

Fitting—O-Ring Face Seal

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1. **Scope**—This SAE Standard covers material, dimensional, and performance requirements of steel O-ring face seal fittings for tubing and the O-ring face seal interface and nut portion of hose stem assemblies for nominal tube or hose diameters 6.35 mm (0.250 in) through 38.1 mm (1.500 in). These fittings 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 fittings are capable of providing leak-proof full flow connections in hydraulic systems operating from 95 kPa (28 in Hg) vacuum to working pressures shown in Table 1. 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 assure that required performance levels will be safe. See Figure 1.

The rated working pressure of a fluid conductor assembly using SAE J1453 hose stem connections or formed tube connection per Figure 32a, shall not exceed rated working pressure of the lowest rated component thereof.

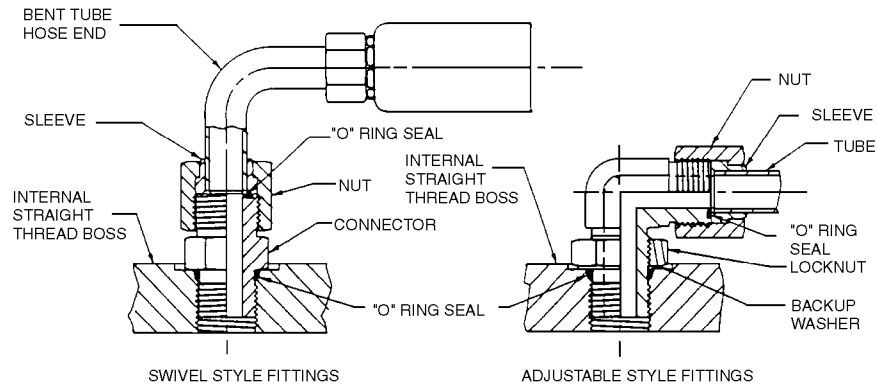
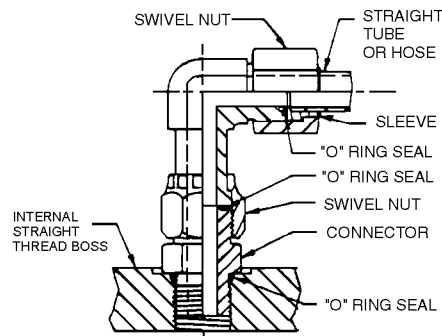


FIGURE 1A—TYPICAL EXAMPLE OF TUBE AND/OR HOSE CONNECTION TO ADAPTER



OPTIONAL CONFIGURATION FOR FULL PERFORMANCE RATING.

FOR -16 AT 41.3 MPa (6000 PSI)
FOR -24 AT 27.5 MPa (4000 PSI)

FIGURE 1B—EXAMPLE OF TUBE AND/OR HOSE CONNECTION TO SWIVEL ELBOW

TABLE 1—WORKING PRESSURE RATINGS CAPABLE OF 4 TO 1 MINIMUM BURST

Nom SAE Dash Size	Nom Tube OD mm	Nom Tube OD in	Straight Fittings MPa	Straight Fittings psi	Adjustable Style Fittings MPa	Adjustable Style Fittings psi
–4	6.35	0.250	41.3	6000	41.3	6000
–6	9.52	0.375	41.3	6000	41.3	6000
–8	12.70	0.500	41.3	6000	41.3	6000
–10	15.88	0.625	41.3	6000	41.3	6000
–12	19.05	0.750	41.3	6000	41.3	6000
–16	25.40	1.000	41.3	6000	34.5	5000
–20	31.75	1.250	27.5	4000	27.5	4000
–24	38.10	1.500	27.5	4000	20.7	3000

1.1 Rationale—SAE J1453 is being cancelled because it has been replaced by SAE J1453-1, SAE J1453-2, and SAE J1453-3.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

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

SAE J515—Hydraulic O-Rings

SAE J343—Tests and Procedures for SAE 100R Series Hydraulic Hose and Hose Assemblies

SAE J846—Coding Systems for Identification of Fluid Conductors and Connectors

2.1.2 ASTM PUBLICATION—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 117—Method of Salt Spray (Fog) Testing

2.1.3 ANSI PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ANSI B1.1—Screw Thread

ANSI B46.1—Surface Texture

3. Size Designation

3.1 Fitting sizes are designated by the nominal outside diameter of the tubing or nominal inside diameter of hose. (See SAE J846.)

4. Material and Manufacture

4.1 Material—Fittings shall be made from manufacturer's standard steel that will fulfill the performance requirements in Section 9.

4.2 Finish—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. 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, and other post-plate metal forming operations.
- d. Areas where the parts are suspended or affixed in the test chamber where condensate can accumulate.

