SURFACE VEHICLE INFORMATION REPORT

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Information Report for the Installation of Fluid Conductors and Connectors

RATIONALE

This revision is the result of a general Five-Year Review of this document. Changes made were minor corrections to reflect current committee practice, and resulted in no significant changes to content or practice.

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For more information on this standard, visit
https://www.sae.org/standards/content/J2593_202201/

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1. SCOPE

This SAE Information Report provides general information for installing and tightening fluid conductors and connectors. Following these guidelines, with the consistent proper use of torque wrenches, tightening procedures, and correct torque levels, will result in diminishing leaks and improving service life by avoiding hose twisting, tube binding, false torque, and improper joint closures. Since many factors influence the pressure at which a hydraulic system will or will not perform satisfactorily, this report should not be used as a “standard” nor a “specification,” and the values shown should not be construed as “guaranteed” minimums, maximums, or absolutes.

This document is an information report to help users by gathering available information from the various connector standards and publishing the information in one source for easy retrieval and applied common usage. This SAE Information Report is primarily intended for mobile/stationary industrial equipment applications. Aircraft, automotive, and aerospace applications were not considered during the preparation of this document.

When assembly procedure and torque level discrepancies between this document and associated connector specifications occur, the current connector specifications shall take precedence.

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 J246	Spherical and Flanged Sleeve (Compression) Tube Fittings
SAE J476a	Dryseal Pipe Threads
SAE J513	Refrigeration Tube Fittings - General Specifications
SAE J514	Hydraulic Tube Fittings
SAE J516	Hydraulic Hose Fittings
SAE J518-1	Hydraulic Flanged Tube, Pipe, and Hose Connections, 4-Screw Flange Connection Part 1: 3.5 MPa to 35 MPa (Code 61)
SAE J518-2	Hydraulic Flanged Tube, Pipe, and Hose Connections, 4-Screw Flange Connection Part 2: 42 MPa (Code 62)
SAE J530	Automotive Pipe Fittings
SAE J531	Automotive Pipe, Filler, and Drain Plugs
SAE J532	Automotive Straight Thread Filler and Drain Plugs
SAE J1176	External Leakage Classifications for Hydraulic Systems
SAE J1231	Formed Tube Ends for Hose Connections and Hose Fittings
SAE J1273	Recommended Practices for Hydraulic Hose Assemblies
SAE J1453-1	Specification for O-Ring Face Seal Connectors: Part 1 - Tube Connection Details and Common Requirements for Performance and Tests

SAE J1453-2 Specification for O-Ring Face Seal Connectors: Part 2 - Requirements, Dimensions, and Tests for Steel Unions, Bulkheads, Swivels, Braze Sleeves, Braze-on Tube Ends, Caps, and Connectors with ISO 6149-2 Metric Stud Ends and ISO 6161 4-Bolt Flange Heads

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

SAE J1615 Thread Sealants

SAE J1926-1 Connections for General Use and Fluid Power - Ports and Stud Endgs with ASME B1.1 Threads and O-Ring Sealing - Part 1: Threaded Port with O-Ring Seal in Truncated Housing

SAE J1926-2 Connections for General Use and Fluid Power - Ports and Stud Ends with ASME B1.1 Threads and O-Ring Sealing - Part 2: Heavy-Duty (S Series) Stud Ends

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 J1926-4 Connector Fluid Power and General Use - Ports and Stud End with ASME B1.1 Threads and O-Ring Seal - Part 4: External Hex and Internal Hex Inch Port Plugs - Dimensions, Design, Test Methods, and Requirements

2.1.2 ISO Publications

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

ISO 7-1 Pipe Threads Where Pressure-Tight Joints Are Made on the Threads - Part 1: Dimensions, Tolerances and Designation

ISO 7-2 Pipe Threads where Pressure-Tight Joints are Made on the Threads - Part 2: Verification by Means of Limit Gauges

ISO 228-1 Pipe Threads Where Pressure-Tight Joints are Not Made on the Threads - Part 1: Dimensions, Tolerances and Designation

ISO 228-2 Pipe Threads Where Pressure-Tight Joints are Not Made on the Threads - Part 2: Verification by Means of Limit Gauges

ISO 6149-1 Connections for Fluid Power and General Use - Ports and Stud Ends with ISO 261 Metric Threads and O-Ring Sealing - Part 1: Ports with O-Ring Seal in Truncated Housing

ISO 6149-2 Connections for Fluid Power and General Use - Ports and Stud Ends with ISO 261 Metric Threads and O-Ring Sealing - Part 2: Heavy-Duty (S Series) Stud Ends - Dimensions, Design, Test Methods and Requirements

ISO 6149-3 Connections for Fluid Power and General Use - Ports and Stud Ends with ISO 261 Metric Threads and O-Ring Sealing - Part 3: Heavy-Duty (L Series) Stud Ends - Dimensions, Design, Test Methods and Requirements

ISO 6149-4 Connections for Fluid Power and General Use - Ports and Stud Ends with ISO 261 Metric Threads and O-Ring Sealing - Part 4: Dimensions, Design, Test Methods and Requirements for External Hex and Internal Hex Port Plugs

ISO 6162-1 Hydraulic Fluid Power - Flange Connectors with Split or One-Piece Flange Clamps and Metric or Inch Screws - Part 1: Flange Connectors for Use at Pressures of 3.5 MPa (35 bar) to 35 MPa (350 bar), DN 13 to DN 127

ISO 6162-2 Hydraulic Fluid Power - Flange Connectors with Split or One-Piece Flange Clamps and Metric or Inch Screws - Part 2: Flange Connectors for Use at Pressures of 35 MPa (350 bar) to 40 MPa (400 bar), DN 13 to DN 51

ISO 8434-1 Metallic Tube Connections for Fluid Power and General Use - Part 1: 24° Compression Connectors

ISO 8434-2 Metallic Tube Connections for Fluid Power and General Use - Part 2: 37° Flared Connectors

ISO 8434-3 Metallic Tube Connections for Fluid Power and General Use - Part 3: O-Ring Face Seal Connectors

ISO 8434-4 Metallic Tube Connections for Fluid Power and General Use - Part 4: 24° Cone Connectors with O-Ring Weld-on Nipples

ISO 8434-5 Metallic Tube Connections for Fluid Power and General Use - Part 5: Test Methods for Threaded Hydraulic Fluid Power Connectors

ISO 11926-1 Connections for General Use and Fluid Power - Ports and Stud Ends with ISO 725 Inch Threads and O-Ring Sealing - Part 1: Ports with O-Ring Seal in Truncated Housing

ISO 11926-2 Connections for General Use and Fluid Power - Ports and Stud Ends with ISO 725 Inch Threads and O-Ring Sealing - Part 2: Heavy-Duty (S Series) Stud Ends

ISO 11926-3 Connections for General Use and Fluid Power - Ports and Stud Ends with ISO 725 Inch Threads and O-Ring Sealing - Part 3: Light-Duty (L Series) Stud Ends

ISO 12151-1 Connections for Hydraulic Fluid Power and General Use - Hose Fittings - Part 1: Hose Fittings with ISO 8434-3 O-Ring Face Seal Ends

ISO 12151-2 Connections for Hydraulic Fluid Power and General Use - Hose Fittings - Part 2: Hose Fittings with ISO 8434-1 24° Compression Connectors and ISO 8434-4 24° Cone Connectors with O-Ring Weld-on Nipples

ISO 12151-3 Connections for Hydraulic Fluid Power and General Use - Hose Fittings - Part 3: Hose Fittings with ISO 6162 Flange Ends

ISO 12151-4 Connections for Hydraulic Fluid Power and General Use - Hose Fittings - Part 4: Hose Fittings with ISO 6149 Metric Stud Ends

ISO 12151-5 Connections for Hydraulic Fluid Power and General Use - Hose Fittings - Part 5: Hose Fittings with ISO 8434-2 37° Flared Ends

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

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

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

SAE J515 Specification for O-Ring Materials Used with Hydraulic Connectors

SAE J517	Hydraulic Hose
SAE J524	Seamless Low-Carbon Steel Tubing Annealed for Bending and Flaring
SAE J525	Welded and Cold Drawn Low-Carbon Steel Tubing Annealed for Bending and Flaring
SAE J526	Welded Low-Carbon Steel Tubing Suitable for Bending, Flaring, Beading, Forming, and Brazing
SAE J527	Brazed Double Wall Low-Carbon Steel Tubing
SAE J533	Flares for Tubing
SAE J844	Nonmetallic Air Brake System Tubing
SAE J846	Coding Systems for Identification of Fluid Conductors and Connectors
SAE J1065	Nominal Reference Working Pressures for Steel Hydraulic Tubing
SAE J1149	Metallic Air Brake System Tubing and Pipe
SAE J1290	Automotive Hydraulic Brake System - Metric Tube Connections
SAE J1394	Metric Nonmetallic Air Brake System Tubing
SAE J1401	Road Vehicle - Hydraulic Brake Hose Assemblies for Use with Nonpetroleum-Base Hydraulic Fluids
SAE J1402	Automotive Air Brake Hose and Hose Assemblies
SAE J1467	Clip Fastener Fitting
SAE J1475	Hydraulic Hose Fitting for Marine Applications
SAE J1527	Marine Fuel Hoses
SAE J1532	Transmission Oil Cooler Hose
SAE J1644	Metallic Tube Connections for Fluid Power and General Use - Test Methods for Threaded Hydraulic Fluid Power Connectors
SAE J1650	Seamless Copper-Nickel 90-10 Tubing
SAE J1677	Tests and Procedures for Carbon Steel and High Strength Low Alloy Steel Tubing
SAE J1754/1	Hose Assemblies, Rubber, Hydraulic, Steel Wire Reinforced - Part 1: Procurement Document
SAE J1754/2	Hose Assemblies, Rubber, Hydraulic, Steel Wire Reinforced - Part 2: Ordering Information
SAE J1942	Hose and Hose Assemblies for Marine Applications
SAE J1942-1	Qualified Hoses for Marine Applications
SAE J2050	High-Temperature Power Steering Pressure Hose
SAE J2064	Coupled Automotive Refrigerant Air-Conditioning Hose Assemblies
SAE J2094	Vehicle and Control Modifications for Drivers with Physical Disabilities Terminology

