

Flareless Hydraulic Tube Fittings

RATIONALE

SAE J514 is being split into three parts: (1) 37-degree flare fittings, (2) flareless fittings, and (3) pipe fittings and adapter unions. Part 1, 37-degree flare fittings, was revised to include new artwork for better clarity, metric hexes for new designs, and general updates. Parts 2 and 3 will be separated out with no technical changes, except those to harmonize the SAE straight thread dimensions with the revised SAE J1926-3 document and rationalized metric pressure rating numbers.

1. SCOPE

This SAE Standard covers complete general and dimensional specifications for flareless type of hydraulic tube fittings. These fittings are intended for general application in hydraulic systems on industrial equipment and commercial products.

These fittings are capable of providing leakproof, full flow connections in hydraulic systems operating at working pressures as specified in Table 1.

For any application, it is recommended that sufficient testing be conducted and reviewed by both the user and fitting manufacturer to assure that performance levels will be safe and satisfactory.

Table 1 - Working pressure ratings^(a) capable of 4-to-1 minimum burst

Nom SAE Dash Size	Nom Tube OD (mm)	Nom Tube OD (inch)	Straight Thread Size	Nom Pipe Size	Rigid SAE St. Threads Unions and Bulkheads (MPa)	Rigid SAE St. Threads Unions and Bulkheads (psi)	Adjustable SAE St. Threads and Female Swivels (MPa)	Adjustable SAE St. Threads and Female Swivels (psi)	Fittings With Pipe Threads (MPa)	Fittings With Pipe Threads (psi)
2	3.18	0.125	5/16-24	1/8	35	5000	35	5000	35	5000
3	4.76	0.188	3/8-24	1/8	35	5000	35	5000	35	5000
4	6.35	0.250	7/16-20	1/8	35	5000	31.5	4500	35	5000
5	7.94	0.313	1/2-20	1/8	35	5000	28	4000	35	5000
6	9.52	0.375	9/16-18	1/4	35	5000	28	4000	28	4000
8	12.70	0.500	3/4-16	3/8	31.5	4500	28	4000	21	3000
10	15.88	0.625	7/8-14	1/2	24.5	3500	21	3000	21	3000
12	19.05	0.750	1-1/16-12	3/4	24.5	3500	21	3000	17.5	2500
14	22.22	0.875	1-3/16-12	3/4	21	3000	17.5	2500	17.5	2500
16	25.40	1.000	1-5/16-12	1	21	3000	17.5	2500	14	2000
20	31.75	1.250	1-5/8-12	1-1/4	17.5	2500	14	2000	8	1150
24	38.10	1.500	1-7/8-12	1-1/2	14	2000	10.5	1500	7	1000
32	50.80	2.000	2-1/2-12	2	10.5	1500	8	1125	7	1000

^(a) Working pressures given are for low-carbon steel fittings only. Consult the manufacturer for values for other materials.

Formerly, SAE J514 was organized as a single document with ten clauses, which included six sections. This revision of SAE J514 has been organized into three sections as follows:

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Documents

Document Sharing Hub

- Part 1: 37-degree flared fittings
- Part 2: Flareless (bite type) fittings
- Part 3: NPTF pipe fittings and pipe unions

It is important to note that this and all SAE J-documents are intended for ground vehicle use only and not intended for aerospace applications.

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 J405	Chemical Compositions of SAE Wrought Stainless Steels
SAE J476	Dryseal Pipe Threads
SAE J515	Specification for O-Ring Materials Used with Hydraulic Connectors
SAE J846	Coding Systems for Identification of Fluid Conductors and Connectors
SAE J1065	Nominal Reference Working Pressures for Steel Hydraulic Tubing
SAE J1926-3	Connections for General Use and Fluid Power - Ports and Stud Ends with ASME B1.1 Threads and O-Ring Sealing - Part 3: Light-Duty (L-Series) Stud Ends SAE J2593 Information report for the Installation of Fluid Conductors and Connectors

2.1.2 ANSI Accredited Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI B18.2.2	Standard Wrench Openings
ANSI B1.20.3	Dryseal Pipe Threads (Inch)

2.1.3 ASTM Publications

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

ASTM B117	Method of Salt Spray (Fog) Testing
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2.1.4 ISO Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

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

ISO 9227 Corrosion Tests in Artificial Atmospheres - Salt Spray Tests

3. GENERAL SPECIFICATIONS

The following general specifications supplement the dimensional data contained in Tables 4 to 8 with respect to all unspecified detail.

