BOMBARDIER Toronto (de Havilland) PROPRIETARY INFORMATION	**PPS 6.03** PRODUCTION PROCESS STANDARD

Installation of Fluid Lines and Fittings

Issue 38 - This standard supersedes PPS 6.03, Issue 37.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- This PPS is effective as of the distribution date.
- Validation of issue status is the responsibility of the user.

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	Core Methods - PPS		

Issue 38 - Summary of Changes (over the previous issue)

The following summaries are not detailed and are intended only to assist in alerting PPS users to changes which may affect them; refer to the applicable sections of this PPS for detailed procedure and requirements.

- Deleted vestigial reference to red markers from the Materials section.
- Added instruction to use MIL-PRF-27617 Type I grease (e.g., Krytox 240) as a thread lubricant for straight threads on oxygen system lines.
- Added notation that if in doubt as to the applicable fitting torque value to contact Liaison Engineering.
- Added procedure and requirements for installation of B0305144 threadless fixed cavity ferrule type couplings.

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1 Scope

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for installation of fluid lines and fittings.

1.1.1 This PPS complements the engineering drawings that specify its use as an authorized instruction. The procedure specified in this PPS must be followed to ensure compliance with all applicable specifications. In general, if this PPS conflicts with the engineering drawing, follow the engineering drawing. The requirements specified in this PPS are necessary to fulfil the engineering design and reliability objectives.

1.1.2 Refer to PPS 13.26 for the subcontractor provisions applicable to this PPS.

1.1.3 Procedure or requirements specified in a Bombardier BAPS, MPS, LES or P. Spec. **do not** supersede the procedure or requirements specified in this PPS.

2 Hazardous Materials

2.1 Before receipt at Bombardier Toronto (de Havilland), all materials must be approved and assigned Material Safety Data Sheet (MSDS) numbers by the Bombardier Toronto (de Havilland) Environment, Health and Safety Department. Refer to the manufacturer's MSDS for specific safety data on any of the materials specified in this PPS. If the MSDS is not available, contact the Bombardier Toronto (de Havilland) Environment, Health and Safety Department.

3 References

3.1 General

3.1.1 Unless a specific issue is indicated, the issue of the reference documents specified in this section in effect at the time of manufacture shall form a part of this specification to the extent indicated herein.

3.2 Bombardier Toronto (de Havilland) Process Specifications

3.2.1 PPS 6.01 - Fabrication of Rigid Fluid Lines.

3.2.2 PPS 6.04 - Identification of Fluid System Lines.

3.2.3 PPS 6.05 - Closure of Fluid lines and Fluid Systems Components.

3.2.4 PPS 6.10 - Cleaning of Fluid System Components.

3.2.5 PPS 6.13 - Installation of Permaswage Fittings.

3.2.6 PPS 9.06 - Electrical Bonding of Aircraft Structures.

3.2.7 PPS 13.26 - General Subcontractor Provisions.

3.2.8 PPS 13.28 - Storage Life of Adhesives, Sealants, Paints and Composite Products.

3.2.9 PPS 14.01 - Torquing Methods and Identification.

3.2.10 PPS 19.01 - Safetying Devices.

3.2.11 PPS 31.17 - Solvent Usage.

3.2.12 PPS 38.01 - Application of Plastic Lacing.

4 Materials and Equipment

4.1 Materials

4.1.1 Unless otherwise specified in this section, use only the materials specified; use of superseding or alternative materials is not allowed.

4.1.2 Thread lubricant (or anti-seize compound) as specified in Table 1.

4.1.3 O-ring, seal and sleeve lubricant as specified in Table 6.

4.1.4 Teflon tape (e.g., DSC 91-6, Scotch Tape #48, Mystic Tape #7500).

4.1.5 Hydraulic fluid, petroleum base, to MIL-H-5606 (e.g., Aeroshell fluid #4 or Univis J43).

4.1.6 Hydraulic fluid, synthetic phosphate ester base, to BMS 3-11 Type IV Class 1, Grade A.

4.1.7 O-rings as specified on the engineering drawing.

4.1.8 Tamper proof sealant, white:

- Dykem Cross Check tamper proof torque mark, p/n 83319 (white)
- Organic Products Co. F-900 or F-925 Torque Seal
- 3M EC-1252 tamper proof sealant

4.1.8.1 Refer to PPS 13.28 for the storage life of tamper proof sealant. The tamper proof sealants specified herein are resistant to splashes of hydraulic fluid (e.g., Skydrol) but are not resistant to immersion. After application, allow tamper proof sealant to cure undisturbed according to the manufacturer's recommendations. Apply tamper proof sealant sparingly, do not apply more than needed, especially in overhead applications.

4.2 Equipment

4.2.1 Bombardier Toronto (de Havilland) SD 9179 flange reforming tool.

4.2.2 Regulated source of compressed air or nitrogen.

5 Procedure

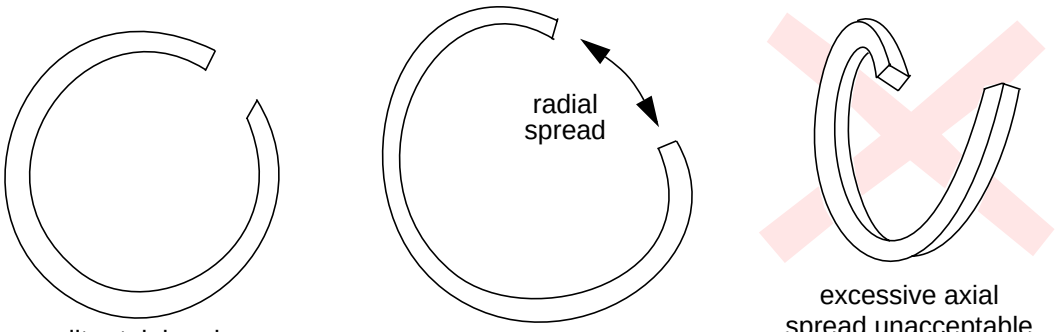
5.1 General

5.1.1 Ensure that all lines to be installed are free from flat spots, dents, cuts or gouges and that all fittings are not damaged in any way.

5.1.2 Check that identification bands are properly secured and are neither deteriorated nor torn.

5.1.3 Do not use installed fluid lines as stops or hand holds. Do not suspend lamps or other items from tubing, hoses or fittings.

5.1.4 When installing split retaining rings or washers over flanged ferrules or beaded tube ends, spread the washer or ring **radially** (see following figure) only as much as necessary to get it over the ferrule flange or bead. Take special care to avoid excessive **axial** spread of the washer or ring resulting in permanent axial deformation, as this could prevent proper sealing of the o-ring and lead to eventual leaking of the coupling in service (see following figure).



5.2 Cleanliness

5.2.1 Take care to ensure that no foreign matter enters the fluid system when handling fluid system components. This is of the utmost importance, particularly in the case of hydraulic and oxygen systems.

5.2.2 Before installation, re-clean all fluid lines, fittings and components that are received without closures according to PPS 6.10. If installation is not to follow immediately or is not in the same work area, seal re-cleaned parts according to PPS 6.05.

5.2.3 Only remove sealing plugs and caps before assembly of the particular connection. If assembly is then delayed, re-install the sealing plugs and caps.

5.2.4 Ensure that the interior of oxygen lines or fittings do not become contaminated with oil or grease because such contaminants on the internal surfaces could cause an explosion. Clean oxygen system lines or fittings having oil or grease contamination according to PPS 6.10.

5.3 Routing and Securing of Lines

5.3.1 Mask cut-out edges of bulkhead webs, etc. to prevent damage to the lines during installation through cut-outs. Remove masking after installation is complete.

5.3.2 If grommets are used to protect lines passing through aperture holes, ensure that the line is aligned with the hole (if misaligned, the line may apply enough pressure to eventually cut the grommet).

5.3.3 Ensure a minimum clearance of 1/8" (0.125") between the installed line and any adjacent structure.

5.3.4 Slight hand correction of routing is permissible.

5.3.5 If specified on the engineering drawing, secure lines according to PPS 38.01.

5.3.6 When installing fluid line assemblies incorporating Cryoflare sleeves, be particularly careful to avoid jolting of the fitting to the side during installation as this could result in “loosening” the fitting and leakage.

5.4 Lubrication of Threads

5.4.1 Use the lubricants specified in Table 1 only.

5.4.2 To prevent clogging of the fluid system and contamination of the fluid, apply lubricant sparingly to male threads only. Ensure that no lubricant enters the bore of the fitting.

5.4.3 When applying lubrication to straight threads, apply the lubricant to all but the first two threads.

5.4.4 When applying lubrication to tapered pipe threads, apply lubricant to the first three threads. When using teflon tape on oxygen and pitot static systems with tapered pipe threads, wrap the tape around the thread circumference once, cut the tape to leave a minimum overlap and work in with the fingers.

