Fundamentals
M7
MAINTENANCE PRACTICES

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M7.9
Pipes and Hoses

EASA Part-66
CAT B1

Training Manual

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M7 MAINTENANCE PRACTICES

M7.9 PIPES AND HOSES

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BENDING & BELLING/FLARING AIRCRAFT PIPES

Introduction

General

The bending of tubes needs high precision in order to fulfill the desired high requirements. Length and form dimensions must be adhered exactly. Therefore tube bending machines are available for the batch production, with whose help tubes can be reproduced in the desired quality. Tube lines can be manufactured according to production drawings or model. Such bending machines are necessary due to the very complex tube forms and the high requirements in batch production.

Bending by hand

For single tubes or for repair cases tools are available for the manual bending of tubes. Such manual bending machines are quite simple and available for different tube sizes and materials. With the help of this tool almost all angles and also joggles can be bent.

CAUTION: TUBE LINE MUST NOT BE BENT BACK FOR CORRECTION!

CAUTION: A STRESS FREE INSTALLATION IS A MAIN FACTOR FOR A GOOD FUNCTION AND LIFETIME OF TUBE LINES!

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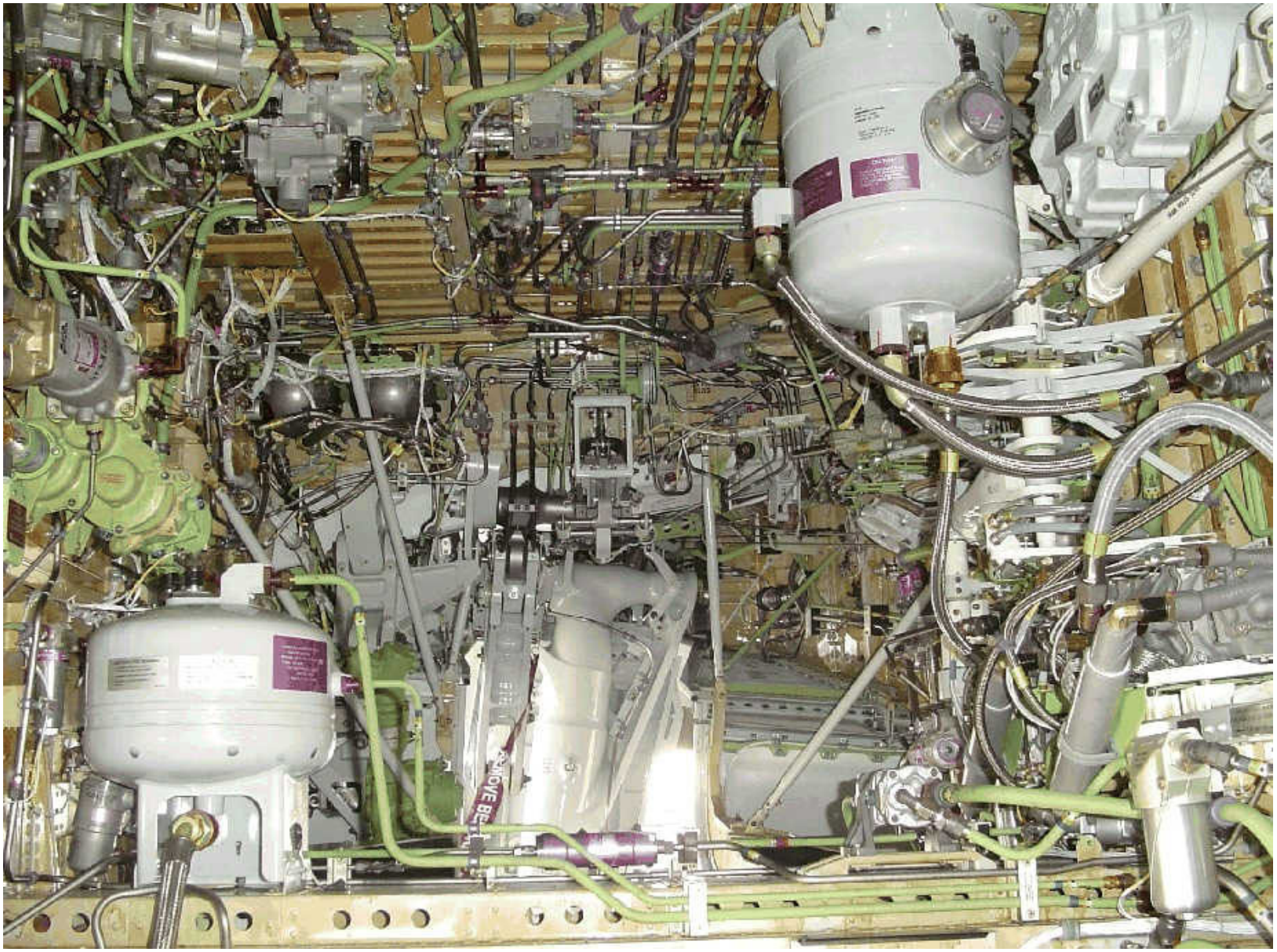


Figure 1 Hydraulic Components MLG Bay B737

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Production of a tube

Tube Cutting

In order to produce a tube with an accurate size the right cutting is very important. It is advisable to cut the tube to the desired length after bending. This means that the tube's pre-cut is a little bit longer than the desired length. Normally a pipe cutter is used for cutting tubes.

The Pipe Cutter

The pipe cutter normally has to guiding pulleys and a cutting wheel. The cutting pressure can be adjusted by a screw in the handle. The tube is cut with a constant and low cutting pressure in order to prevent deformation of the tube end. After 2–3 revolutions the cutting pressure is adjusted. Periodical lubrication of pulleys and cutting wheel are necessary to prevent early wear. Of course the tube ends have to be burred after cutting.

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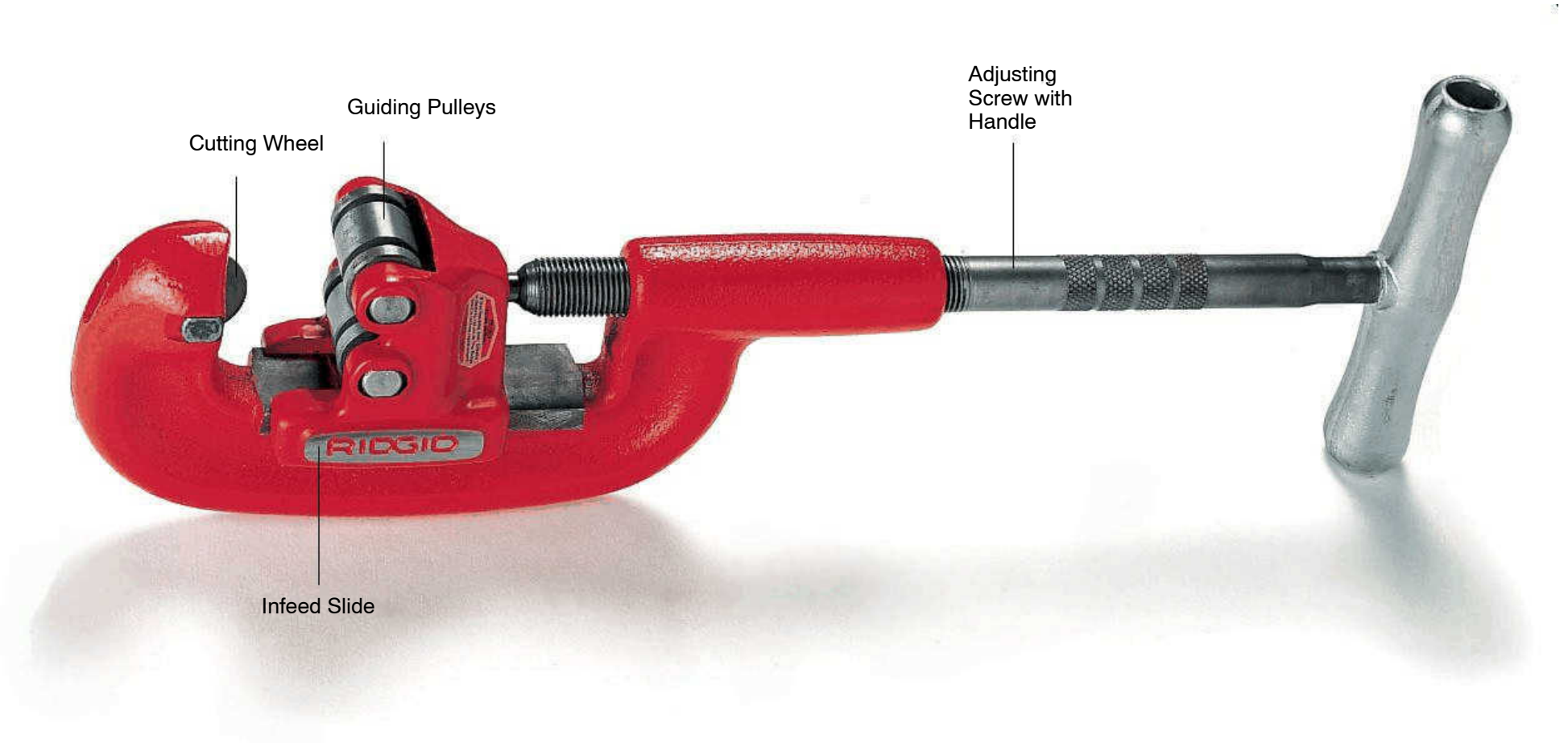