3.1 Size Designations

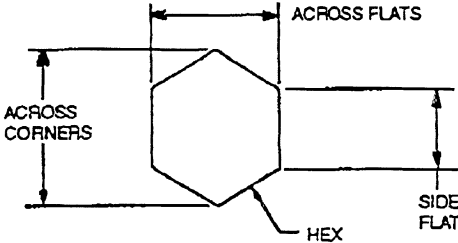
Fitting sizes are designated by the corresponding outside diameter of the tubing for the flareless tube end and by the corresponding standard nominal pipe size for pipe thread ends or corresponding nominal dash size for the SAE straight thread ends or corresponding nominal dash size for the SAE straight thread ends.

Refer to SAE J846 for nominal sizes, proper coding, and call out.

3.2 Dimensions and Tolerances

Except for nominal sizes and thread specifications, dimensions and tolerances are given in both SI Units and U.S. customary, as designated. Tabulated dimensions shall apply to the finished parts, plated or otherwise processed, as specified by the purchasers. Hex tolerances across flats are listed in Table 1A. The minimum across corners dimensions of hexagons shall be 1.092 times the nominal width across flats, but shall not result in a side-flat width less than 0.43 times the nominal width across flats. The minimum across-corners dimensions of external squares shall be 1.25 times the nominal width across flats, but shall not result in a side flat width less than 0.75 times the nominal width across the flats.

Table 1A - Hex tolerances

	Nominal Hex Size Across Flats (mm) Over	Nominal Hex Size Across Flats (mm) Include	Nominal Hex Size Across Flats (inch) Over	Nominal Hex Size Across Flats (inch) Include	Tolerance Minus Only (mm)	Tolerance Minus Only (inch)
	—	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

Tolerance on all dimensions not otherwise limited shall be ± 0.4 mm (± 0.016 inch). Fitting seats shall be concentric with straight thread pitch diameters within 0.25 mm (0.010 inch) full indicator movement (FIM).

Unless otherwise specified, tolerance on hole diameters for designated drills in the dimensional tables shall be as tabulated in Table 1B:

Table 1B - Drill tolerances

Drill Size Range (mm)	Drill Size Range (inch)	Tolerance (mm) Plus	Tolerance (mm) Minus	Tolerance (inch) Plus	Tolerance (inch) Minus
0.00-6.00	0.000-0.236	0.1	0.1	0.004	0.004
Over 6.00-30	0.237-1.181	0.2	0.2	0.008	0.008
Over 30	Over 1.181	0.3	0.3	0.012	0.012

Angular tolerance on axis of ends on elbows, tees, and crosses shall be ± 2.50 degrees for 1/8 to 3/8 inch tube fittings or 1/8 and 1/4 pipe fittings; ± 1.50 degrees for 1/2 to 2 inch OD tube fittings or 3/8 to 2 inch pipe fittings.

Where so illustrated and not otherwise specified, hexagon corners shall be chamfered 15 to 30 degrees to a diameter equal to the width across flats, with a minus tolerance of 0.4 mm (0.016 inch); or, where design permits, corners may be chamfered to the diameter of the abutting surface providing the length of chamfer does not exceed that produced by the 30-degree chamfer previously described.

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.

3.3 Passages

Where passages in straight fittings are machined from opposite ends, the offset at the meeting point shall not exceed 0.4 mm (0.016 inch). The cross-sectional area at the junction of passages in angle fittings shall not be less than that of the smallest passage.

3.4 Wall Thickness

Unless otherwise designated, the wall thickness at any point on fittings shall not be less than the thickness established by the specified dimensions, tolerances, and eccentricities for inner and outer surfaces.