5.4.5 If the applicable line fluid is used as a lubricant, it may be applied generously.

Table 1 - Thread Lubricant

Line Content	Type of Thread	Thread Lubricant
Fuel or Oil	Straight threads	Anti-seize compound to TT-A-580 or PENRECO amber petrolatum
	Tapered threads	Titeseal #2 or #3
Hydraulic fluid (petroleum base)	Straight threads	PENRECO amber petrolatum, Aeroshell fluid #4 or Univis J43
	Tapered threads	PENRECO amber petrolatum
Hydraulic fluid (synthetic phosphate ester)	Straight threads	Monsanto MCS 352, Allube HI-LO MS #1, Hydraulic fluid (synthetic phosphate ester) or Phosphocent 246
	Tapered threads	MCS 352 (Monsanto), HI-LO MS #1 (Allube) or Phosphocent 246
Water/Methanol	All	PENRECO amber petrolatum
Oxygen	Straight threads	MIL-PRF-27617 Type I grease (e.g., Krytox 240)
	Tapered threads	Teflon tape
Pitot - static	Straight threads	Dow Corning pneumatic grease 55M
	Tapered threads	Teflon tape
Compressed air (not oxygen)	All	Dow Corning pneumatic grease 55M
Hot gases (up to 800°F (427°C))	All	MIL-PRF-83483 molydenum disulfide-petrolatum
Other fluids (up to 300°F (149°C))	All	Anti-seize compound to TT-A-580

5.5 Torquing/Tightening

5.5.1 Wherever torquing is specified herein, perform torquing operations according to PPS 14.01.

5.5.2 Except as noted in paragraph 5.5.2.1, torque all AN818 and NAS593 tube coupling nuts, all tapered pipe thread fittings, straight threaded fittings and all fittings used to connect flexible lines, regardless of whether or not torquing is specified on the engineering drawing. If the engineering drawing does not show torquing values, torque according to Table 2, Table 3 or Table 4; if in doubt as to the applicable torque value, contact Liaison Engineering.

Table 2 - Torquing Coupling Nuts on Flared Tubes and Fittings

Size (Note 2)	**Torque Value** (in-lbs) (Note 1)		
	Straight Threads on Aluminum Alloy Tubes or Fittings	**Straight Threads on Steel Alloy, CRES or Titanium Tubes or Fittings**	**Tapered Pipe Threads** (except oxygen & pitot systems)
1/8"	20 - 30	75 - 85	40 - 300
3/16"	25 - 35 (15 - 35 for 5052-O aluminum tubing with a wall thickness of 0.022")	95 - 105	---
1/4"	50 - 65 (20 - 65 for 5052-O aluminum tubing with a wall thickness of 0.022")	135 - 150	60 - 600
5/16"	70 - 90 (30 - 90 for 5052-O aluminum tubing with a wall thickness of 0.022")	170 - 200	---
3/8"	110 - 130 (35 - 130 for 5052-O aluminum tubing with a wall thickness of 0.022")	270 - 300	75 - 700
1/2"	230 - 260	450 - 500	100 - 900
5/8"	330 - 360	650 - 700	---
3/4"	460 - 500	900 - 1000	300 - 1600
1"	500 - 700	1200 - 1400	400 - 2200
1 1/4"	800 - 900	1520 - 1680	500 - 2500
1 1/2"	800 - 900	1900 - 2100	----
2"	1800 - 2000	2660 - 2940	----

Note 1. If the hose fitting material and the tube material are different, use the lower torque value.

Note 2. For the purposes of this table, size may be considered the tube size, nut size or fitting size, as applicable.

Table 3 - Leak-Proof Torque Values for Flared Coupling Nuts

Size (Note 2)	**Torque Value** (in-lbs) (Note 1)	
	Aluminum fitting	**CRES fitting**
1/4"	157 - 173	200 - 220
3/8"	242 - 268	380 - 420
1/2"	400 - 440	713 - 787
5/8"	513 - 567	998 - 1102
3/4"	641 - 708	1283 - 1417
1"	1069 - 1181	1710 - 1890

Note 1. These torque values are used to correct leaks in threaded connections (see paragraph 5.5.4).

Note 2. For the purposes of this table, size may be considered the tube or hose size, nut size or fitting size, as applicable.

Table 4 - Torquing Flareless Fittings (Note 1)

Boss or Flareless Fittings with Lubricated Threads (3000 psi hydraulic systems)	**Size** (Note 3)	**Torque** (in-lbs)
CRES or titanium fitting material (Note 2)	1/4"	133 - 147
	3/8"	256 - 284
	1/2"	475 - 525
	5/8"	665 - 735
	3/4"	855 - 945
	1"	1145 - 1255
Aluminum fitting material	1/4"	105 - 116
	3/8"	162 - 179
	1/2"	266 - 294
	5/8"	342 - 378

Note 1. Use this table to determine the required torque value for all flareless fittings, including hydraulic and fuel systems.

Note 2. When installing CRES or titanium fittings on aluminum lines, use the torque values specified for aluminum fitting material.

Note 3. For the purposes of this table, size may be considered the tube size, hose size or fitting size, as applicable.

5.5.2.1 Torque oxygen and pitot system thread fittings installed with teflon tape (as specified in paragraph 5.4.4) as follows:

Step 1. Screw in the fitting at least 2-1/2 turns.

Step 2. Torque to 22 - 30 inch·lbs.

Step 3. If a leak-free joint cannot be obtained at a torque of 30 inch·lbs, unscrew the fitting and install another fitting or line.

5.5.3 Torque Permaswage bulkhead fitting jam nuts according to PPS 6.13. Torque all other types of jam nuts on bulkhead fittings according to Table 5. Torque all other fittings as specified on the engineering drawing. Always torque fittings to the minimum value, unless further torquing is required for adjusting positioning-type fittings or for correcting leaking connections.

Table 5 - Torquing Jam Nuts on Bulkhead Fittings (except Permaswage)

Fitting Material	**Size** (Note 1)	**Torque** (in-lbs)
Steel, CRES (except annealed) or titanium	1/4"	133 - 147
	3/8"	256 - 284
	1/2"	475 - 525
	5/8"	665 - 735
	3/4"	855 - 945
	1"	1140 - 1260
Aluminum or annealed CRES	1/4"	105 - 116
	3/8"	162 - 179
	1/2"	266 - 294
	5/8"	342 - 378
	3/4"	428 - 472

Note 1. For the purposes of this table, size may be considered the tube or hose size, nut size or fitting size, as applicable.

5.5.4 Correct leaks in threaded connections by further tightening up to the specified maximum torque value. **For flared coupling nuts only**, if the fitting is still leaking, it is acceptable to leak-proof torque as follows:

Step 1. Back off the fitting to relax the torque.

Step 2. Re-torque to the values specified in Table 3.

Step 3. If the leak persists, replace the fitting or the line.

5.5.5 Discard fittings which have been over-torqued. Do not unscrew and re-torque an over-torqued fitting.

5.5.6 Use only the correct size wrenches for the nut being torqued. Improper tools can cause distortion of the nut resulting in binding and incorrect torque values.

5.5.7 When torquing or tightening a tube coupling nut on a fitting or a jam nut on a bulkhead fitting, hold the fitting with another wrench while tightening the nut.

5.5.8 Take care to ensure that flexible hoses and rigid lines are not twisted or under pre-load (i.e., forced into the proper position and held) during torquing. Such conditions can cause incorrect torque readings, leakage or line failures.

5.5.9 Before applying a torque stripe mark, solvent clean fittings contaminated with phosphate ester hydraulic fluid or other contaminant which would interfere with adhesion of the torque stripe mark according to PPS 31.17.

5.5.10 Except as noted below, apply a torque stripe mark of white tamper proof sealant to all torqued fittings. The mark must be a continuous stripe approximately 1/8" wide overlapping onto both halves of the fitting or fitting and adjacent structure. For fittings which must be re-torqued as specified in this section, remove the original torque stripe mark before applying the new torque stripe mark.

- For Permaswage bulkhead fittings, apply a rotation witness mark according to PPS 6.13 in place of torque stripe marking.
- For fittings located inside the fuel tank, torque stripe mark using F21 type II primer, prepared and applied according to PPS 21.03, in place of tamper proof sealant.

5.5.11 For torqued hose clamps, apply a torque stripe mark according to PPS 14.01.

5.6 Installation of Tapered-Thread Fittings in Threaded Holes

5.6.1 Install tapered-thread fittings as follows:

Step 1. Lubricate threads as specified in section 5.4.

Step 2. Screw the fitting into the threaded hole.

Step 3. Tighten with the correct size wrench and if applicable, torque as specified in section 5.5. If the fitting is of the positioning type, tighten with a wrench to the required position. If torquing is specified, torque the fitting to the minimum torque value. If the fitting is not then correctly positioned, torque to the correct position.

Step 4. If the torque value range will be exceeded in obtaining the correct position, continue torquing to the maximum value, then unscrew the fitting one half turn. If it is necessary to unscrew an oxygen or pitot static fitting to which teflon tape has been applied, remove the fitting and replace the teflon tape.

Step 5. Re-torque fitting to the correct position.

5.7 Installation of Positioning Type Universal Fittings in Hydraulic and Pneumatic Systems

5.7.1 Install positioning-type universal fittings in hydraulic and pneumatic systems as follows:

Step 1. Lubricate the ring and o-ring gasket sparingly with the lubricant specified in Table 6.

Step 2. Assemble the ring and o-ring on the fitting as shown in Figure 1(A), with the smooth side of the ring towards the gasket.