Figure 2 Pipe Cutter

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BENDING TOOLS

Tube Bender

The tube bender mainly consists out of the form wheel handle with form wheel, the swivel handle with a guide and the tube clamp

The form wheel handle is formed in such a way that it can easily be put into a vice. There are markings from 0° to 180° on the form wheel in order to achieve the desired angle exactly. The tube clamp can be used for fixing the tube. A guide is installed at the swivel handle. On it the markings 0°, 45°, R (RIGHT) and 90° (= LEFT) can be found. These markings are used for the correct orientation of the tube in the tube bender and therefore have influence on the accuracy of the bending.

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Figure 3 Tube Bender

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BENDING OF SIMPLE 90° BEND

Alignment of the Tube

The first step to manufacture an accurate tube is to mark the distance between the both 90° bends on the unfinished tube. The bending tool is firmly clamped in a vice and the form wheel and guide is lightly greased. After that the tube is inserted. The tube clamp is fixed and the tube is aligned in such a way that the marking on the tube is identical to the 90° marking on the guide. During this it has also be controlled that the 0° marking on the guide and form wheel match.

Bending of the first 90° Bend

If the tube is aligned, the tube is pulled with a constant force by the swivel handle around the form wheel until the 0° marking of the guide matches with the 90° marking of the form wheel.

Inspection/Correction

After removal of the tube and the inspection of the angle often another bending turn is needed since the tube does spring back, which results in a larger angle.

Alignment/Bending the second 90° Bend

The tube is aligned in the bending tool in such a way that the second marking on the tube matches the „R“ marking of the guide. Also here the two 0° markings of the guide and the form wheel have to be aligned. After checking the horizontal angle, the tube can be pulled with the swivel handle until reaching the 90° marking.

Inspection/Correction/Cutting

Like after the first bending turn here the second angle has to be checked and, if needed, corrected. After that the tube is cut to the right length.

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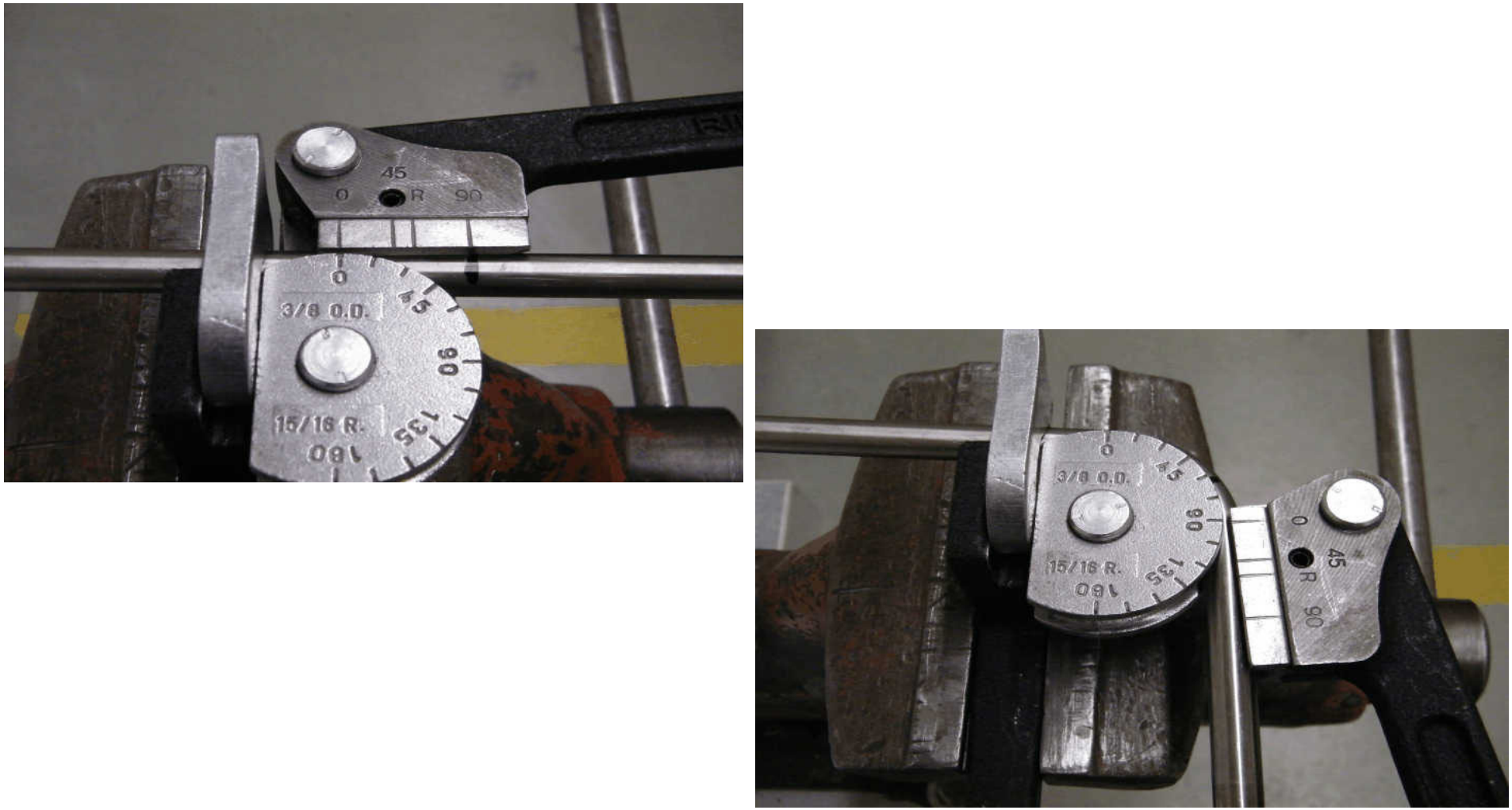


Figure 4 Bending with a Bending Tool

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BENDING OF AN OFFSET

Introduction

An offset means that the tube changes the horizontal distance between both ends with an arbitrary angle. Normal angles are 30 or 45° offsets. The offset of the tube is always measured from center to center (Y dimension). The length of the tube's part which follows the noted angle is measured from the center to the center of the bending (X dimension). In order to achieve the right offset, the exact x position, which depends on the bending angle, has to be determined. This can be read in tabular or be determined by multiplying the Y dimension with a bending factor, which depends on the bending angle

Bending Angle/Factor

- 10,0° Offset ≈ 5,76
- 22,5° Offset ≈ 2,6
- 30,0° Offset ≈ 2
- 45,0° Offset ≈1,41
- 60,0° Offset ≈1,15

Length Determination - 45° Offset

To bent a 45° offset firstly the **Y** dimension has to be measured. If this value is, for example, 2 inch, you go in the tabular to the column " **45° Offset** " and search in the **Y** dimension the value of 2 inch. Then the value of 2–13/16 inch can be found in the **X** dimension.

