalent to that of the fluid conductor.

FIGURE 9 - FORMED TUBE CONNECTION

TABLE 10 - DIMENSIONS OF FORMED TUBE CONNECTION FOR FACE SEAL CONNECTORS[1]

(NOTE: Dimensions shown are required after 01JAN2009;
alternate dimensions given in SAE J1453-1 Appendix A are permissible until 31DEC2008)

Dimensions in mm

Nominal Tube OD Metric Tubing	Nominal Tube OD Inch Tubing Dash Size	Nominal Tube OD Inch Tubing Inch	Thread Size Ref.	d_8 min/max Sleeve OD	d_{23} min/max Formed OD	d_{24} max	d_{25} min dia	L_{20} min/max	L_{40} min/max
6	– 4	0.250	9/16-18	12.6/12.75	12.10/12.75	7.3	12.1	6.6/9	6.6/12.5
8	– 5	0.312	5/8-18	14.2/14.35	13.45/14.35	8.4	13.2	6.6/9	6.6/12.5
10	– 6	0.375	11/16-16	15.6/15.75	14.85/15.75	8.9	14.3	7.0/9.5	7.9/13
12	– 8	0.500	13/16-16	18.75/18.9	18.00/18.9	12.1	17.4	8.6/11.5	9.4/17
16	–10	0.625	1-14	23.3/23.45	22.20/23.45	15.3	21.2	11.5/13.5	10.3/17
20	–12	0.750	1-3/16-12	27.7/27.85	26.60/27.85	18.5	24.8	12.6/14.5	11.9/18.5
22	–14	0.875	1-5/16-12	30.85/31	29.60/31	21.7	27.5	12.5/14.5	12.7/19
25	–16	1.250	1-7/16-12	34.05/34.2	32.95/34.2	23.2	30.6	12.5/14.5	12.7/19
30	–20	1.250	1-11/16-12	40.4/40.55	39.35/40.55	29.5	36.9	12.5/14.5	12.7/19
38	–24	1.500	2-12	48.35/48.5	47.25/48.5	37.4	44.9	12.5/14.5	12.7/19