Step 3. Lubricate the threads of the fitting with the correct lubricant as specified in section 5.4.

Step 4. Screw the nut until the o-ring is firmly pressed against the threaded portion of the fitting.

Step 5. Screw the fitting into the threaded hole, allowing the nut to rotate freely with the fitting until the o-ring gasket comes in contact with the chamfered edge of the threaded holes (see Figure 1(B)).

Step 6. Holding the nut with a wrench to prevent it from turning, screw the fitting 1 1/2 turns into the hole. Position the fitting using no more than one additional full turn.

Step 7. Holding the fitting in the correct position, tighten the nut with a wrench or torque wrench according to section 5.5. Slight extrusion of the gasket is acceptable (see Figure 1(C)).

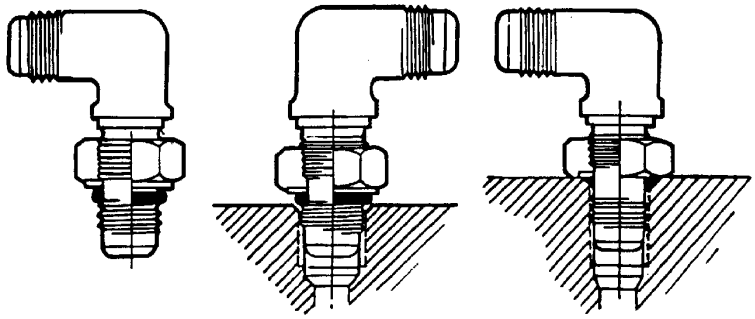


Figure 1 - Positioning-Type Fittings for Hydraulic & Pneumatic Systems

5.8 Installation of Positioning Type Universal Fittings in Systems other than Hydraulic or Pneumatic

5.8.1 Install positioning-type universal fittings in systems other than hydraulic and pneumatic as follows:

Step 1. Lubricate the threads of the fitting with the correct lubricant according to section 5.4.

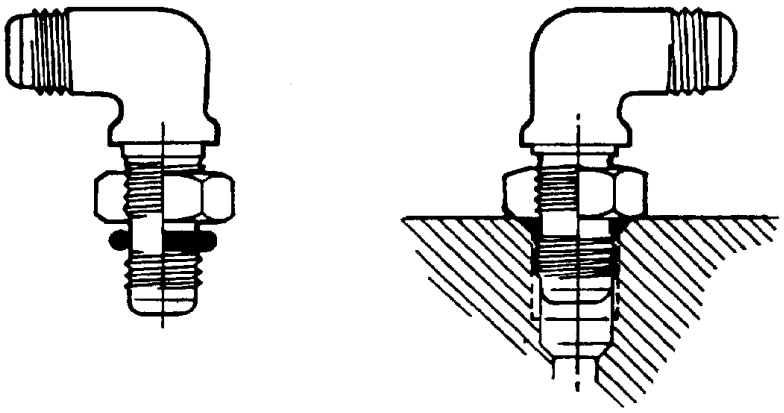
Step 2. Screw the nut onto the fitting until the washer face of the nut aligns with the edge of the undercut of the fitting (see Figure 2(A)).

Step 3. Lubricate the o-ring gasket sparingly with the lubricant as specified in Table 6. Place the gasket in the undercut of the fitting.

Step 4. Screw the fitting into the threaded hole allowing the nut to rotate freely with the fitting until the o-ring gasket becomes compressed in the chamfered edge of the threaded hole (see Figure 2(B)).

Step 5. Adjust the fitting to the correct position, either by screwing in 3/4 turn maximum or by unscrewing 1/4 turn maximum.

Step 6. Holding the fitting in the correct position, tighten the nut with a wrench, or torque wrench according to section 5.5.



A B

Figure 2 - Positioning-Type Fittings for Other Systems

5.9 Installation of Non-Positioning Type Straight Threaded Fittings

5.9.1 Install non-positioning type straight threaded fittings as follows:

Step 1. Select the correct o-ring gasket as specified in Table 6.

Step 2. Lubricate sparingly with the lubricant specified in Table 6.

Step 3. Locate the gasket on the fitting (see Figure 3).

Step 4. Lubricate the threads of the fitting with the appropriate lubricant according to section 5.4.

Step 5. Screw the fitting into the threaded hole and tighten with a wrench or, if specified on the engineering drawing, torque according to section 5.5.

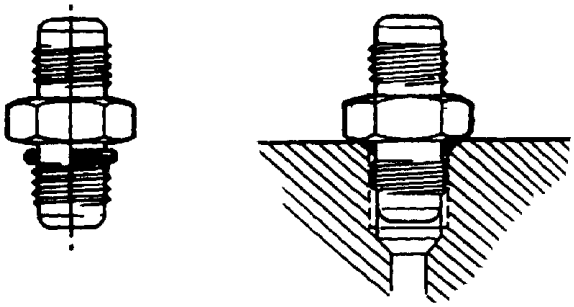


Figure 3 - Non-Positioning Type, Straight Threaded Fittings

Table 6 - Gasket/Seal and Lubricant Selection

LINE CONTENT	GASKET	LUBRICANT
Hydraulic fluid (petroleum base)	MS28778	PENRECO amber petrolatum, Aeroshell Fluid #4 or Univis J43
Hydraulic fluid, MIL-H-5606 (Learjet Model 45)	MIL-P-83461/2	Hydraulic fluid, MIL-H-5606
Hydraulic fluid (synthetic phosphate ester base)	NAS1612	Monsanto MCS352, HI-LO #1 or Hydraulic fluid (synthetic phosphate ester base)
Fuel	MS29512	Same fuel
Engine air	MS28778	Engine oil
Compressed air (except oxygen)	MS28778	Pneumatic grease
Water/Methanol system	MS29512	PENRECO amber petrolatum

5.10 Connecting Fluid Lines

5.10.1 Connecting Rigid Fluid Line Assemblies

5.10.1.1 Connect rigid fluid line assemblies as follows:

Step 1. Ensure that the connection fitting mates squarely without being pre-loaded and that the flared ends seat properly on the cones when the line is in position. Check for correct dimensional accuracy of the tube installation by loosely connecting the tubing fittings and clamps by hand to ensure that it is possible to run the coupling nuts down by hand until the tube bottoms on the fitting (without forcing the tubing into alignment). See Figure 4 for the maximum allowable degree of mismatch.

Step 2. Lubricate the threads of attachment fittings according to section 5.4.

Step 3. Lubricate the exterior of the flares and sleeves sparingly with the same lubricant used for the threads.

Step 4. Screw the nut onto the connection fitting until finger tight. If there is any movement or looseness of the line or connection fitting and the nut cannot be further tightened by hand, remove the nut and check for foreign matter or a cross-threaded condition. Do not tighten the nut with a wrench until the flared ends and cone are properly seated and the nut fully finger tight. Never attempt to pull a flared end onto a cone by tightening the nut, as damage can result.

Step 5. Tighten the nut with a wrench or, if torquing is specified on the engineering drawing, torque according to section 5.5.

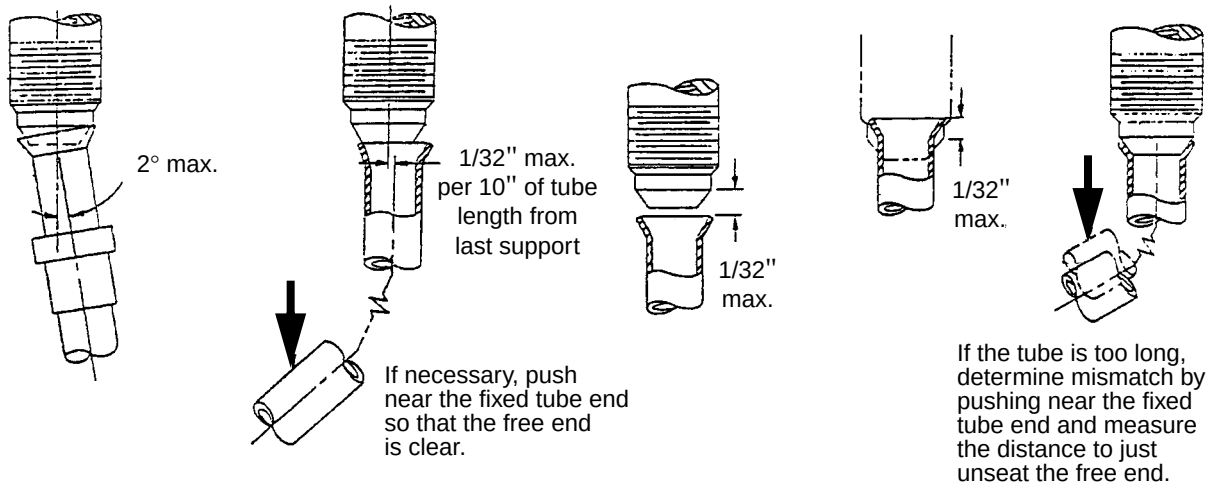


Figure 4 - Rigid Fluid Line Mismatch Limits

5.10.2 Installation of Hose and Clamps on Rigid Tubing

5.10.2.1 Install tubes so that the misalignment or off-set maximums (see Figure 5) are not exceeded.

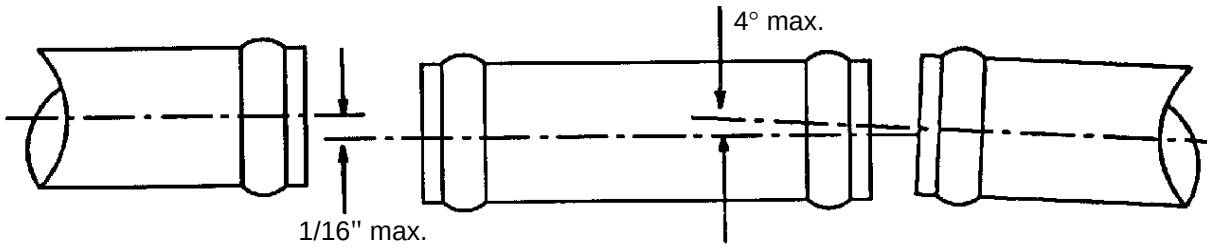


Figure 5 - Limitation on Alignment of Rigid Lines

5.10.2.2 Allow a minimum gap between installed tubes of 1/2" or 1/4 of the outside tube diameter, whichever is greater. Except on suction lines with non-self-sealing hose, there is no maximum limit to the gap between installed tubes. On suction lines with non-self-sealing hose, the maximum gap shall be 1 1/2" or one tube diameter, whichever is greater.