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Offset Bend Calculater							
Angle of Offset 30°				Angle of Offset 45°			
Amount of Offset in Inches		Amount of Offset in Inches		Amount of Offset in Inches		Amount of Offset in Inches	
Y-Dimension	X-Dimension	Y-Dimension	X-Dimension	Y-Dimension	X-Dimension	Y-Dimension	X-Dimension
1	**2**	**4**	**8**	**1**	**1**-13/32	**4**	**5**-21/32
-1/8	2-1/4	-1/8	8-1/4	-1/8	1-19/32	-1/8	5-27/32
-1/4	2-1/2	-1/4	8-1/2	-1/4	1-25/32	-1/4	6
-3/8	2-3/4	-3/8	8-3/4	-3/8	1-15/16	-3/8	6-3/16
-1/2	3	-1/2	9	-1/2	2-1/8	-1/2	6-3/8
-5/8	3-1/4	-5/8	9-1/4	-5/8	2-5/16	-5/8	6-17/32
-3/4	3-1/2	-3/4	9-1/2	-3/4	2-15/32	-3/4	6-23/32
-7/8	3-3/4	-7/8	9-3/4	-7/8	2-21/32	-7/8	6-29/32
2	**4**	**5**	**10**	**2**	**2**-13/16	**5**	**7**-1/16
-1/8	4-1/4	-1/8	10-1/4	-1/8	3	-1/8	7-1/4
-1/4	4-1/2	-1/4	10-1/2	-1/4	3-3/16	-1/4	7-7/16
-3/8	4-3/4	-3/8	10-3/4	-3/8	3-11/32	-3/8	7-19/32
-1/2	5	-1/2	11	-1/2	3-17/32	-1/2	7-25/32
-5/8	5-1/4	-5/8	11-1/4	-5/8	3-23/32	-5/8	7-31/32
-3/4	5-1/2	-3/4	11-1/2	-3/4	3-7/8	-3/4	8-1/8
-7/8	5-3/4	-7/8	11-3/4	-7/8	4-1/16	-7/8	8-5/16
3	**6**	**6**	**12**	**3**	**4**-1/4	**6**	**8**-15/32
-1/8	6-1/4	-1/8	12-1/4	-1/8	4-13/32	-1/8	8-5/8
-1/4	6-1/2	-1/4	12-1/2	-1/4	4-19/32	-1/4	8-13/16
-3/8	6-3/4	-3/8	12-3/4	-3/8	4-25/32	-3/8	9
-1/2	7	-1/2	13	-1/2	4-15/16	-1/2	9-5/32
-5/8	7-1/4	-5/8	13-1/4	-5/8	5-1/8	-5/8	9-11/32
-3/4	7-1/2	-3/4	13-1/2	-3/4	5-1/16	-3/4	9-17/32
-7/8	7-3/4	-7/8	13-3/4	-7/8	5-15/32	-7/8	9-11/16

Figure 5 Offset Bending Tabular

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BENDING OF AN 45° OFFSET

Alignment

The in the x dimension marked tube is inserted into the bending tool and the tube clamp is fixed (Grease guide and form wheel lightly). The tube is adjusted with the first marking to the 45° marking of the guide. It has to be checked if the 0° marking of the guide and the form wheel are aligned.

Bending of the first 45° Bend

The tube is bent with a constant force to the 45° marking of the form wheel.

Inspection/Correction

After removal of the tube from the tool and after checking the angle often a second correction bending turn is needed since the tube does spring-back.

Alignment/Bending of the second 45° Bend

The tube is now aligned with the second marking to the 45° marking of the guide under consideration of the bending direction. Also here the 0° marking of the form wheel and guide must align.

Afterwards is tube is bent to the 45° marking of the form wheel with constant force.

Inspection/Correction/Cutting

Like after the first bending turn here the second angle has to be checked and, if needed, corrected. After that the tube is cut to the right length.

FLARE-TYPE FITTINGS

General

Flare-type fittings (in aircraft production 37°) are often used in the engine area. The main reason is the good vibration resistance of this fitting type. In a flare-type fitting the flared tube is pressed against the fitting's cone by tightening a union nut and the conical sleeve.

Single Flare

Single 37° flares are used for aluminium and steel tubes. They are manufactured with the help of a rolling tool. By rolling a constant deformation of the tube's end without a heavy force can be achieved. To fulfill the high quality standards, the sealing surface of the flare has to have a surface quality of minimum 32 Microinches and has to be free from scratches and dents (BACD2046). During the flare's manufacturing a decreasing of the wall thickness at the tube's end does occur. This must not exceed 15% of the tube's wall thickness.

Double Flare

A double flare has a higher strength/stiffness. Due to the high deformation a double flare can only be used for aluminium tubes up to 3/8“ outer diameter and a maximum wall thickness of .049“.

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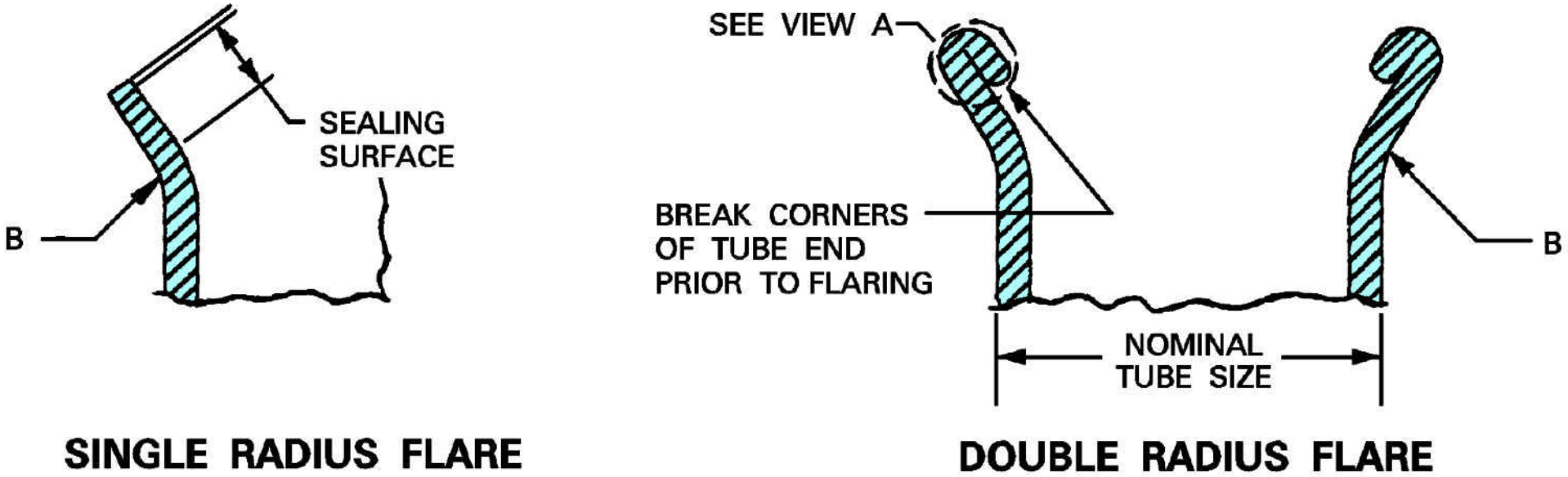


Figure 6 Flared Type Fitting

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Flaring Tools

A Flaring tool mainly consists out of two parts, a clamping device for the tube and the actual flaring tool. With the help of the clamping device tubes from 3/16“ to 5/8“ diameter can be clamped. The main flaring tool consists out of a aluminium casted mounter which is clamped in a vice and holds a cone with three tapered rolls for forming the flare. With the help of a pivoting calliper the tube can be adjusted in its height in order to achieve the right flare diameter depending on the tube size.

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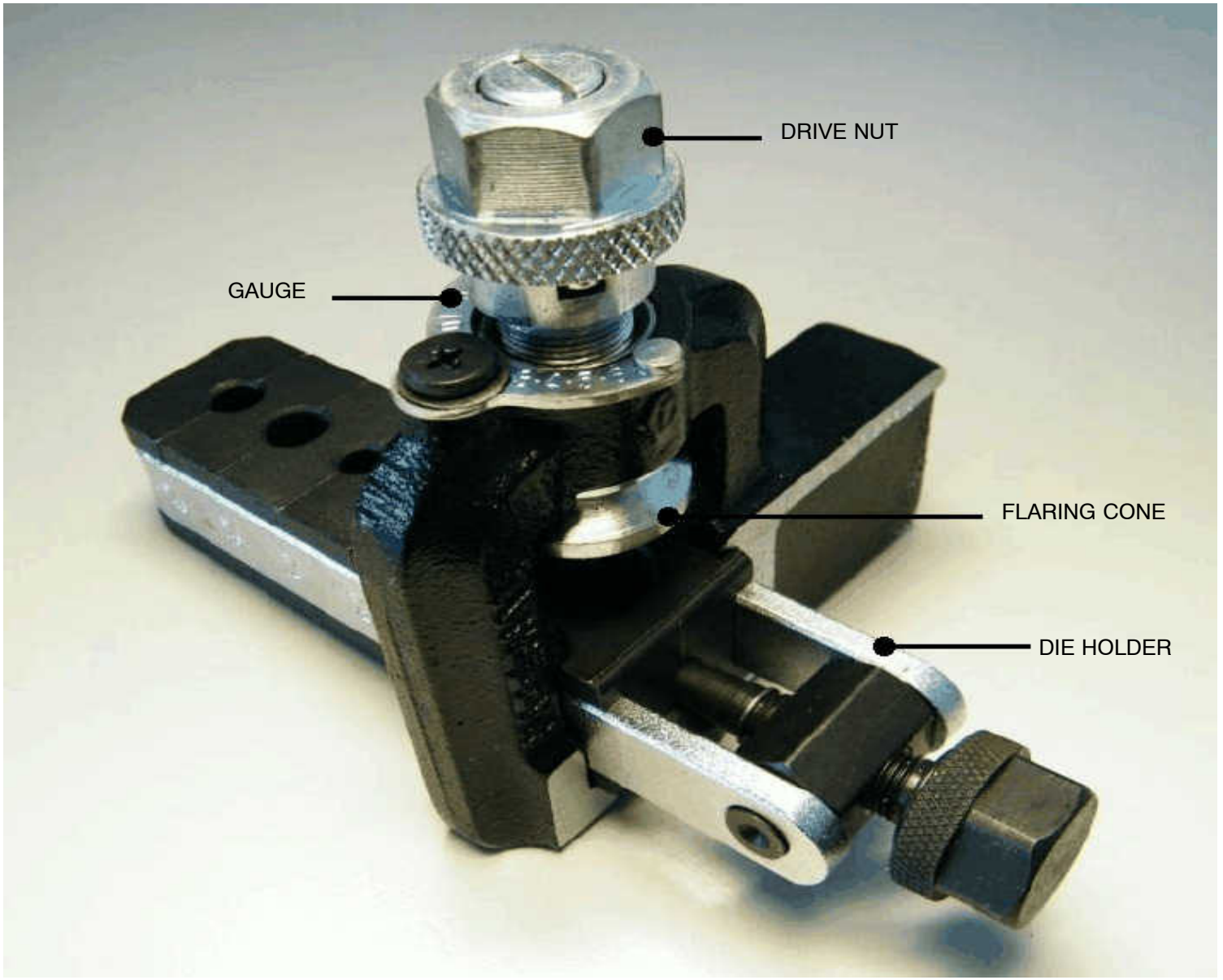