3.5 Contour

Details of contour shall be optional with manufacturer provided the tabulated dimensions are maintained and serviceability of the fittings is not impaired.

3.6 Straight Threads

The screw threads on the tube/hose connection ends of the connectors shall be inch screw thread per ASME B1.1. All straight threads shall be class 2A or 2B. External threads which are plated or coated may exceed 2A diameters but shall not exceed maximum of 3A diameters. Internal threads of all classes shall 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.

External threads shall be chamfered and internal threads shall be countersunk as specified in the dimensional tables.

3.7 Pipe Threads

Pipe threads, unless there is specific authorization to the contrary, shall conform to the Dryseal American Standard Taper Pipe Thread (NPTF). Specifications are given in detail in SAE J476 (ANSI B1.20.3).

The length of full form external thread shall not be shorter than L_2 plus one pitch (thread).

Where external pipe threads are produced by roll threading, the diameter of the unthreaded shank adjacent to shoulder may be reduced to the E_2 pitch diameter for brass fittings and to the root diameter on steel fittings.

External pipe threads shall be chamfered from the diameters tabulated below to produce the specified length of chamfer or partial thread. Internal pipe threads shall be countersunk 90 degrees, included angle, to the diameters tabulated in Table 2.

Table 2 - Pipe thread chamfer diameters

Nominal Pipe Thread Size	External Thread Chamfer Dia Max (mm)	External Thread Chamfer Dia Max (inch)	External Thread Chamfer Dia Min (mm)	External Thread Chamfer Dia Min (inch)	External Thread Length of Chamfer or Partial Thread Min (mm)	External Thread Length of Chamfer or Partial Thread Min (inch)	External Thread Length of Chamfer or Partial Thread Max (mm)	External Thread Length of Chamfer or Partial Thread Max (inch)	Internal Thread Counter- sink Dia Min (mm)	Internal Thread Counter- sink Dia Min (inch)	Internal Thread Counter- sink Dia Max (mm)	Internal Thread Counter- sink Dia Max (inch)
1/8	8.1	0.32	7.6	0.30	0.94	0.037	1.40	0.055	10.7	0.42	11.2	0.44
1/4	10.7	0.42	10.2	0.40	1.42	0.056	2.13	0.084	14.0	0.55	14.5	0.57
3/8	14.0	0.55	13.5	0.53	1.42	0.056	2.13	0.084	17.5	0.69	18.0	0.71
1/2	17.3	0.68	16.8	0.66	1.80	0.071	2.72	0.107	21.6	0.85	22.1	0.87
3/4	22.6	0.89	22.1	0.87	1.80	0.071	2.72	0.107	26.9	1.06	27.4	1.08
1	28.4	1.12	27.7	1.09	2.21	0.087	3.30	0.130	34.0	1.34	34.8	1.37
1-1/4	37.1	1.46	36.3	1.43	2.21	0.087	3.30	0.130	42.7	1.68	43.4	1.71
1-1/2	43.2	1.70	42.4	1.67	2.21	0.087	3.30	0.130	48.8	1.92	49.5	1.95
2	55.1	2.17	54.4	2.14	2.21	0.087	3.30	0.130	60.7	2.39	61.5	2.42

Tabulated diameters conform with Appendix A of SAE J476.

3.8 Material

Unless otherwise specified, fittings and ferrules shall be made from carbon steel. Ferrules in Figures 13 and 14 shall be made from carbon steel and sufficient case hardening to meet qualification requirements. See Figures 2B and 3B for bite depth requirements.

Stainless steel fittings shall be made from AISI Type 300 Series stainless steel of good quality (refer to SAE J405). Ferrules in Figures 13 and 14 shall be made from stainless steel of such hardness as to be capable of biting, fully annealed type 304 stainless steel tubing. Unless otherwise specified by the purchaser, stainless steel fittings shall be passivated. Carbon steel and stainless steel fittings fabricated from multiple components must be bonded together with materials having a melting point of not less than 996 °C (1825 °F).