5.10.2.3 Install the hose specified by the engineering drawing so that the hose is centered on the gap specified in paragraph 5.10.2.2. Place hose clamps 1/4" to 3/8" from the hose ends. If a specific hose length is not specified by the engineering drawing or DSC, cut the hose to a length equal to the gap plus 3" ± 1/8" so that the hose will cover 1 1/2" of each tube end as shown in Figure 6.

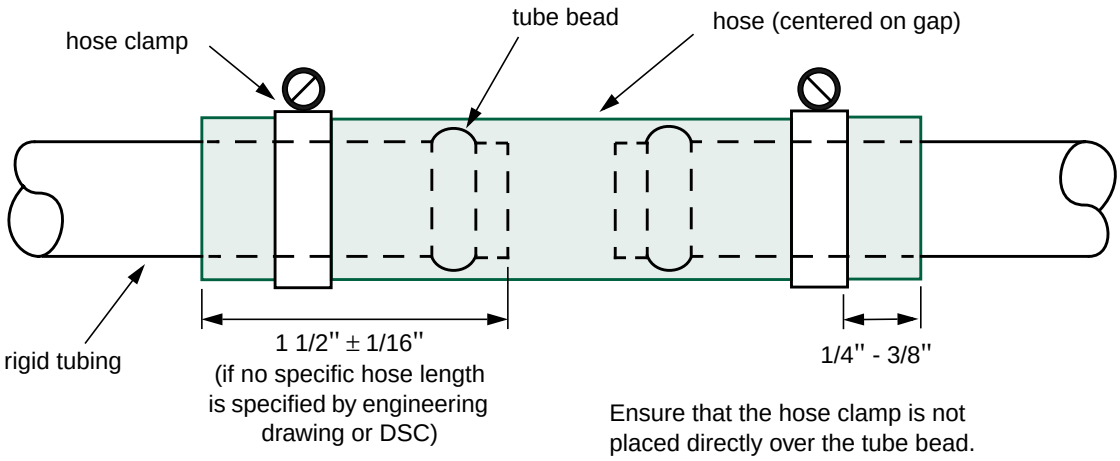


Figure 6 - Installation of Hose

5.10.2.4 Use hose clamps as specified on the engineering drawing. Use the hose clamp specified by Table 7 only if the engineering drawing does not specify the hose clamp to use. Never over tighten clamps such that the clamp cuts into the flexible tubing. Never tighten clamps over the bead of a tube or fitting. If the engineering drawing specifies a torque value or range (e.g. “Torque to XX in. lbs.”), torque according to PPS 14.01.

5.10.2.5 If specified on the engineering drawing, electrically bond tubing according to PPS 9.06.

Table 7 - Hose Clamp Selection (Note 1)

Inside Diameter of Hose (3/16'' std. wall thickness)	**Hose Clamp**
1/4'', 5/16'', 3/8''	DSC70S6
3/8'', 1/2'', 5/8''	DSC70S10
3/4'', 7/8'', 1''	DSC70S16
1 1/4'', 1 1/2''	DSC70S24
1 1/2'', 1 3/4'', 2''	DSC70S32
2'', 2 1/4'', 2 1/2''	DSC70S40
2 1/2'', 2 3/4'', 3''	DSC70S48
3 1/4'', 3 1/2''	DSC70S56
3 3/4'', 4''	DSC70S64
4 1/2'', 5''	DSC70S80
5 1/2'', 6''	DSC70S96
6 1/4'', 6 1/2''	DSC70S104
6 3/4'', 7'', 7 1/4''	DSC70S116
7 1/2'', 8''	DSC70S128

Note 1. Use the hose clamp specified herein only if the engineering drawing does not specify the hose clamp to use.

5.10.3 Installation of Flexible Hose Lines

5.10.3.1 Install flexible hose lines as follows:

Step 1. Lubricate threaded fittings according to section 5.4.

Step 2. Tighten the nut finger tight. If axial movement of the hose is still possible, unscrew the nut and check the threads for the presence of chips, crossed threads, burrs, etc.

Step 3. Ensuring that the cone and flared end are properly seated and the nut is finger tight, tighten the nut with a wrench or torque wrench according to section 5.5, if applicable.

5.10.3.2 Do not bend hose lines through a radius less than six times the outside hose diameter.

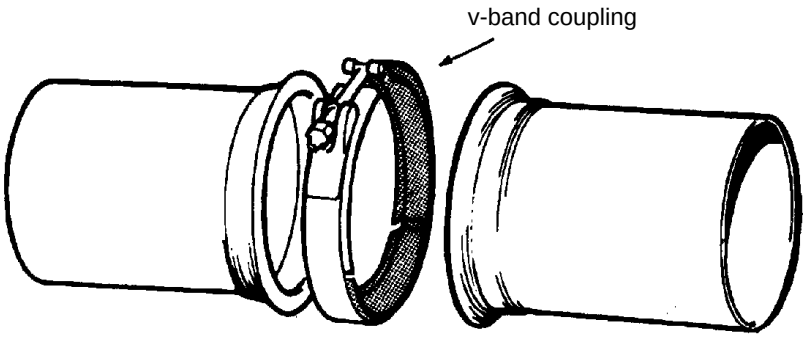
5.10.3.3 Do not stretch hose lines between end fittings. Allow a slack of at least 5% to compensate for change in length.

5.10.3.4 Do not twist hoses during or after installation. Ensure linear stripes are parallel to the axis of the bore.

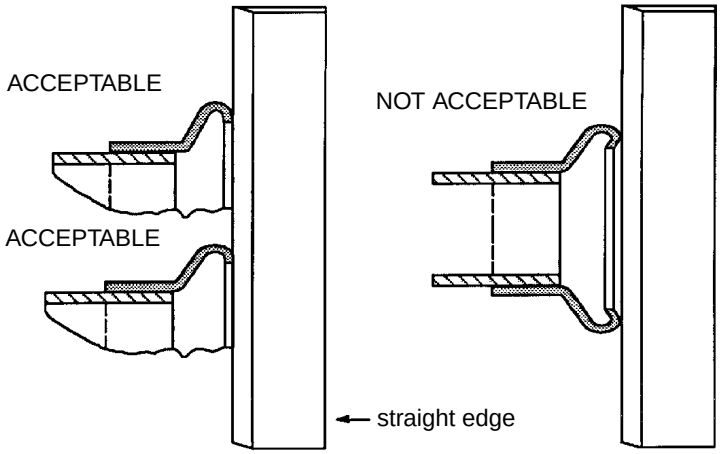
5.11 Installation of V-Band Couplings

5.11.1 Install V-band couplings as follows:

Step 1. Weld flanges for the V-band coupling to the tube assembly according to the appropriate welding PPS as shown below:



Step 2. Check the mating flange faces to ensure they are square and that a tight seal will result as shown below:



Step 3. Rework nicks or scratches up to 0.004" deep to remove any burrs. Flanges with deeper scratches or nicks are not acceptable.

Step 4. Rework gasketless flanges that have become deformed using the SD 9197 flange reforming tool.

Step 5. Pressure test the tube assemblies according to PPS 6.01.

Step 6. Place the coupling over one tube end of the assembly.

Step 7. Pull the mating flange faces together. If required, install a gasket on the appropriate flange half.

Step 8. Slide the coupling to a centered position on the flanges and press the connector firmly around the joint engaging the latch.