Figure 7 Flaring Tool

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INSTALL, CLAMP, INSPECT .& TEST OF PIPES & HOSES

Tubes

Installation of Tubes

A basic requirement for leak tightness and the lifetime of a hydraulic tube is a vibration-free and stress-free installation. This is achieved by a periodical clamping of the line with the structure.

Tube lines are installed with a predetermined distance to each other to prevent contact between the lines which could result in wear.

Cleaning and Pressure Test

Manufacturered tube assemblies have to be cleaned from the inside with pressurized air. The air has to be applied alternating from both sides. After cleaning a pressure test is conducted with 1.5 times the normal working pressure. Therefore one end of the assembly has to be closed.

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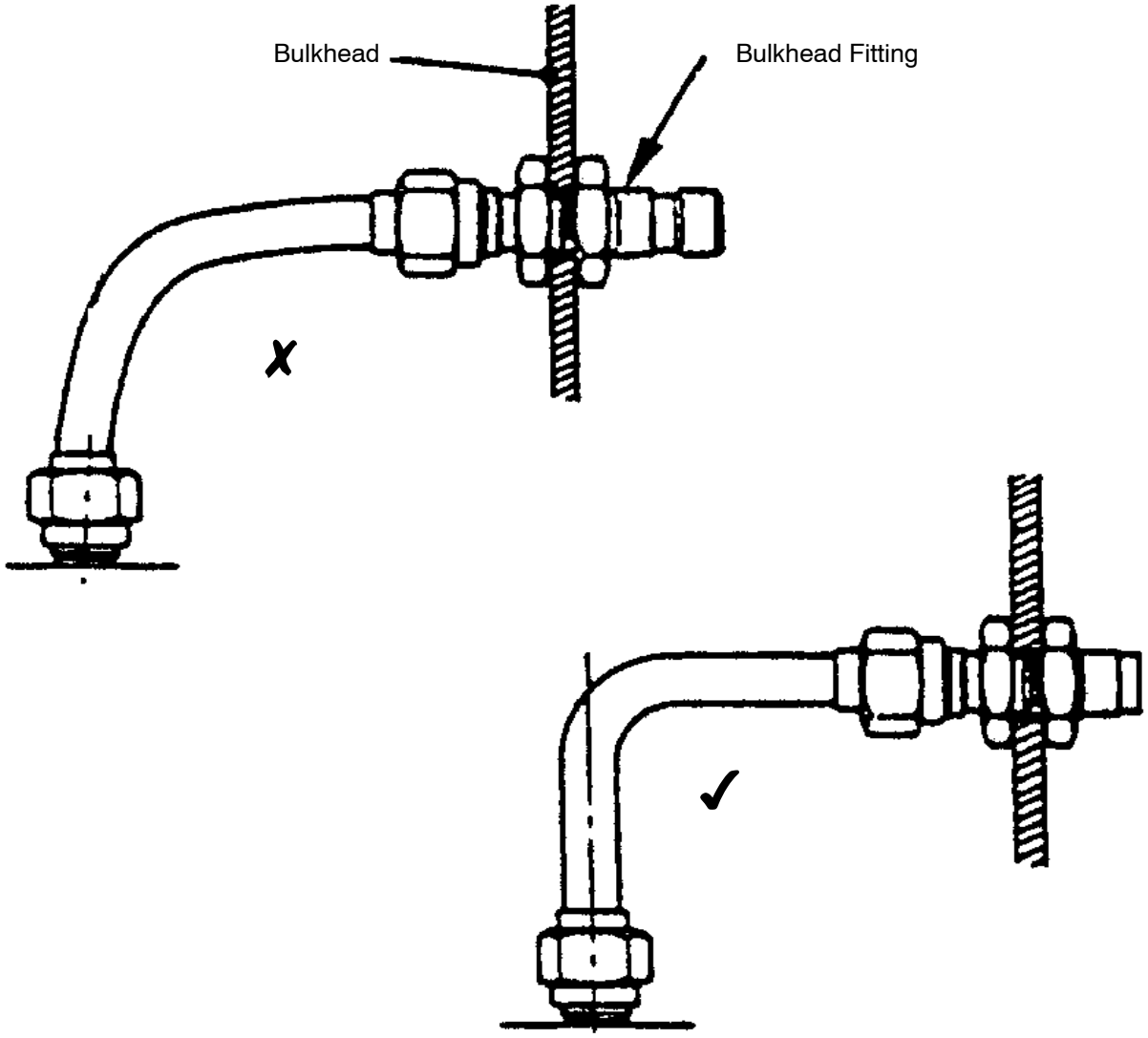


Figure 8 Correct Tube Alignment

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Clamps

Introduction

For appearance' sake and ease of attachment, all fluid lines should follow structural members of the aircraft and be secured with appropriate **clamps**; e.g. all fuel lines must be bonded to the structure with integrally bonded line support clamps.

It is important that no fluid line be allowed to chafe against any control cable or aircraft structure, electrical wiring bundles or conduit-carrying electrical wires.

Furthermore, you should avoid routing fluid lines through passenger compartments. If, however, this is unavoidable, it must be supported and protected against damage and installed in such a way that it cannot be used as a hand-hold.

Support Clamps

Support clamps are used to secure fluid lines to the aircraft structure or to assemblies in the engine nacelle.

In addition to providing support, these clamps prevent chafing and reduce stress.

The two clamps most commonly-encountered are the **rubber cushioned** clamp and the **plain** clamp.

The rubber cushioned clamp secures lines which are subject to vibration. It reduces the transmission of vibrations to the line and prevents chafing.

In areas subject to contamination by fuel or hydraulic fluid, cushioned clamps utilizing Teflon are used, which are highly-resistant to deterioration.

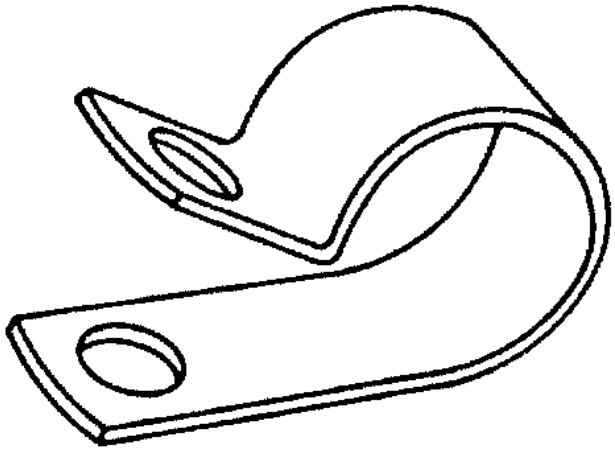
Bonded Clamps

A bonded clamp is used to secure metal fuel, oil or hydraulic lines. It has an electrical lead connected to the aircraft structure to ground the line.