NOTE—Cadmium plating is not preferred due to environmental reasons. Parts manufactured to this standard after January 1, 1997, shall not be cadmium plated. Internal fluid passages shall be protected from corrosion during storage. Changes in plating may affect assembly torques and require requalification, when applicable.

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

4.3 Workmanship—Workmanship shall conform to the best commercial practice to produce high-quality fittings. Fittings must be free from visual contaminants, all hanging burrs, loose scale, and slivers which might be dislodged in usage, and any other defects that might affect the function of the parts.

4.4 Construction—Fittings may be made by forging, cold heading, formed tubing, or machined from bar stock. Carbon steel fittings fabricated from multiple components must be bonded together with materials having a melting point of not less than 996 °C (1825 °F).

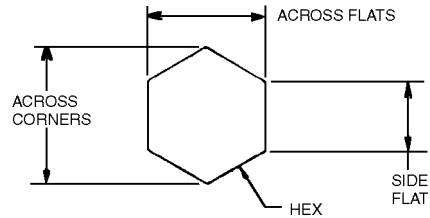
4.5 Fitting bodies and tube nuts must be permanently marked with individual supplier's trademark or code identifier, unless otherwise agreed upon by user and manufacturer.

5. Dimensions and Tolerances

5.1 Dimensions specified apply to finished parts. Tolerances on all untoleranced dimensions are ± 0.4 mm (± 0.016 in). Special nonstandard fittings may have additional tolerance. On nonstandard size fittings, the larger end is considered standard and is the basis for dimensions and tolerances (overall, end to center, stock size, etc.). The tolerance on centerline to end of nonstandard shaped fittings will be ± 1.5 mm (± 0.06 in). See Tables 7, 8, 9, 10, and 11 for factors on how to calculate jump size and reduced sized fittings.

5.2 Hex tolerances across flats are listed in Figure 2. Minimum across corner hex dimensions are 1.092 times the nominal width across flats. The minimum side flat is 0.43 times the nominal width across flats (see Figure 2). 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 $+0.0$ mm $+0.000$ in
 -0.4 -0.016

Alternatively, on connections other than SAE straight thread, a 5 degree chamfer starting at the undercut diameter behind the threads or outside diameter of the threads shall be allowed, providing the hex width at corners is not reduced below that produced by the 30 degree chamfer previously described.



Nominal Hex Size Across Flats mm Over	Nominal Hex Size Across Flats mm Include	Nominal Hex Size Across Flats in Over	Nominal Hex Size Across Flats in Include	Tolerance (Minus Only) mm	Tolerance (Minus Only) in
—	19.05	—	0.750	0.3	0.012
19.05	25.40	0.750	1.000	0.4	0.016
25.40	34.92	1.000	1.375	0.5	0.020
34.92	AND UP	1.375	AND UP	0.8	0.031

FIGURE 2—HEX TOLERANCES

- 5.3** The across flat dimensions of elbows, tees, bulkhead, and swivel fittings shown as “JJ forging” or “JJ barstock” in Table 6 are intended to be for nominal inch wrench sizes with a minus tolerance only. The basic forging size may be increased up to the maximum size shown for barstock, but the size selected must be a nominal inch wrench size across flats with minus tolerance only.

NOTE—For optional metric stock sizes, see Appendix D.

- 5.4** Where passages in straight fittings are machined from opposite ends, the offset at the meeting point shall not exceed 0.4 mm (0.016 in). No cross-sectional area at a junction of passages shall be less than that of the smallest passage.
- 5.5** Angular tolerance on axis of ends on elbows, tees, and crosses is ± 2.5 degrees for sizes up to 9.52 mm (0.375 in) and ± 1.5 degrees for all larger sizes.
- 5.6** Details of contour are optional with the manufacturer, providing the tabulated dimensions are maintained. Wrench flats on elbows and tees must meet the tabulated dimensions. Abrupt reduction of a section must be avoided. Junctions of small external sections and adjoining relatively heavy sections must be blended by means of ample fillets.
- 5.7** Tolerances on hole diameters designated as drill diameter in other dimensional tables shall be as shown in Table 2.

TABLE 2—DRILL TOLERANCES

Drill Size Range mm	Drill Size Range in	Tolerance Plus mm	Tolerance Minus mm	Tolerance Plus in	Tolerance Minus in
0.35- 6.25	0.0135-0.246	0.08	0.08	0.003	0.003
6.35-12.70	0.250-0.500	0.10	0.10	0.004	0.004
13.10-19.05	0.516-0.750	0.13	0.13	0.005	0.005
19.40-25.40	0.765-1.000	0.18	0.13	0.007	0.005
25.80-38.10	1.016-1.500	0.20	0.13	0.008	0.005
38.50 and up	1.516 and up	0.25	0.13	0.010	0.005

- 5.8** The O-ring washer must be clinched to fitting with a tight slip fit to an interference fit. The slip fit shall be tight enough so that washer cannot be shaken loose to cause it to drop from its uppermost position by its own weight. The interference fit shall not require a locknut torque more than that indicated in Table 3. Position the washer farthest from the end of the fittings as shown in Figure 9. Care must be taken not to clinch washer on the transition area between diameter Y and locknut thread which results in a loose washer when it is repositioned at assembly. Washer flatness allowance is given in Table 3. Any surface out of flatness must be uniform (not wavy) and concave with respect to the O-ring boss end of the fitting. Maximum torque to move washer is shown in Table 3.