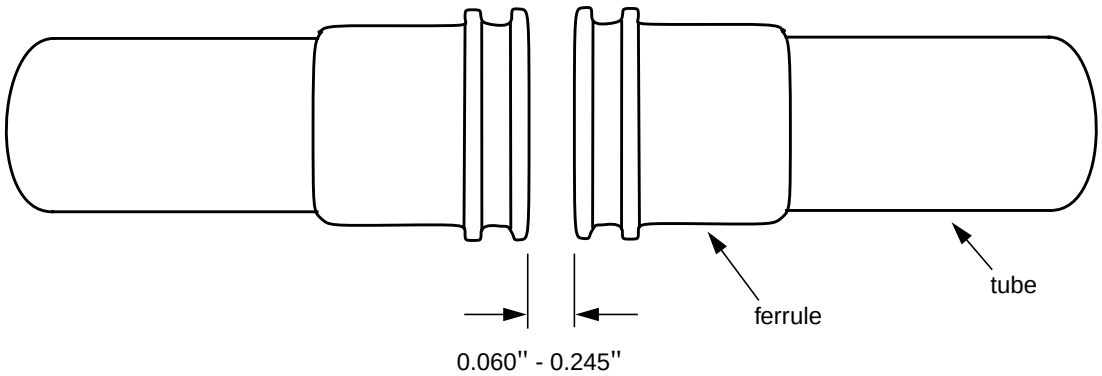
Step 9. Tighten the clamp to within 50% of the specified torque and lightly tap the clamp with a plastic mallet to ensure proper alignment and seating of the parts.

Step 10. Torque to the value specified on the engineering drawing.

5.12 Installation of Threadless Fixed Cavity Ferrule Type Couplings
(including B0305025, B0305080, B0305081 and B0305144 Couplings)

5.12.1 Install threadless fixed cavity ferrule type couplings as follows:

Step 1. Ensure that the gap between the ends of the ferrules is 0.060" - 0.245" as shown below (gap dimensions specified on the engineering drawing in brackets are for reference only). If the gap is too small or too large, contact Liaison Engineering.



Step 2. For B0305080 and B0305144 couplings, ensure that the coupling alignment meets the requirements of Figure 7. For B0305081 couplings, ensure that the coupling alignment meets the requirements of Figure 8.

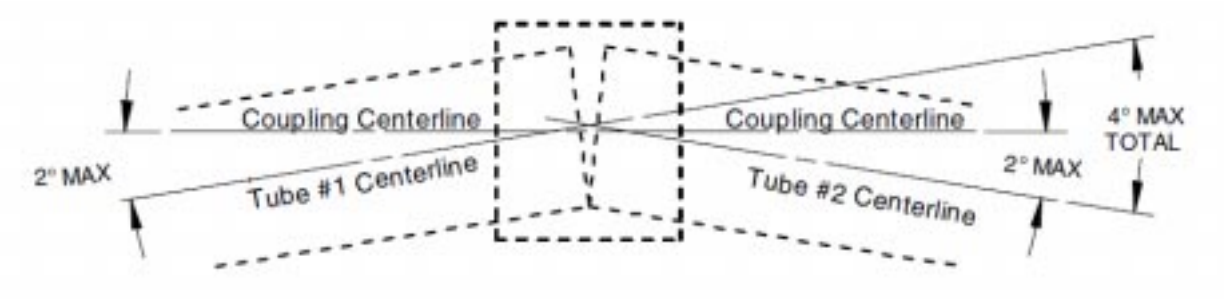


Figure 7 - B0305080 and B0305144 Coupling Alignment Limits

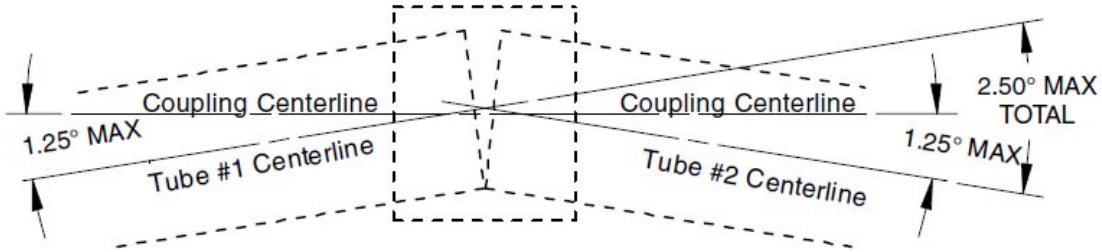


Figure 8 - B0305081 Coupling Alignment Limits

Step 3. Slip seals into seal cavities on flanges.

Step 4. **Lightly** lubricate seals and sleeves using the lubricant specified in Table 6. Take care to avoid contact of the lubricant with the surface of the ferrules as this may interfere with electrical bonding. If the surface of a ferrule comes into contact with lubricant, solvent clean the ferrule surface according to PPS 31.17.

Step 5. Using a slight rocking motion to facilitate entry, slide the sleeve over the two flanges and over both seals. Ensure that the sleeve spans both flanges completely.

Step 6. Place the clam-shell assembly over the sleeve and snap shut by engaging all three latch pawls.

5.13 Installation of Peri-Seal Joints

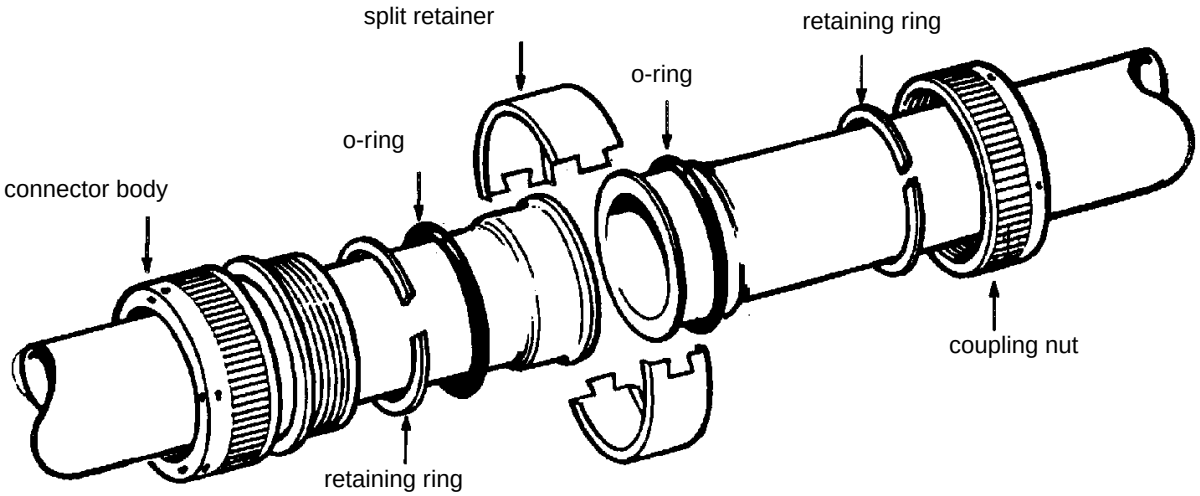
5.13.1 Peri-Seal joints come as a complete assembly incorporating a Janitrol flange on each end. Unless otherwise specified by the engineering drawing, install Peri-Seal joints using V-band couplings according to section 5.11.

5.13.2 Rework Janitrol flanges that have become deformed using the SD 9197 flange reforming tool.

5.14 Installation of Wiggins W700 Connectors

5.14.1 Install flexible Wiggins W700 series connectors as follows:

Step 1. Slip the connector body over one end of the tube and the coupling nut over the other as shown below. Orient the connector body and nut positions to agree with the engineering drawing.



Step 2. Install a retaining ring over each ferrule and onto the tube.

Step 3. Place an o-ring (lubricated as specified in Table 6) over each ferrule approximately 1/2" from the ferrule flange.

Step 4. Assemble the split retainer around the ferrules on both tube ends, trapping the flanges inside of the split retainer shoulders. Hold in place.

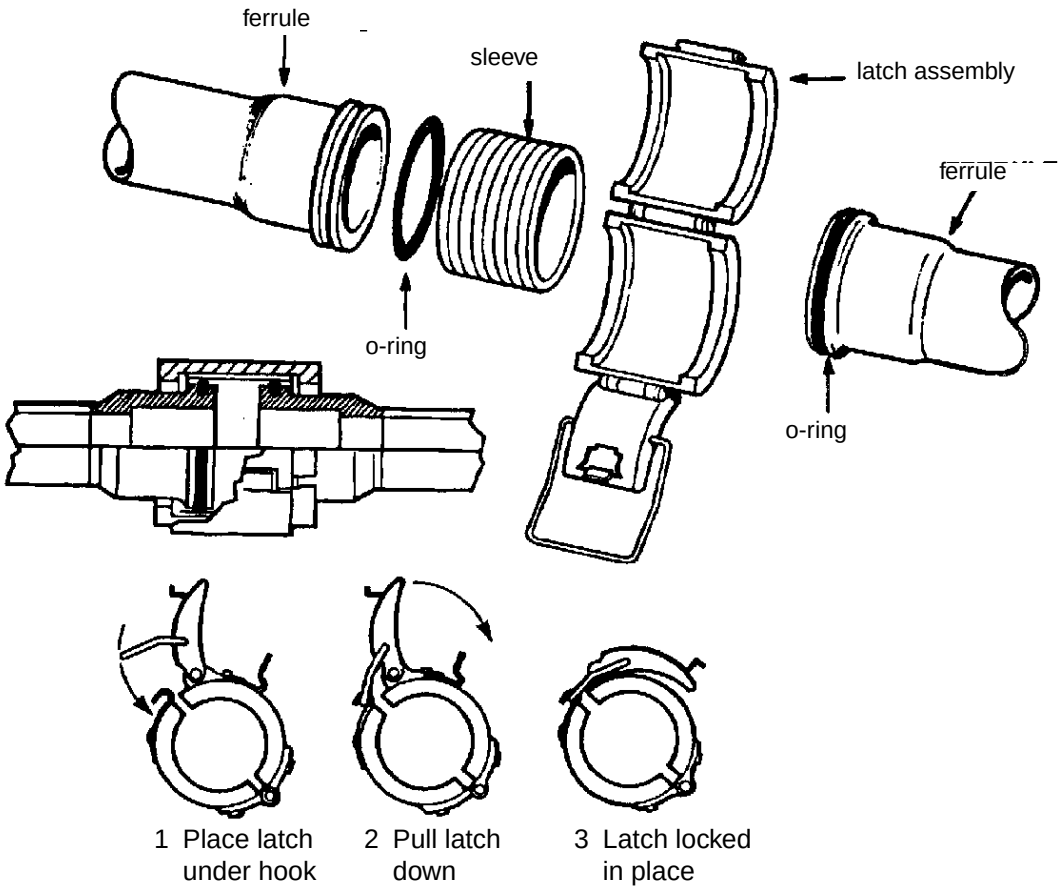
Step 5. Slide the connector body over the split retainer assembly. Ensure that the retaining ring fits squarely against the back of the coupling body.