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

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

SAE J2551 Recommended Practices for Fluid Conductor Carbon and Alloy Steel Tubing Applications

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

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

SAE J2658 Carbon and Steel Alloy Tube Conductor Assemblies for Fluid Power and General Use - Test Methods for Hydraulic Fluid Power Metallic Tube Assemblies

2.2.2 ISO Publications

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

ISO 261 ISO General Purpose Metric Screw Threads - General Plan

ISO 263 ISO Inch Screw Threads - General and Selection for Screws, Bolts and Nuts - Diameter Range 0.06 to 6 Inch

ISO 272 Fasteners - Hexagon Products - Widths Across Flats

ISO 273 Fasteners - Clearance Holes for Bolts and Screws

ISO 898-1 Mechanical Properties of Fasteners - Part 1: Bolts, Screws and Studs

ISO 898-1 Mechanical Properties of Fasteners - Part 2: Nuts with Specified Proof Load Values - Coarse Thread

ISO 1179-1 Connections for General Use and Fluid Power - Ports and Stud Ends with ISO 228-1 Threads with Elastomeric or Metal to Metal Sealing - Part 1: Threaded Ports

ISO 1179-2 Connections for General Use and Fluid Power - Ports and Stud Ends with ISO 228-1 Threads with Elastomeric or Metal to Metal Sealing - Part 2: Heavy-Duty (S Series) and Light-Duty (L Series) Stud Ends with Elastomeric Sealing (Type E)

ISO 1179-3 Connections for General Use and Fluid Power - Ports and Stud Ends with ISO 228-1 Threads with Elastomeric or Metal to Metal Sealing - Part 3: Light-Duty (L Series) Stud Ends with Sealing by O-Ring with Retaining Ring (Types G and H)

ISO 1179-4 Connections for General Use and Fluid Power - Ports and Stud Ends with ISO 228-1 Threads with Elastomeric or Metal to Metal Sealing - Part 4: Stud Ends for General Use Only with Metal to Metal Sealing (Type B)

ISO 1436 Rubber Hoses and Hose Assemblies - Wire-Reinforced Hydraulic Type - Specification

ISO 2944 Fluid Power Systems and Components - Nominal Pressures

ISO 3304 Plain End Seamless Precision Steel Tubes - Technical Conditions for Delivery

ISO 3305 Plain End Welded Precision Steel Tubes - Technical Conditions for Delivery

ISO 3448 Industrial Liquid Lubricants - ISO Viscosity Classification

ISO 3457	Earth Moving Machinery - Guards and Shields - Definitions and Specifications
ISO 3601-1	Fluid Systems - Sealing Devices - O-Rings - Part 1: Inside Diameters, Cross-Sections, Tolerances and Size Identification Code
ISO 3601-2	Fluid Systems - Sealing Devices - O-Rings - Part 2: Design Criteria for O-Ring Housings - Basic Calculations
ISO 3601-3	Fluid Systems - Sealing Devices - O-Rings - Part 3: Quality Acceptance Criteria
ISO 3862	Rubber Hoses and Hose Assemblies - Rubber-Covered, Spiral Wire Reinforced, Hydraulic Type - Specification
ISO 3949	Plastic Hoses and Hose Assemblies - Thermoplastics, Textile-Reinforced, Hydraulic Type - Specification
ISO 4079	Rubber Hoses and Hose Assemblies - Textile-Reinforced Hydraulic Type - Specification
ISO 4200	Plain End Steel Tubes, Welded and Seamless - General Tables of Dimensions and Masses per Unit Length
ISO 4397	Fluid Power Systems and Components - Connectors and Associated Components - Nominal Outside Diameters of Tubes and Nominal Inside Diameters of Hoses
ISO 4399	Fluid Power Systems and Components - Connectors and Associated Components - Nominal Pressures
ISO 5598	Fluid Power Systems and Components- Vocabulary
ISO 6072	Hydraulic Fluid Power - Compatibility Between Elastomeric Materials and Fluids
ISO 6150	Pneumatic Fluid Power - Cylindrical Quick-Action Couplings for Maximum Working Pressures of 10 bar, 16 bar and 25 bar (1 MPa, 1.6 MPa and 2.5 MPa) Connecting Dimensions, Specifications, Application Guidelines And Testing
ISO 6163-1	Hydraulic Fluid Power - Round-Flange Connectors for Use at Working Pressures of 50 MPa (500 bar) - Part 1: Eight-Screw Connectors, DN 65 and DN 80
ISO 6163-2	Hydraulic Fluid Power - Round-Flange Connectors for Use at Working Pressures of 50 MPa (500 bar) - Part 2: Twelve-Screw Connectors, DN 100 and DN 150
ISO 6164	Hydraulic Fluid Power - Four-Screw, One-Piece Square-Flange Connections for Use at Working Pressures of 25 MPa and 40 MPa (250 bar and 400 bar)
ISO 6605	Hydraulic Fluid Power - Hose Assemblies - Method of Test
ISO 6743-4	Lubricants, Industrial Oils and Related Products (Class L) - Part 4: Family H (hydraulic systems)
ISO 7241-1	Hydraulic Fluid Power - Quick Action Couplings - Part 1: Interference Dimensions
ISO 7241-2	Hydraulic Fluid Power - Quick Action Coupling - Part 2: Test Methods
ISO 8331	Rubber and Plastics Hoses and Hose Assemblies - Guide to the Selection, Use and Maintenance
ISO 9974-1	Threaded Port with ISO 261 Threads and Elastomeric or Metal to Metal Sealing
ISO 9974-2	Stud End with ISO 261 Threads and Elastomeric Sealing (Type E)
ISO 9974-3	Stud Ends with ISO Threads and Metal to Metal Sealing (Type B)

ISO 10583 Hydraulic Fluid Power - Test Methods for Tube Connections

ISO 10763 Hydraulic Fluid Power - Plain-End, Seamless and Welded Steel Tubes - Dimensions and Nominal Working Pressures

ISO 15171-1 Connections for Hydraulic Fluid Power and General Use - Hydraulic Couplings for Diagnostic Purposes - Part 1: Coupling not for Connection Under Pressure

ISO 15171-2 Connections for Hydraulic Fluid Power and General Use - Hydraulic Couplings for Diagnostic Purposes - Part 2: Coupling with M16 X 2 End for Connection Under Pressure

ISO 16028 Hydraulic Flush Face Quick-Action Couplings

2.2.3 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 A268/A268M Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service

ASTM A269-96 Seamless and Welded Austenitic Stainless Steel Tubing for General Service

ASTM A312A/A312M Seamless and Welded Austentic Stainless Steel Pipes

ASTM A450/A450M-96a General Requirements for Carbon, Ferritic Alloy and Austenitic Alloy Steel Tubing

3. EXPLANATION OF TERMS AND TERMINOLOGY

Refer to SAE J1273, SAE J2551, and ISO 5598 for terms and terminology for use with fluid connectors and conductors.

4. FLUID CONDUCTOR AND CONNECTOR SERVICE LIFE

Tube assemblies are made from very robust materials, often used in applications where the tube assembly and connector is considered a lifetime part of the system. When designed, manufactured, applied, and installed properly, most tube assemblies will last for the life of the unit.

Hose assemblies are subject to aging and therefore have a finite life. An inspection and maintenance plan to check the hose assemblies is recommended to ensure assemblies are replaced before they fail; refer to SAE J1273.

4.1 Leak Classifications

Refer to SAE J1176 for the various classifications of leaks.

4.2 Common Causes of Leaks with Fluid Conductors and Connectors

Typical reasons for connector and conductor leaks include, but are not limited to, the following. Correcting these items will reduce leakage, improve reliability, and minimize warranty costs.

4.2.1 Incorrect Tightening Sequence

The sealing interfaces of the connections must be properly aligned and tightened first. The clamps must be tightened last. If the clamps are tightened first, the ability to properly align the joint interface surfaces is lost and the joint will eventually leak.

4.2.2 Incorrect Use of Adjustable Brackets

The purpose of the adjustable brackets is to provide enough correct joint interface alignment adjustability to properly close the joint. Improper use may compound the leak problems.

4.2.3 Joint Side Loads

Excessive strain on joints due to vibration or other motion due to improper design or assembly.

4.2.4 Material Imperfections

Imperfections in the base material, tubing, hose, connector, or hydraulic component (i.e., control valve, cylinder, etc.) is not a common problem. However, some common imperfections that may cause crack initiation, failure, and leaks, are as follows: bad seam weld of the tubing, imperfections in the hose, porosity/inclusions in the base connector material, incorrect material, too much plating, and damaged threads.