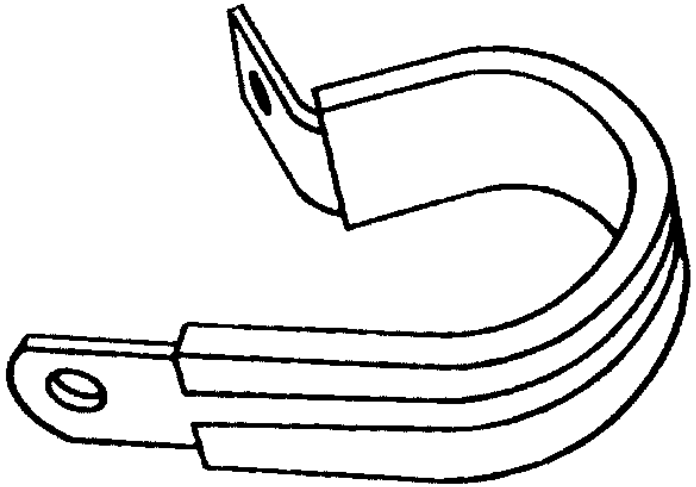
WARNING: WHEN INSTALLING A BONDED CLAMP, ENSURE ANY PAINT OR ANODIZING IS REMOVED FROM THE LINE WHERE THE CLAMP IS FITTED FOR ELECTRICAL CONTINUITY.

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Plain Clamp



Cushioned Clamp

Figure 9 Clamp Types

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Tube Damages

Judging of Tube Damages

In the aircraft manuals different damage types are noted:

- A **sharp-bottomed surface defect** is defined as a damage during which a loss of material occurs. The damage cuts into the material and creates sharp edges at the bottom (e.g. scratches).
- **A round bottomed surface defect** is defined as a damage during which a loss of material occurs. But the damage is not sharp edged but round edged at the bottom (e.g. scores).
- A **sharp bottomed trace of impact** is a dent in the tube wall.

Generally the following restrictions are valid: If a damage is not noted in the manual it is not permissible.

Sharp bottomed nicks e.g. (angle lower than 90°) are not permitted since there are not noted in the manual.

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TUBE MATERIAL: CReS 21.6.9 (ASNA3288)

OUTER DIAMETER OD	DASH	-20	-24
	in	1-1/4	1-1/2
	mm	31.750	38.100
THICKNESS T	in	0.024	0.024
	mm	0.610	0.610
OPERATING PRESSURE	PSI	1000	1000
	Bar	70	70
SHARP-BOTTOMED DEFECT A	in	0.001	0.001
	mm	0.031	0.031
ROUND-BOTTOMED DEFECT B	in	0.002	0.002
	mm	0.061	0.061
ROUND-BOTTOMED IMPACT C	in	0.025	0.030
	mm	0.635	0.762

TUBE MATERIAL: CReS 321 (NSA3507)

TIME LIMIT ON AIRCRAFT		PERMITTED FOR ALL AIRCRAFT LIFE	PERMITTED UNTIL SUBSEQUENT C-CHECK
OUTER DIAMETER OD	DASH	-32	
	in	2	
	mm	50.800	
THICKNESS T	in	0.028	
	mm	0.710	
OPERATING PRESSURE	PSI	220	
	Bar	15	
SHARP-BOTTOMED IMPACT	in	N/A	0.079
	mm	N/A	2.000
ROUND-BOTTOMED IMPACT C	in	0.04	0.098
	mm	1.016	2.500
SHARP-BOTTOMED DEFECT A / SCRATCH	in	0.001	0.004
	mm	0.036	0.100
ROUND-BOTTOMED DEFECT B / CHAFING	in	0.003	0.012
	mm	0.071	0.300

Figure 10 Hydraulic Tube Damage Limits

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Hoses

General

Hoses (including fittings) are produced mainly by a manufacturer. It is unusual to fabricate hose assemblies.

Fitted hoses must meet the following requirements:

- there must be a certain amount of slack between both fittings because hoses reduce their length by between 2% and 4% and expand in diameter when under pressure. Tensile stress on the fittings is unsafe and therefore not permitted.
- they must not twist when the end-fittings are tightened. Twisted hoses have a shortened life and can be damaged or buckle when there is movement. End-fittings can loosen off.

Why hoses?

Flexible hoses are used extensively on aircraft to connect **stationary to moving** parts and in areas of **high vibration**.

Applications

There are essentially three types of hose ratings:

- Low pressure . . . up to 600 pounds per square inch (psi)
- Medium pressure up to 3000 psi
- high pressure . . . 3000 psi +

Lay Lines

Lay lines run along the length of a hose. They are yellow, red or white stripes, incorporating MIL-SPEC numbers and various other manufacturers' information.

Besides identifying the hose, it serves to indicate whether the assembly is twisted when installed.

Construction

Hoses are built up from layers.

- The **inner** layer carries the fluid and therefore must be compatible (chemically) with the fluid being transported and have the minimum amount of porosity.

  The four main compounds used to construct inner liners are
  - Neoprene (for petroleum-based fluids)
  - Buna-N (better suited for petroleum-based fluids)
  - Butyl (phosphate ester-base hydraulic fluid (Skydrol)
  - Teflon (compatible with almost every fluid carried).
- **Reinforcement** layers cover the inner liner and determine the hose's strength.

  Common materials used for reinforcement layers are
  - cotton
  - rayon
  - polyester fabric
  - carbon-steel wire
  - stainless steel wire braid.

  Diligent design of reinforcement layers can minimize the dimensional changes of hoses under pressure.
- The protective **outer cover** is usually made of rubber-impregnated fabric or stainless steel braid. It is put over the reinforcement to protect from physical damage or heat.

Inspection

At designated intervals, hoses should be inspected for deterioration. Particular attention should be paid to indications of leakage and mechanical damage (braid separation from the covering or broken wire braids).

Damage limits will be found in the AMM.

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Figure 11 Build Up of Hoses

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Reusable Fittings

It is possible to re-manufacture certain hose assemblies by re-using the end-fittings (the socket, nut and nipple).

Prior to this, however, it is important to thoroughly inspect the salvaged fittings for wear or other damage.

If any doubt exists as to the item's serviceability, it is to be discarded.

Method

Determine the length of hose required (usually using old assembly as pattern).

Protect the outer covering by wrapping with tape, then cut the hose to length with a fine-tooth saw, ensuring both ends are square-cut.

Work Steps

1. With the socket held firmly in a vice (using suitable protection for its surface) and the tape removed, screw the hose into it. Having bottomed the hose in the socket, back it off approximately half a turn.
2. With the socket still held firmly in the vice, force the lubricated end of the assembly tool into the hose sufficiently far for the nipple to be inserted.
3. Using the assembly tool, the nipple is then screwed into the socket, squeezing the hose tightly between socket and nipple.
4. Finally, back off the nipple to leave a gap, permitting the nut to turn freely.

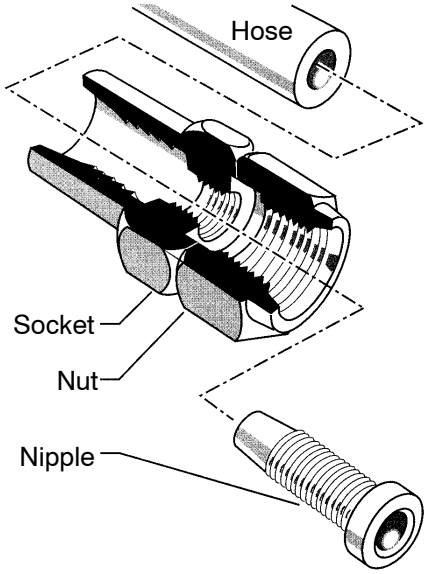
Cleaning and Pressure-Testing

The completed hose assembly must be cleaned out internally with compressed air (blown from both directions alternately) and then proof-tested (normally at 1 1/2 times working pressure) by capping one end.

WARNING: PRESSURE TESTING IS NORMALLY THE RESPONSIBILITY OF SPECIALISTS. A HOSE THAT BURSTS UNDER PRESSURE CAN CAUSE SERIOUS OR EVEN FATAL INJURIES.

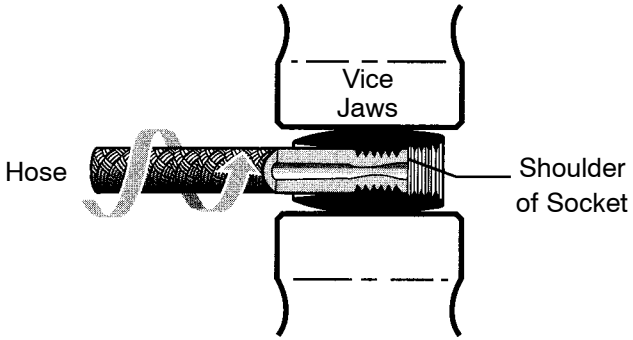
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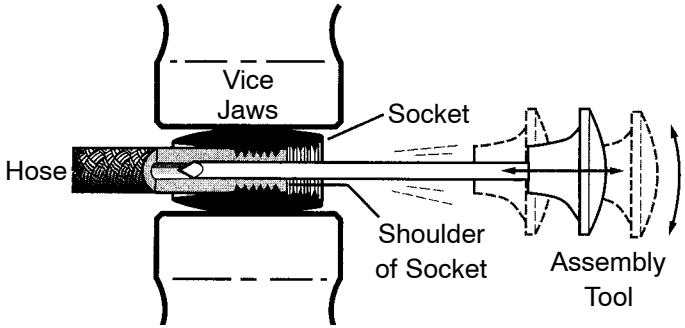


Breakdown of Reusable Hose Fitting

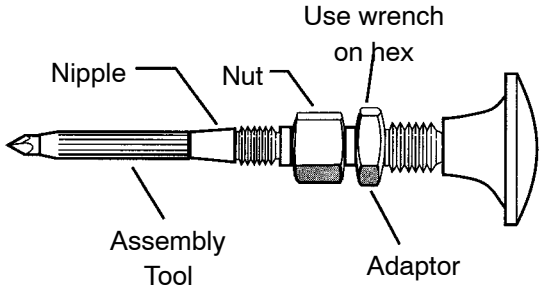
1. With socket held in vice, screw hose into socket.