1. For detailed explanation of various dimensions. See Appendix B.

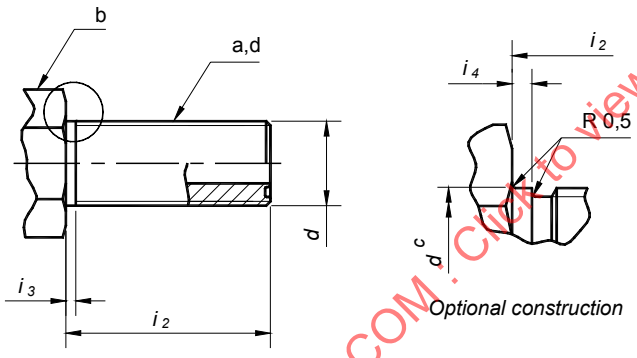


FIGURE 10 - BULKHEAD CONNECTOR

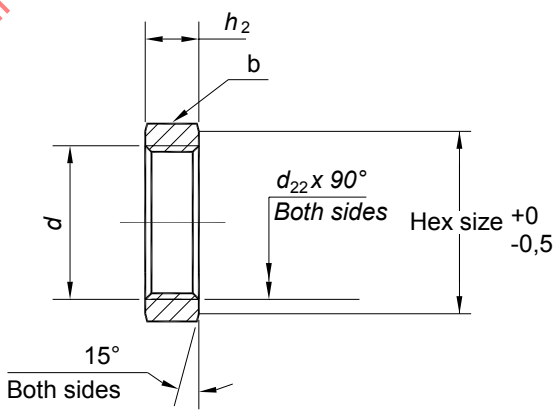


FIGURE 11 - BULKHEAD LOCKNUT

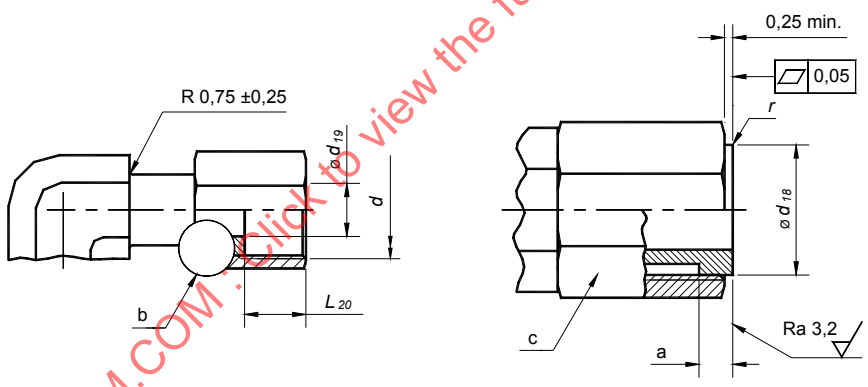
a. For dimensions not shown, see Figure 4 and Table 5.
b. For Hex sizes, see SAE J1453-2 or SAE J1453-3.
c. Pilot diameter equal to thread outside diameter.
d. Recommended clearance hole for bulkhead fittings is 0.4 over thread diameter.

TABLE 11 - DIMENSIONS OF BULKHEAD CONNECTORS AND LOCKNUTS

(NOTE: Dimensions shown are required after 01JAN2009; alternate dimensions given in SAE J1453-1 Appendix A are permissible until 31DEC2008)

Dimensions in mm

Nominal Tube OD Metric Tube mm	Nominal Tube OD Inch Tube Dash Size	Nominal Tube OD Inch Tube mm	d Thread ref.	h_2 ±0.8	i_2 ±0.8	i_3 max.	i_4 ±0.5	d_{22} +0.4 0
6	– 4	6.35	9/16-18	7	31.5	3	1.5	14.5
8	– 5	7.94	5/8-18	7	32	3	1.5	16
10	– 6	9.52	11/16-16	8	34	3	1.5	17.5
12	– 8	12.70	13/16-16	9	36.5	3	2.5	21
16	–10	15.88	1-14	10.5	40.5	4	2.5	25.5
20	12	19.05	1-3/16-12	10.5	41.5	4	3	30.5
22	–14	22.22	1-5/16-12	10.5	42	4	3	33.5
25	–16	25.4	1-7/16-12	10.5	42	4	3	36.5
30	–20	31.75	1-11/16-12	10.5	42	4	3	43
38	–24	38.1	2-12	10.5	42	4	3	51



a. Shoulder length and overall nut length are optional with the manufacturer as long as L_{20} is maintained, and connector performance requirements are met.
b. Method of attachment of swivel nut is optional with the manufacturer as long as performance requirements are met.
c. For hex size, see SAE J1453-2 or SAE J1453-3.