4.2.5 Sealing surfaces on the hose couplings and/or tube assemblies not to specifications.

4.2.6 Incorrect Coating, Plating, or Painting Durability

Coating not durable enough for the system environment, tube material corrodes through causing leak.

4.2.7 Incorrect Tube or Hose Material Size and/or Wall Thickness Selection

Pressure spikes in the system that exceed the pressure rating of the selected material of the suspect conductor assembly.

4.2.8 Incorrect Use of Connectors

Example: The tube or hose end of male 37 degree flare connectors and ORFS connectors will thread into a straight thread O-ring port; however, this will result in a leaky non-functional connection.

4.2.9 Shipping Damage

Fluid conductors and connectors bent or damaged during shipment.

4.2.10 Correct joint interface load of fluid connections is not accomplished due to one or all of the following:

- Back-up wrenches not being used. Back-up wrenches are important to ensure proper abutment for tightening.
- Conductors and/or connectors not properly tightened due to obstructed wrench access.
- Conductors and/or connectors not properly tightened due to wrong torque specified on drawing or work order.
- Conductors and/or connectors not properly tightened because torque wrenches were not used.
- Conductors and/or connectors not properly tightened because the torque wrench is broken or out of calibration.
- Conductors and/or connectors not properly tightened because wrong torque wrench is being used.

5. HYDRAULIC FLUID CONDUCTOR AND CONNECTOR INSTALLATION

5.1 Typical Tightening Sequence

To ensure proper alignment of the sealing interfaces, close attention must be paid to the correct tightening sequence when installing all fluid conductors and connectors. See Figure 1 for a typical system installation.

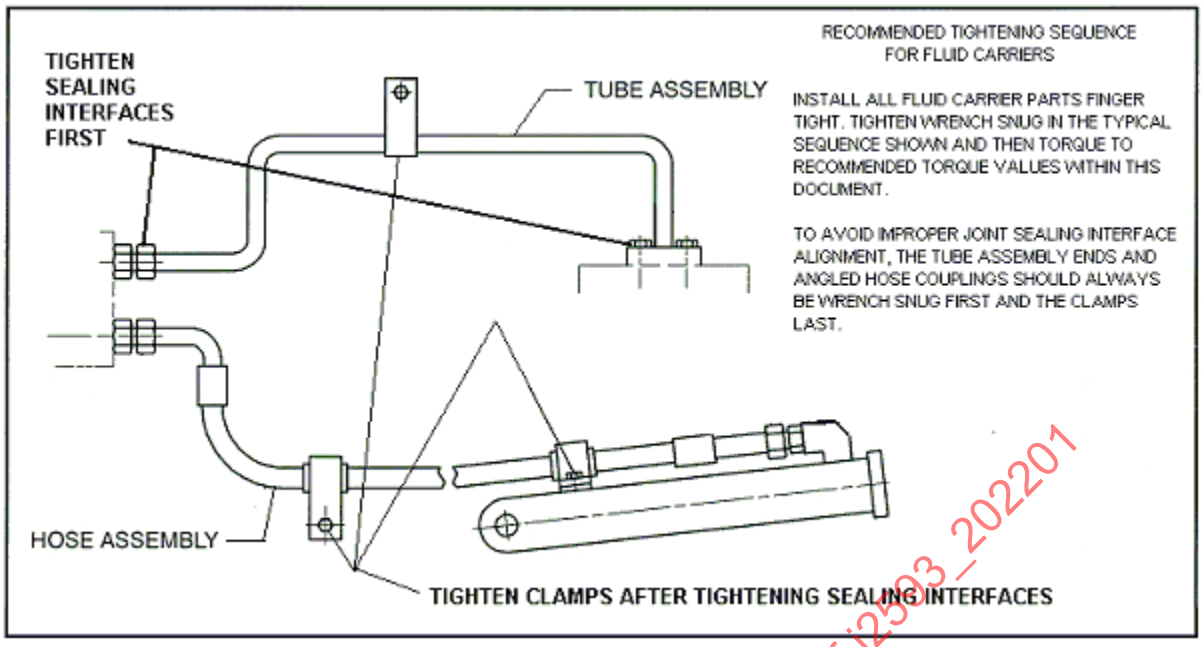


Figure 1 - Typical hydraulic fluid conductor and connector installation

5.2 Typical Multiple Tube Installation Tightening Sequence

To ensure proper alignment when multiple tubes connect two separate units which make one complete sub-assembly, follow these steps:

Step 1: Thread both ends of each single tube, leaving loose 1/2 turn. Note: One bank of connections to be stationary with opposite bank floating, permitting tolerance.

Step 2: Tighten and torque to specifications the outer tubes on the opposite ends.

Step 3: Continue through assembly sequence until complete.

See Figure 2 for a typical system with multiple tube installations.

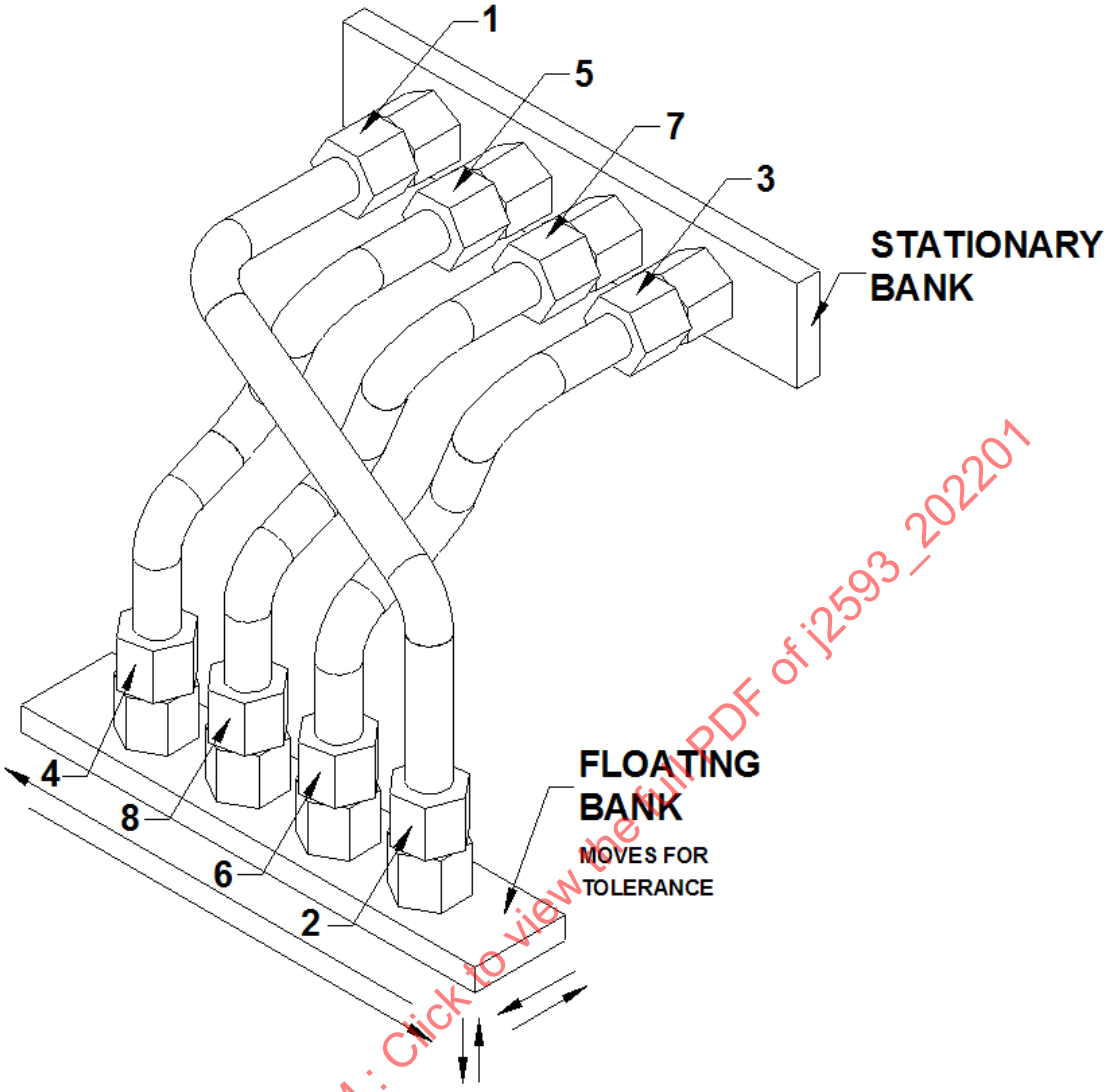


Figure 2 - Multiple tube installation tightening sequence

5.3 Proper Joint Closure

Leaks will be minimized when the joint interface is properly closed, as shown in Figure 3.

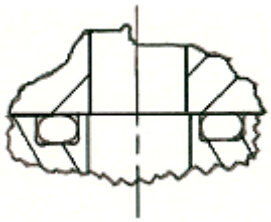


Figure 3 - Properly closed joint

5.4 Improper Joint Closure

When the clamps are tightened first, the tube becomes fixed in space and the sealing interfaces at the tube assembly ends may become improperly aligned, as shown in Figure 4, and may eventually leak.