TABLE 3—MAXIMUM TORQUE TO MOVE WASHER AND WASHER FLATNESS

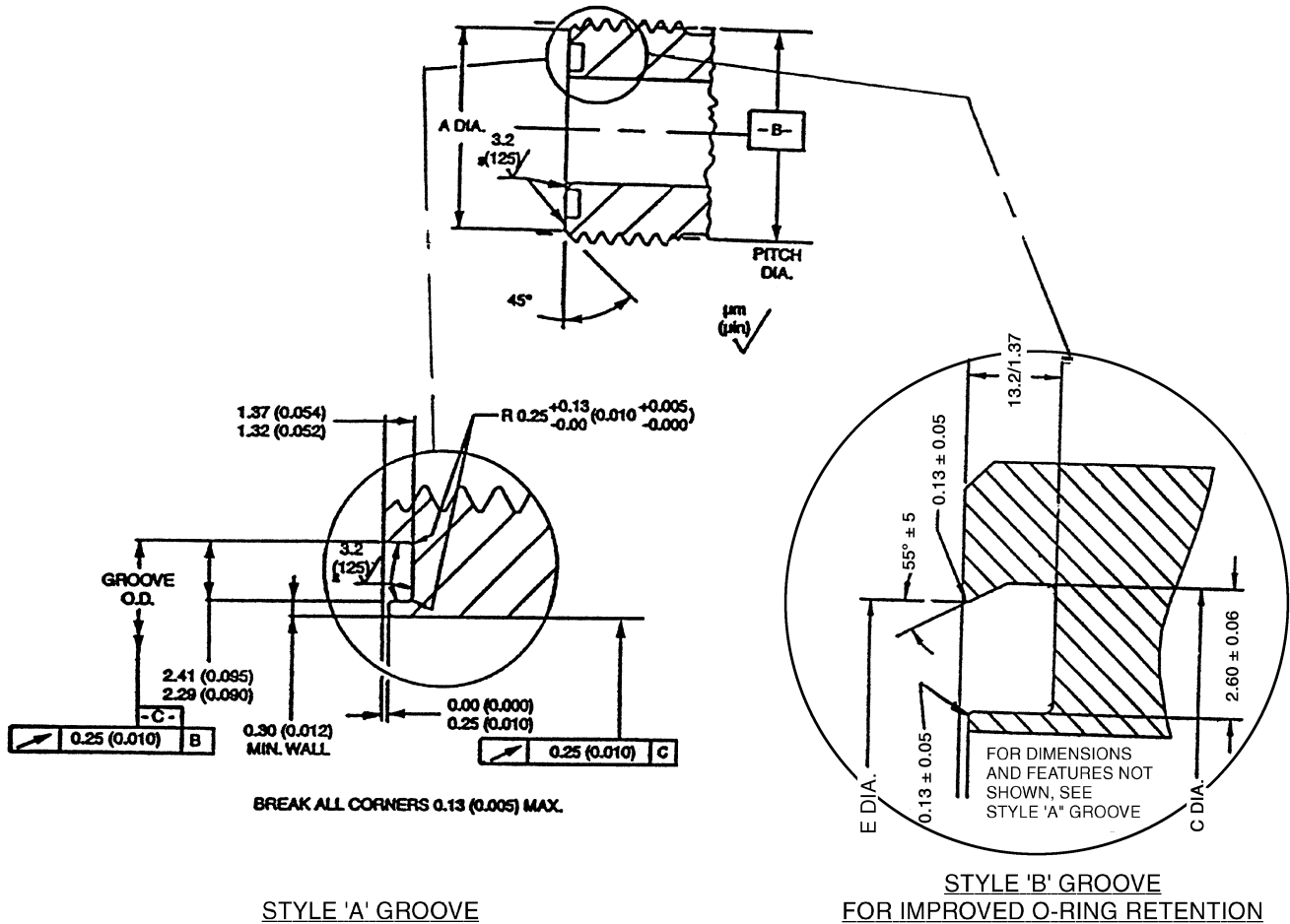
Nom Tube OD mm	Nom Tube OD in	Nom SAE Dash Size	Thd Size Inch	Nom Hex Size mm	Nom Hex Size in	Maximum Torque To Move Washer N·m	Maximum Torque To Move Washer lb·in	Washer Flatness Allowance mm	Washer Flatness Allowance in
3.18	0.125	-2	5/16-24	12.70	0.500	1	9	0.25	0.010
4.76	0.187	-3	3/8 -24	14.29	0.562	3	26	0.25	0.010
6.35	0.250	-4	7/16-20	15.88	0.625	4	35	0.25	0.010
7.94	0.312	-5	1/2 -20	17.46	0.687	5	44	0.25	0.010
9.52	0.375	-6	9/16-18	19.05	0.750	7	62	0.25	0.010
12.70	0.500	-8	3/4 -16	23.81	0.937	10	88	0.25	0.010
15.88	0.625	-10	7/8 -14	26.99	1.062	12	106	0.25	0.010
19.05	0.750	-12	1-1/16-12	34.92	1.375	15	133	0.40	0.016
22.22	0.875	-14	1-3/16-12	38.10	1.500	18	159	0.40	0.016
25.40	1.000	-16	1-5/16-12	41.28	1.625	20	177	0.40	0.016
31.75	1.250	-20	1-5/8 -12	47.62	1.875	25	221	0.50	0.020
38.10	1.500	-24	1-7/8 -12	53.98	2.125	30	265	0.50	0.020
50.80	2.000	-32	2-1/2 -12	69.85	2.750	40	353	0.50	0.020