FIGURE 12 - SWIVEL END CONNECTION

TABLE 12 - DIMENSIONS OF SWIVEL CONNECTION

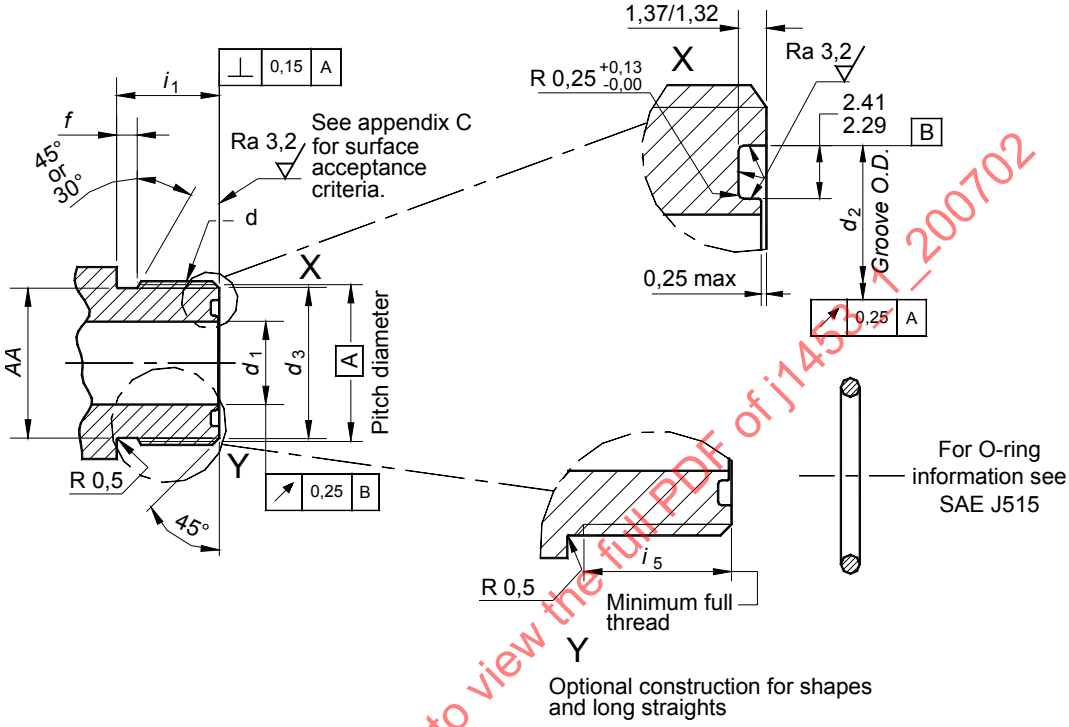
Dimensions in mm

Nominal Tube OD Metric Tube mm	Nominal Tube OD Inch Tube Dash Size	Nominal Tube OD Inch Tube mm	d Thread ref.	d_{18} Minimum Seal Diameter	d_{19} nom.	d_{19} tol.	L_{20}	r max.
6	– 4	6.35	9/16-18	12.6	4	±0.1	6.6/9	0.25
8	– 5	7.94	5/8-18	14.1	5.5	±0.1	6.6/9	0.25
10	– 6	9.52	11/16-16	15.6	6.5	±0.2	7.0/9.5	0.25
12	– 8	12.70	13/16-16	18.75	9	±0.2	8.6/11.5	0.25
16	–10	15.88	1-14	22.45	11.5	±0.2	11.5/13.5	0.25
20	–12	19.05	1-3/16-12	26.85	14	±0.2	12.6/14.5	0.4
22	–14	22.2	1-5/16-12	30	18	±0.2	12.5/14.5	0.4
25	–16	25.4	1-7/16-12	33.2	20	±0.2	12.5/14.5	0.4
30	–20	31.75	1-11/16-12	39.55	26	±0.2	12.5/14.5	0.4
38	–24	38.1	2-12	47.5	32	±0.3	12.5/14.5	0.4

PREPARED BY SAE FLUID CONDUCTORS AND CONNECTORS TECHNICAL COMMITTEE S1—AUTOMOTIVE AND HYDRAULIC TUBE AND FITTING

APPENDIX A - OPTIONAL DESIGNS FOR FACE SEAL CONNECTION, TUBE NUT, BULKHEAD CONNECTION, BRAZE SLEEVE AND SWIVEL

THE STRAIGHT SIDED GROOVE (Figure A1) HAS BEEN MOVED TO THIS APPENDIX TO PERMIT CONTINUED USE AS AGREED TO BY USER AND MANUFACTURER. The dovetail groove shown in the front of this document offers improved seal retention. Both designs offer users a leak-free connection.



Appendix A does not apply to SAE J1453-2 parts.

FIGURE A1 - O-RING FACE SEAL CONNECTION

TABLE A1 - DIMENSIONS OF O-RING FACE SEAL CONNECTION (SAE J1453 JUN2002)

Nominal Tube OD Inch Tube Dash Size	Nominal Tube OD Inch Tube mm	Nominal Tube OD Metric Tube mm	d Thread	d_1 (D)[1] Nom	d_1 (D)[2] Tol.	d_2 (Groove OD) Nom	d_2 (Groove OD) Tol.	d_3 (A) Nom	d_3 (A) Tol	(AA) ±0.15	f (EE) +0.4 0	i_1 (CC) ±0.4	i_5[2] (J) Min	O-ring Seal Size
– 4	6.35	6	9/16-18	4.4	+0.08 –0.08	11	±0.08	12.27	±0.15	12.14	2.1	9.8	9	–011
– 6	9.52	10	11/16-16	6.7	+0.10 –0.10	12.6	±0.08	15.1	±0.25	15.09	2.4	11.2	10.3	–012
– 8	12.70	12	13/16-16	9.6	+0.10 –0.10	15.77	±0.08	18.25	±0.25	18.26	2.4	12.8	11.9	–014
–10	15.88	16	1-14	12.3	+0.10 –0.10	19	±0.08	22.6	±0.40	22.76	2.7	15.5	14	–016
–12	19.05	20	1-3/16-12	15.5	+0.13 –0.13	22.17	±0.1	27	±0.40	27.15	3.2	17	15	–018
–16	25.40	25	1-7/16-12	20.6	+0.18 -0.13	26.87	±0.1	33.35	±0.40	33.50	3.2	17.5	15.5	–021
–20	31.75	30	1-11/16-12	26	+0.20 -0.13	33.25	±0.13	39.75	±0.40	39.85	3.2	17.5	15.5	–025
–24	38.10	38	2-12	32	+0.20 -0.13	41.17	±0.13	47.65	±0.40	47.78	3.2	17.5	15.5	–029