3.9 Corrosion Protection

The external surfaces and threads of all carbon steel parts shall be plated or coated with a suitable material that passes a salt spray test in accordance with ISO 9227 or ASTM B117. The following requirements shall apply:

- No appearance of corrosion products of the protective coating before 96 hours.
- No appearance of corrosion products of the base metal before 144 hours.

The following exceptions shall apply:

- All internal fluid passages.
- 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.
- Areas where there is mechanical deformation of the plating or coating caused by crimping, flaring bending, and other post-plate metal forming operations.
- Areas where the parts are suspended or affixed in the test chamber where condensate can accumulate.

Parts manufactured to this specification shall not be cadmium plated and shall not use hexavalent chromate coatings. Internal fluid passages shall be protected from corrosion during storage and shipping. Changes in plating or coating shall be re-qualified to ensure assembly torque is not affected.

3.10 Workmanship

Workmanship shall conform to the best commercial practice to produce high-quality fittings. Fittings shall be free from all hanging burrs, loose scale, and slivers which might become dislodged in usage and all other defects which might affect their serviceability. All sealing surfaces must be smooth except that annular tool marks up to Ra max 2.5 µm (100 µin) shall be permissible.

3.11 Assembly Considerations

Use of a compatible lubricant/sealant is desirable in assembling dryseal pipe threads on hydraulic tube or pipe fittings to minimize galling and affect a pressure-tight seal.

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 4 of SAE J1926-3. Position the washer farthest from the end of the fittings as shown in Figure 12A. 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 4 of SAE J1926-3. Any surface out of flatness must be uniform (not wavy) and concave with respect to the O-ring boss end of the fitting.

Torque values listed in Table 3 are for controlled testing to establish compliance to the performance requirements set forth in Table 1. Flareless ends are assembled to a number of turns past finger tight position. Use assembly instructions listed in Section 5. Recommended assembly torques and number of turns from finger tight position by manufacturers may vary from those in Table 2A and Section 5, respectively.

Plating combination, surface finish, lubrication, etc., influence performance of the SAE straight thread end of the fitting. Use the manufacturer's recommended torque values for final assembly.

4. PERFORMANCE REQUIREMENTS

See Appendix C for minimum number of samples required for testing. All tests shall be conducted as specified in ISO 19879, assembled at the minimum torque (Table 2A for SAE straight thread end) or number of turns from finger tight position specified in assembly procedure by manufacturer for pipe thread end and per assembly instructions given in Section 5 for the flareless end. In case of a conflict, requirements of this document take precedence.

Assembly instructions for SAE adjustable end are given in SAE J2593. Adjustable fittings shall be backed out one full turn from finger tight position prior to lock-nut tightening.

For testing only, all tube fitting threads and contact surfaces shall be lubricated with SAE 10W hydraulic oil prior to assembly.

4.1 Working Pressure

Working pressures for fittings shall be as listed in Table 1. Proof pressures shall be twice the working pressures, and minimum burst pressures shall be four times the working pressures.

4.2 Proof Test

All fittings shall be capable of withstanding proof pressure for a period of 1 minute without failure or leakage.

4.3 Burst Test

Test blocks for burst testing shall be hardened to 45 to 55 HRC and left unplated. All fittings shall be capable of withstanding burst pressure without failure or leakage.

4.4 Cyclic Endurance (Impulse) Test

All fittings shall pass a cyclic endurance test for one million cycles at 133% of working pressures as listed in Table 1. The cycle test shall be conducted at minimum torque or number of turns from finger tight assembly.

4.5 O-Ring

The standard O-ring used on SAE straight thread end for testing shall be nitrile (NBR) rubber with a hardness of 90 durometer, Shore "A." Refer to SAE J515.