6. Threads

- 6.1** Straight threads must be class 2A or 2B in accordance with ANSI B1.1 screw thread specification, except for internal thread minor diameter (see Figure 4, Note C). External class 2A threads which are plated or coated may exceed 2A diameters but shall not exceed maximum 3A diameters. Internal threads of all classes must be within specified limits after plating or coating.
- 6.2** 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.

7. Fitting Seat

- 7.1 The face seal end dimensions shall conform to Figure 3. Surface finish of O-ring groove, and mating surfaces, shall be as shown in Figure 3 in accordance with ANSI B46.1.



Nom SAE Dash Size	Nom Tube Dia mm	A Chamfer Dia mm	Style 'A' C Groove OD mm	Style 'B' C Groove OD mm	E Retention Ledge Dia ±0.15	O-Ring Seal SAE J515 Seal Size (90 Durometer, Shore A)
-4	6.35	12.27 ± 0.15	11.00 ± 0.08	11.00 ± 0.08	10.65	-011
-6	9.52	15.10 ± 0.25	12.60 ± 0.08	12.80 ± 0.08	12.25	-012
-8	12.70	18.25 ± 0.25	15.77 ± 0.08	15.97 ± 0.08	15.40	-014
-10	15.88	22.60 ± 0.40	19.00 ± 0.08	19.20 ± 0.08	18.50	-016
-12	19.05	27.00 ± 0.40	22.17 ± 0.10	22.37 ± 0.10	21.65	-018
-16	25.40	33.35 ± 0.40	26.87 ± 0.10	27.10 ± 0.13	26.40	-021
-20	31.75	39.75 ± 0.40	33.25 ± 0.13	33.45 ± 0.13	32.75	-025
-24	38.10	47.65 ± 0.40	41.17 ± 0.13	41.37 ± 0.13	40.65	-029

NOTE—See Appendix A for details on surface finish requirements.

FIGURE 3—FACE SEAL DIMENSIONS

7.2 O-ring—See J515 for O-ring details.

8. Protection

8.1 By agreement between purchaser and supplier, the face of O-ring fittings and threads (both internal and external) must be protected by the manufacturer from nicks and scratches detrimental to their function. All passages must be securely covered to prevent entrance of dirt or other contaminants prior to assembly and for parts distribution, handling, and storage. Paper caps and plugs are not permitted.