Step 6. Position the coupling nut against the connector body and thread the nut and body together hand tight.

5.15 Installation of Wiggins W900 & Gamah Series 33 Connectors

5.15.1 Install Wiggins W900 and Gamah Series 33 connector as follows:

Step 1. Assemble 0-rings (lubricated as specified in Table 6) into 0-ring groove on each ferrule as shown below:



Step 2. Install the sleeve over the ferrules.

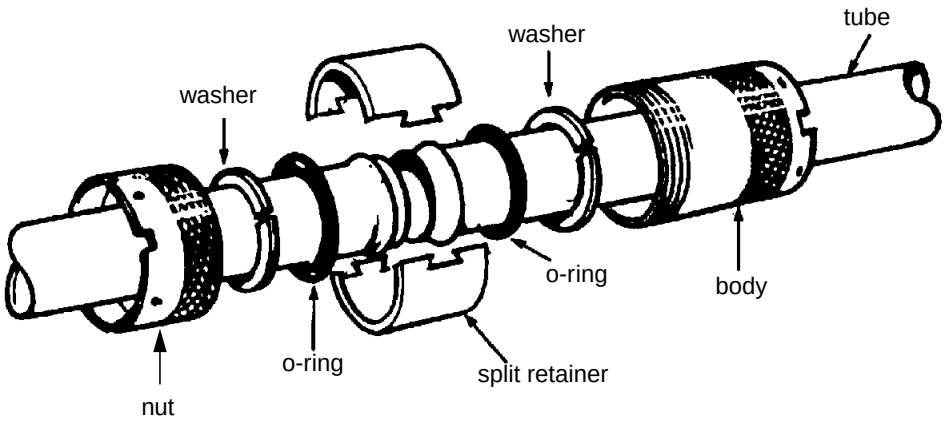
Step 3. Position the latch assembly over the sleeve.

Step 4. Close and latch the connector.

5.16 Installation of Wig-O-Flex 3600 Series Threaded Connectors

5.16.1 Install Wig-O-Flex 3600 series threaded connector tube joints which do not include a body drain as follows:

Step 1. Place the connector body over one tube end and the nut over the other as shown below. If specified, orient the body and nut to agree with the engineering drawing.



Step 2. Align the ends of the tube to be joined. Ensure that any off-set is within the limits shown in Figure 5.

Step 3. Fit one metal washer over each tube end and gently twist the washer to permit clearing of the bead.

Step 4. Install an o-ring over each tube end.

Step 5. Lubricate the o-ring as specified in Table 6.

Step 6. Carefully assemble both halves of the split retainer to the joint. Ensure tube beads are between the retainer shoulders and the tongues fit in the mating grooves.

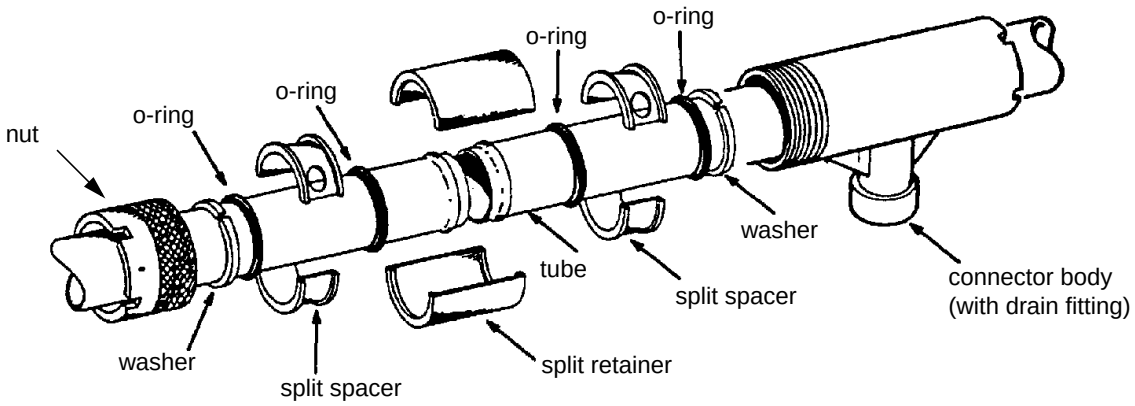
Step 7. Pull the connector body over the split retainer halves until the body covers the retainer halves.

Step 8. Slide the nut to the connector body and thread together until hand tight.

Step 9. Lock wire the connector according to PPS 19.01.

5.16.2 Install Wig-O-Flex 3600 series threaded connector tube joints which include a body drain as follows:

Step 1. Slide the connector body over the tube end and the mating nut over the other tube end, as shown below. If specified, orient the nut and body to agree with the engineering drawing.



Step 2. Align the ends of the tube to be joined. Ensure that the off-set (measured from the centerline of the threaded component inlet) is within the limits shown in Figure 5.

Step 3. Fit one split washer over each tube end and gently twist the washer to permit clearing of the beaded end.

Step 4. Place two o-rings (lubricated as specified in Table 6) over each tube end.

Step 5. Assemble the split spacer halves to the tube ends between the two o-rings.

Step 6. Slide the body or nut over the spacers to contain them.

Step 7. Position the split retainer halves over the beaded tube ends. Ensure that both beaded ends are fully contained between the retainer shoulders.

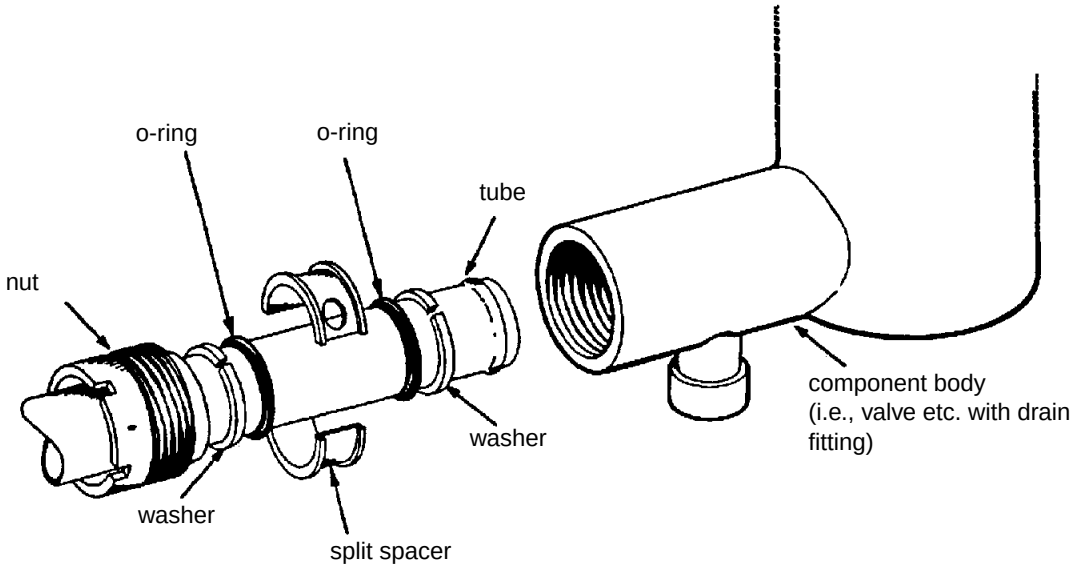
Step 8. Slide the body over the retainer halves until the halves are fully contained in the body.

Step 9. Slide the nut to the body, engage and thread parts together until they are hand tight.

Step 10. Lock wire the connector according to PPS 19.01.

5.16.3 Install Wig-O-Flex 3600 series threaded connectors with a component body drain as follows:

Step 1. Slide the coupling nut over the tube end as shown below:



Step 2. Align the tube with the component. Ensure that the off-set (measured against the centerline of the threaded component inlet) is within the limits shown in Figure 5.

Step 3. Fit one washer over the tube end. Gently twist the washer to permit clearing of the bead.