Table 3 - Qualification test torque^(b) requirements for SAE straight thread end

Nom SAE Dash Size	SAE O-Ring Port Thread Size	SAE O-Ring ^(a) Port End Torque (N·m)	SAE O-Ring ^(a) Port End Torque (lb·ft)
2	5/16-24	8-9	6-7
3	3/8-24	11-12	8-9
4	7/16-20	18-20	13-15
5	1/2-20	23-26	17-19
6	9/16-18	29-33	22-24
8	3/4-16	49-53	40-43
10	7/8-14	59-64	43-48
12	1-1/16-12	93-102	68-75
14	1-3/16-12	122-134	90-99
16	1-5/16-12	151-166	112-123
20	1-5/8-12	198-218	146-161
24	1-7/8-12	209-231	154-170
32	2-1/2-12	296-325	218-240

^(a) Test torques given here are for low carbon steel fittings only. Consult the manufacturer for values for other materials.

^(b) For stud end test torques, refer to SAE J1926-3

The flareless tube fittings shall be as shown in Figures 1 to 17 and Tables 4 to 8. The basic design of these fittings is derived from existing military standards.

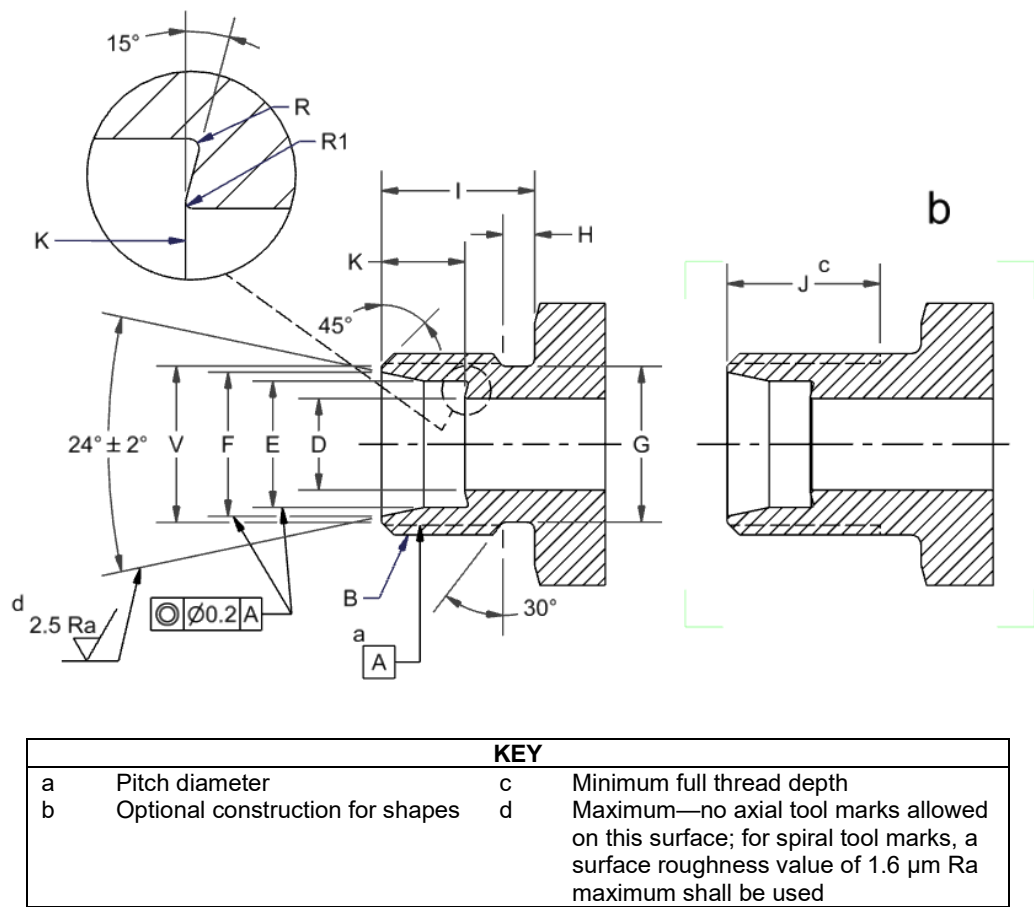


Figure 1 - Flareless connection details
(see Table 5 for dimensions)