8.2 Braze-on type fittings require protection on sealing face and threaded end only.

8.3 Nuts and sleeves furnished separately must be protected from rust but do not require capping.

9. Performance Requirements—See Appendix B for minimum number of samples required for testing.

9.1 The working, proof, and minimum burst pressures are shown for straight and adjustable fittings in Table 4.

TABLE 4—WORKING, PROOF, AND MINIMUM BURST PRESSURES

Nom SAE Dash Size	Straight Fittings Working MPa	Straight Fittings Working psi	Straight Fittings Proof MPa	Straight Fittings Proof psi	Straight Fittings Min Burst MPa	Straight Fittings Min Burst psi	Adjustable Fittings Working MPa	Adjustable Fittings Working psi	Adjustable Fittings Proof MPa	Adjustable Fittings Proof psi	Adjustable Fittings Min Burst MPa	Adjustable Fittings Min Burst psi
–3	41.3	6000	82.5	12 000	165.0	24 000	41.3	6000	82.5	12 000	165.0	24 000
–4	41.3	6000	82.5	12 000	165.0	24 000	41.3	6000	82.5	12 000	165.0	24 000
–5	41.3	6000	82.5	12 000	165.0	24 000	41.3	6000	82.5	12 000	165.0	24 000
–6	41.3	6000	82.5	12 000	165.0	24 000	41.3	6000	82.5	12 000	165.0	24 000
–8	41.3	6000	82.5	12 000	165.0	24 000	41.3	6000	82.5	12 000	165.0	24 000
–10	41.3	6000	82.5	12 000	165.0	24 000	41.3	6000	82.5	12 000	165.0	24 000
–12	41.3	6000	82.5	12 000	165.0	24 000	41.3	6000	82.5	12 000	165.0	24 000
–14	41.3	6000	82.5	12 000	165.0	24 000	34.5	5000	69.0	10 000	138.0	20 000
–16	41.3	6000	82.5	12 000	165.0	24 000	34.5	5000	69.0	10 000	138.0	20 000
–20	27.5	4000	55.0	8 000	110.0	16 000	27.5	4000	55.0	8 000	110.0	16 000
–24	27.5	4000	55.0	8 000	110.0	16 000	20.7	3000	41.3	6 000	82.5	12 000

9.2 All O-ring face seal fittings for tubing and adapters must be capable of withstanding proof pressure for a period of 1 min without failure or leakage.

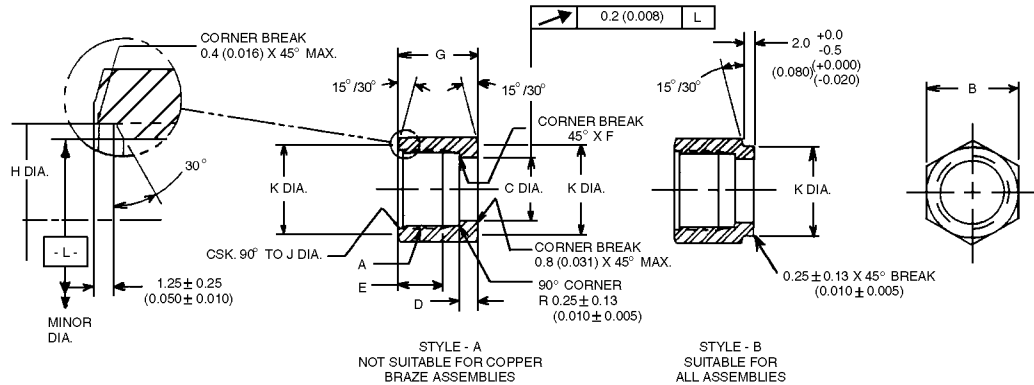
9.3 Burst test shall be conducted at minimum torque values shown in Table 5. For testing only, all adapter to hose fittings or tube fitting threads and contact surfaces shall be lubricated with SAE 10W hydraulic oil prior to application of torque shown in Table 5. Test blocks for burst testing must be unplated and hardened to Rockwell C50-55. Adjustable fittings must be backed out one full turn from finger-tight position to correctly test possible actual assembly conditions. Burst test at a rate not to exceed 138 000 kPa (20 000 psi) per minute.

TABLE 5—QUALIFICATION TEST TORQUE REQUIREMENTS

Nom SAE Dash Size	Nominal Tube OD mm	Nominal Tube OD in	O-ring Face Seal End Thread Size in	O-ring Face Seal End Swivel Nut Torque N·m	O-ring Face Seal End Swivel Nut Torque lb·ft	Over Torque N·m	Over Torque lb·ft	SAE O-ring Boss End Thread Size in	SAE O-ring Boss End Straight Fitting or Locknut Torque N·m	SAE O-ring Boss End Straight Fitting or Locknut Torque lb·ft
-3	4.76	0.188	(a)	(a)	(a)	(a)	(a)	3/8 -24	11- 13	8- 10
-4	6.35	0.250	9/16-18	14- 16	10- 12	32	24	7/16-20	20- 22	14- 16
-5	7.94	0.312	(a)	(a)	(a)	(a)	(a)	1/2 -20	24- 27	18- 20
-6	9.52	0.375	11/16-16	24- 27	18- 20	54	40	9/16-18	33- 35	24- 26
-8	12.70	0.500	13/16-16	43- 47	32- 35	81	60	3/4 -16	68- 78	50- 60
-10	15.88	0.625	1-14	60- 68	46- 50	136	100	7/8 -14	98-110	72- 80
-12	19.05	0.750	1- 3/16-12	90- 95	65- 70	180	140	1-1/16-12	170-183	125-135
-14	22.22	0.875	1- 3/16-12	90- 95	65- 70	180	140	1-3/16-12	230-260	170-190
-16	25.40	1.000	1- 7/16-12	125-135	92-100	270	200	1-5/16-12	270-300	200-220
-20	31.75	1.250	1-11/16-12	170-190	125-140	380	280	1-5/8 -12	285-380	210-280
-24	38.10	1.500	2-12	200-225	150-165	450	330	1-7/8 -12	370-490	270-360

(a) O-ring face seal type end not defined for this tube size.