Step 4. Install the o-rings and remaining washer onto the tube.

Step 5. Assemble the halves of the split spacer onto the tube between the o-rings.

Step 6. Slide the washers, o-rings and retainer against the bead and carefully insert the tube into the threaded inlet of the component.

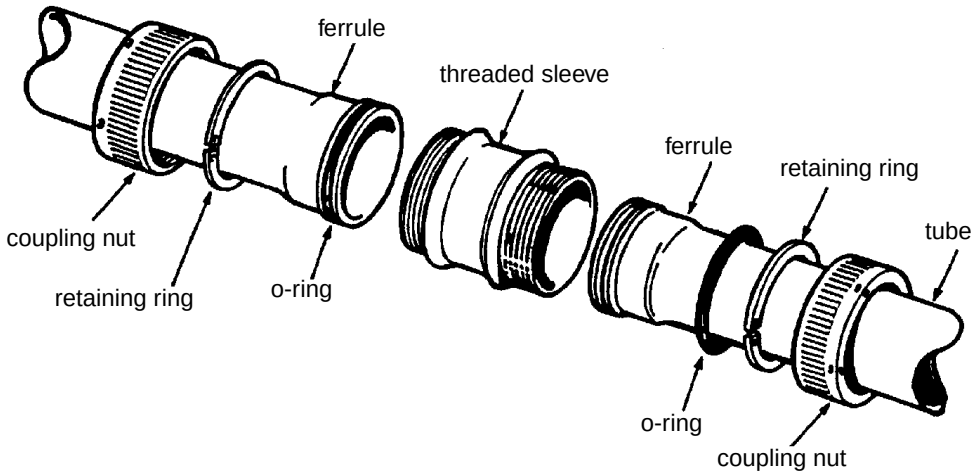
Step 7. Slide the coupling nut to the component, engage and thread together until hand tight.

Step 8. Lockwire the component according to PPS 19.01.

5.17 Installation of Gamah Threaded Couplings

5.17.1 Install Gamah threaded couplings as follows:

Step 1. Slip one nut and one retaining ring (respectively) past the ferrules on each of the tube ends as shown below:



Step 2. Lubricate both o-rings as specified in Table 6.

Step 3. Slip one o-ring over each ferrule end, ensuring that the o-rings are seated properly in the ferrule groove.

Step 4. Slip the sleeve over one tube end so that the sleeve end is approximately flush with the ferrule face.

Step 5. Align the ferrules on both tubes and slide the sleeve over the exposed o-ring so that the sleeve is approximately centered on the joint.

Step 6. Slide the two nuts up to the sleeve and engage the threads.

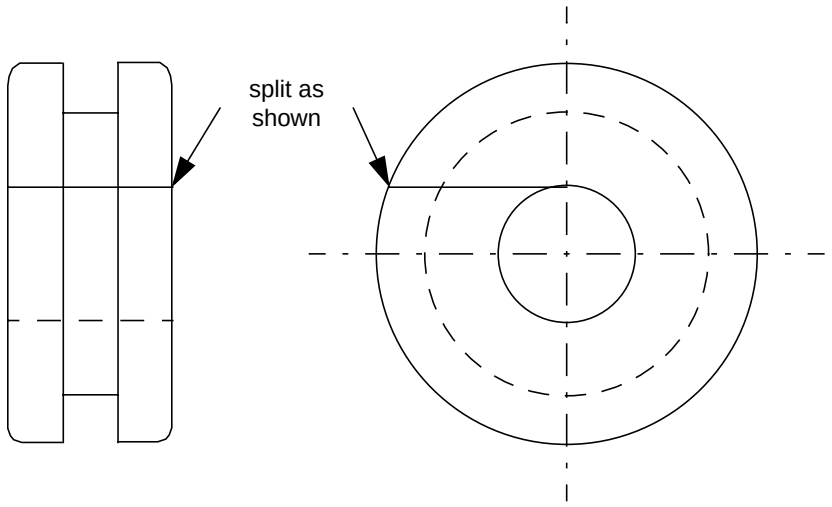
Step 7. Tighten the nuts by hand until they butt against the flanges on the sleeve.

Step 8. Lockwire the nuts together according to PPS 19.01.

5.18 Installation of MS35489 Grommets

5.18.1 If the engineering drawing specifies the use of MS35489 grommets, prepare the grommets for installation as follows:

Step 1. Using a singe edge razor blade or an X-Acto knife, cut the grommet at a tangent to the center hole, being careful not to cut past the center line of the bore as shown below:



Step 2. Twist the grommet where it has been split. This will allow the grommet to be compressed sufficiently so that it can be located into the desired position.

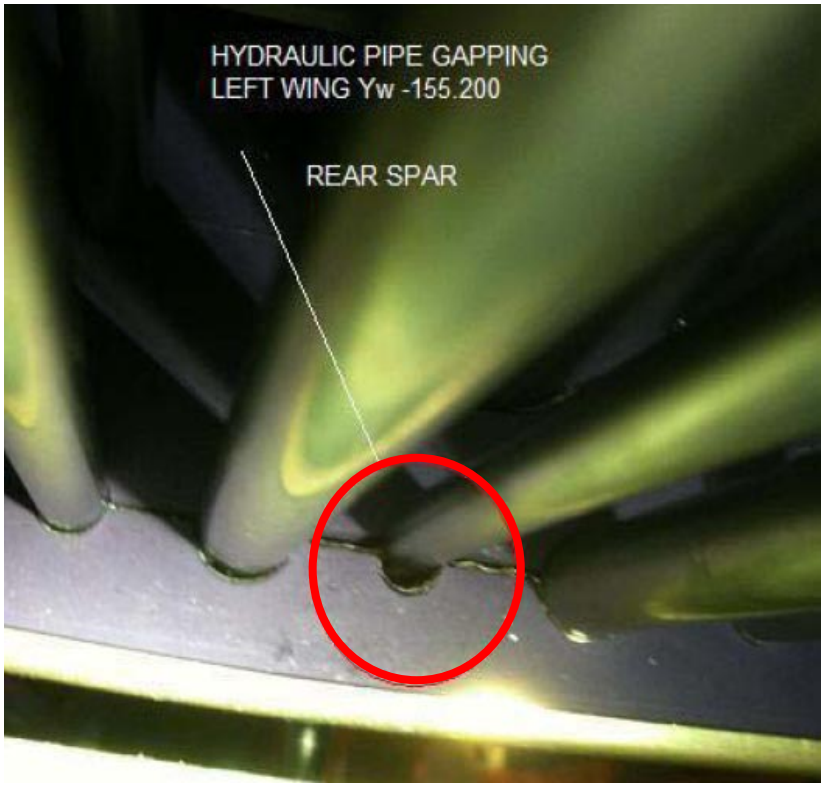
5.19 Fairlead/Tubing Misalignment Allowance

5.19.1 If there is misalignment between tubing and a fairlead (see Figure 9), check the acceptability of the misalignment as follows:

Step 1. For all tube diameters, ensure that the maximum offset between the centre of the tube and the centre of the fairlead is no more than 0.100" (see Figure 10).

Step 2. Measure the tube deflection between loose and when tightened in the fairlead clamp, in conjunction with the distance to the closest support.

- For -4 (1/4") and -6 (3/8") diameter tubes the maximum acceptable misalignment is 1/32" per 5" to the closest support (for example, if the closest support is within 5" - 10" of the fairlead clamp, the maximum acceptable tube deflection between loose and when tightened is 2 X 1/32" = 1/16").
- For -8 (1/2") or larger diameter tubes, the maximum acceptable misalignment is 1/64" per 5" to the closest support (for example, if the closest support is within 10" - 15" of the fairlead clamp, the maximum acceptable tube deflection between loose and when tightened is 3 X 1/64" = 3/64").