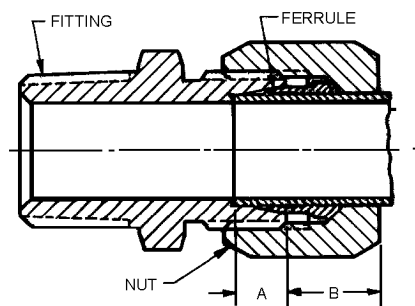


Figure 2A - Assembly with a Style A ferrule
(Figure 13)

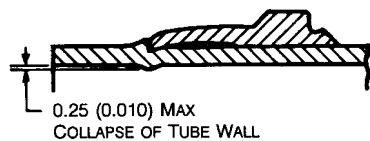


Figure 2B - Enlarged view of a Style A ferrule bite

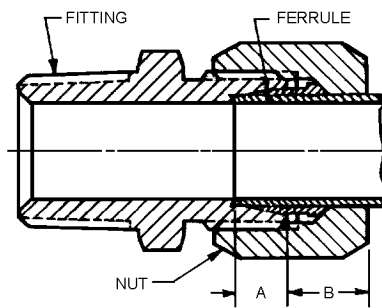


**Figure 3A - Assembly with Style B ferrule
(Figure 14)**

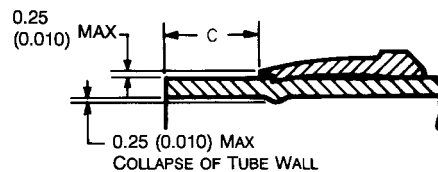


Figure 3B - Enlarged view of Style B ferrule bite

**Table 4 - Dimensions of flareless hydraulic tube fitting assemblies
(Figures 2A, 2B, 3A, and 3B)**

Nominal Tube OD	A (Ref) (mm)	A (Ref) (inch)	B (Ref) (mm)	B (Ref) (inch)	C (Ref) (mm)	C (Ref) (inch)
1/8	4.78	0.188	7.9	0.31	2.0	0.08
3/16	5.94	0.234	8.6	0.34	3.0	0.12
1/4	5.94	0.234	10.7	0.42	3.6	0.14
5/16	6.35	0.250	10.7	0.42	3.6	0.14
3/8	6.35	0.250	11.9	0.47	3.6	0.14
1/2	7.75	0.305	12.7	0.50	3.6	0.14
5/8	8.89	0.350	13.5	0.53	3.6	0.14
3/4	8.89	0.350	14.2	0.56	3.6	0.14
7/8	8.89	0.350	13.5	0.53	—	—
1	10.54	0.415	16.8	0.66	4.3	0.17
1-1/4	10.54	0.415	18.3	0.72	5.1	0.20
1-1/2	12.32	0.485	18.3	0.72	5.1	0.20
2	12.32	0.485	21.3	0.84	5.1	0.20

5. ASSEMBLY INSTRUCTIONS FOR HYDRAULIC FLARELESS TUBE FITTINGS

These instructions apply to the assembly of hydraulic tube fittings of the flareless type given in Tables 4 to 8 and Figures 1 to 17.

The following instructions should be used to assure proper make-up of the fitting when assembled since the fitting depends on securing the ferrule to the tube by the cutting action of the ferrule into the tube.

- Cut tube square and burr inside and outside corner (not excessive).
- Assemble fitting by sliding nut over tubing with open end out. Slide ferrule on tubing with cutting edge out, the large head end should be inside of the nut. Lubricate the ferrule and the threads on the body and nut with oil or petrolatum. Insert tube into fitting.