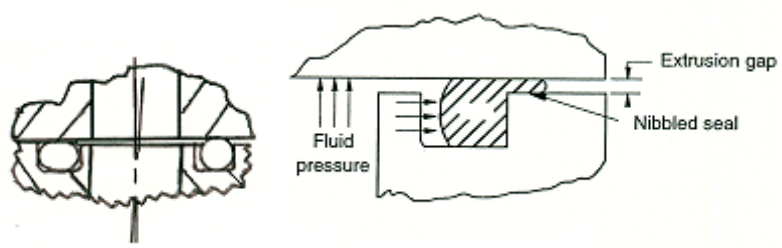


Figure 4 - Improperly closed joint

5.5 Proper Wrench Usage

To prevent undesired hose or tube torsional rotation, which may induce unwanted assembly side loads and effect the proper joint sealing interface load and component life, two wrenches must be used; one torque wrench and one back-up wrench. Two wrenches are required to provide the proper abutment so the joint sealing interface will receive the correct load. If two wrenches are not used, this allows inadvertent component rotation, which absorbs torque and causes improper joint load, which leads to leaks. The lay-line printed on the hose is commonly a good indicator of proper hose installation. A twisted lay-line usually indicates the hose is twisted. See Figure 5 for typical wrenching recommendations.

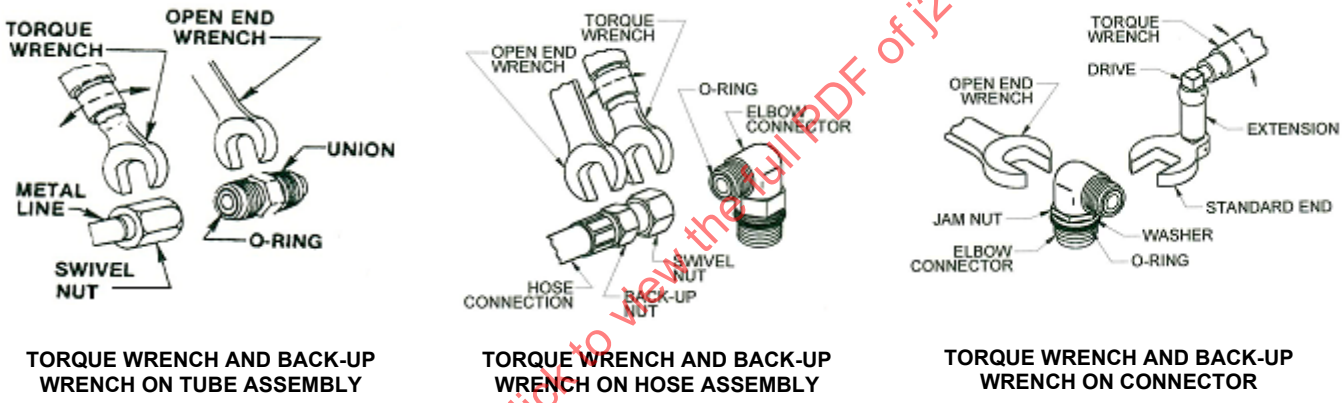


Figure 5 - Typical combinations of proper use of torque wrench and back-up wrench for threaded connections

5.6 Using the Torque Wrench Correctly

The torque levels listed in this document are essential for obtaining the working pressures listed throughout this document. When the torque wrench clicks or indicates the appropriate selected torque, the wrench motion should be discontinued immediately. Do not continue to turn the wrench. Continuance of the wrench past the calibrated torque will cause joint over-torque, which may result in component damage and premature failure. Care must be taken when using “crowfoot” type wrenches. Follow the tool manufacturers recommendations when adding moment arms to achieve correct torque levels. If it is impossible for torque wrenches to be used on the application because of nearby constraints, consult connector manufacturer for “flats from finger tight” torquing method.

5.7 Co-Efficient of Friction

Net tightening torque depends on many factors, including material, lubrication, coatings, and surface finishes. Torque levels listed in this document were developed using a nominal co-efficient of friction of 0.17, which is widely accepted in the fluid power industry.

5.8 Component Materials

The torque levels listed in this document are for carbon steel conductors and connector components; for other materials, consult the manufacturer.

5.9 SAE Dash Size

SAE dash size is equal to the nominal ID of hoses and the nominal OD of tubes expressed in 1/16 of an inch; i.e., 1/2 inch = 0.50 inch ID hose = 0.50 OD tube = 8/16 = -8 SAE dash size.

5.10 Metric Size

Metric size is equal to the nominal OD of tubes expressed in millimeters. For metric hose sizes, refer to SAE J517.

5.11 Connector Identification

Prior to selecting the appropriate torque from the tables within this document, it is necessary to properly identify the connector being installed. Refer to the pictorials accompanying each table. To determine the specific thread size and pitch, it may be necessary to use a thread identification kit, available from most connector manufacturers.

5.12 Hydraulic System Cleanliness - General Information for Assembly and Installation

5.12.1 Origins of Solid Contaminations

5.12.1.1 Inbuilt

All new hydraulic systems will contain some contaminants left during manufacture and assembly. These may consist of fibers (from rags, etc.), casting sand, pipe scale, cast iron or other metal particles, jointing material, or loose paint. When the system is operated, of course it is possible these inbuilt contaminants will be dislodged. It is very important these contaminants be minimized as much as possible.

5.12.1.2 Generated

When a normal hydraulic system has been operated for a period of time, a quantity of solid contaminant material may be present in the form of small metallic platelets, created by bedding-in and the normal wear process. Typically the hydraulic system will be designed with suitable filtration to remove particle sizes above 15 µm, most hydraulic systems will accommodate particle size below 15 µm.

5.12.1.3 Ingested

Considerable quantities of contaminants may be introduced during the filling and topping up of the system process unless the proper care is taken. Always use clean system fluids that have been properly protected from contamination. Always clean the reservoir cap before reinstallation. Reservoir breathers should be properly maintained and periodically cleaned. Worn rod seals, etc., will also allow the possibility of introducing contaminants.

5.12.2 Particle Size

A very important criteria when considering the effects of dirt and debris that may be ingested into a hydraulic system.

5.12.2.1 100 µm

The size of a typical grain of table salt.

5.12.2.2 70 to 80 µm

The diameter of a human hair.

5.12.2.3 40 to 50 µm

The size of a particle visible to the naked eye, under ideal conditions, with good lighting conditions.

5.12.2.4 30 µm

The size of a particle that is very difficult to see with the naked eye; however, it can cause a leak, a sticky control valve, and can adversely affect hydraulic system performance.

5.12.2.5 15 µm

Cannot be seen with the naked eye; however, this particle size may be detrimental to some hydraulic systems.

5.12.3 Conscious Care

The assembler must take conscious care to install clean components. If the part is dropped on the floor or in some way exposed to getting dirty, the component must not be used until properly cleaned. Some hydraulic systems may require relatively low attention to cleanliness, while other hydraulic systems may require significantly more focus to prevent potential ingestion of contamination which can lead to leaks and sticky control valves and can adversely affect hydraulic system performance. In any case, good work habits to build hydraulic systems as clean as possible, must be maintained to ensure proper hydraulic system operation and acceptable operating life.

5.12.4 Connectors, Tube Assemblies, and Hose Assemblies

It is mandatory to keep the protective caps, plugs, and/or bags in place on the connectors, tube assemblies, and hose assemblies until they are ready to be assembled to the finished product. These protective devices are required to remain in place to just prior to assembly to prevent dirt, dust, and other contaminants from getting into the hydraulic system. Each dirty part is a potential source for a leak, a field failure, and the resulting downtime.

5.12.5 Shop Atmosphere

Internal passages of the tubes, hoses, connectors, and sub-assemblies must not be exposed to the shop atmosphere for indefinite periods of time. The protection on all pre-assembled components must remain in place until just prior to assembly to the finished product.

5.12.6 O-Rings

All O-rings, especially pre-lubricated O-rings, must not be exposed to the atmosphere for extended periods. The lubrication draws dirt and debris to the O-ring, where it remains until it enters the hydraulic system or gets trapped in the joint interface, either of which may cause an early hour leak or downtime.

5.12.7 O-Ring Lubrication

Clean O-ring lubrication shall be used and shall not be exposed to shop atmosphere. Excessive amounts of O-ring lubrication can be considered a contaminant and also create false leaks. Too much lubricant will drip from the joint and appear to be a leaking joint. Lubricant must be compatible with the system fluid.

6. ASSEMBLY PROCEDURES AND TORQUE LEVELS FOR FLUID CONDUCTOR AND CONNECTORS

6.1 ISO 6162-1, ISO 6162-2/SAE J518-1, and SAE J518-2 Flange Connections - Recommended Identification, Assembly Procedures, Screw Torque Levels, and Maximum Working Pressure Tables

6.1.1 Identification

SAE J518 -1 and SAE J518-2 are technically identical to ISO 6162-1 and ISO 6162-2.

6.1.1.1 ISO 6162-1 and -2 Type 1 Flange Clamps

Are designed to be used with metric screws.

6.1.1.2 SAE J518-1 and SAE J518-2 Flange Clamps

Are designed to be used with metric and inch screws.

6.1.1.3 How to determine if the port is threaded to accept metric or inch screws:

Metric threads: The face of the port should be marked with an “M.”

Inch threads: The face of the port will have no marking.

6.1.1.4 How to determine if the flange clamps are intended to accept metric or inch screws:

Metric threaded screws: The flange clamp should be marked with an “M.”