- 9.4** All tube fittings and adapters must pass a cyclic endurance test for one million cycles at 133% of corresponding working pressures for straight and adjustable fittings per Table 4. Cycle test to be conducted at minimum torque values shown in Table 5. For testing only, all adapter to hose fittings or tube fitting threads and contact surfaces shall be lubricated with SAE 10W hydraulic oil prior to application of torque shown in Table 5. Cycle rate shall be uniform at 30 to 75 cpm and shall conform to magnitude and frequency to the wave pattern shown in Figure 1 of SAE J343.
- 9.5** Components that require brazing to assemble and all style "B" 520110 nuts must be processed through a copper braze cycle of 996 to 1150 °C, with the cycle time sufficiently long to permit parts to reach above temperature and then be cooled in a protective atmosphere to prevent scaling. After annealing and before burst, cyclic endurance, or torque testing, the nuts must be plated per 4.2.
- 9.6** Fitting shall be capable of withstanding 95 kPa (28 in Hg) vacuum without leakage for 5 min.
- 9.7** The standard face seal O-ring used for test shall be nitrile (NBR) rubber with a durometer "A" hardness of 90. (See Figure 3.)
- 9.8** Fitting swivel nuts shall be capable of withstanding the over torque qualification test with no indication of failure. For testing only, fitting threads and contact surfaces shall be lubricated with SAE 10W hydraulic oil prior to application of over torque specified in Table 5. For torque testing, use an unplated steel mandrel hardened to Rockwell C40-45. Fittings shall be restrained during test and the wrench shall be located at the threaded end of the nut hex.
- Definition of failure after torque testing.
- The nut cannot be removed by hand after breakaway.
 - The nut cannot swivel freely by hand.
 - The nut will not retract to its original position by hand.
 - Any visible cracks or severe deformation that would render nut unusable.
- 9.9** Parts which pass burst test or over torque test must not be tested further, used, or returned to stock.
- 9.10** Parts which pass burst test or over torque test must not be tested further, used, or returned to stock.



Nom Tube OD mm	Nom Tube OD in	A Thread Size in	Thread	Thread	Thread	Thread	B Hex ^(a) mm	B Hex ^(a) in	C Dia mm ±0.08	C Dia in ±0.003	D LG mm ±0.25	D LG in ±0.010
			Minor Dia ^(c) mm	Minor Dia ^(c) mm	Minor Dia ^(c) in	Minor Dia ^(c) in						
			min	max	min	max						
6.35	0.250	9/16-18	12.90	13.08	0.508	0.515	17.46	0.687	10.46	0.412	2.50	0.098
9.52	0.375	11/16-16	15.90	16.10	0.626	0.634	20.64	0.812	13.51	0.532	3.00	0.118
12.70	0.500	13/16-16	19.08	19.28	0.751	0.759	23.81	0.938	16.56	0.652	5.00	0.197
15.88	0.625	1-14	23.60	23.83	0.929	0.938	28.58	1.125	21.06	0.829	4.00	0.157
19.05	0.750	1- 3/16-12	28.02	28.32	1.103	1.115	34.92	1.375	24.13	0.950	5.00	0.197
22.22 ^(b)	0.875	1- 3/16-12	28.02	28.32	1.103	1.115	34.92	1.375	25.04	0.986	5.00	0.197
25.40	1.000	1- 7/16-12	34.37	34.67	1.353	1.365	41.28	1.625	29.06	1.144	6.00	0.236
31.75	1.250	1-11/16-12	40.72	41.02	1.603	1.615	47.62	1.875	35.94	1.415	6.00	0.236
38.10	1.500	2-12	48.67	48.97	1.916	1.928	57.15	2.250	43.89	1.728	6.00	0.236