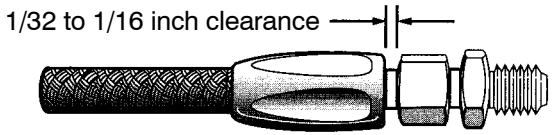
2. Lubricate assembly tool and force into hose to open inner liner.



3. Nipple is screwed into socket with assembly tool.



4. After installation there should be clearance between nut and socket to permit nut to turn freely.



Swivel Type

Figure 12 Reusable Hose Fittings

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Hose Installation

There are a number of checks to carry out prior to installing a flexible hose.
Inspect the hose for:

- applicability
- length
- cleanliness
- damage.

Check the hose identification tag for:

- part number
- cure date (within limits)
- manufacturing date (within limits)

When fitting a hose assembly, it is important:

- not to twist it, thereby placing it under undue strain. Check the lay line printed along the hose length, it is an indicator of twisting
- that it is subjected to the minimum of flexing during operation
- that it is supported at least every 24 inches
- that it is not stretched tightly between its fittings
- that the minimum bend radius is observed.

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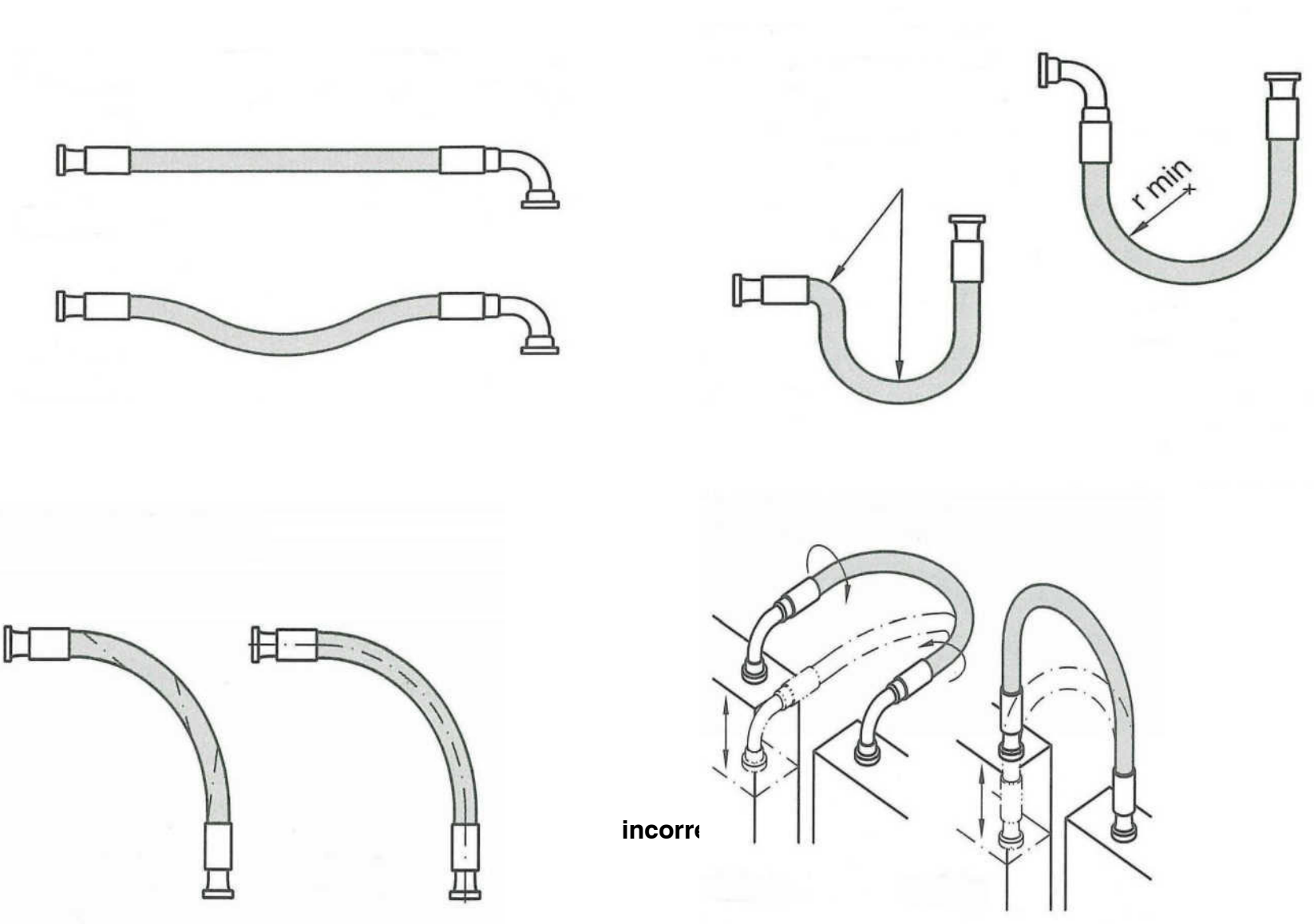


Figure 13 Hose Installation General

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Hose Installation (Cont'd)

It is possible to replace a short bend radius with an elbow fitting, but the largest possible bend radius is still preferred.

The minimum permissible bend radius is determined by the operating pressure, the type of hose and the nominal size. The bend radius required increases when the hose has to carry out movements in the operating condition.

If they can move and become twisted, they are to be fixed with clamps to prevent this.

Clamps are also necessary where there is a danger to the hoses due to vibration, long lengths or sharp edges.

Protective Sleeves

There are areas on an aircraft that produce wear (from abrasion) or extreme heat.

Flexible hoses must be protected from these dangers with suitable sleeving.

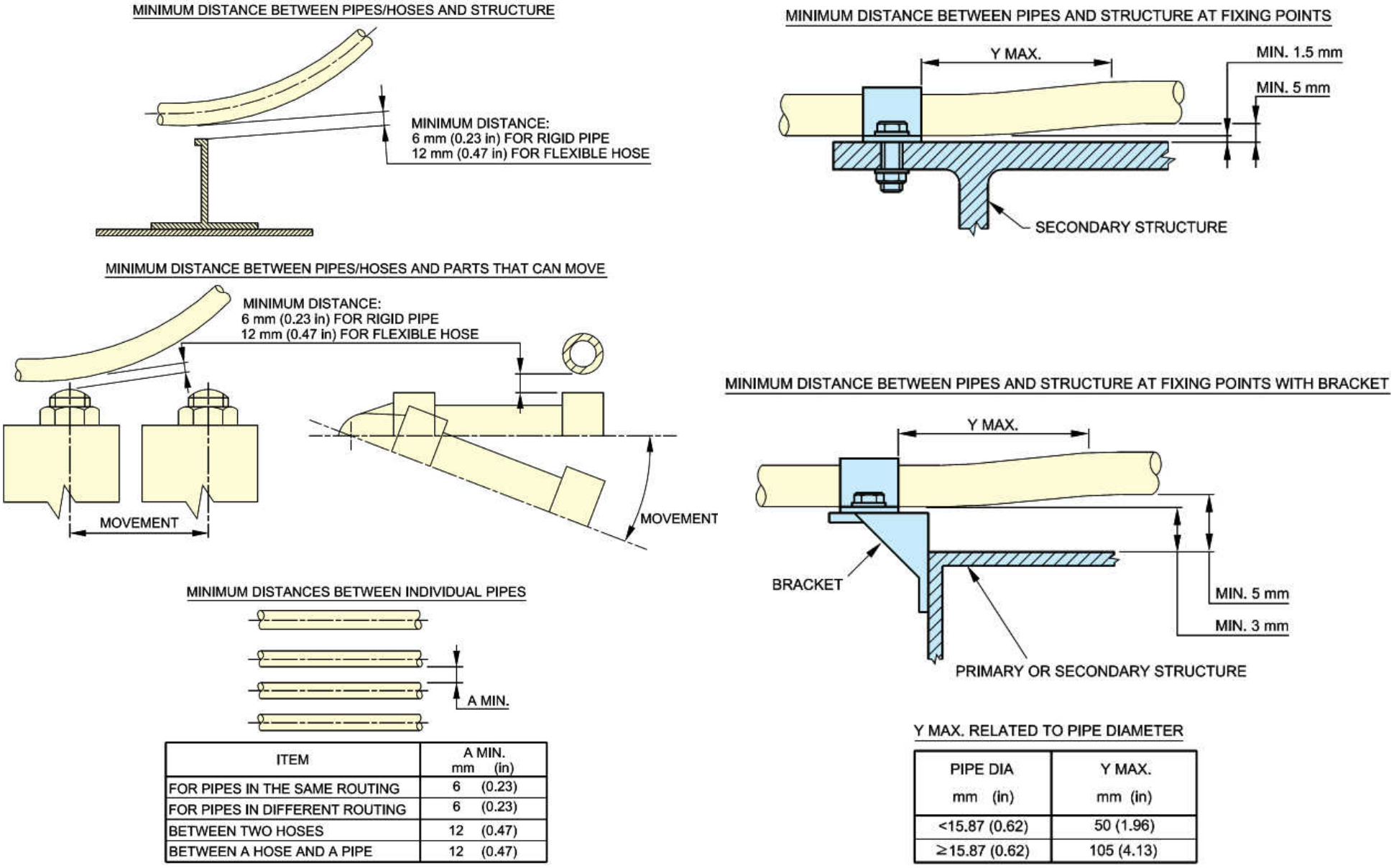
Sleeving is available in a variety of materials, including