- c. Bottom the tube in the fitting, and tighten the nut until the ferrule just grips the tube. With a little experience, the mechanic can determine this point by feel. If the fittings are bench assembled, the gripping action can be determined by rotating the tube by hand as the nut is drawn down. When the tube can no longer be turned by hand, the ferrule has started to grip the tube.
- d. After the ferrule grips the tube, tighten the nut one full turn. This may vary slightly with different tubing materials, but for general practice, it is a good rule for the mechanic to follow.
- e. The fittings can now be disassembled for inspection. The two styles of ferrules differ somewhat in inspection even though their principles of makeup and application are similar.
 - 1. For the ferrule in Figure 13, the bite or cut into the tube can be readily seen since it is on the lead edge of the ferrule. The bite into the tube should show a definite groove where the ferrule cuts into the tube and peels the metal over the lead edge of the ferrule. See Figure 2 for further detail.
 - 2. For the ferrule in Figure 14, the pilot at the end of the ferrule should be contacting or be within 0.038 mm (0.0015 inch) of the tube for hard material or not more than 0.13 mm (0.005 inch) on soft material. See Figure 3 for further detail. This is an indication that the cutting edge has performed its function and has taken a secure bite in the tube. The sleeve should be slightly sprung or arched.

For both styles of ferrules, the rounded or lead edge should show a good seat in the fitting, and the head or shoulder end should be collapsed tight against the tube. The ferrules should have no end movement; however, the ferrule may be rotated on the tube due to spring back of the material. The performance of the fitting is not affected if the ferrule rotates.

- f. In production, it may be preferable to use a threaded presetting tool to preform the ferrule onto the tubing. The presetting tool is a counterpart of the fitting hardened to provide good wearing properties for repeated usage. When using the presetting tool, the assembly instructions are the same, as the presetting tool takes the place of the fitting. Care should be taken to keep the cam surface of the presetting tool free of defects since they would transfer themselves to the ferrule, which would result in improper seating when the fitting is installed.
- g. In some installations, it may be necessary to use a mandrel to support the inside of the tube when setting the ferrule. This is only necessary when the tube wall is so thin or so soft that it will not resist the biting action of the ferrule without collapsing. The mandrel in this instance supports the tube and allows the ferrule to bite into the tube without deforming or collapsing. Because the use of a mandrel allows very little give in the tubing, the setting of the ferrule may be made with slightly fewer turns than described previously.

5.1 Reassembly Instructions for Flareless Fittings

After disassembly of the fitting joint, the flareless fitting can be reassembled by assembling the tube and ferrule into the socket of the fitting and threading the nut onto the fitting.

The operation of assembly up to the point at which the ferrule seats itself in the fitting can usually be accomplished by hand or with the use of a small wrench. If a wrench is required, only low torques are necessary to seat the ferrule.

When the ferrule is seated, an increase in the torque will be quite evident. When this point is reached, draw the nut up approximately 1/6 of a turn minimum, but not more than 1/3 of a turn, to complete the tightening operation.

NOTE: Instructions for assembling adjustable hydraulic fittings in straight thread O-ring port are given in SAE J2593.

6. NOTES

6.1 Revision Indicator

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

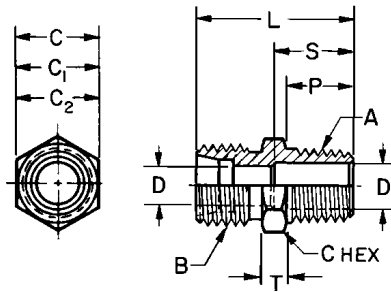


Figure 4A - Male connector (080102)

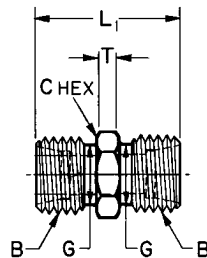


Figure 4B - Union (080101)

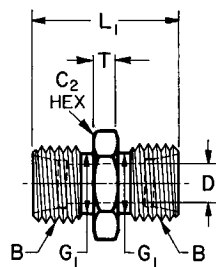


Figure 4C - Large hex union* (080119)

* These types of fittings are not compatible with MS 33649 (or superseded and 10050) bosses.

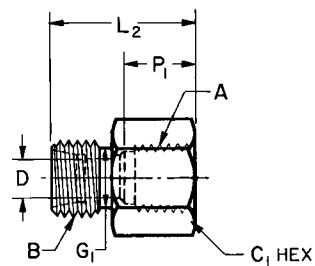


Figure 4D - Female connector (080103)