Inch threaded screws: The flange clamp should have no marking.

NOTE: If for use with only metric screws, parts are stamped with an “M.” Many flanges can be used with both inch and metric screws and are not marked.

6.1.1.5 Determine the Maximum System Working Pressure (Max W.P.)

Tables 1, 2, and 3 define the maximum working pressures for flange connections. Select flange style, bolts, and clamps with a working pressure equal or greater than the maximum system working pressure.

Flange connections per ISO 6162-1 (known as Code 61 flanges) have lower pressure ratings than flange connections per ISO 6162-2 (known as Code 62 flanges).

Warning: The pressure rating of the assembly is dependent on the use of the correct bolt grade. The two styles are differentiated by different hole patterns and cannot be intermixed.

6.1.2 ISO 6162-1, ISO 6162-2, SAE J518-1, and SAE J518-2 Recommended Assembly Procedures

6.1.2.1 Use ISO 6162-1, ISO 6162-2 Type 1 flange clamps with metric screws.

6.1.2.2 Use ISO 6162-1, ISO 6162-2 Type 2, SAE J518-1, or SAE J518-2 flange clamps with inch screws.

6.1.2.3 Make sure all sealing and surface interfaces are free of burrs, nicks, scratches, or any foreign material.

6.1.2.4 Lubricate the O-ring with a light coat of system fluid or compatible oil.

6.1.2.5 Position the flange head and the flange clamps.

6.1.2.6 Place hardened washers (optional) on the screws and place the screws through the holes in the clamps.

6.1.2.7 Hand tightened and snug up the screws in the sequence shown in Figure 6 to ensure uniform contact at all four screw locations to prevent flange tipping, which may lead to flange breakage at final torque.

6.1.2.8 Torque the screws in diagonal sequence shown in Figure 6 in two or more increments to the appropriate torque levels listed in Tables 1 or 2.

Table 1 is for medium pressure (Code 61) flanges.

Table 2 is for higher pressure (Code 62) flanges.

6.1.3 ISO 6162-1, ISO 6162-2, SAE J518-1, and SAE J518-2 Screw Torque Levels and Maximum Working Pressure Tables

6.1.3.1 ISO 6162-1, ISO 6162-2, SAE J518-1, and SAE J518-2 Four-Bolt Split Flange Tightening Sequence

Choose the appropriate table depending upon the maximum working pressure of the application and the screw pattern of the port. Then obtain and use the appropriate screws, flange clamps, O-ring seals, tube assemblies and hose assemblies, etc., to match. Make sure the tube assemblies and hose assemblies have rated maximum working pressures equal to or greater than the maximum working pressure of the hydraulic system being assembled.

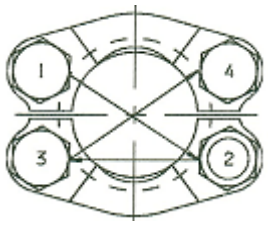


Figure 6 - ISO 6162-1, ISO 6162-2, SAE J518-1, and SAE J518-2 four-bolt split flange tightening sequence

BEFORE PROCEEDING, SEE ASSEMBLY INSTRUCTIONS IN 6.1.1 THROUGH 6.1.3.1, THEN TORQUE SCREWS IN DIAGONAL SEQUENCE IN SMALL INCREMENTS TO THE APPROPRIATE TORQUE LEVELS LISTED IN TABLES 1 OR 2

6.1.3.2 ISO 6162-1 and SAE J518-1 Screw Torque and Maximum Working Pressures for Medium Pressure (Code 61) Flanged Port Assemblies when Using High Strength Screws, Property Class 10.9 Metric Screws or Grade 8 Inch Screws (see Table 1)

Table 1 - ISO 6162-1 and SAE J518-1 screw torque and maximum working pressures for medium pressure (Code 61) flanged port assemblies when using high strength screws, property class 10.9 metric screws or grade 8 inch screws

Metric Screw Threads				Inch Screw Threads					
Metric Flange Size ISO 4397 mm	Metric Thread Size mm	Metric Wrench Size ISO 4017 mm	Assembly Torque +10% -0% N•m[1]	Nominal Tube OD Inch	Inch Flange SAE Dash Size	Inch Thread Size	Wrench Size Inch	Assembly Torque +10% -0% N•m[1]	Maximum Working Pressure MPa[2]
13	M8X1.25	13	32	1/2	-8	5/16-18	1/2	32	35
19	M10X1.5	16	70	3/4	-12	3/8-16	9/16	60	35
25	M10X1.5	16	70	1	-16	3/8-16	9/16	60	31.5
32	M10X1.5	16	70	1-1/4	-20	7/16-14	11/16	92	25
38	M12X1.75	18	130	1 1/2	-24	1/2-13	3/4	150	20
51	M12X1.75	18	130	2	-32	1/2-13	3/4	150	20
64	M12X1.75	18	130	2-1/2	-40	1/2-13	3/4	150	16
76	M16X2	24	295	3	-48	5/8-11	15/16	295	16
89	M16X2	24	295	3-1/2	-56	5/8-11	15/16	295	3.5
102	M16X2	24	295	4	-64	5/8-11	15/16	295	3.5
127	M16X2	24	295	4-1/2	-80	5/8-11	15/16	295	3.5

(1) To convert from N•m to lb-ft, multiply by 0.737.
(2) To convert from MPa to bar, multiply by 10; to convert from MPa to psi, multiply by 145.04.

6.1.3.3 ISO 6162-2 and SAE J518-2 Screw Torque and Maximum Working Pressures for High Pressure (Code 62) Flanged Port Assemblies when Using High Strength Screws, Property Class 10.9 Metric Screws or Grade 8 Inch Screws (see Table 2)

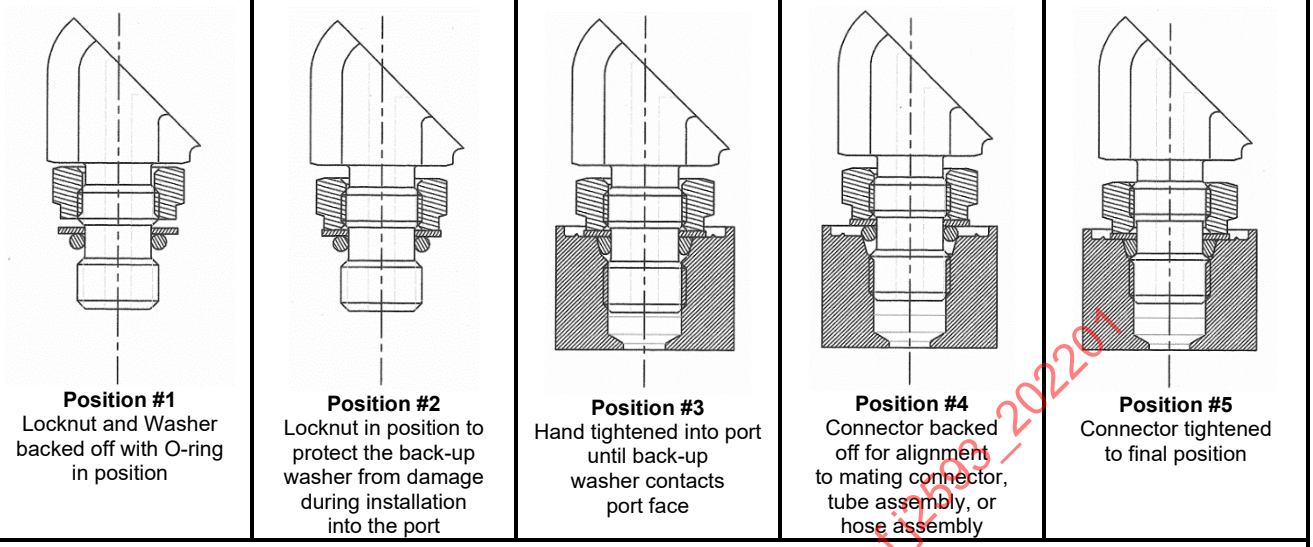
Table 2 - ISO 6162-2 and SAE J518-2 screw torque and maximum working pressures for high pressure (Code 62) flanged port assemblies when using high strength screws, property class 10.9 metric screws or grade 8 inch screws

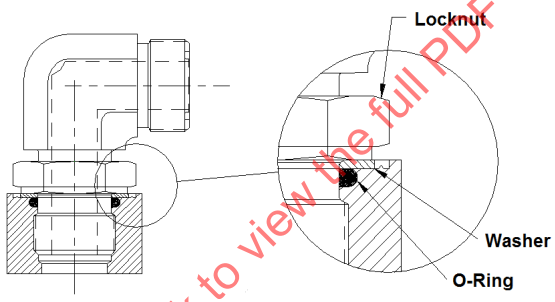
Metric Screw Threads				Inch Screw Threads					
Metric Flange Size ISO 4397 mm	Metric Thread Size mm	Metric Wrench Size ISO 4017 mm	Assembly Torque +10% -0% N•m[1]	Nominal Tube OD Inch	Inch Flange SAE Dash Size	Thread Size Inch	Wrench Size Inch	Assembly Torque +10% -0% N•m[1]	Maximum Working Pressure MPa[2]
13	M8X1.25	13	32	1/2	-8	5/16-18	1/2	32	42
19	M10X1.5	16	70	3/4	-12	3/8-16	9/16	60	42
25	M12X1.75	18	130	1	-16	7/16-14	11/16	92	42
32	M12X1.75	18	130	1 1/4	-20	1/2-13	3/4	150	42
									42
38	M16X2.	24	295	1 1/2	-24	5/8-11	15/16	295	42
51	M20X2.5	30	550	2	-32	3/4-10	1-1/8	450	42

(1) To convert from N•m to lb-ft, multiply by 0.737.
(2) To convert from MPa to bar, multiply by 10; to convert from MPa to psi, multiply by 145.04.