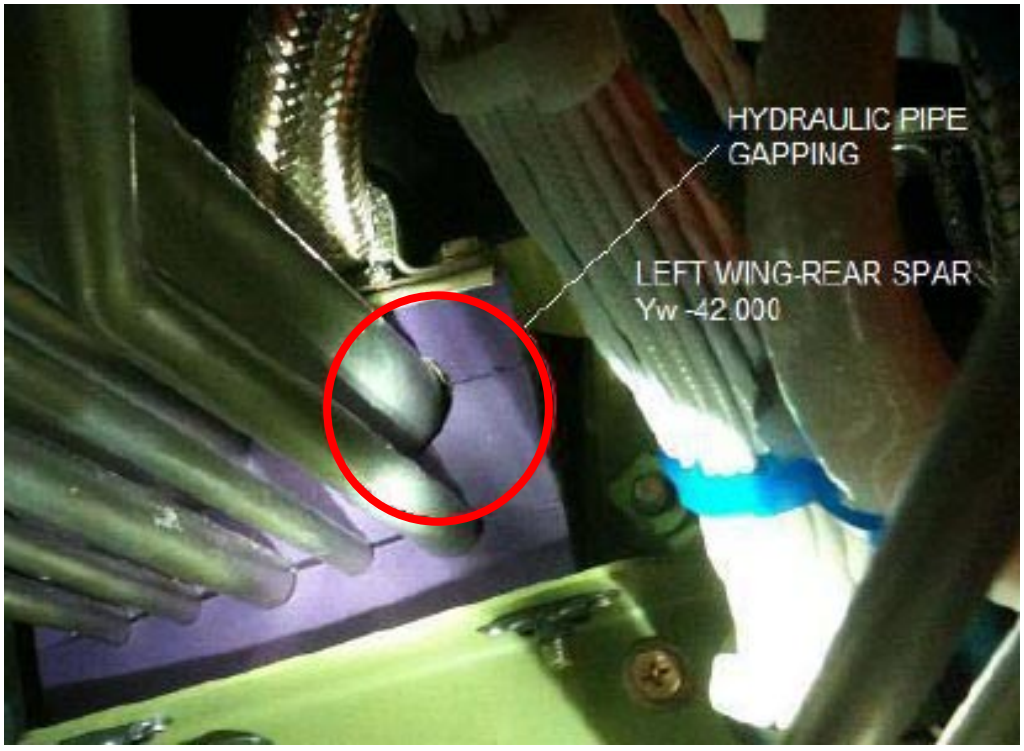


Figure 9 - Fairlead/Tubing Misalignment

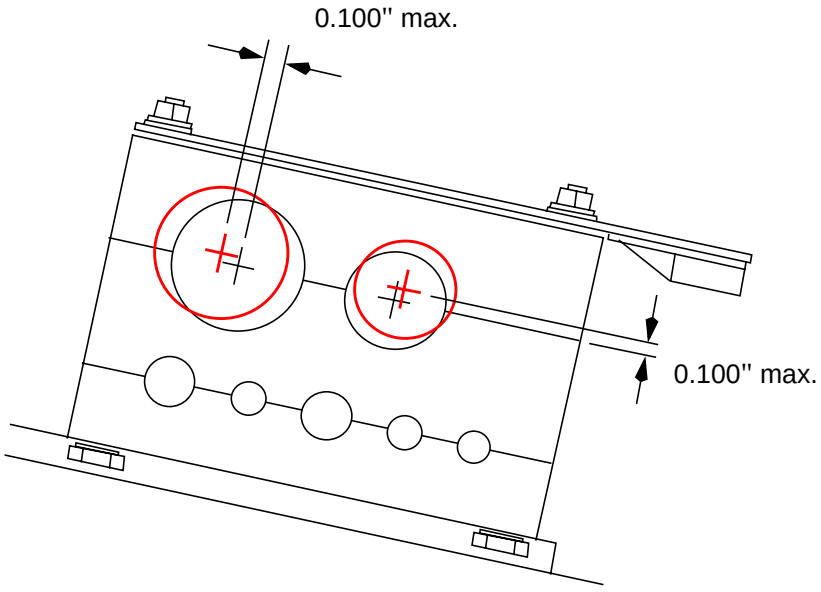


Figure 10 - Maximum Acceptable Misalignment of Fairlead and Tubing centres

5.20 Securing Fluid Lines using Cushioned Loop Type Clamps (P-Clamps)

5.20.1 Where the engineering drawing specifies securing fluid lines using cushioned loop type clamps (P-clamps) use the size of clamp specified by the engineering drawing. The clamp should secure the fluid line without damage or deformation to the fluid line or clamp. If the clamp specified by the engineering drawing is too small or too large for installation without deformation of the fluid line or clamp, refer to Liaison Engineering for authority to install a larger or smaller clamp, as applicable. Do not substitute a smaller or larger clamp without Liaison Engineering approval. Do not deform clamps to fit.

5.20.2 When installing 2 clamps on one mounting screw, do not interlace terminating ends (see Figure 11).

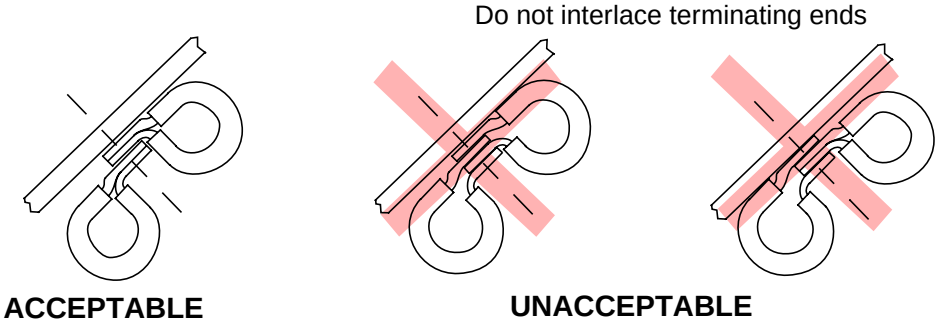


Figure 11 - Two Clamps on One Mounting Screw

6 Requirements

6.1 General

6.1.1 Meticulous cleanliness shall be observed throughout and great care exercised at all times to avoid damaging the parts.

6.2 Lubrication

6.2.1 Thread lubrication must be as specified in section 5.4 and Table 1.

6.2.2 Flare exteriors and sleeves shall be lubricated sparingly with the same lubricant used for threads.

6.2.3 Gaskets shall be lubricated sparingly, according to Table 6.

6.3 Installation

6.3.1 Ensure that only the correct tools for the nuts and fittings being torqued or tightened are used.

6.3.2 Flexible lines shall not be twisted and rigid lines shall not be pre-loaded during final tightening (or torquing) of fittings.

6.3.3 After installation is complete, check the rotation witness marks on Permaswage bulkhead fittings for evidence of rotation. If rotation has occurred, action according to PPS 6.13.

6.3.4 V-band, Marmon or Janitrol flanges having scratches or nicks deeper than 0.004" are not acceptable.

6.3.5 Check reformed flange faces (including Janitrol flanges) for acceptability. Deformed flanges which cannot be successfully reformed are not acceptable.

6.3.6 Peri-Seal fittings having deformed housings are not acceptable.

6.3.7 Misalignment between tubing and fairlead clamps must be within the limits specified in section 5.19.

6.4 Torqued Fittings

6.4.1 Except as noted in paragraph 6.4.1.1, all torqued fittings (including those located in fuel tank areas) must be identified with a properly aligned, unbroken torque stripe mark applied as specified in section 5.5. If the torque stripe mark is misaligned or broken due to causes other than over-torquing, that torque stripe mark must be removed and the fitting re-torqued and a new torque stripe mark applied. Over-torqued fittings shall be removed and discarded.

6.4.1.1 Permaswage bulkhead fittings must have a rotation witness mark applied according to PPS 6.13 in place of torque stripe marking.

6.5 Identification of Fluid Lines

6.5.1 All fluid lines shall be identified according to PPS 6.04.

7 Safety Precautions

7.1 The safety precautions specified herein are specific to Bombardier Toronto (de Havilland) to meet Canadian Federal and Provincial government environmental, health and safety regulations. It is recommended that other facilities consider these safety precautions; however, suppliers, subcontractors and partners are responsible for ensuring that their own environmental, health and safety precautions satisfy the appropriate local government regulations.

7.2 Observe general shop safety precautions when performing the procedure specified herein.

7.3 Observe standard safety practices for handling and use of compressed gases at all times.

7.4 Take extreme care to ensure that oxygen system lines and fittings do not come in contact with grease or oil of any kind.

7.5 Exposure to hydraulic fluids and fuels may result in irritation of skin. Avoid repeated or prolonged contact and use barrier cream as a precaution. For continuous exposure, wear rubber gloves. If skin contact occurs, wash affected areas thoroughly with soap and water.

7.6 Eye contact with hydraulic fluids and fuels will cause severe irritation. If eye contact occurs, flush eyes thoroughly with large amounts of water and contact the Health Centre immediately.

7.7 If ingestion of hydraulic fluids or fuels occurs, do not induce vomiting. Contact the Health Centre immediately.

7.8 Smoking is prohibited in areas where fuels are stored.

7.9 Ensure sufficient ventilation when applying tamper proof sealant, especially in confined areas.

7.10 Avoid skin and eye contact with tamper proof sealant. Wear chemical resistant protective gloves when applying tamper proof sealant. If skin contact occurs, wash the affected area immediately and thoroughly with soap and water. If eye contact occurs, immediately flush eyes with large quantities of water at an eye-wash station; after initial flushing, remove any contact lenses and continue flushing for at least 15 minutes. Report any contact with tamper proof sealant to the Health Centre. Take care when applying tamper proof sealant in overhead applications to avoid applying excess sealant, as drips may result.

8 Personnel Requirements

8.1 Personnel responsible for installation of fluid lines and fittings must have a good working knowledge of the procedure and requirements as specified herein and shall have exhibited their competency to their supervisor.

9 Storage

9.1 Store hydraulic fluids and fuels in closed, clearly labelled containers.

9.2 Refer to PPS 13.28 for the storage life of Titeseal anti-seize compound (#2 and #3) and tamper proof sealant.

10 Additional Information

10.1 Take care to ensure that hydraulic fluid lines and hydraulic system components used with MIL-H-5606 hydraulic fluid do not come into contact with solvent blends containing isopropyl alcohol, also known as isopropanol and 2-propanol. Hydraulic fluid lines and hydraulic system components used with MIL-H-5606 hydraulic fluid which have been contaminated with solvent blends containing isopropyl alcohol must be cleaned according to PPS 6.10.