1. Dimension symbols in parenthesis are from SAE J1453 JUN1998.
2. J – Minimum Full Thread with runout.

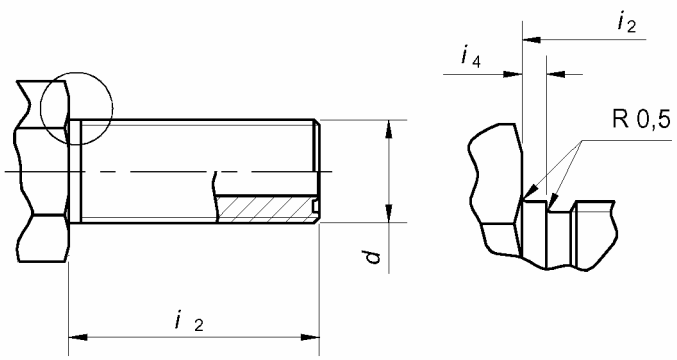


FIGURE A2 - BULKHEAD CONNECTION

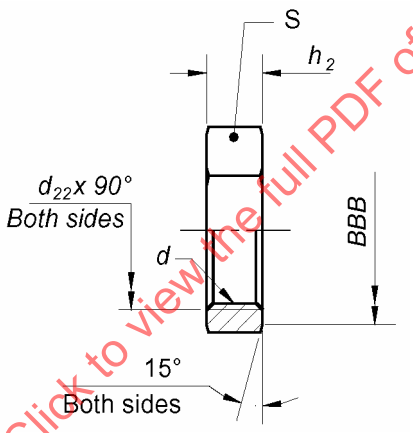


FIGURE A3 - BULKHEAD LOCKNUT

TABLE A2 - DIMENSIONS OF BULKHEAD CONNECTORS (SAE J1453 JUN2002)

(NOTE: Dimensions shown are permissible until 31DEC2008)

Dimensions in mm

Tube OD Inch Tube Dash Size	Tube OD Inch Tube mm	d Thread (A)[1] Ref.	h_2 (TT) ±0.5	i_2 (WW) ±0.5	i_4 (SS) ±0.5	(BBB) ±0.25	d_{22} (VV) +0.4 0	S (B) Hex
– 4	6.35	9/16-18	6.9	31.5	1.5	20.64‘	14.4	20.64
– 6	9.52	11/16-16	8	34	1.5	25.40	17.6	25.4
– 8	12.70	13/16-16	9	36.5	1.5	28.58	20.8	28.58
–10	15.88	1-14	10.4	40.6	1.5	33.34	25.5	33.34
–12	19.05	1-3/16-12	10.4	41.7	1.5	38.10	30.3	38.1
–16	25.40	1-7/16-12	10.4	42.2	1.5	44.45	36.6	44.45
–20	31.75	1-11/16-12	10.4	42.2	1.5	50.8	43	50.8
–24	38.10	2-12	10.4	42.2	1.5	60.33	50.9	60.33

1. Dimension symbols in parentheses are from SAE J1453 JUN2002.

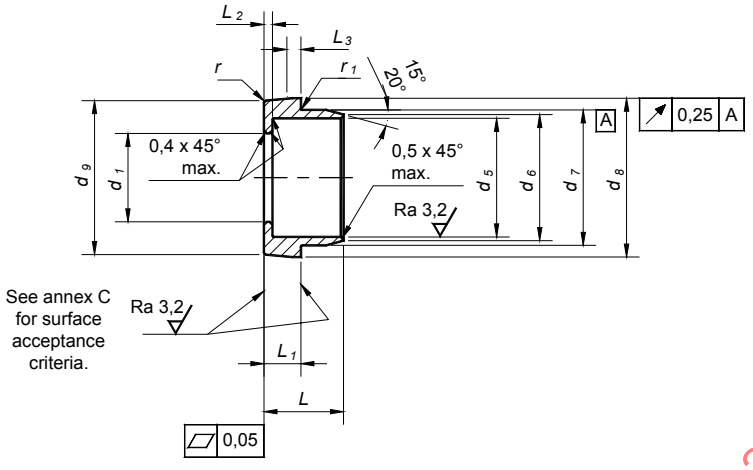


FIGURE A4 - BRAZE-ON SLEEVE (520115)