BEFORE PROCEEDING, SEE FIGURES 5 AND 6 AND ASSEMBLY INSTRUCTIONS IN 6.1.1 THROUGH 6.1.3.1

6.2 ISO 6149-2/ISO 6149-3/SAE J1926-2/SAE J1926-3 Straight Thread O-Ring Port Connectors Recommended Assembly Procedures (see Figure 7)





Final Assembly of Adjustable Stud End

1. To protect the sealing surfaces and prevent dirt and other contaminants from entering the system, do not remove the protective caps and/or plugs until it is time to assemble the components.
2. Prior to assembly, remove protective caps and/or plugs and inspect the connector and the port to ensure both mating parts are free of burrs, nicks, scratches, or any foreign material.
3. If O-ring is not present, install O-ring on the port end of the connector using a proper O-ring installation tool, taking care not to cut or nick the O-ring.
4. Lubricate the O-ring with a light coat of system fluid or compatible oil.
5. **Position #1** - The O-ring should be located in the groove adjacent to the face of the back-up washer. The washer and O-ring should be positioned at the extreme top end of the groove as shown.
6. **Position #2 -** Position the locknut to just touch the back-up washer as shown. The locknut in this position will eliminate potential back-up washer damage during the next step.
7. **Position #3** - Install the connector into the straight thread boss port until the metal back-up washer contacts the face of the port as shown.
   Caution: Over tightening beyond contact may cause washer damage, if the washer is not supported by the locknut.
8. **Position #4** - Adjust the connector to the proper position by turning out (counterclockwise) up to a maximum of one turn as shown to provide proper alignment with the mating connector, tube assembly, or hose assembly.
9. **Position #5** - Using two wrenches, use the backup wrench to hold the connector in the desired position and then use the torque wrench to the tighten the locknut to the appropriate torque level shown in **Tables 4, 5, 6, or 7**.
10. Visually inspect, where possible, the joint to ensure the O-ring is not pinched or bulging out from under the washer and that the backup washer is properly seated flat against the face of the port.

Figure 7 - ISO 6149-2/ISO 6149-3 and SAE J1926-2/SAE J1926-3 straight thread O-ring port connectors recommended assembly procedures

6.2.1 ISO 6149-3 Metric Straight Thread O-Ring Port Connectors Recommended Torque Levels for Use in Light-Duty Applications (see Table 3)

Table 3 - ISO 6149-3 metric straight thread O-ring port connector recommended torque levels for use with ISO 8434-3/SAE J1453 ORFS and/or ISO8434-2/SAE J514 flared connectors in light-duty applications

Metric Size			Non-Adjustable		Adjustable	
Nominal Tube OD Metric Size mm	Metric Thread Size mm	Assembly Torque +25% -0% N•m[1]	Metric Wrench Size mm	Working Pressure Up to MPa[2]	Metric Wrench Size mm	Working Pressure Up to MPa[2]
4	M8 X 1	8	12	40	12	31.5
5	M10 X 1	15	14	40	14	31.5
6	M12 X 1.5	25	17	40	17	31.5
8	M14 X 1.5	35	19	40	19	31.5
10	M16 X 1.5	40	22	31.5	22	25
12	M18 X 1.5	45	24	31.5	24	25
16	M22 X 1.5	60	27	31.5	27	25
20	M27 X 2	100	32	20	32	16
22	M30 X 2	130	36	20	36	16
25	M33 X 2	160	41	20	41	16
32	M42 X 2	210	50	20	50	16
38	M48 X 2	260	55	20	55	16
50	M60 X 2	315	65	16	65	10

(1) To convert from N•m to lb-ft, multiply by 0.737.
(2) To convert from MPa to bar, multiply by 10; to convert from MPa to psi, multiply by 145.04.

BEFORE PROCEEDING, SEE FIGURE 7 FOR ASSEMBLY PROCEDURES

6.2.2 ISO 6149-2 Metric Straight Thread O-Ring Port Connectors Recommended Torque Levels for Use in Heavy-Duty Applications (see Table 4)

Table 4 - ISO 6149-2 metric straight thread O-ring port connector recommended torque levels for use with ISO 8434-3/SAE J1453 ORFS connectors in heavy-duty applications

Metric Size			Non-Adjustable		Adjustable	
Nominal Tube OD Metric Size mm	Metric Thread Size mm	Assembly Torque +25% -0% N•m[1]	Metric Wrench Size mm	Working Pressure Up to MPa[2]	Metric Wrench Size mm	Working Pressure Up to MPa[2]
4	M8 X 1	10	12	63	12	40
5	M10 X 1	20	14	63	14	40
6	M12 X 1.5	35	17	63	17	40
8	M14 X 1.5	45	19	63	19	40
10	M16 X 1.5	55	22	63	22	40
12	M18 X 1.5	70	24	63	24	40
16	M22 X 1.5	100	27	63	27	40
20	M27 X 2	170	32	40	32	40
22	M30 X 2	215	36	40	36	40
25	M33 X 2	310	41	40	41	31.5
32	M42 X 2	330	50	25	50	25
38	M48 X 2	420	55	25	55	20
50	M60 X 2	500	65	25	65	16

(1) To convert from N•m to lb-ft, multiply by 0.737.
(2) To convert from MPa to bar, multiply by 10; to convert from MPa to psi, multiply by 145.04.

BEFORE PROCEEDING, SEE FIGURE 7 FOR ASSEMBLY PROCEDURES

6.2.3 SAE J1926-3 Inch Straight Thread O-Ring Port Connectors Recommended Torque Levels for Use in Light-Duty Applications (see Table 5)

Table 5 - SAE J1926-3 inch straight thread O-ring port connector recommended torque levels for use with ISO 8434-1 flareless connectors and ISO 8434-2/ SAE J514 flared connectors in light duty applications

Inch Size					Non-Adjustable		Adjustable	
Nominal Tube OD Inch Size mm	Nominal Tube OD Inch	Inch SAE Dash Size	Thread Size Inch	Assembly Torque +25% -0% N•m[1]	Wrench Size mm	Working Pressure Up to MPa[2]	Wrench Size Inch	Working Pressure Up to MPa[2]
3.18	1/8	-2	5/16-24 UNF	8	10	35	10	35
4.76	3/16	-3	3/8-24 UNF	10	12	35	12	35
6.35	1/4	-4	7/16-20 UNF	18	14	35	14	31.5
7.94	5/16	-5	1/2-20 UNF	25	17	35	17	31.5
9.52	3/8	-6	9/16-18 UNF	30	17	35	17	28
12.70	1/2	-8	3/4-16 UNF	50	22	31.5	22	28
15.88	5/8	-10	7/8-14 UNF	60	27	25	27	21
19.05	3/4	-12	1-1/16-12 UN	95	32	25	32	21
22.22	7/8	-14	1-3/16-12 UN	125	36	21	36	17.5
25.40	1	-16	1-5/16-12 UN	150	41	21	41	17.5
31.75	1 1/4	-20	1-5/8-12 UN	200	50	17.5	50	14
38.10	1 1/2	-24	1-7/8-12 UN	210	55	17.5	55	14
50.8	2	-32	2-1/2-12 UN	300	70	14	70	10.5
63.50	2 1/2	-40	3-12 UN	300	85	7	85	7
76.20	3	-48	3-1/2-12 UN	350	95	7	95	7
101.60	4	-64	4-1/2-12 UN	350	120	3.5	120	3.5

(1) To convert from N•m to lb-ft, multiply by 0.737.
(2) To convert from MPa to bar, multiply by 10; to convert from MPa to psi, multiply by 145.04.