- heat shrink
- nylon spiral wrap
- Teflon.

WARNING: TAKE CARE WHEN REMOVING FIRE SLEEVES; EARLY PRODUCTS CONTAINED ASBESTOS.

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ITEM	A MIN. mm (in)
FOR PIPES IN THE SAME ROUTING	6 (0.23)
FOR PIPES IN DIFFERENT ROUTING	6 (0.23)
BETWEEN TWO HOSES	12 (0.47)
BETWEEN A HOSE AND A PIPE	12 (0.47)

Y MAX. RELATED TO PIPE DIAMETER

PIPE DIA mm (in)	Y MAX. mm (in)
<15.87 (0.62)	50 (1.96)
≥15.87 (0.62)	105 (4.13)

Figure 14 Hose Installation acc. AMM A380

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Tightening Practices - Hydraulic Connections

Introduction

To ensure that pipe and hose assemblies do not leak due to loose connections or deform because of over-tightening, specific torque figures are published in the relevant AMM and must be adhered to.

Additionally, parts must be clean and free from defects prior to assembly.

Visual Inspection before Assembly

1. Make sure that the parts you assemble are clean and free of contamination.
2. Make sure that the parts you assemble are not damaged. Specially, inspect the sealing surfaces (on fittings and pipe ends) and the threads of the fittings.

CAUTION: PARTS WITH DAMAGES LIKE SCRATCHES, NICKS OR DEFORMATIONS MUST NOT BE INSTALLED.

Lubrication

Only use the specified lubricant to lubricate the fitting threads and the shoulder of the sleeve. Lubricate the thread on the male fitting to get the highest possible load on the contact surfaces.

Do not apply lubricant on the female thread.

Do not apply lubricant on the contact surfaces between the sleeve and the sealing surface of the fitting. Lubricant can cause a rotation of the pipe when you torque the sleeve nut. Remove excess of lubricant with a clean, dry lint–free cloth.

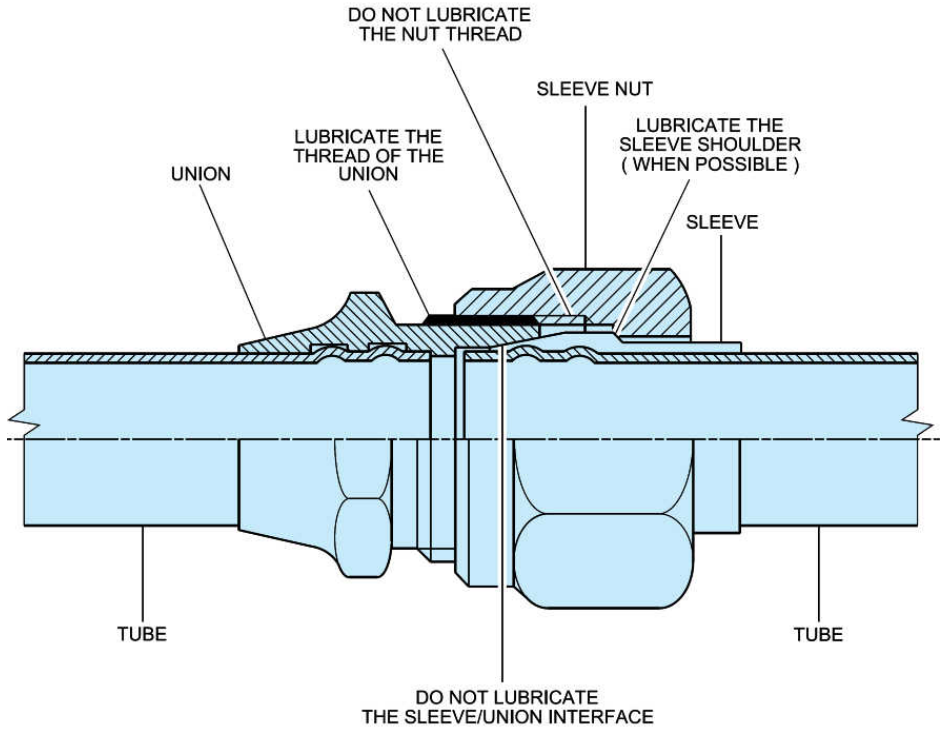


Figure 15 Tightening of Connections

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Assembly

Connection on straight plug–in fitting or bulkhead fittings:

Straight plug–in fittings

- You must install and torque the straight plug–in fitting to the applicable torque value before you connect the pipe.

Straight bulkhead fittings

- You must install the straight bulkhead fittings and torque the locknut to the applicable value before you connect the pipe.

Swivel bulkhead fittings

- You must connect and torque to the applicable value the pipe sleeve nuts (at each end of the fitting) before you torque the locknut of the swivel bulkhead fitting to the applicable value.

Position the pipe and make sure that:

- the pipe you install is not too short or too long
- the pipe you install can be positioned without too much force on the clamp blocks
- the pipe alignment at unions is correct.

The force necessary to correct the alignment must not be more than light finger pressure (1 daN (2.2480 lbf)).

Align the pipe and the fitting and insert tube end. The sleeve must be fully bottomed against the mating surface of the fitting. Tighten the sleeve nut with your hand until it bottoms against sleeve shoulder. The nut must turn freely on the thread. This shows that the tube ends are correctly aligned. You must connect and tighten with your hand all the ends of the pipe before you apply the tightening torque on one end.

CAUTION: IF YOU CONNECT A FLEXIBLE HOSE, MAKE SURE THAT YOU DO NOT TWIST THE HOSE DURING THE ASSEMBLY.

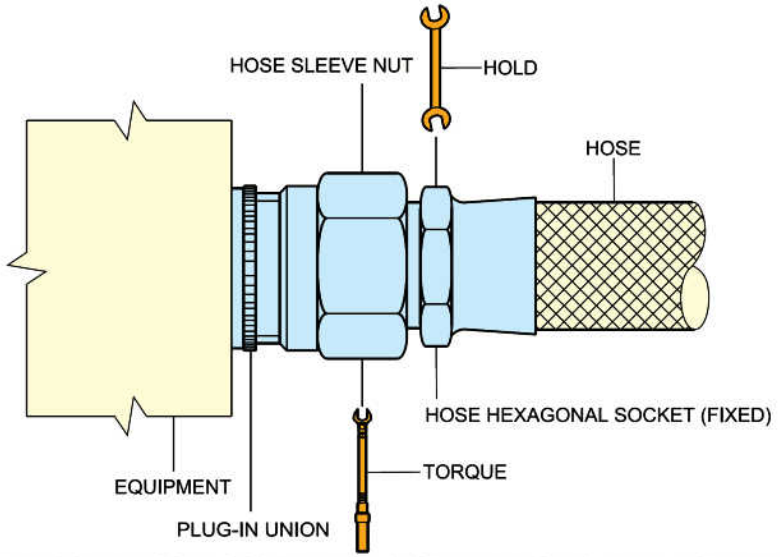


Figure 16 Tightening of Flexible Hoses

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Tightening Torque Application

When you torque the nut, always use a second wrench to apply a counter torque to the fitting.