Nom Tube OD mm	Nom Tube OD in	E Min Full Thread mm min	E Min Full Thread in min	F Chamfer mm ±0.13	F Chamfer in ±0.005	G LG mm ±0.25	G LG in ±0.010	H Dia mm ±0.25	H Dia in ±0.010	J Dia mm +0.4 −0.0	J Dia in +0.016 −0.000	K Dia mm ±0.3	K Dia in ±0.01
6.35	0.250	9.0	0.35	0.13	0.005	14.70	0.580	—	—	14.4	0.567	17.0	0.67
9.52	0.375	10.3	0.41	0.13	0.005	17.00	0.670	—	—	17.6	0.693	20.3	0.80
12.70	0.500	11.9	0.47	0.13	0.005	21.00	0.827	—	—	20.8	0.819	23.5	0.92
15.88	0.625	14.5	0.57	0.25	0.010	23.50	0.925	25.91	1.020	—	—	28.2	1.11
19.05	0.750	15.5	0.61	0.25	0.010	26.00	1.024	30.68	1.208	—	—	34.6	1.36
22.22 ^(b)	0.875	15.5	0.61	0.25	0.010	30.86	1.215	30.68	1.208	—	—	34.6	1.36
25.40	1.000	16.0	0.63	0.38	0.015	27.80	1.095	37.03	1.458	—	—	41.0	1.61
31.75	1.250	16.0	0.63	0.38	0.015	27.80	1.095	43.38	1.708	—	—	47.2	1.86
38.10	1.500	16.0	0.63	0.38	0.015	27.80	1.095	51.31	2.020	—	—	56.9	2.24

(a) For hex tolerance, see 5.2 and Figure 2).

^(b)For use with expanding sleeve 91.05 to 22.22, see Figure 34.)

^(c)Modified minor dia (not the minor dia listed in ANSI B1.1)

FIGURE 4—NUT (520110)

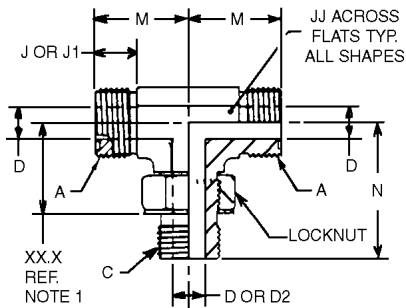


FIGURE 5—STRAIGHT THREAD BRANCH TEE (520429)

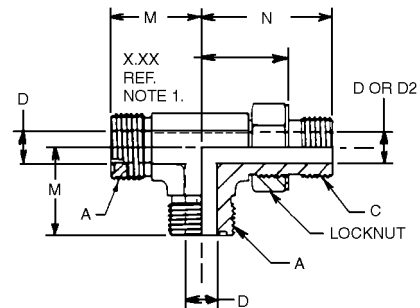


FIGURE 6—STRAIGHT THREAD RUN TEE (520428)

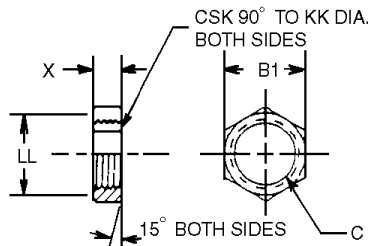


FIGURE 7—STRAIGHT THREAD LOCKNUT (520117)

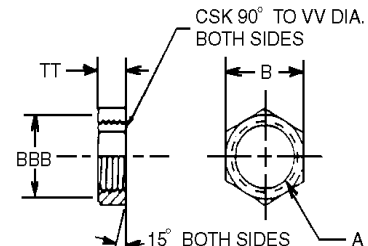


FIGURE 8—BULKHEAD LOCKNUT (520118)

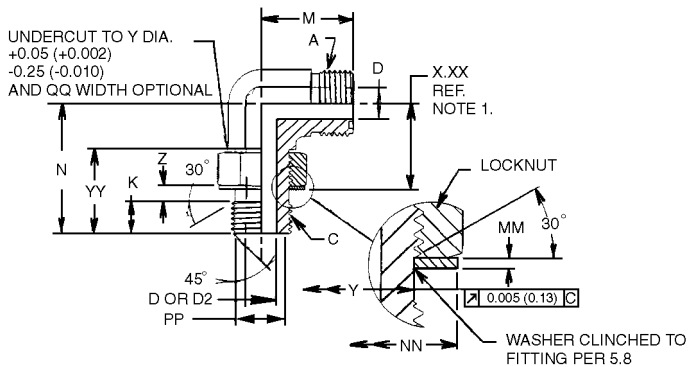


FIGURE 9—90 DEGREE STRAIGHT THREAD ELBOW (520220)

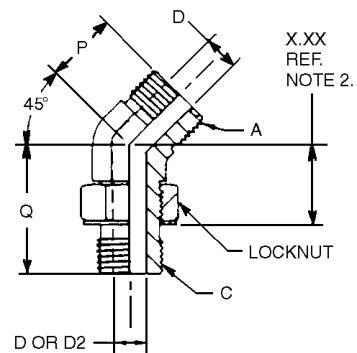


FIGURE 10—45 DEGREE STRAIGHT THREAD ELBOW (520320)

NOTE 1—Ref dim. calculated by formula $\text{ref} = N - (K + Z - MM)$.

NOTE 2—Ref dim. calculated by formula $\text{ref} = Q - (K + Z - MM)$.

For O-ring groove dimensions and thread chamfer diameter, see Figure 3.