BEFORE PROCEEDING, SEE FIGURE 7 FOR ASSEMBLY PROCEDURES

6.2.4 SAE J1926-2 Inch Straight Thread O-Ring Port Connectors Recommended Torque Levels for Use in Heavy-Duty Applications (see Table 6)

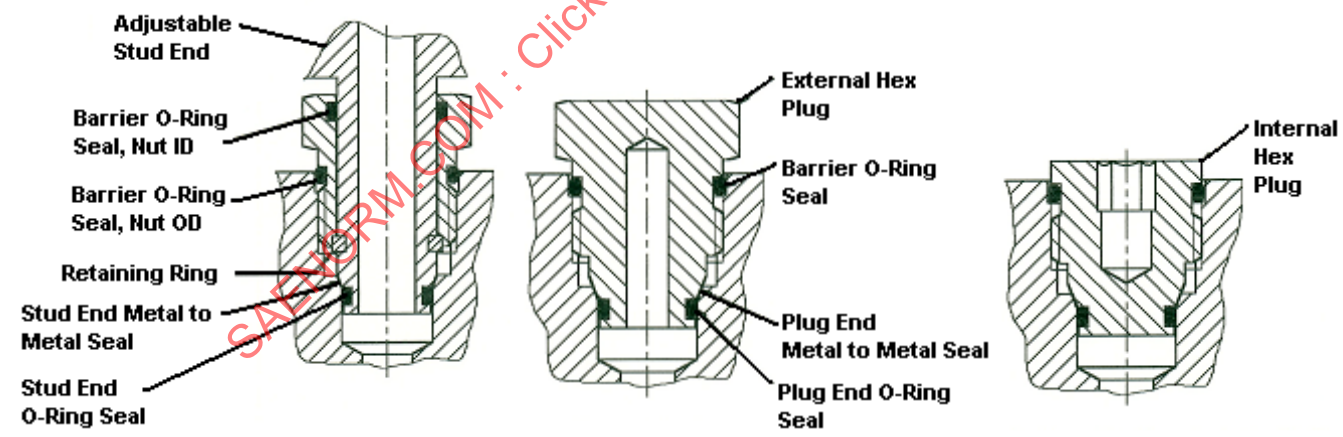
Table 6 - SAE J1926-2 inch straight thread O-ring port connector recommended torque levels for use with ISO 8434-3/SAE J1453 ORFS connectors

Inch Size					Non-Adjustable		Adjustable	
Nominal Tube OD Inch Size mm	Nominal Tube OD Inch	Inch SAE Dash Size	Thread Size Inch	Assembly Torque +25% -0% N•m[1]	Wrench Size mm	Working Pressure Up to MPa[2]	Wrench Size mm	Working Pressure Up to MPa[2]
4.76	3/16	-3	3/8-24 UNF	10	14	63	14	42
6.35	1/4	-4	7/16-20 UNF	20	14	63	14	42
7.94	5/16	-5	1/2-20 UNF	25	17	63	17	42
9.52	3/8	-6	9/16-18 UNF	35	19	63	19	42
12.70	1/2	-8	3/4-16 UNF	70	24	63	24	42
15.88	5/8	-10	7/8-14 UNF	100	27	63	27	42
19.05	3/4	-12	1-1/16-12 UN	170	32	42	36	42
22.22	7/8	-14	1-3/16-12 UN	215	36	42	41	42
25.40	1	-16	1-5/16-12 UN	270	41	42	41	35
31.75	1 1/4	-20	1-5/8-12 UN	285	50	28	50	28
38.10	1 1/2	-24	1-7/8-12 UN	370	55	28	55	21
50.80	2	-32	2-1/2-12 UN	540	70	21	70	17.5
63.50	2 1/2	-40	3-12 UN	540	85	17.5	85	14
76.20	3	-48	3-1/2-12 UN	640	95	17.5	95	14

(1) To convert from N•m to lb-ft, multiply by 0.737.
(2) To convert from MPa to bar, multiply by 10; to convert from MPa to psi, multiply by 145.04.

BEFORE PROCEEDING, SEE FIGURE 7 FOR ASSEMBLY PROCEDURES

6.3 SAE J2337-2 High Pressure Connections and SAE J2337-3 High Pressure Plugs Recommended Assembly Procedures (see Figure 8)



1. To protect the sealing interface and prevent dirt and other contaminants from entering the system, do not remove the protective caps and/or plugs until it is time to assemble the components.
2. Prior to assembly, remove protective caps and/or plugs and inspect the connector and the port to ensure both mating parts are free of burrs, nicks, scratches, or any foreign material.
3. Lubricate the O-rings with a light coat of system fluid or compatible oil.
4. Install O-rings onto the connector or plug using a proper O-ring installation tool, taking care not to cut or nick the O-ring.
5. Screw the connector into the port.
7. Rotate the connector to provide proper alignment with the mating connector, tube assembly, or hose assembly.
8. Using two wrenches, hold the connector in the desired position and tighten the locknut to the appropriate torque levels shown in Table 8.
9. Visually inspect the joint to ensure the O-ring is not pinched/bulging out and is properly seated into the port.

Figure 8 - SAE J2337-2 connectors and SAE J2337-3 plugs assembly procedures

6.3.1 SAE J2337-2 High Pressure Connections and SAE J2337-3 High Pressure Plugs Recommended Torque Levels (see Table 7)

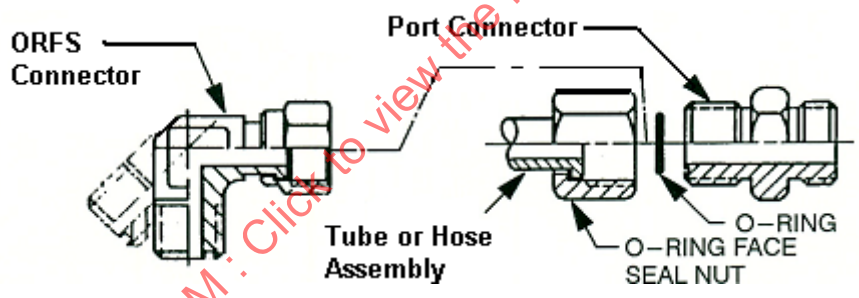
Table 7 - SAE J2337-2 high pressure connectors and SAE J2337-3 high pressure plugs recommended torque levels to tube assemblies, hose assemblies, other high pressure connectors and components

Nom Tube OD mm	Nom Tube OD Inch	Inch SAE Dash Size	Metric Thread Size mm	Metric Wrench External Hex Size mm	Metric Wrench Internal Hex Size mm	Assembly Torque +25% -0% N•m[1]	Working Pressure Up to MPa[2]
6	1/4	-4	M14 X 1.5	15	6	24	80
10	3/8	-6	M18 X 1.5	19	6	34	80
12	1/2	-8	M22 X 1.5	24	8	70	80
16	5/8	-10	M27 X 2	28	12	120	80
20	3/4	-12	M30 X 2	32	12	182	63
25	1	-16	M39 X 2	41	14	275	63
30	1-1/4	-20	M45 X 2	46	14	320	50
38	1-1/2	-24	M50 X 2	52	17	400	40

(1) To convert from N•m to lb-ft, multiply by 0.737.
(2) To convert from MPa to bar, multiply by 10; to convert from MPa to psi, multiply by 145.04.

BEFORE PROCEEDING, SEE FIGURE 8 FOR ASSEMBLY PROCEDURES

6.4 ISO 8434-3/SAE J1453 O-Ring Face Seal Connections Recommended Assembly Procedures (see Figure 9)



NOTE: For Stud End Assembly Procedures and Torque See Section 7.2

1. To protect the sealing interface and prevent dirt and other contaminants from entering the system, do not remove the protective caps and/or plugs until it is time to assemble the components.
2. Prior to assembly, remove protective caps and/or plugs and inspect the connectors to ensure both mating parts are free of burrs, nicks, scratches, or any foreign material.
3. Lubricate the O-rings with a light coat of system fluid or compatible oil.
4. Install O-rings into grooves using a proper O-ring installation tool, taking care not to cut or nick the O-ring.
5. Align the mating connector faces together by hand and maintain contact of the connector faces while hand tightening the threads. Screw the connectors together until they are snug, light wrenching may be necessary.
6. Using two wrenches, hold the connectors in the desired position and tighten to the appropriate torque levels shown below in Table 9.

Figure 9 - ISO 8434-3/SAE J1453 O-ring face seal connectors recommended assembly procedures to tube assemblies, hose assemblies and other ORFS connectors

6.4.1 ISO 8434-3/SAE J1453 O-Ring Face Seal Connections Recommended Torque Levels (see Table 8)

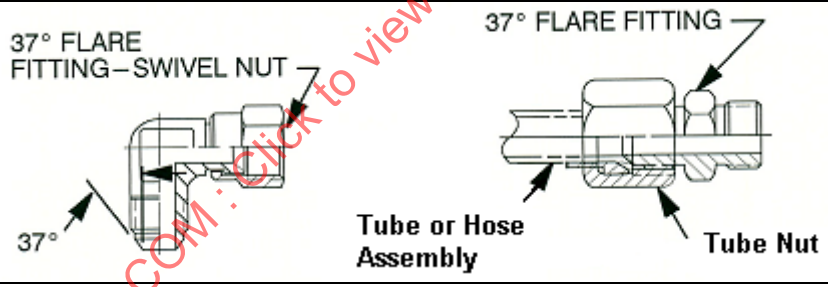
Table 8 - ISO 8434-3/SAE J1453 O-ring face seal connectors recommended torque levels to tube assemblies, hose assemblies, and other ORFS connectors

ISO 8434-3 Metric Size			SAE J1453 Inch Size						
Metric Nominal Tube OD Metric Size mm	Tube Nut Metric Wrench Size mm	Connector Metric Wrench Size mm	Inch Nominal Tube OD Inch Size mm	Inch SAE Dash Size	Tube Nut Wrench Size Inch	Connector Wrench Size Inch	Thread Size Inch	Assembly Torque +25% -0% N•m[1]	Working Pressure Up to MPa[2]
6	17	17	1/4	-4	17	17	9/16-18 UNF	25	63
8	19	19	5/16	-5	19	19	5/8-18 UNF	30	63
10	22	19	3/8	-6	22	19	11/16-16 UN	40	63
12	24	22	1/2	-8	24	22	13/16-16 UN	55	63
16	30	27	5/8	-10	30	27	1-14 UNS	60	41.3
20	36	32	3/4	-12	36	32	1-3/16-12 UN	90	41.3
22	41	36	7/8	-14	41	36	1-5/16-12 UN		
25	41	41	1	-16	41	41	1-7/16-12 UN	125	41.3
30	50	46	1-1/4	-20	50	46	1-11/16-12 UN	170	27.5
38	60	55	1-1/2	-24	60	55	2-12 UN	200	27.5
-	-	-	2	-32	70	65	2-1/2-12 UN	510	21

(1) To convert from N•m to lb-ft, multiply by 0.737.
(2) To convert from MPa to bar, multiply by 10; to convert from MPa to psi, multiply by 145.04.