Find the right Torque Value

To find the correct torque value, you must know the material and the size of the parts you assemble. If the connection has different materials, you must use the torque value for *the weakest material*.

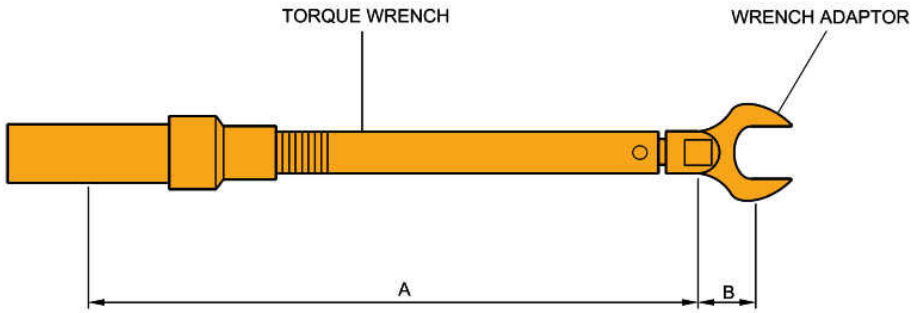
Get the applicable torque wrench and the applicable wrench adapter for the nut and an applicable second wrench to apply the counter torque to the fitting.

Set the torque wrench to the applicable value. When you use a wrench adapter, you must adjust the value.

Position the torque wrench on the sleeve nut and the counter torque wrench on the fitting

We recommend that you install the wrench adapter in the same axis as the torque wrench. Apply a slow and continuous force on the torque wrench until you reach the set torque value.

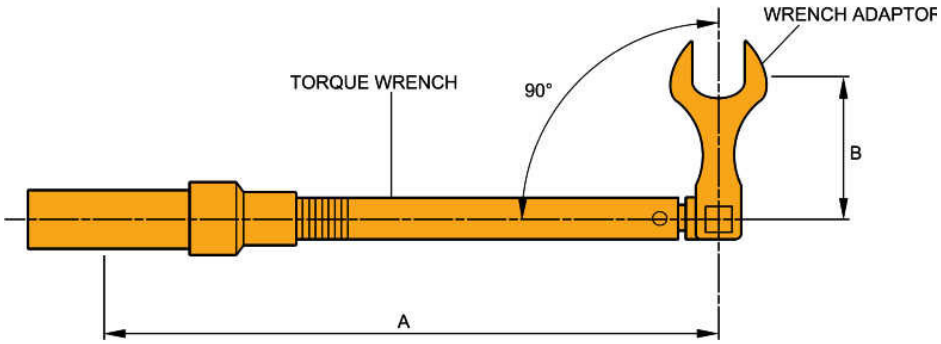
Always pull (or push) at right angles to the handle of the torque wrench. Try to apply load to the center of the hand grip of the torque wrench.



WHEN YOU USE A WRENCH ADAPTOR,
YOU MUST ADJUST THE TORQUE VALUE.
USE THIS FORMULA TO ADJUST THE TORQUE VALUE:

$$T' = \frac{T \times A}{A + B}$$

T'= NEW TORQUE VALUE (ADJUSTED) TO BE SET ON THE TORQUE WRENCH.
T= SPECIFIED TORQUE VALUE (APPLIED ON THE CONNECTION).
A= LENGTH OF THE TORQUE WRENCH.
B= LENGTH OF THE ADAPTOR.



ADAPTOR AT 90° TO THE TORQUE WRENCH, NO CORRECTION IS NECESSARY.

Figure 17 Torque Wrench Adjustment

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Tightening Torques - Hydraulic Fittings

General

The torque figures for hydraulic fittings can be found in the AMM.

The following tables are just two samples, taken from the Airbus A340 AMM.

Item Code	Outer Diameter		Tightening Torques			
			Steel			
			Minimum		Maximum	
	In	mm	m daN	lbf in	m daN	lbf in
3	3/16	4.76	1.07	95	1.18	105
4	1/4	6.35	1.52	135	1.63	145
5	5/16	7.93	1.92	170	2.15	190
6	3/8	9.52	2.43	215	2.76	245
8	1/2	12.70	4.86	430	5.31	470
10	5/8	15.87	7.00	620	7.68	680
12	3/4	19.05	9.66	855	10.68	945
16	1	25.40	12.90	1140	14.20	1260
20	1 1/4	31.75	17.20	1520	19.00	1680
24	1 1/2	38.10	21.50	1900	23.70	2100

Tightening Torques for Flexible Hoses (Both Constituents Made of Steel)

Item Code	Outer Diameter		Tightening Torques			
			CRES and Titanium Tubes			
			Minimum		Maximum	
	In	mm	m daN	lbf in	m daN	lbf in
3	3/16	4.76	1.1	97	1.2	106
4	1/4	6.35	1.5	133	1.7	150
5	5/16	7.93	2.0	177	2.3	204
6	3/8	9.52	2.9	257	3.2	283
8	1/2	12.70	5.4	478	5.9	522
10	5/8	15.87	7.5	664	8.3	735
12	3/4	19.05	9.7	859	10.07	947
16	1	25.40	12.90	1142	14.20	1257
20	1 1/4	31.75	17.20	1522	19.00	1682
24	1 1/2	38.10	21.50	1903	23.70	2098

Tightening Torques for Hydraulic Unions and In-Line Check Valves (Both Constituents Made of Steel or Steel and Titanium)

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Markings

After the installation of the tube or hose union with the corresponding torque value, the connection must be marked. Therefore a 2 to 4mm thin red line is painted with special paint along the connected elements.

If, for example, the connection has loosened e. g. by vibration, the broken line is indicating that. Thus a loosened connection can be detected fastly by a visual inspection.

If a union is deinstalled due to maintenance or repair reasons, the old marking must be removed entirely and after reassembly a new marking must be painted on.

In the Aircraft Maintenance Manual (ATA 20–Standard Practices) examples for the markings of different connections are denoted.

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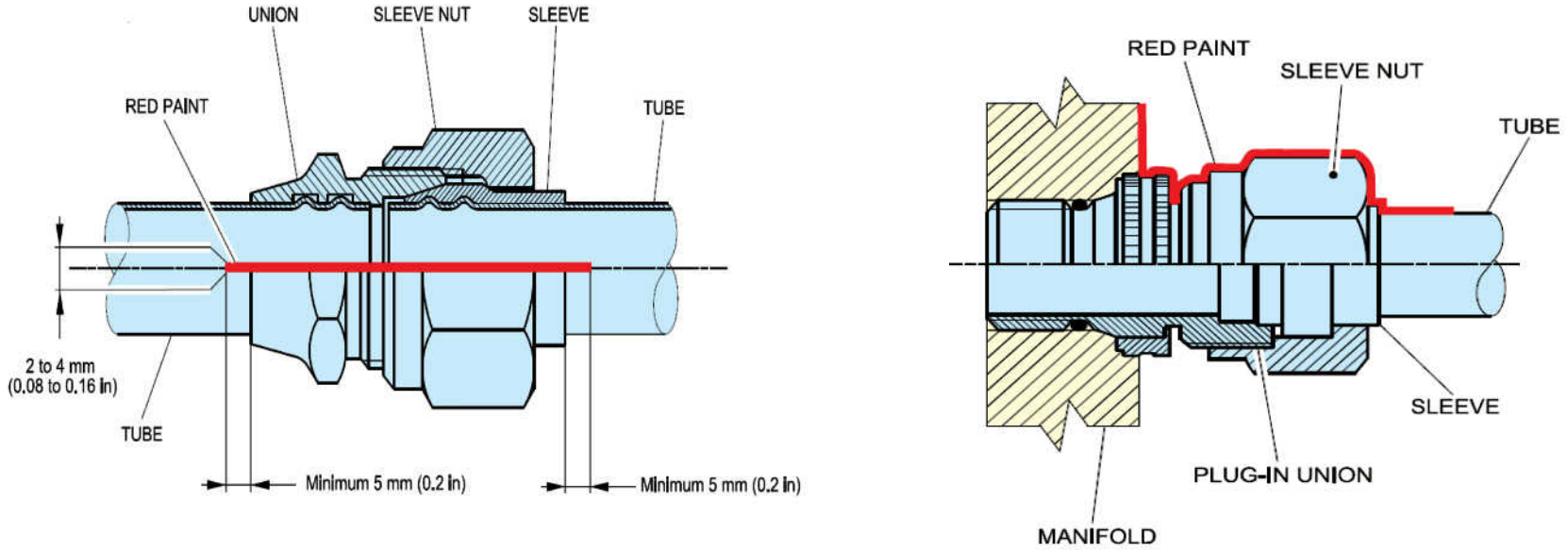


Figure 18 Marking of Unions

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