FIGURES 5 TO 25—FITTINGS

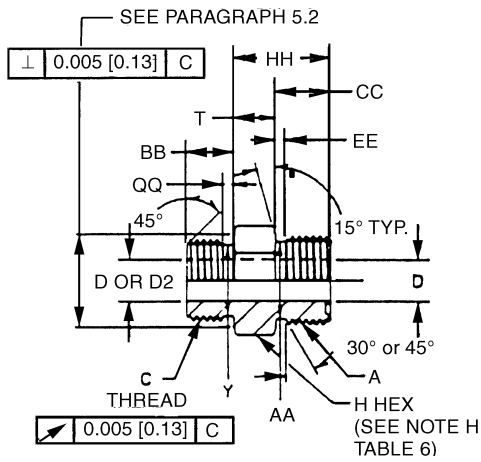


FIGURE 11—STRAIGHT THREAD CONNECTOR (520120)

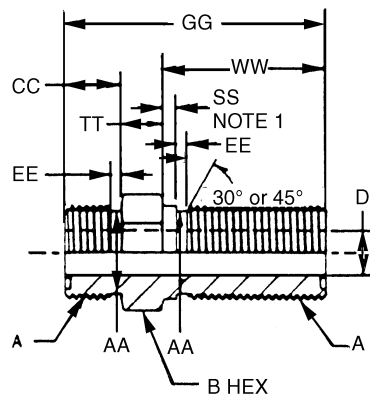


FIGURE 12—BULKHEAD UNION (520601)

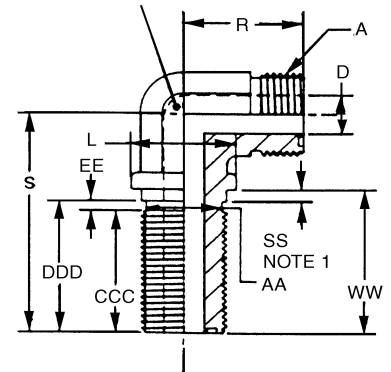


FIGURE 13—90 DEGREE BULKHEAD ELBOW (520701)

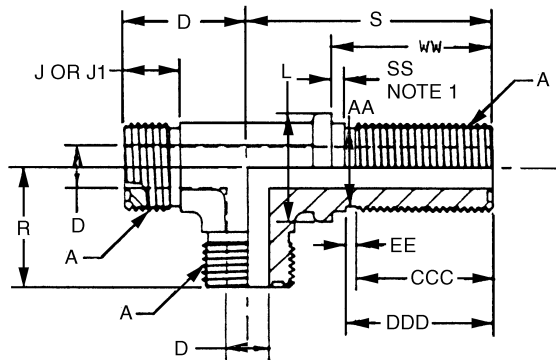


FIGURE 14—BULKHEAD RUN TEE (520958)

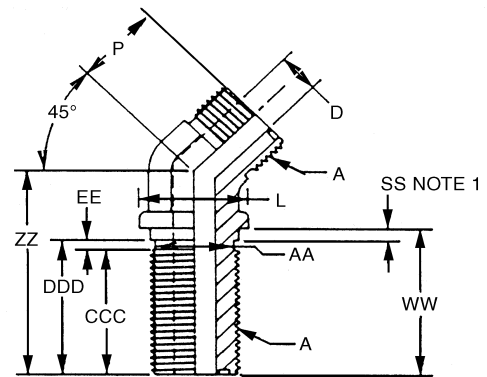


FIGURE 15—45 DEGREE BULKHEAD ELBOW (520801)

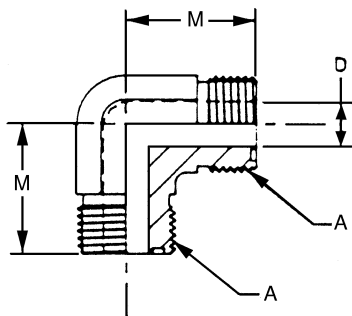


FIGURE 16—90 DEGREE UNION ELBOW (520201)

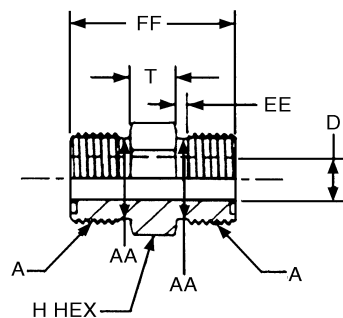


FIGURE 17—UNION (520101)

NOTE 1—Recommended clearance hole for bulkhead fittings is 0.4 (0.015) over major thread diameter. Diameter of SS pilot is same as major thread diameter.

For O-Ring groove dimensions and thread chamfer diameter, see Figure 3.

FIGURES 5 TO 25—(CONTINUED)