BEFORE PROCEEDING, SEE FIGURE 9 FOR ASSEMBLY PROCEDURES

6.5 ISO 8434-2/SAE J514 - Flared Connections Recommended Assembly Procedures (see Figure 10)



1. To protect the sealing interface and prevent dirt and other contaminants from entering the system, do not remove the protective caps and/or plugs until it is time to assemble the components.
2. Prior to assembly, remove protective caps and/or plugs and inspect the connectors to ensure both mating parts are free of burrs, nicks, scratches, or any foreign material.
3. Align the mating connector faces together and hand tighten the threads. Screw the connectors together until they are snug, light wrenching may be necessary.
4. Using two wrenches, hold the connectors in the desired position and tighten to the appropriate torque levels shown below in Table 10.

Figure 10 - ISO 8434-2/SAE J514 flared connectors recommended assembly procedures for tube assemblies, hose assemblies and other flared connectors

6.5.1 ISO 8434-2/SAE J514 Flared Connections Recommended Torque Levels (see Table 9)

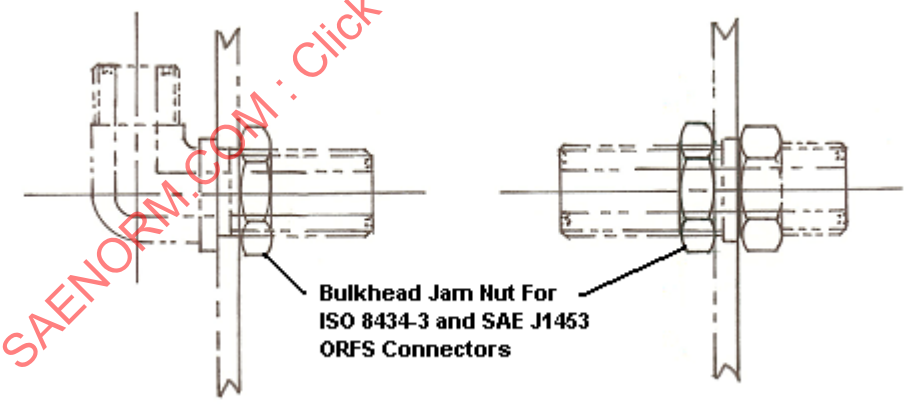
Table 9 - ISO 8434-2/SAE J514 flared connectors recommended torque levels to tube assemblies, hose assemblies, and other flared connectors

ISO 8434-2 Metric Size Tubes			SAE J514 Inch Size Tubes						
Metric Nominal Tube OD Metric Size mm	Tube Nut Metric Wrench Size mm	Connector Metric Wrench Size mm	Nominal Tube OD Inch	Inch SAE Dash Size	Tube Nut Wrench Size Inch	Connector Wrench Size Inch	Thread Size Inch	Assembly Torque +25% -0% N•m[1]	Working Pressure Up to MPa[2]
-	-	-	1/8	-2	3/8	7/16	5/16-24	8	34.5
-	-	-	3/16	-3	7/16	7/16	3/8-24	11	34.5
6	14	12	1/4	-4	9/16	1/2	7/16-20	15	34.5
8	17	14	5/16	-5	5/8	9/16	1/2- 20	19	34.5
10	19	17	3/8	-6	11/16	5/8	9/16- 18	24	34.5
12	22	19	1/2	-8	7/8	13/16	3/4-16	49	31
16	27	24	5/8	-10	1	15/16	7/8-14	77	24
20	32	27	3/4	-12	1-1/4	1-1/8	1-1/16-12	107	24
-	-	-	7/8	-14	1-3/8	1-1/4	1-3/16-12	127	21
25	41	36	1	-16	1 1/2	1-3/8	1-5/16-12	147	21
32	50	46	1-1/4	-20	2	1-5/8	1-5/8-12	172	17
38	60	50	1-1/2	-24	2-1/4	1-7/8	1-7/8-12	215	14
50	75	65	2	-32	2-7/8	2-3/4	2-1/2-12	332	10.5

(1) To convert from N•m to lb-ft, multiply by 0.737.
(2) To convert from MPa to bar, multiply by 10; to convert from MPa to psi, multiply by 145.04.

BEFORE PROCEEDING, SEE FIGURE 10 FOR ASSEMBLY PROCEDURES

6.6 ISO 8434-3 and SAE J1453 ORFS Threaded Connectors Recommended Assembly Procedures for Bulkhead Fastening Jam Nuts (see Figure 11)



1. To protect the sealing interface and prevent dirt and other contaminants from entering the system, do not remove the protective caps and/or plugs until it is time to assemble the components.
2. Prior to assembly, remove protective caps and/or plugs and inspect the connectors to ensure both mating parts are free of burrs, nicks, scratches, or any foreign material.
3. Lubricate the O-rings with a light coat of system fluid or compatible oil.
4. Install O-rings into grooves using a proper O-ring installation tool, taking care not to cut or nick the O-ring.
5. Position the appropriate end of the connector through the bulkhead fastening hole, install the jam nut and hand tighten.
6. Using two wrenches, hold the connectors in the desired position and tighten to the appropriate torque levels shown below in Table 11.

Figure 11 - ISO 8434-3 and SAE J1453 ORFS connectors recommended assembly procedures for bulkhead fastening jam nuts

6.6.1 ISO 8434-3 and SAE J1453 ORFS Bulkhead Fastening Jam Nuts Recommended Torque Levels (see Table 10)

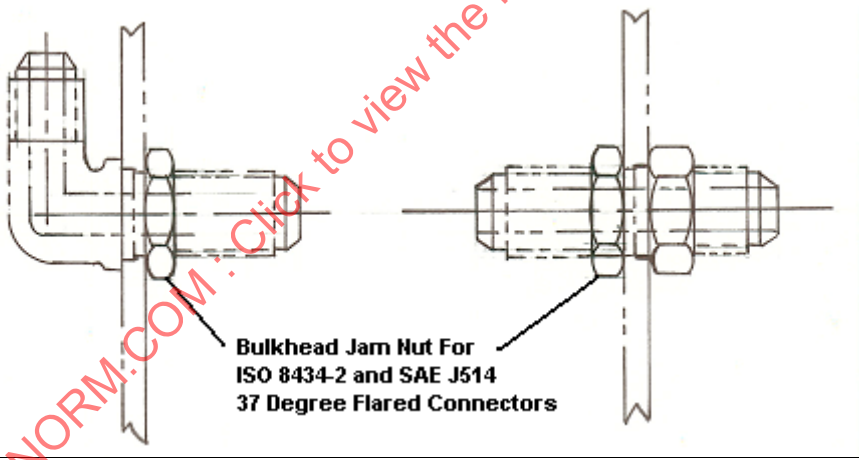
Table 10 - ISO 8434-3 and SAE J1453 recommended assembly torque levels or ORFS connector bulkhead fastening jam nuts

ISO 8434-3 and SAE J1453 ORFS Bulkhead Fastening Jam Nut Recommended Torque Levels									
Metric				Inch					
Nominal Metric Tube OD mm	Connector Metric Wrench Size mm	Jam Nut Metric Wrench Size mm	Jam Nut Assembly Torque +25% -0% N•m[(1)]	Nominal Tube OD Inch	Inch SAE Dash Size	Nominal Thread Size Inch	Connector Wrench Size Inch	Jam Nut Wrench Size Inch	Jam Nut Assembly Torque +25% -0% N•m[(1)]
6	22	22	22	1/4	-4	9/16-18	13/16	13/16	22
10	27	27	30	3/8	-6	11/16-16	1	1	30
12	30	30	40	1/2	-8	13/16-16	1-1/8	1-1/8	40
16	36	36	60	5/8	-10	1-14	1-5/16	1-5/16	60
20	41	41	90	3/4	-12	1-3/16-12	1-1/2	1-1/2	90
25	46	46	125	1	-16	1-7/16-12	1-3/4	1-3/4	125
32	50	50	150	1-1/4	-20	1-11/16-12	2	2	150
38	60	60	170	1-1/2	-24	2-12	2-3/8	2-3/8	170

(1) To convert from N•m to lb-ft, multiply by 0.737.

BEFORE PROCEEDING, SEE FIGURE 11 FOR ASSEMBLY PROCEDURES

6.7 ISO 8434-2 and SAE J514 Threaded Connectors Recommended Assembly Procedures for Bulkhead Fastening Jam Nuts (see Figure 12)



1. To protect the sealing interface and prevent dirt and other contaminants from entering the system, do not remove the protective caps and/or plugs until it is time to assemble the components.
2. Prior to assembly, remove protective caps and/or plugs and inspect the connectors to ensure both mating parts are free of burrs, nicks, scratches, or any foreign material.
3. Position the appropriate end of the connector through the bulkhead fastening hole, install the jam nut and hand tighten.
4. Using two wrenches, hold the connectors in the desired position and tighten to the appropriate torque levels shown below in Table 12.

Figure 12 - ISO 8434-2 and SAE J514 flared connectors recommended assembly procedures for bulkhead fastening jam nuts